BOTSWANA ENVIRONMENT STATISTICS

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PREFACE

This publication is the second edition of Botswana Environment Statistics by the Central Statistics Office. The first edition was published in 2000. In between the years, the office has compiled detailed statistical reports on Wildlife, Energy and Environmental Indicators.

The compilation of Environment Statistics is dictated by recognition of the fact that in order to achieve sustainable development, the natural resources and the environment which are used in development processes have to be taken into consideration in development planning.

The CSO did not conduct any survey to come up with data presented in this publication, rather the department used secondary data collected from various government departments, ministries, parastatals, NGOs, and private companies.

The Pressure - State - Response Model was used in preparing this publication. The model is based on a Framework for Development of Environmental Statistics developed by the United Nations Statistical Division. It looks at human activities as the 'Pressure' on the environment. Such activities include the production of goods and services; for example the production and consumption of water. The impacts of human activities on the environment are the 'State'. The quality of water is an aspect of the state of the environment. The 'Response' is the reaction to the state of the environment by governments, Non-Government Organisations (NGOs) and individuals. The response is intended to 'control, counter, reverse or avoid negative impacts' and to generate, promote or reinforce positive ones.' Environment-related Government policies and laws, and International Conventions are the responses.

Most of the data published here reflect the “pressure” and the “response” parts of the model; data on the “state” is often not available. Environmental issues covered are Climate, Land, Population, Water, Agriculture, Wildlife, Forestry, Energy, Mining, NGOs involved in environment work, and environment related legislation.

The CSO acknowledges and extends gratitude to various departments and/or organizations that provided the information used in this publication.

Thank you.

A. Majelantle
Government Statistician

CONTENTS

Miscellaneous	*Abbreviations*
AEA	*Agricultural Extension Areas*
AH	*Area Harvested*
AP	*Area Planted*
AP	*Areal Proportion*
ARAP	*Accelerated Rain fed Arable Programme*
AYH	*Average Crop Yield per Hectare*
BCL	*Bamangwato Concessions Limited*
BEMP	*Botswana Energy Master Plan*
BLDC	*Botswana Livestock Development Corporation*
BMC	*Botswana Meat Commission*
BOD	*Biochemical Oxygen Demand*
BPC	*Botswana Power Corporation*
CBPP	*Contagious Bovine Pleuropneumonia*
CFIMP	*Chobe Forests' Inventory and Management Project*
COD	*Chemical Oxygen Demand*
CSO	*Central Statistics Office*
DEMS	*Department of Electrical and Mechanical Services*
DGS	*Department of Geological Services*
DS	*Destumping Scheme*
DWA	*Department of Water Affairs*
DWNP	*Department of wildlife and National Parks*
EAD	*Energy Affairs Division*
FEC/FED	*Final Energy Consumption / Final Energy Demand*
FR	*Forest Reserve*
FPDP	*Forestry Protection and Development Project*
GR	*Game Reserve*
GS	*Growing Stock*
GTZ	*Germany Technical Cooperation*
Ha	*Hectare*
LTAs	*Long-term Averages*
MAI	*Mean Annual Increment*
MCM	*Million Cubic Metres*
MMEWA	*Ministry of Minerals, Energy and Water Affairs*
MoA	*Ministry of Agriculture*
NADP	*National Agricultural Development policy*
NCS	*National Conservation Strategy*
NCSA	*National Conservation Strategy Co-ordinating Agency*
NES	*Net Energy Supply*
NGO	*Non-Government Organisations*
NOAA	*National Oceanic and Atmospheric Administration*
NP	*National Park*
NTU	*Neo Turbidity Unity*
OECD	*Organisation for Economic Cooperation and Development*
	Protected Areas

Chemical	*Names of Gases and Substances*
Ca	*Calcium*
CO_2	*Carbon dioxide*
CH_4	*Methane*
GHG	*Greenhouse gas*
HC	*Hydrocarbons*
H_2SO_4	*Sulphuric Acid*
SO_2	*Sulphur dioxide*
SO_X	*Sulphur oxides*
SO_4	*Sulphate*
N_2O	*Nitrous oxide*
NO_X	*Nitrogen oxides*
NO_3	*Nitrates*
Cl	*Chlorine*
CI_2	*Chloride Residual*
Cu	*Copper*
F	*Fluorides*
Fe	*Iron*
H_2O	*Water*
LPG	*Liquefied Petroleum Gas*
Mg	*Magnesium*
Na	*Sodium*
Ni	*Nickel*
PO_4	*Phosphorus*
Pb	*Lead*
PH	*Degree of acidity or alkalinity*
PH_4	*Potential Hydrogen*
TDS	*Total Dissolved Solids*
TH	*Total Hardness*
Zn	*Zinc*

Abbreviations	***Symbols Used in Tables***
-	*Zero Values*
..	*Not Available*
n/a	*Not Applicable*
n/s	*Not Stated*
TJ	*Terajoules*
Past/arab/resid	*Pasture, arable and Residential area*

PA	*Proportion of Land that is Planted*
PLP	*Primary Energy Supply*
PES	*Persistent Organic Pollutants*
POPs	*Proportion of Planted Area that is Harvested*
PPH	*Pressure State Response*
PSR	*Proportion of Total Crop Production*
PTC	*Quarantine and Botswana Livestock Development Corporation*
QBLDC	*Ranches*
	Southern African Development Community
SADC	*State of the Environment Reporting*
SOER	*Tribal Grazing Land Policy*
TGLP	*Trans-Frontier Conservation Area*
TFCA	*Total Hardness*
TH	*Total Production*
TP	*Total Suspended Particulates*
TSP	*Wildlife Management Areas*
WMAs	*Water Stress Ratio*
WSR	*Water Utilities Corporation*
WUC	

INTRODUCTION

Botswana is endowed with a range of natural resources. Some of the resources are renewable while others are non renewable. Due to the pressure exerted on the resources by human activities, the resources have a potential to deplete or degrade. This therefore calls for the sustainable use of natural resources in economic development hence the concept of sustainable development.

It is noted that in a lot of cases, economic planners separate environmental factors from economic planning. In a bid to consider environmental issues in planning, the Government of Botswana formulated the National Conservation Strategy as a vehicle through which sustainable economic development can be achieved. The Strategy identified major environmental problems in Botswana as follows:

- Pressure on water resources
- Degradation of rangeland pasture resources
- Depletion of wood resources
- Exploitation of veldt products
- Pollution
- Resource pressure due to growth in human population
- Depletion and conservation of wildlife resources
- The need to improve environmental awareness

To foster sustainable development concept, there is need to develop strategies to mitigate against environmental impacts by economic activities as well as address the environmental problems identified above, such strategies must be informed by environment data. Thus Environmental Statistics was borne out of the need to inform policy making and economic planning. Among others, the data are used by the Department of Environmental Affairs (formerly National Conservation Strategy Agency) on the state of the environment reports every five years basing on the above issues. This is one way of integrating environmental factors into planning.

State of Environment Report (SOER)

"State of Environment Reporting (SOER) is essentially a tool for communicating useful and relevant information about the condition of the environment and pressures acting upon it, to the public, government, industry and non-government organizations.

The purpose of this information is to raise awareness and understanding of the environment and to assist decision-making by highlighting the cumulative environmental impacts of natural events and human activities, identifying emerging trends and highlighting the actions needed to improve the management of our environment for long-term environmental sustainability.

It outlines innovative way of understanding the condition and the trends of natural environment within the context of social and economic factors" (Department of Environmental Affairs, 2007).

The State of the Environment report thus aims to inform Batswana about the status of the environment in the country and Environment Statistics provide the base data for such reporting.

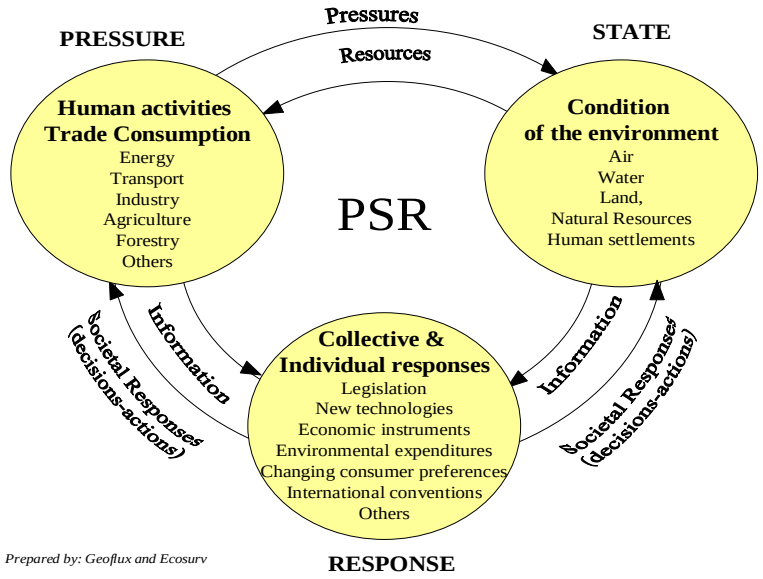
The most frequently used approach to compile Environmental Statistics both internationally and within Botswana is the **Pressure – State – Response** (PSR) model developed by the Organization for Economic Cooperation and Development (OECD 1993). The PSR model provides for the organization of information on the **state** or condition of the environment, in regard to its quality and the functioning of natural processes, and on human **pressures** affecting the natural environment. It also captures information on the societal **responses** implemented through programs or legislation to address the pressures and environmental issues. This information is primarily captured using indicators.

PSR model elements can be defined as;

Response: - are organized actions people take to reduce environment pressures or improve environmental conditions. These can include scientific monitoring and research, imposition of law and rules to make people change their behavior and use of economic penalties or incentives to bring about voluntary behavior change (such as taxes, fees, grants, subsidies, tradable permits and quotas).

Once a "**pressure**" is identified as having an adverse effect on the "**state**" of the environment, mitigating measures or "**responses**", are actions that would reduce harmful impact.

Pressure-State-Response Model



Challenges

There are challenges associated with collecting environmental data because it is generally scattered over many and uncoordinated sources. It is usually stored in different formats and standards, and is not readily available. This publication tries to bring together data for the

different environmental issues guided by the P-S-R model but it should be noted that in most cases data on impacts are not readily available.
The following is a synopsis of the chapters in the report.

1.0 CLIMATE

Botswana is an arid country due to its location in the high pressure belt and its landlocked-ness. Temperatures are very high and rainfall is low and erratic. The climate is also characterized by natural disasters such as floods and drought.

Long term monthly maximum temperature ranged from 20 to 35^0C between 1971 and 2000. Temperatures start to drop around April with June and July being the coldest months. On the other hand, long term monthly minimum temperature ranged from 07 to 19.9^0C between 1971 and 2000.

Rainfall normally occurs in the summer months from October to March. The amount of rainfall received varied from one weather station to another in the years 1971 to 2000. The northern parts tend to receive more rain than the other parts of the country.

Looking at the long term monthly rainfall averages from 1971 to 2000; Shakawe registered the highest average rainfall of 134.5mm in the rainy season (October to March) and the lowest average of 13.3mm was registered still in Shakawe during the rainy season.

2.0 POPULATION

The human population plays a major role in the sustainable use of natural resources. It goes without saying that the increase in population places pressure on the available resources due to the increased economic activities. Some of the resources are finite which may lead to their depletion, while others though infinite; their unsustainable use may result in degradation and pollution. Therefore the relationship between population growth, increased production and unsustainable consumption is quite intricate.

The chapter on Population highlights the basic demographic dynamics of Botswana; population growth rate, density, and distribution.

3.0 LAND

Land is one of the main natural resources because it supports all economic activities especially farming which is the pre-dominant activity in the country. However, this land is finite, even though the population density is still low, the extent of poor soils and the unreliability of water supply limit land potential. In that regard, land with arable potential is only five percent of total land area of Botswana (Soil Mapping Section, MoA).

Generation of wealth which is based on land places much pressure on it resulting in land degradation, a situation that is worsened by recurring drought. But information on the extent to which land is degraded is not readily available. Therefore this chapter concerns itself with issues of land classification and land use only.

Total land area of Botswana is 581,730 km^2. It is classified into two broad categories of Eastern Hardveld and Kalahari Sandveld depending on the soil composition. The Hardveld constitutes about one third of the total land area while the Sandveld constitutes about two thirds.

Land is divided into three main tenure systems of communal land, State land and Freehold Land. Communal land is tribal land on which every Motswana can have access to a piece of land for use in grazing, ploughing and residential purposes. This type of tenure accounts for approximately 55 percent of total land area. State Land comprises protected Areas and towns/cities. It accounts for approximately 42 percent of total land area. Freehold land makes up to 3 percent of total land area and gives the owner perpetual and exclusive rights to the land.

Major changes in land use were effected in the period between 1974 and 1995 due to the creation of wildlife Management Areas. About 23 percent of Communal land was degazetted to State Land for this purpose.

4.0 WATER

Botswana is considered one of the most water scarce countries in southern Africa owing to the high evaporation rate which exceed precipitation. About 75 percent of the population depends on groundwater from boreholes. This is found in rural areas. The towns and cities rely on surface water from dams; however, some urban villages rely on surface water due to pollution of groundwater in those areas.

However, these water sources are swamped by challenges which include the following:

- Limited groundwater due to low recharge and salinity
- The flat terrain inhibits the positioning of dams in the country. The few surface water sources are located far from demand centers
- Perennial surface water sources (rivers) are shared with other countries thus use is restricted by international treaties

In providing water to the nation, the Department of Water Affairs (DWA), Water Utilities Corporation (WUC) and Councils contend with issues of demand, supply and quality. These are the three areas that set the thrust of the water chapter in this report in the form of consumption, abstraction, production and quality of water.

As can be expected, with a growing population, there is a generally increasing trend in water consumption and production. Mogoditshane village had the highest consumption level among the 17 major villages in 2005/06 and 2006/07 (DWA Administrative Records). This can be attributed to the huge population as well as the major industries taking place in the area. Overall, the Domestic Sector accounted for about 70 percent of all consumption in the year 2005/06. Through out the period from 1990 to 2005, none of the major dams in the country reached a 100 percent level indicating the scarcity in surface water.

The quality is measured through monitoring of various parameters and assessed against the recommended World Health Organisation (WHO) guidelines and Botswana Bureau of Standards (BOBS) set standards.

5.0 AGRICULTURE

Agriculture by nature relies on environmental inputs, that is, solar, land and its nutrients and water. The challenge with agricultural production is to increase output without degrading the resource base for sustainability. The increase in production may come in the form of intensified use of fertilizers and pesticides, which may lead to contamination of soils, water and biota. It may also come in the form of intensive irrigation which would increase yield in the short to medium term but may lead to conditions like salinisation, alkalinity and water logging.

In addition, agriculture may lead to deforestation as large tracts of land are cleared to create area for ploughing, livestock also graze on land already impacted by drought, further degrading it.

The chapter on agriculture looks at the crop and livestock production in the period from 1983 to 2003. Throughout this period, commercial livestock farming has been much lower than the traditional sub sector. Cattle are found to be the highest in number compared to other types of livestock. The exceptions are however noted between 1993 and 1998 when goats were seen to outnumber cattle. In the same vein, the traditional crop production was much higher than the commercial farming between 1983 and 2003. It is however noted that the average yield per hectare planted was higher in the commercial sector than in the traditional sector in the same period.

This chapter stops short of giving the impacts of the production sectors on the environment because the data is not yet available.

6.0 WILDLIFE

Wildlife management embodies the conservation and protection of fauna and flora. As with other natural resources, these are impacted on by growing human populations and associated economic activities which often create resource use conflict.

To ensure wildlife sustainability, Botswana's wildlife is protected in six (6) major game reserves and national parks (17 percent of total land area). These are spread out over all the ecological regions of the country. In addition, Wildlife Management Areas (WMAs) have been set up as buffer zones between the game reserves and human settlements. They also serve as corridors for migrating species between Protected Areas (PAs). But even with these measures in place, human-wildlife conflict remains a sore. It invariably robs rural communities of their livelihoods as problem animals damage their property. It also costs heavily on government as compensation is paid out to farmers for damage caused by dangerous species.

Other challenges facing wildlife management include drought which has become a regular phenomenon in Botswana. Inadequate rainfall causes degradation in productive capacity of rangeland. Some water dependent species like zebra and wildebeest die due to lack of water. To this end, Department of Wildlife and National Parks is striving to provide water to wild animals in PAs.

Furthermore, diseases such as anthrax pose a threat to wildlife populations, although they have not yet had major impact on the populations, they have a potential to. Poaching is another challenge and the DWNP conducts regular anti-poaching patrols as a preventative measure.

In this chapter, the estimate of wildlife population is given for the period 1989/91 to 2007. However, the figures for all years are not directly comparable because the areas covered in each survey vary from year to year depending on the issue at hand. In this regard, 1994 and 2003 were country-wide surveys, while 1996, 1999, 2001, 2002, 2003, 2004 and 2005 only covered Kgalagadi, Ghanzi, Ngamiland, Chobe, Kweneng, and northern Central districts. In 2006, the survey covered only the northern elephant range and in 2007 only Kgalagadi, Ghanzi and parts of Kweneng were covered.

Notwithstanding the inconsistencies in coverage, it is evident that elephant, gemsbok and buffalo are the most populous species. Elephant and buffalo populations are felt particularly because of high densities due to their confinement to the northern districts (Ngamiland, Chobe and parts of Central Districts).

Reported cases of poaching have been recorded for the years 2005 to 2007 and have indicated that the levels of poaching are quite low. This may be attributed in part to the surveillance efforts of the Anti Poaching Unit. These efforts are complemented by the Botswana Defence Force.

The statistics show that in 2005, elephant and kudu had the highest number of poaching incidences. In 2006, species with the highest incidences were elephant and gemsbok, while in 2007; gemsbok followed by eland had the highest poaching incidences.

7.0 FORESTRY

Among other uses, forests are a source of energy as they provide fuelwood for cooking and heating. They also provide raw material for construction industry. In addition, forests provide habitat for various organisms and they play an important role in the ecosystem of regulating water and carbon flow. The importance of forests cannot therefore be over-emphasised.

Like any form of life, dynamics of forests are a function of rate of depletion and rate of regeneration, both of which are determined by conditions of soil, climate and human activities. The human activities apparently influence these rates as forests are treated as free for all public good.

In Botswana, forestland is found in the Chobe District where climatic and soil conditions are favourable. A good proportion (409,600 hectares) is protected under six Forest Reserves. Much of the land is however characterized by interspersed woodland.

One of the challenges in forestry management is the incidence of wild fires which destroy large tracts of rangeland. In the year 1993/94 more than 200,000 hectares of land was burnt in Ngamiland District. In 2006, the area burnt was 1,869,200 hectares. The Department of Forestry and Range Resources controls the fires through construction and maintenance of fire breaks. The unsustainable harvesting of forest resources is another potential threat to forestry. Data is however not available on the exploitation rate of the range resources.

This chapter looks at the forest management practices in Botswana and at the challenges besieging the sector.

8.0 ENERGY

Energy is central to driving development processes. It is required for cooking, heating/cooling and lighting purposes. At the same time, the use of energy contributes significantly to pollution of the environment thereby has a bearing on global warming; a phenomenon currently gripping the world over. So for sustainable development to be attained, the energy source used must be affordable, environmentally friendly and sustainable.

Both traditional and conventional energy sources are used in Botswana. The most prevalent traditional energy source is fuelwood while the prevalent conventional energy sources include gas (LPG) and paraffin for households, diesel for agriculture, coal for industry and petrol for transport. Fuelwood is the principal energy source for cooking in households. Approximately 77 percent households in rural areas and 46 percent nationally use it. But the trend observed is a move away from wood to use of LPG gas for cooking, and a move towards use of electricity for lighting. The main consumer of electricity over the years is mining. It is worth noting that the uptake of solar electricity is still very low at 0.23 percent of households countrywide.

Sectorally, households, industry and transport are the dominant contributors to final energy demand. Among them households are the principal users of energy in the country. Its share of final energy demand was 38 percent in 2003. The transport sector saw a growth in share of final energy demand from 13 percent in 1981 to 25 percent in 2003 with principal energy sources being petrol and diesel. Industry sector share was 26 percent in 2003.

With the consumption of energy comes the emission of green house gases which are responsible for over warming the atmosphere. GHG emissions in Carbon dioxide equivalents from use of energy increased from 2.4 million tones in 1981 to 7.2 million tons in 2000 and declined to 6.5 million tons in 2003. The emissions are mainly from combustion of coal, petrol, diesel and wood in that order.

The widespread use of fuelwood if live trees are cut may deplete forest resource thereby limiting the chances of forests acting as a carbon sink.

9.0 MINING

The mining sector is the mainstay of the economy of Botswana. But despite increase in mining production over the years, employment in the sector has remained fairly constant due to the capital intensive nature of mining.

The government through the Ministry of Mines, Energy and Water Resources is responsible for the administration of mineral exploration, mining and mineral processing. Private companies do the actual prospecting and mining. The government has shares with mining companies for example shareholding with De Beers Company for diamond mining and with Anglo American Corporation for copper/nickel.

The principal mineral developments are diamond mines at Jwaneng, Orapa, Letlhakane and Damtshaa Mines, Coal at Morupule, Copper/nickel at Selibe Phikwe, Soda Ash and Salt at Sua Pan, and gold mining in the Francistown area. Most production is exported. In spatial extent, Soda Ash mining takes the largest (about 54 percent) land area designated for mining; on the

other hand, diamond mining, which is the mainstay of the country's economy, takes up about 17 percent of land designated for mining.

Production of diamond and copper/nickel has been on the increase over the years. It should be noted that the increase in diamond production is not always proportional to the value of exports as at times production is stockpiled depending on the market prices. Coal production has been relatively constant over the years, while Soda Ash and Gold production has been fluctuating. Gold production fluctuation has been more pronounced.

In terms of employment, diamond mining contributes about 43 percent of total mining employment closely followed by copper/nickel with 42 percent.

The chapter on mining covers mining inventory only that is, mineral reserves, production and location. Information on the impact of mining process on the environment is not readily available.

10.0 RESPONSES (Acts on environment and NGOs)

Developmental activities and natural events have an impact on the environment. This provokes an individual or social response to avoid or mitigate the impacts. Among other things, the response is reflected through government policies that protect, conserve and rehabilitate the environment and natural resources.

Some of the policies are reactive and aim at negative impacts that already occurred; other policies are preventive because they tend to prevent the occurrence of any impacts at the outset (UN Framework for Environmental Statistics, 1991). These are less costly policies.

Policies are however formulated to implement certain pieces of legislation. In Botswana, an overarching Act on the environment is still under development by the Ministry of Environment, Wildlife and Tourism. Therefore there are various pieces of legislation related to different environmental issues, housed within and administered by relevant departments and ministries. Ministries that have Acts that have a bearing on the environment are Ministry of Environment, Wildlife and Tourism, Ministry of Lands and Housing, Ministry of Mining, Energy and Water Resources, Ministry of Agriculture, and Ministry of Health.

To further foster the sustainable management and use of natural resources, the society forms organizations that strive to control negative impacts on the environment and reinforce positive ones. These organizations are non governmental and they get support from donors including government. The list of these Non Governmental Organizations (NGOs) engaged in environment work and what they do is given in this report.

1.0 CLIMATE

1.1 Introduction

Climate is usually defined as the average weather that is observed over a long period of time, typically 30 years. Weather is often used to explain seasonal and year – to – year changes. Climate changes refer to long-term trends in the average weather such as changes in average temperatures. Climates do change naturally over long periods of time. Climate factors such as temperature, rainfall, cloudiness and winds have a significant impact on many aspects of the nation's economy as well as human health and quality of life. There are climate extremes which have an adverse impact on human welfare and these are normally referred to as climatic disaster.

Types of climate extremes that affect human welfare in Botswana are:

- Droughts – due to increased evaporation and reduced precipitation.
- Floods – due to increased precipitation
- Storms

1.2 Temperature

Temperatures in Botswana are hot during summers and cold in winters. The summers are long and winters are short. Temperatures can reach up to 40^0C in some parts of the country during summer, in winter temperatures are mild and can go down below 0^0C with chances of night frost in the western parts of the country like Tsabong, Tshane and Jwaneng.

Tables 1.1 and 1.2 show the specific monthly averages for long-term maximum and minimum temperatures respectively of different weather stations through out the country.

Table1.1 Maximum Specific Monthly Average Temperatures (long-term) by Weather Stations

Weather Stations	Maximum Monthly Temperatures (1971- 2000)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Ghanzi	32.4	31.9	31.1	29.3	26.9	24.1	24.0	27.2	31.2	33.2	33.6	33.3
Shakawe	31.2	30.8	30.8	30.1	28.1	25.7	25.7	29.2	32.9	34.4	33.7	32.4
Maun	32.2	32.1	31.9	30.7	28.4	25.7	25.6	28.8	32.8	34.5	34.0	32.9
Francistown	30.8	30.1	30.1	28.3	26.1	23.7	23.4	26.5	30.1	31.5	31.5	31.0
Mahalapye	31.3	30.6	29.7	27.8	25.5	22.8	22.6	25.5	29.1	30.6	31.0	31.3
Tshane	33.5	32.5	31.3	28.5	25.5	22.5	22.6	25.5	29.5	31.8	33.1	33.8
Tsabong	34.6	33.6	31.9	28.7	25.1	22.2	22.1	24.7	28.9	31.4	33.2	34.4

Source: Dept. of Meteorology

Figure 1.1
Long Term Maximum Monthly Temperatures (^{O}C) : 1971-2000

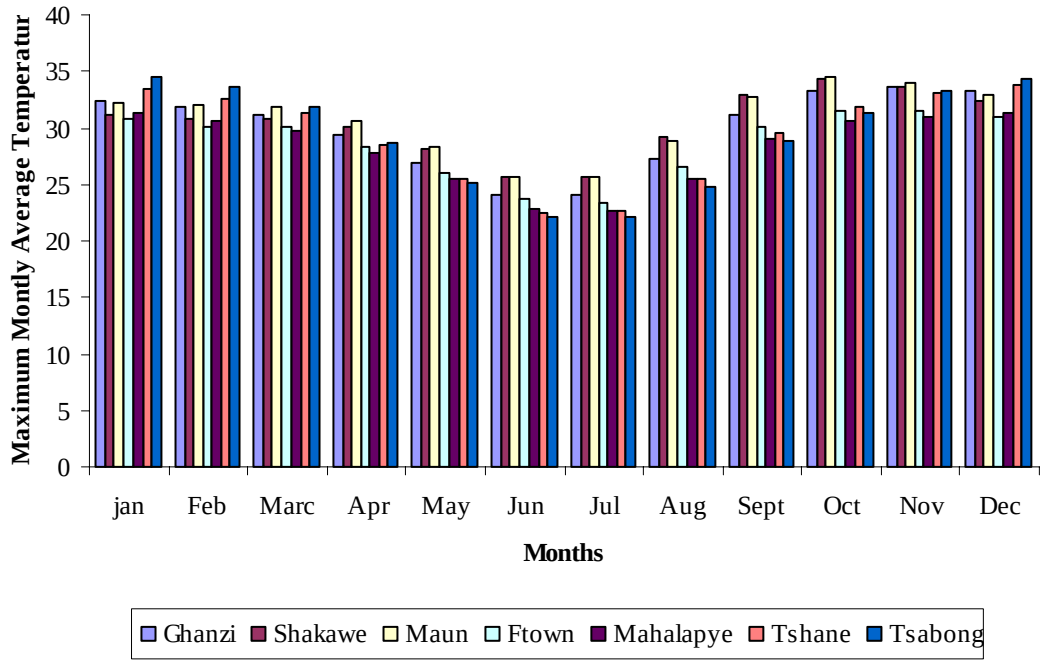


Figure 1.1 above illustrates the long term maximum monthly average temperatures by weather stations. Comparison for all the weather stations covered in Figure 1 shows that Botswana Maximum Temperatures range between 20 and 35^{0}C. Tsabong, Ghanzi and Shakawe registered the hottest long term monthly temperatures in January, October, November and December.

Table 1.2 Minimum Specific Monthly Average Temperatures (long-term) by Weather Stations

Weather Stations	Minimum Monthly Temperatures (1971-2000)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Ghanzi	19.3	18.7	17.0	13.2	8.2	4.5	4.1	7.0	11.8	15.9	17.8	18.9
Shakawe	19.8	19.6	19.3	15.9	11.6	7.1	6.3	8.9	13.5	17.6	19.1	19.7
Maun	19.8	19.6	18.7	15.9	11.0	7.7	7.5	10.3	15.3	19.1	19.8	19.9
Francistown	18.9	18.1	17.2	13.4	8.5	5.0	4.6	7.5	12.6	16.6	18.0	18.6
Mahalapye	19.6	19.1	17.5	13.9	9.1	5.5	5.0	8.4	13.1	16.5	18.3	19.0
Tshane	19.8	19.2	17.4	13.4	8.2	4.1	3.9	6.3	11.1	15.2	17.3	19.0
Tsabong	19.3	18.8	16.6	11.7	5.5	1.3	0.7	3.5	8.7	13.1	15.7	17.7

Source: Dept. of Meteorology

Figure 1.2
Long Term Minimum Monthly Average Temperatures
By Weather Stations (1971-2000)

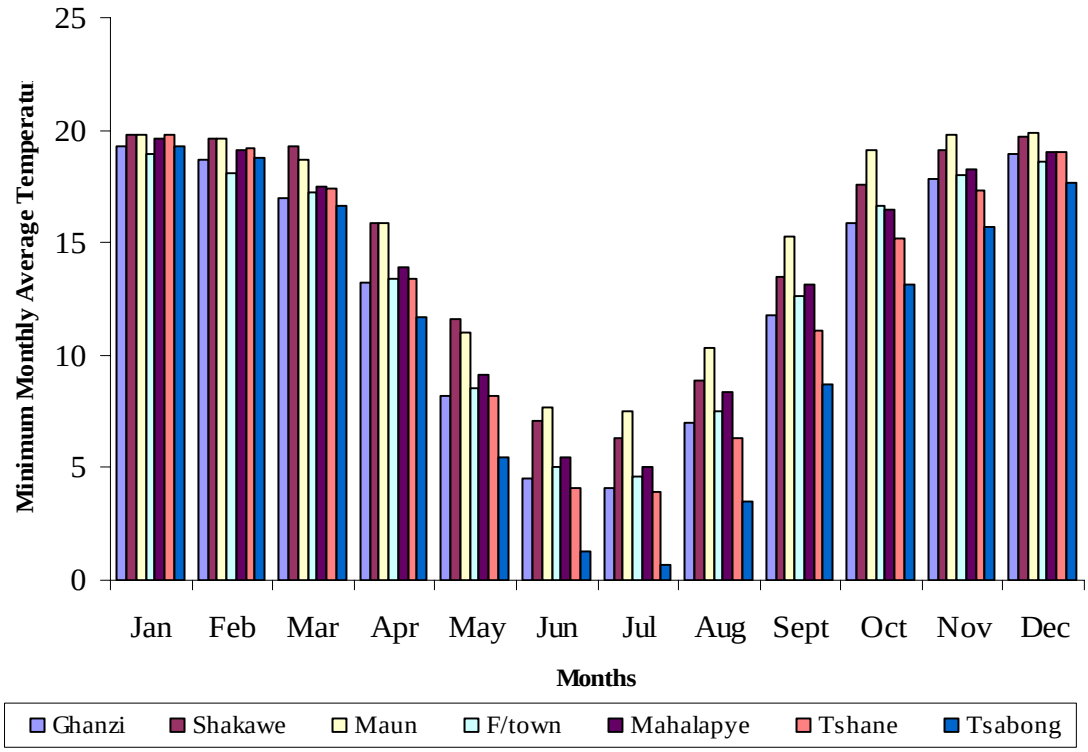


Figure 1.2 above shows that Minimum Monthly Average Temperature start dropping from the month of April for all seven Meteorological weather stations throughout the country with June and July being the coldest months. Temperatures start rising again during the month of September. The trend of long term minimum monthly temperatures shows a downward normal curve with the lowest peak registered in winter.

Table 1.3 below shows the number of months in which the maximum monthly temperatures were higher than the long-term averages for different weather stations throughout the country. The data on monthly maximum temperatures for seven meteorology stations for the period 1987-2005 was compared to the Long-term Averages (LTA's) for the same stations and months. It was observed from the comparison that eleven (11) months spread over three (3) of the seven (7) stations had monthly maximum temperatures that were greater than their respective LTA'S and these were mostly in the north western and central parts of the country.

Table 1.3 Number of Months in which Maximum Mean Monthly Temperatures were greater than Long-term mean monthly maximum temperatures by weather Station: 1987-2005

	Number of Months by Weather Stations						
Years	Ghanzi	Shakawe	Maun	Francistown	Mahalapye	Tshane	Tsabong
1987	6	8	9	6	6	6	6
1988	5	5	4	4	3	4	3
1989	4	4	5	6	7	4	5
1990	8	7	9	9	7	6	7
1991	2	7	5	9	7	2	4
1992	8	10	9	10	10	9	8
1993	6	7	10	7	7	6	7
1994	7	7	6	5	5	6	7
1995	9	10	10	7	6	8	5
1996	7	10	5	5	4	5	4
1997	5	7	7	5	6	7	7
1998	9	9	9	8	7	8	9
1999	7	9	9	3	9	8	8
2000	3	5	3	0	5	3	4
2001	7	6	7	7	5	3	5
2002	9	11	10	9	10	9	10
2003	10	9	11	10	11	10	8
2004	4	5	5	6	5	3	5
2005	9	10	10	12	11	10	8

Table 1.4 Number of Months in which Minimum Mean Temperatures were greater than the long-term mean monthly minimum temperature by Weather Stations: 1987- 2005

	Number of Months by Weather Stations						
Years	Ghanzi	Shakawe	Maun	Francistown	Mahalapye	Tshane	Tsabong
1987	4	1	3	3	2	2	2
1988	6	3	6	8	9	4	7
1989	7	6	8	4	8	7	7
1990	3	2	2	3	4	2	4
1991	7	6	0	7	4	8	6
1992	3	12	3	0	1	4	9
1993	3	9	3	2	1	2	4
1994	9	9	8	7	6	3	10
1995	2	6	1	1	2	2	3
1996	4	7	3	7	8	8	7
1997	3	6	3	5	8	6	4
1998	2	3	2	5	2	3	2
1999	2	9	2	5	3	3	1
2000	5	10	2	8	10	6	5
2001	4	7	0	6	5	5	5
2002	6	5	0	6	3	1	5
2003	5	4	1	2	1	1	4
2004	6	7	4	4	4	2	3
2005	0	3	2	0	0	4	1

1.3 Rainfall

Botswana is a semi-arid country. Rainfall in Botswana is seasonal and very unreliable with recurrent droughts as a normal part of the pattern. Seasonal rainfall fluctuations are higher than the annual ones. Areas with lower average rainfall experience a less reliable rainfall pattern. Rainfall in Botswana normally occurs during summer months from October to March, but during drought years it can delay in some parts of the country. The low amount of rainfall received has a negative impact on rural livelihoods of farming communities as they depend on it.

Table 1.5 Long Term Average Monthly Rainfall (1971 - 2000) by Weather Stations and Months

Weather Stations	Average Monthly Rainfall mm (long-term)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Ghanzi	95.2	87.3	68.4	33.8	7.2	0.7	0.3	0.5	3.1	21.5	47.0	66.4
Shakawe	134.5	127.9	78.5	24.7	2.1	0.3	0.0	0.2	2.7	13.3	54.8	102.2
Maun	109.4	97.0	67.0	24.5	4.9	0.7	0.1	0.4	3.0	15.8	47.0	78.8
Francistown	99.9	84.5	60.3	23.1	6.9	3.3	0.8	0.9	5.4	25.1	64.9	88.7
Mahalapye	88.8	81.5	64.6	24.3	9.1	3.6	2.0	2.3	7.2	29.7	68.3	81.9
Tshane	71.0	65.5	50.4	29.3	8.3	1.9	0.6	1.1	3.8	24.0	33.6	45.4
	50.5	52.4	49.7	31.3	10.6	5.0	1.2	2.4	6.5	18.4	28.7	40.1

Source: Dept. of Meteorology

Figure 1. 3
Long Term Average Monthy Rainfall By Rainfall Statons
(1971-2000)

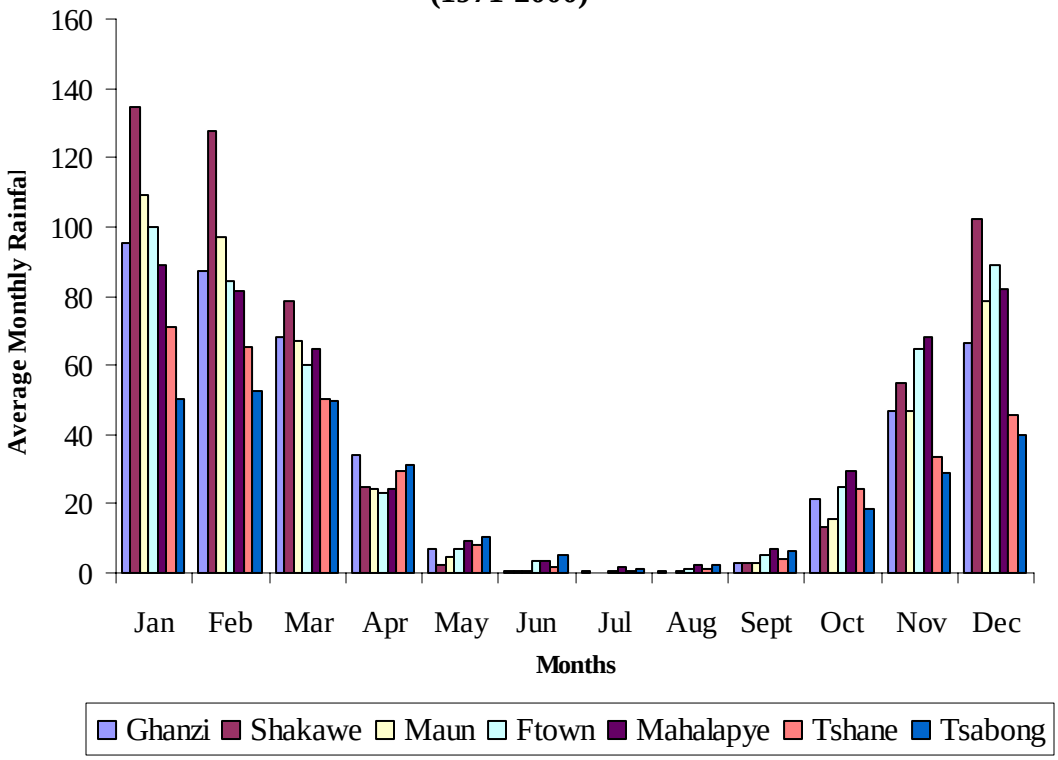


Figure 1.3 shows the long term average amount of rainfall received in Botswana for different rainfall stations since 1971. The observation in Figure 1.3 shows that rainfall in Botswana is seasonal and the amount received varies from one rainfall station to another. A large amount of rainfall was received between the months of November and March and this varies according to different rainfall stations through out the country.

More rainfall is registered in the Northern parts of the country unlike in the western parts of the country. Shakawe registered the highest average amount of rainfall receiving 134.5mm in January. Figure 1.3 shows that there was a less significant amount of rainfall received between the months of May and September. The lowest average amount of long term average rainfall received in Botswana during rainy season (i.e October – March) was registered in Shakawe with 13.3mm in October, followed by Maun with 15.8mm during the same month (see Table 1.5).

Table 1.6 Number of Months in which Average Monthly Rainfall was more than 20% smaller than Long-term Averages by Weather Stations: 1995 – 2005

Years	Number of months which monthly average rainfall was greater than 20% smaller than LTA						
	Ghanzi	Shakawe	Maun	Francistown	Mahalapye	Tshane	Tsabong
1995	7	9	11	6	7	8	8
1996	8	10	9	6	9	4	7
1997	6	6	6	7	6	6	7
1998	8	11	8	7	7	8	6
1999	8	9	10	7	10	9	8
2000	8	8	5	5	7	6	7
2001	10	6	4	7	9	8	4
2002	7	6	6	6	7	7	7
2003	8	10	9	5	9	9	11
2004	9	6	8	6	5	7	9
2005	9	10	8	7	8	9	10

Table1.7: Number of Months in which Average Monthly Rainfall was more than 20% greater than long-term monthly average by Weather Stations: 1995 – 2005

Years	Number of months in which average monthly rainfall was greater than Long –term Averages by Weather Station						
	Ghanzi	Shakawe	Maun	Francistown	Mahalapye	Tshane	Tsabong
1995	3	1	1	4	4	4	4
1996	3	0	3	4	2	6	4
1997	4	4	3	4	4	3	5
1998	3	1	3	3	2	2	4
1999	2	1	1	1	1	3	2
2000	3	3	4	5	4	3	4
2001	2	4	7	4	3	3	6
2002	4	3	3	5	4	2	5
2003	3	1	2	4	1	1	0
2004	3	5	3	6	6	4	2
2005	1	2	1	2	2	2	2

Table 1.7 shows the number of months in which the amount of rainfall received was greater than the long term averages shown in Table 1.5. The observation from the table shows that a lot of rainfall was registered in 2001 and 2004 nationally, that can be seen from the number of months recorded during the period ranging from 2 to 7 months. In 2001, Maun registered the highest number with 7 months of rainfall followed by Tsabong with 6 months. In 2004 6 months of rainfall spread between Francistown and Mahalapye, followed by Shakawe with 5 months. There was low rainfall amount received in 1999 and 2005 as can be seen from the number of months recorded in table 1.7 ranging from 1 to 3 months and these can be regarded as dry years.

2.0 POPULATION INVENTORY

2.1 Introduction

The link between population growth, resources use and environmental quality are too complex to permit straightforward generalization about direct casual relationships. However, rapid population growth has increased the number of poor people in developing countries, thus contributing to degradation of the environment'. (R.Repetto,1989). Clear-cut generalization are not possible because the impact of population growth on the environment will vary in time and space depending on the interaction of several other factors that will either mitigate or exacerbate this impact. Such factors include the pattern of distribution of the population and the level of economic development of the country.

Rapid population growth can exert pressure on resources like land, water, flora and fauna on which human beings depend to meet their three basic needs of food, shelter and clothing. This pressure could lead to the unsustainable use of the resources if the population growth rate is faster than the rate at which the resources are renewed. For example, it could contribute to land degradation, deforestation and the loss of flora and fauna species, either because of over-harvesting by humans or the destruction of squatter settlements most of which may not have access to properly ventilated residences, piped water and waste disposal services. The availability of water is a dominant factor influencing the pattern of human settlement. The exploitation of minerals also influences population settlements. Such settlements can have a negative impact on environmental quality.

This chapter presents an overview of population statistics in Botswana, with particular reference to population growth (observed and projected), distribution and density.

2.2 Demographic Indicators

Table 2.1: Demographic Indicators

Indicators	1971	1981	1991	2001	2011	2021	2031
Population	574,094	941,027	1,326,796	1,680,863	1,826,022	2,082,106	2,362,022
Infant Mortality Rate	97.1	71.0	48.0	56.0	30.8	16.1	11.2
Total Fertility Rate	6.5	6.6	4.2	3.3	2.6	2.5	2.4
Crude Birth Rate	45.3	47.7	39.3	28.9	24.8	21.7	19.9
Crude Death Rate	13.7	13.9	11.5	12.4	11.9	8.7	7.6
Life Expectancy	55.5	56.5	65.3	55.6	55.6	64.4	68.0
Dependency Ratio	113.3	110.3	93.0	71.5			
Population Growth	3.1	4.1	3.5	2.5	1.29	1.29	1.23

Source: 1971, 1981, 1991 and 2001 are census population figures while 2011, 2021 and 2031 are projections, CSO

Table 2.1 shows that the population has increased from 1,326,796 in 1991 to 1,680,863 in 2001. The growth rate declined from 3.5 in 1991 to 2.5 in 2001, much as the Total Fertility Rate which

shows a downward trend from 4.2 in 1991 to 3.8 in 2001. However, life expectancy has increased from 65.3 to 68.0 years.

2.3 Population Density

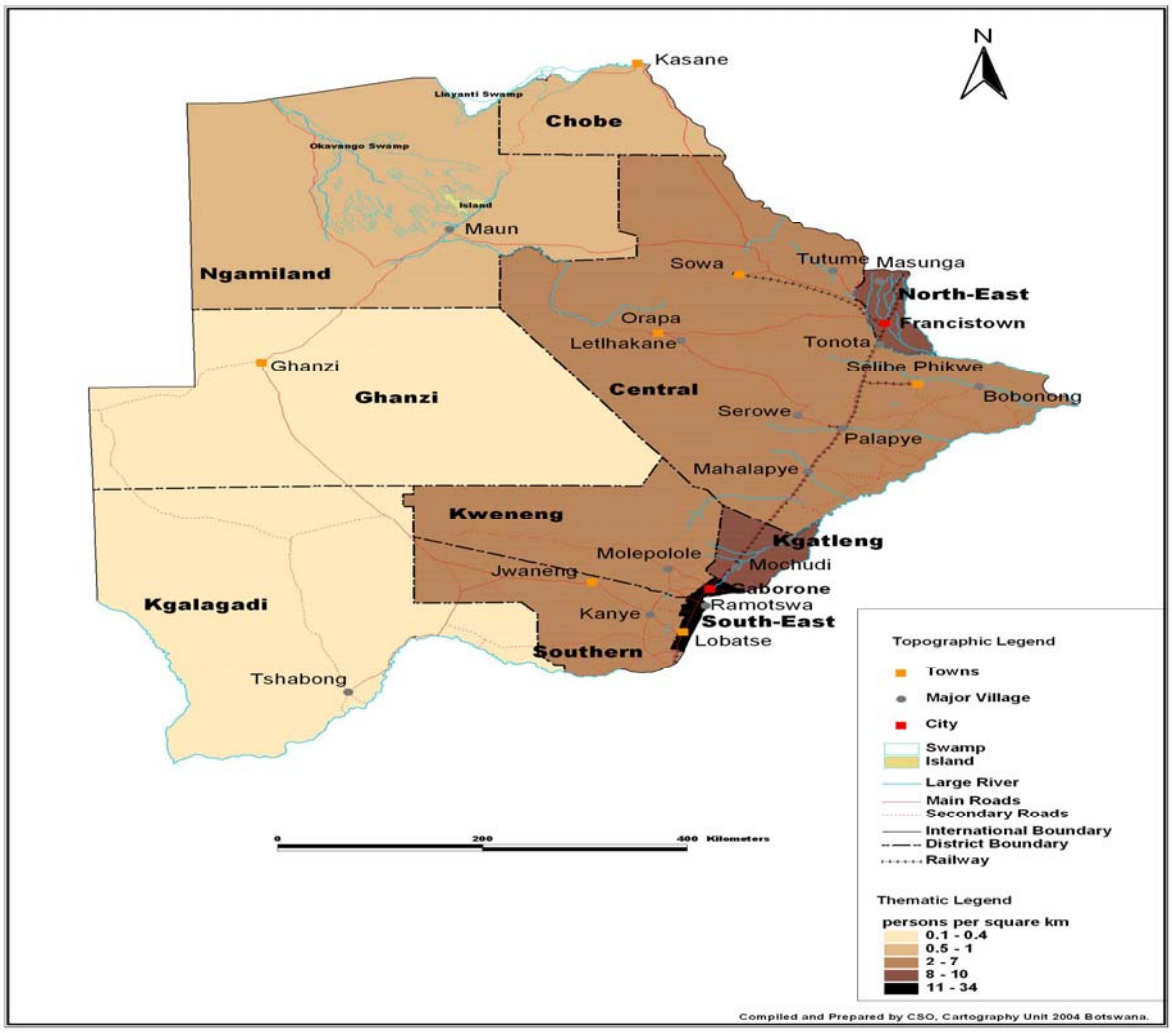
The national population density was on the increase between the two periods of 1991 and 2001 population and housing censuses. It went up from 2.3 persons per square kilometer in 1991 to 2.9 persons in 2001 (see Table 2.2). There was an increase in all the cities/towns and districts population density. Gaborone population density increased from 790.0 in 1991 to 1101.0 in 2001 while Francistown increased from 826.0 to 1051.0 during the same periods. All the districts near the cities of Gaborone and Francistown have realized a significant increase in population densities which may be linked to pressure on land in the cities, and this could lead to squatter settlements most of which do not have access to adequate sanitation and piped water. The observation from Table 2.2 below shows that the South East District is the most densely populated with 34 persons per square kilometer from the result of the 2001 population census, which is an increase of 9.5 persons from the 1991 figure of 24.5 persons per square kilometer. The western part of the country is sparsely populated, as shown by the two districts of Ghanzi and Kgalagadi which recorded 0.1 and 0.4 persons per square kilometer respectively.

Table 2.2 Population Density By Administrative Districts

Location	1971	1981	1991	2001
National Population Density	1.0	1.6	2.3	2.9
Density of Cities and Towns				
Gaborone	111.0	353.0	790.0	1101
Francistown	267.0	393.0	826.0	1051
Lobatse	294.0	453.0	620.0	707
Selibe-Phikwe	105.0	589.0	795.0	997
Orapa	72.0	308.0	519.0	538
Jwaneng	..	56.0	112.0	152
Sowa	..	..	14.0	18
Density of Districts				
Southern	2.9	4.2	5.2	6
South East	11.3	13.7	24.5	34
Kweneng	1.8	3.3	4.8	7
Kgatleng	3.9	5.6	7.3	9
Central	1.5	2.1	2.8	5
North East	5.0	7.2	8.5	10
North West	0.4	0.6	0.8	1
Ghanzi	0.1	0.2	0.2	0.1
Kgalagadi	0.2	0.2	0.3	0.4

Source: Central Statistics Office

2001 POPULATION DENSITY BY ADMINISTRATIVE DISTRICTS



2.4 Population Distribution

The Population of Botswana is concentrated in the south eastern part of the country as can be clearly seen from the population density map below. This could be due to better rainfalls and the reasonably fertile soils for farming when compared to the western part of the country which is dry and the soils are not good for arable farming.

3.0 LAND

3.1 Introduction

The total land area of Botswana is 581,730 square kilometres. The land is generally flat, making production of water very difficult. Land is one of the main natural resources because it supports farming which is the predominant economic activity in Botswana. Nevertheless, only about 5 percent of the total land is suitable for arable farming; soil fertility and availability of water are the main restraining factors. These factors also determine the vegetation prevalent in different parts of the country; the western and southern parts have scanty vegetation while the northern part is rich in vegetation.

3.2 Land Classification

There are two main land classifications, depending on soil composition, namely, the Kalahari Sandveld and the Eastern Hardveld. Table 3.1 shows the land classification by district. Some districts fall within both classes while others fall within one specific class.

Table 3.1 Land Area (square kilometres) by Land Classification and District

District	Kalahari Sandveld	Eastern Hardveld	Total Area
Southern	15,328	13,142	28,470
South East	-	1,780	1,780
Kweneng	23,630	12,260	35,890
Kgatleng	-	7,960	7,960
Central	70,347	77,383	147,730
North East	-	5,120	5,120
Ngamiland	109,130	-	109,130
Chobe	7,950	12,850	20,800
Ghanzi	117,910	-	117,910
Kgalagadi	104,912	2,028	106,940
Total	449,207	132,523	581,730

Source: , 1990 Botswana Ecosystem Map, Soil Mapping Section, Ministry of Agriculture

3.2.1 Kalahari Sandveld

The Kalahari Sandveld is composed of sandy sub-soils with low rainfall ranging from 250 mm to 350 mm per annum. It covers an area of 449,207 square kilometres or 77.3 percent of the national area, thus making the country predominantly desert. The sands go as deep as 20 meters underground in some parts. The rainfall is very inadequate. Due to the infertile sandy soils, and low precipitation, the area is able to support only interspersed shrub and savanna type of vegetation. Apart from infertility, these soils have very poor water retention capacity. The districts found in the Kalahari Sandveld are Ghanzi, Ngamiland and parts of Southern, Kweneng, Chobe and Kgalagadi Districts.

3.2.2 Eastern Hardveld

The Eastern Hardveld is characterised by loamy and clay soils. Rainfall in this part of the country varies from 350 mm to 650 mm per annum. It is therefore more fertile and more suitable for agricultural activities. Consequently, it is more heavily populated than the Sandveld. The Hardveld covers only 22.7 percent of the country. The districts found in the Eastern Hardveld are South East, Kgatleng, North East and some parts of all the other districts with the exception of Ngamiland and Ghanzi districts.

3.3 Land Tenure

There are three main categories of land tenure in Botswana, namely; Communal Land, Freehold Land and State Land. Table 3.2 gives the area covered by the three tenure systems in 1995. Figure 3.2, on the next page, gives the same information in a map.

Table 3.2: Land Tenure, 2007

Use/Tenure	Land, square kilometres	Percentage of Total Land
Communal Land		
Pasturer, Arable and Residential areas	253,223	43.5
Tribal Grazing Land Policy Ranches	24,292	4.2
Lease ranches	13,090	2.3
NADP (fencing component)	28,392	4.8
Sub-total	*318,997*	*54.8*
Freehold Land		
Freehold farms	19,109	3.3
Arable blocks	320	0.1
Sub-total	*19,429*	*3.4*
State Land		
National Parks	45,900	7.9
Game Reserves	60,558	10.4
Forest Reserves	4,555	0.8
Wildlife Management Areas	128,574	22.1
Quarantine and Botswana Livestock Development Corporation ranches	3,717	0.6
Sub-total	*243,304*	*41.8*
Total Land	581,730	100.0

Source: 2007 Botswana Land Use Map, Cartographic Section , Ministry of Agriculture.

3.3.1 Communal Land

Communal Land, also called Tribal Land, comprises about 55 percent of the total national land area. The twelve Tribal Land Boards hold all Communal (Tribal) land in trust for the citizens of Botswana and allocate it to citizens for residential, commercial and agricultural uses. All Batswana, irrespective of sex, are entitled to communal land for their own use. On allocation, the holder does not pay any price for the land and does not acquire any exclusive or perpetual rights to it. However, in practice, as long as the land is used for the allocated purpose, it stays in the family indefinitely, and is used as if exclusive and perpetual rights had been attained, with the exception of grazing rights. Nevertheless, the ownership of a borehole holds de facto rights to the water and surrounding grazing resources. In addition, 50-year leases have been introduced on part of the tribal land which has been zoned for commercial use.

3.3.2 Freehold Land

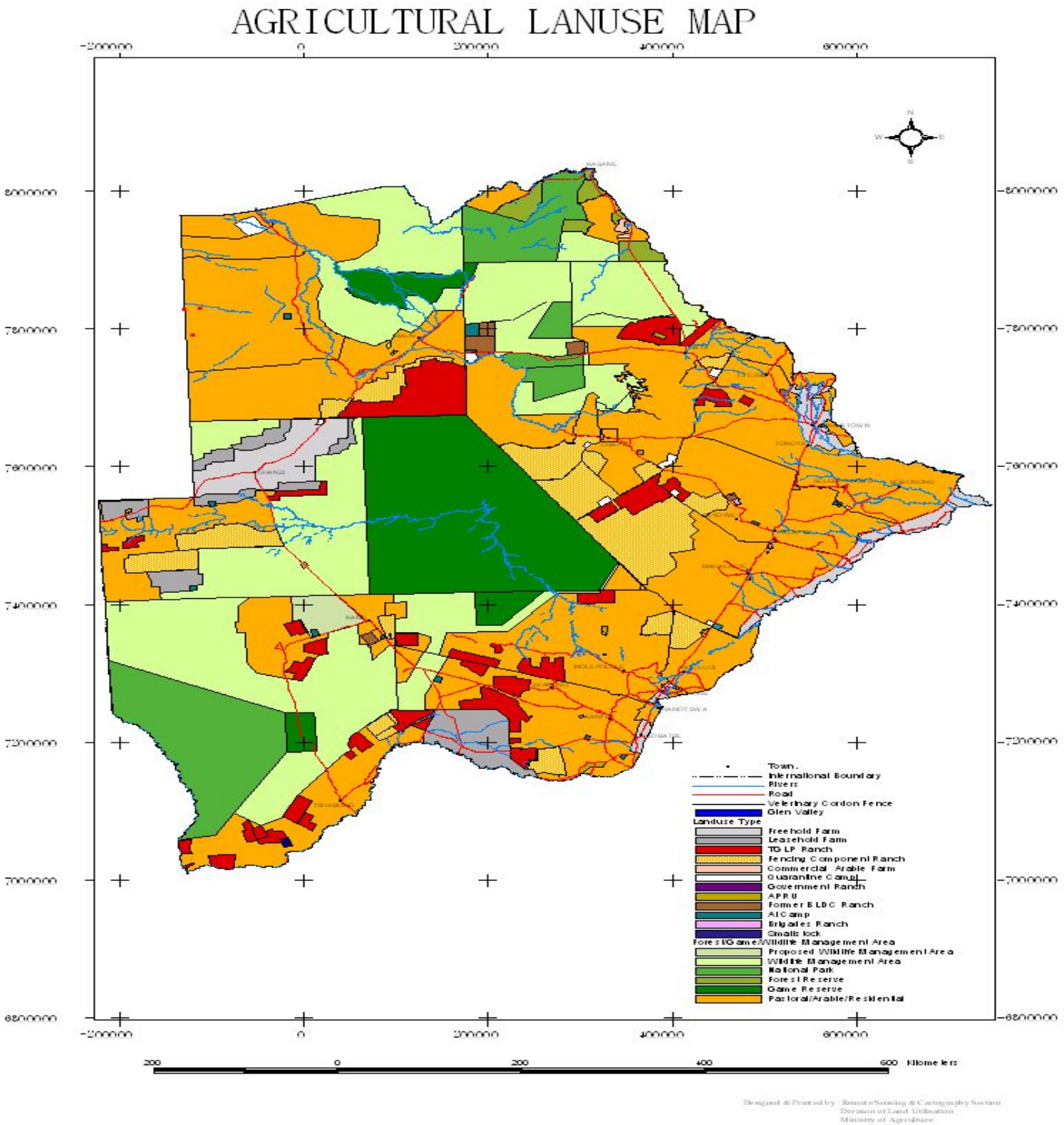
Freehold Land entitles the owner with perpetual and exclusive rights to the land, including the natural resources within the land with the exception of wildlife. It comprises about 3 percent of the total national land area in designated blocks, mostly along the southern and eastern boundaries of the country (Botswana's most suitable agricultural land) and some blocks in the western part of the country, see Figure 3.2. The bulk of Freehold Land is made up of private commercial farms which are dominated by the livestock subsector.

3.3.3 State Land

State Land comprises about 42 percent of the total land area. It consists of land that the Government has reserved for conservation purposes and of land covered by quarantine ranches belonging to the Botswana Livestock Development Corporation (BLDC), towns and cities.

Conservation areas make up the bulk (about 98 percent) of State Land. They consists of National Parks, Game Reserves, Forest Reserves and wildlife Management Areas which comprise 8 percent, 10 percent, 1 percent, and 22 percent of total land area, respectively. The area covered by towns, cities and BLDC quarantine ranches is only about 1 percent of the national total land area.

Figure 3.2 Botswana Land Use Map



3.4 Changes in Land Use

3.3.4 Changes in Land Use at National Level

The shares of total land under the three major land uses changed in the period 1974 to 2007(see Table 3.3). However, the most significant changes took place in Communal Land and State Land major tenure systems as a result of the re-allocation of part of the Communal Land to State Land. This was mainly due to the creation of Wildlife Management Areas (WMA) which never existed in 1974 but had a share of 23.0 percent of the national land area by 1995 and the gazetting of additional Forest Reserves during the same period.

Subsequently, the share of total land area that fell under the Communal Land tenure system remained the same to 318,997 square kilometres (54.8 percent) despite the introduction of the National Agricultural Development Policy (NADP) in some districts, This is a fencing component which still falls within the Communal Land Category. The Communal Land realised a land use change of 4.8 percent (28,392 square Km) at national level as a result of the NADP.

Table 3.3: Land Use Change (square kilometres) 1974 - 2007

Land Use / Tenure	1974		1981		1995		2003		2007	
	Land Area square kilometres	Percentage of Total Land Area	Land Area square kilometres	Percentage of Total Land Area	Land Area square kilometres	Percentage of Total Land Area	Land Area square kilometres	Percentage of Total Land Area	Land Area square kilometres	Percentage of Total Land Area
Communal Land										
Pastr/arab/resid(1)	446,511	76.8	415,315	71.4	281,615	48.4	259,278	44.6	253,223	43.5
TGLP ranches(2)	-	-	24,292	4.2	24,292	4.2	24,292	4.2	24,292	4.2
Lease ranches	13,090	2.3	13,090	2.3	13,090	2.3	13,090	2.3	13,090	2.3
NADP (Fencing Component)	-	-	-	-	-	-	22,337	3.8	6,055	1.0
Sub-total	*459,601*	*79.0*	*452,697*	*77.8*	*318,997*	*54.8*	318,997	*54.8*	*318,997*	*54.8*
Freehold Land										
Freehold farms	18,959	3.3	19,429	3.3	19,109	3.3	19,109	3.3	19,109	3.3
Arable blocks	-	-	-	-	320	0.1	320	0.1	320	0.1
Sub-total	*18,959*	*3.3*	*19,429*	*3.3*	*19,429*	*3.4*	*19,429*	*3.4*	*19,429*	*3.4*
State Land										
National parks	37,360	6.4	37,815	6.5	37,815	6.5	37,815	6.5	37,815	6.5
Game reserves	62,239	10.7	63,517	10.9	63,517	10.9	63,517	10.9	63,517	10.9
Forest reseves	163	-	4,555	0.8	4,555	0.8	4,555	0.8	4,555	0.8
WMA[3]	-	-	-	-	133,700	23.0	133,700	23.0	133,700	23.0
QBLDC[4]	3,408	0.6	3,717	0.6	3,717	0.6	3,717	0.6	3,717	0.6
Sub-total	*103,170*	*17.7*	*109,604*	*18.8*	*243,304*	*41.8*	*243,304*	*41.8*	*243,304*	*41.8*
Total Land	581,730	100.0	581,730	100.0	581,730	100.0	581,730	100.0	581,730	100.0

Source: 2007 Botswana Land Use Map, Cartographic Section , Ministry of Agriculture

3.3.5 Changes in Land Use at District Level

Tables 3.4 to 3.14 present land use change at district level over the period 1974 to 2007.

Table 3.4 shows that in the Southern, Central, Ghanzi, Ngamiland and Kgalagadi Districts there was a change in land use pattern when part of the Communal Land was allocated for the National Agricultural Development Policy (NADP) fencing component. But this was not a loss to the Communal land as the fencing component falls within this category.

The table shows that in 2003, the Central District realised a major land use change of 11.1 percent (16,470 Km^2) from 147,730 Km^2 of total district area. Other land use changes occurred in Southern 4.1 percent (1,176Km) from a total district area of 28,470 Km^2, Ngamiland 1.9 percent (2,076Km^2) from a total district area of 109,130Km^2, Ghanzi 1.8 percent (2,145Km^2) from a total district area of 117,910Km and Kgalagadi 0.4 percent (470Km^2) from a total district area of 106,940km^2. Other changes occurred in 2007.

Table 3.4 Land Use Change from Pastr/arab/resid to Fencing Component (2003 & 2007)

District	District land area (square kilometres)	Percent land use change from pastoral/arable/residential to fencing	
		2003	2007
Central	147,730	11.1	1.5
Ghanzi	117,910	1.8	2.7
Kgalagadi	106,940	0.4	-
Ngamiland	109,130	1.9	0.7
Southern	28,470	4.1	-

Table 3.5 Communal Land Converted to Other Land Use by Disrict[1] (1974 - 2007)

District	Communal land (km^2) in 1974	Land undergone land use change (km^2)		
		From communal use	To State land	To Freehold
Central	139,184	17,291 (12.4)	17,291	-
Chobe	11097	7,017 (63.2)	6,697	320
Ghanzi	55,966	28,595 (51.1)	28,595	-
Kweneng	32,854	6,578 (20.0)	6,578	-
Kgalagadi	80,802	44,015 (54.4)	44,015	-
Ngamiland	100,677	34,145 (33.9)	34,145	-
Northeast	2,020	150 (7.4)	-	150
Southern	28,396	2,813 (9.9)	2813	-

NB: Southern & Kgalagadi land use change was between 1974 and 2003
Chobe, Kweneng and Northeast land use changes were between 1974 and 1995
1: South East and Kgatleng Districts are not included because there was no change in land use over the period

Table 3.5 shows that most of the land converted from communal land use was changed to state land mainly to Wildlife Management Areas.
Data on the South East and Kgatleng Districts indicate no change in land use and are therefore presented together in Table 3.6

Table 3.6 Land Use in Kgatleng and South East Districts

Use/Tenure	Kgatleng District		South East District	
	Land, square kilometres	Percentage of District Land Area	Land, square kilometres	Percentage of District Land Area
Communal Land				
Pastr/arab/resid[1]	7,960	100.0	645	36.2
TGLP ranch[2]	-	-	-	-
Lease ranch	-	-	-	-
Sub-total	7,960	100.0	645	36.2
Freehold Land		-		-
Freehold farms	-	-	1,135	63.8
Sub-total	-	-	1,135	63.8
State Land		-		-
National Parks	-	-	-	-
Game Reserves	-	-	-	-
Forest Reserves	-	-	-	-
WMA[3]	-	-	-	-
QBLDC[4]	-	-	-	-
Sub-total	-	-	-	-
Total Land	7,960	100.0	1,780	100.0

Source: Derived from cartography maps, Cartography Section Ministry of Agriculture.

Table 3.7 Land Use Change in Southern Disrict, 1974 – 2003

Land Use/Tenure	1974		1981		1995		2003	
	Land Area square kilometres	Percentage of District Land Area	Land Area square kilometres	Percentage of District Land Area	Land Area square kilometres	Percentage of District Land Area	Land Area square kilometres	Percentage of District Land Area
Communal Land								
Pastr/arab/resid	28,396	99.7	24,987	87.8	22,179	77.9	21,003	73.8
TGLP ranch	-	-	3,404	12.0	3,404	12.0	3,404	12.0
Leasehold ranch	-	-	-	-	-	-	-	-
NADP Fencing	-	-	-	-	-	-	**1,176**	**4.1**
Sub-total	28,396	99.7	28,391	99.7	25,583	89.9	25,583	89.9
Freehold Land								
Freehold farms	-	-	-	-	-	-	-	-
Sub-total	-	-	-	-	-	-	-	-
State Land		-		-		-	-	-
National Parks	-	-	-	-	-	-	-	-
Game Reserves	-	-	-	-	-	-	-	-
Forest Reserves	-	-	-	-	-	-	-	-
WMA	-	-	-	-	2,808	9.9	2,808	9.9
QBLDC	74	0.3	79	0.3	79	0.3	79	0.3
Sub-total	74	0.3	79	0.3	2887	10.1	2.887	10.1
Total Land	28,470	100.0	28,470	100.0	28,470	100.0	28,470	100.0

Source: 2003 Botswana Land Use Map, Cartographic Section , Ministry of Agriculture.

Table 3.8 Land Use Change in Kweneng Disrict, 1974 - 1995

Land Use/Tenure	1974		1981		1995	
	Land Area square kilometres	Percentage of District Land Area	Land Area square kilometres	Percentage of District Land Area	Land Area square kilometres	Percentage of District Land Area
Communal Land						
pastr/arab/resid	32,854	91.5	29,862	83.2	23,284	64.9
TGLP ranch	-	-	2,992	8.3	2,992	8.3
Leasehold ranch	-	-	-	-	-	-
Sub-total	32.854	91.5	32.854	91.5	26.276	73.2
Freehold Land		-		-		-
Freehold farms	-	-	-	-	-	-
Sub-total	-	-	-	-	-	-
State Land						
National Parks	-	-		-	-	-
Game Reserves	2,729	7.6	2,729	7.6	2,729	7.6
Forest Reserves	-	-	-	-	-	-
WMA	-	-	-	-	6,578	18.3
QBLDC	307	0.9	307	0.9	307	0.9
Sub-total	3,036	8.5	3,036	8.5	9,614	26.8
Total Land	35,890	100.0	35,890	100.0	35,890	100.0

Source: 1995 Botswana Land Use Map, Cartographic Section , Ministry of Agriculture.

Table 3.9 Land Use Change in Central Disrict, 1974 - 2007

Land Use/Tenure	1974		1981		1995		2003		2007	
	Land Area square kilometres	Percentage of District Land Area	Land Area square kilometres	Percentage of District Land Area	Land Area Square kilometres	Percentage of District Land Area	Land Area Square iKilometres	Percentage of District Land Area	Land Area Square kilometres	Percentage of District Land Area
Communal Land										
Pastr/arab/resid	139,184	94.2	132,636	89.8	115,536	78.2	99,066	65.1	96,891	65.6
TGLP ranch	-	-	6,357	4.3	6,357	4.3	6,357	4.3	6,357	4.3
Leasehold ranch	-	-	-	-	-	-	-	-	-	-
NADP (fencing)	-	-	-	-	-	-	**16,470**	**11.1**	**2,175**	**1.5**
Sub-total	139,184	94.2	138,993	94.1	121,893	82.5	121,893	82.5	121,893	82.5
Freehold Land										
Freehold farms	5,616	3.8	5,616	3.8	5,616	3.8	5,616	3.8	5,616	3.8
Sub-total	5,616	3.8	5,616	3.8	5,616	3.8	5,616	3.8	5,616	3.8
State Land										
National Parks	-	-	-	-	-	-				
Game Reserves	2,428	1.6	2,428	1.6	2,428	1.6	2,428	1.6	2,428	1.6
Forest Reserves	-	-	-	-	-	-	-	-	-	-
WMA	-	-	-	-	17,100	11.6	17,100	11.6	17,100	11.6
QBLDC	502	0.3	693	0.5	693	0.5	693	0.5	693	0.5
Sub-total	2,930	2.0	3,121	2.1	20,221	13.7	20,221	13.7	20,221	13.7
Total Land	147,730	100.0	147,730	100.0	147,730	100.0	147,730	100.0	147,730	100.0

Source: 2007 Botswana Land Use Map, Cartographic Section , Ministry of Agriculture.

Table: 3.10 Land Use Change in North East Disrict, 1974 - 1995

Land Use/Tenure	1974		1981		1995	
	Land Area square kilometres	Percentage of District Land Area	Land Area square kilometres	Percentage of District Land Area	Land Area square kilometres	Percentage of District Land Area
Communal Land						
Pastr/arab/resi	2,020	39.5	1,870	36.5	1,870	36.5
TGLP ranch[2]	-	-	-	-	-	-
Lease ranch	-	-	-	-	-	-
Sub-total	2,020	39.5	1,870	36.5	1,870	36.5
Freehold Land						
Freehold farms	3,100	60.5	3,250	63.5	3,250	63.5
Sub-total	3,100	60.5	3,250	63.5	3,250	63.5
State Land		-		-		-
National Parks	-	-	-	-	-	-
Game Reserves	-	-	-	-	-	-
Forest Reserves	-	-	-	-	-	-
WMA	-	-	-	-	-	-
QBLDC	-	-	-	-	-	-
Sub-total	-	-	-	-	-	-
Total Land	5,120	100.0	5,120	100.0	5,120	100.0

Source: 1995 Botswana Land Use Map, Cartographic Section , Ministry of Agriculture.

Table: 3.11 Land Use Change in Chobe Disrict, 1974 - 1995

Land Use/Tenure	1974		1981		1995	
	Land Area square kilometres	Percentage of District Land Area	Land Area square kilometres	Percentage of District Land Area	Land Area square kilometres	Percentage of District Land Area
Communal Land						
Pastr/arab/resid	11,097	53.4	6,385	30.7	4,080	19.6
TGLP ranch	-	-	-	-	-	-
Lease ranch	-	-	-	-	-	-
Sub-total	11,097	53.4	6,385	30.7	4,080	19.6
Freehold Land						
Freehold farms	-	-	320	1.5	-	-
Arable blocks		-		-	320	1.5
Sub-total	-	-	320	1.5	320	1.5
State Land						
National Parks	9,540	45.9	9,540	45.9	9,540	45.9
Game Reserves	0	-	-	-	-	-
Forest Reserves	163	0.8	4,555	21.9	4,555	21.9
WMA	-	-	-	-	2,305	11.1
QBLDC	-	-	-	-	-	-
Sub-total	9,703	46.6	14,095	67.8	16,400	78.8
Total Land	20,800	100.0	20,800	100.0	20,800	100.0

Source: 1995 Botswana Land Use Map, Cartographic Section , Ministry of Agriculture.

Table: 3.12 Land Use Change in Ghanzi Disrict, 1974 – 2007

Land Use/Tenure	1974		1981		1995		2003		2007	
	Land Area square kilometres	Percentage of District Land Area	Land Area square kilometres	Percentage of District Land Area	Land Area square kilometres	Percentage of District Land Area	Land Area square kilometres	Percentage of District Land Area	Land Area square kilometres	Percentage of District Land Area
Communal Land										
Pastr/arab/resid	49,484	42.0	48,359	41.0	19,877	16.9	17,732	15.0		12.4
TGLP ranch	-	-	1,012	0.9	1,012	0.9	1,012	0.9	1,012	0.9
Leasehold ranch	6,482	5.5	6,482	5.5	6,482	5.5	6,482	5.5	6,482	5.5
NADP (fencing)	-	-	-	-	-	-	**2,145**	**1.8**	**5,312**	**2.7**
Sub-total	55,966	47.5	55,853	47.4	27,371	23.2	27,371	23.2		23.2
Freehold Land										
Freehold farms	9,108	7.7	9,108	7.7	9,108	7.7	9,108	7.7	9,108	7.7
Sub-total	9,108	7.7	9,108	7.7	9,108	7.7	9,108	7.7	9,108	7.7
State Land										
National Parks	-	-	-	-	-	-	-	-	-	-
Game Reserves	52,800	44.8	52,800	44.8	52,800	44.8	52,800	44.8	52,800	44.8
Forest Reserves	-	-	-	-	-	-	-	-	-	-
WMA	-	-	-	-	28,482	24.2	28,482	24.2	28,482	24.2
QBLDC	36	-	149	0.1	149	0.1	149	0.1	149	0.1
Sub-total	52.836	44.8	52.949	44.9	81.431	69.1	81.431	69.1	81.431	69.1
Total Land	117.910	100.0	117.910	100.0	117.910	100.0	117.910	100.0	117.910	100.0

Source: 2007 Botswana Land Use Map, Cartographic Section , Ministry of Agriculture

Table: 3.13 Land Use Change in Ngamiland Disrict, 1974 - 2007

Land Use/Tenure	1974		1981		1995		2003		2007	
	Land Area square kilometres	Percentage of Area	Land Area Square kilometres	Percentage of District Land Area	Land Area Square kilometres	Percentage of District Land Area	Land Area Square kilometres	Percentage of District Land Area	Land Area Square kilometres	Percentage of District Land Area
Communal										
	100.677	92.3	92.939	85.2	60.072	55.0	57.996	53.1	57.283	52.5
TGLP ranch	-	-	6.460	5.9	6.460	5.9	6.460	5.9	6.460	5.9
Lease ranch	-	-	-	-	-	-	-	-	-	-
NADP	-	-	-	-	-	-	**2,076**	**1.9**	**713**	**0.7**
Sub-total	100.677	92.3	99.399	91.1	66.532	61.0	66.532	61.0	66.532	61.0
Freehold										
Freehold	-	-	-	-	-	-	-	-	-	-
Sub-total	-	-	-	-	-	-	-	-	-	-
State Land										
National	2.155	2.0	2.155	2.0	2.155	2.0	2.155	2.0	2.155	2.0
Game	4.282	3.9	5.560	5.1	5.560	5.1	5.560	5.1	5.560	5.1
Forest	-	-	-	-	-	-	-	-	-	-
WMA	-	-	-	-	32.867	30.1	32.867	30.1	32.867	30.1
OBLDC	2.016	1.8	2.016	1.8	2.016	1.8	2.016	1.8	2.016	1.8
Sub-total	8.453	7.7	9.731	8.9	42.598	39.0	42.598	39.0	42598	39.0
Total Land	109.130	100.0	109.130	100.0	109.130	100.0	109.130	100.0	109.130	100

Source: 2007 Botswana Land Use Map, Cartographic Section , Ministry of Agriculture

Table 3.14 Land Use Change in Kgalagadi Disrict, 1974 - 2003

Land Use/Tenure	1974		1981		1995		2003	
	Land Area square kilometres	Percentage of Area	Land Area square kilometres	Percentage of Area	Land Area square kilometres	Percentage of Area	Land Area square kilometres	Percentage of Area
Communal Land								
Pastr/arab/resid	74,194	69.4	69,672	65.2	26,112	24.4	25,642	23.9
TGLP ranch	-	-	4,067	3.8	4,067	3.8	4,067	3.8
Lease ranch	6,608	6.2	6,608	6.2	6,608	6.2	6,608	6.2
NADP (fencing)	-	-	-	-	-	-	**470**	**0.4**
Sub-total	80,802	75.6	80,347	75.1	36,787	34.4	36,787	34.4
Freehold Land								
Freehold farms	-	-	-	-	-	-	-	-
Arable blocks	-	-	-	-	-	-	-	-
Sub-total	-	-	-	-	-	-	-	-
State Land								
National Parks	25,665	24.0	26,120	24.4	26,120	24.4	26,120	24.4
Game Reserves	-	-	-	-	-	-	-	-
Forest Reserves	-	-	-	-	-	-	-	-
WMA	-	-	-	-	43,560	40.7	43,560	40.7
QBLDC	473	0.4	473	0.4	473	0.4	473	0.4
Sub-total	26,138	24.4	26,593	24.9	70,153	65.6	70,153	65.6
Total Land	106,940	100.0	106,940	100.0	106,940	100.0	106,940	100.0

Source: 2003 Botswana Land Use Map, Cartographic Section , Ministry of Agriculture.

3.4 Pressure on Land

In most parts of Botswana, pressure on the land resource is primarily a result of an expansion of human activities which are in turn spawned by rapid population growth, poor productive capacity of most of the land and institutional arrangements. These factors interact to produce impacts that vary from place to place depending on the levels at which they interact.

Consistent pressure on land can result in land degradation, that is, a land situation that constitutes the reduction or loss of the biological or economic productivity of rain-fed cropland, irrigated cropland, or range, pasture, forest or woodlands resulting from natural processes.

The National Settlement Policy's Final Report (June, 1998) states that the issues of concern under land use and tenure in Botswana are mismanagement of grazing land particularly in communal areas, unwarranted change of limited fertile arable land to other uses and land use conflicts. The report further elaborates on these issues as follows:

(a) Lack of institutionalised regulatory measures to control and ensure proper use of communal grazing land, as TGLP and freehold ranch owners who have exclusive rights to their ranches continue to let their animals into the communal areas, only to return them to their ranches when pasture is denuded in the communal areas.
(b) Overstocking which is a result of increase of livestock beyond the carrying capacity of the land, leading to degradation of the environment and a reduced quality of livestock.
(c) Sub-division and change of use of arable land and development of such land for other purposes, especially in and around the fast growing towns.
(d) The encroachment of settlements onto agricultural and wildlife areas, through the allocation of land outside the existing settlement's water works boundary. This practice which stems from individuals who prefer to exercise their constitutional right of settling where they wish, leads to sprawling and land use conflicts.
(e) Lack of land use zoning plans and non-adherence to them in some districts where they exist, resulted in improper and un-optimal use of land.

4.0 WATER RESOURCE

4.1 Introduction

Water resources are sources of water that are useful or potentially useful to humans. It is a basic need for human beings and is one of the major keys of any economic development of the world societies and a sustainable use of this resource is of utmost importance. The water resources problem is seen as a potential limit to development and a stress on population and economic growth. Africa's water resources are threatened by the increasing population trend which results in increase in water demand by various users who use water for different activities. In Botswana this very precious resource is scarce due to the semi arid climatic condition of this country which is characterized by recurrence of drought.

It has been reported in the "Caricom Environment in Figures, 2002" that freshwater[1] occupies a space of 2.5 percent of Earth's surface and it exist in the form of rivers, lakes, wells, reservoirs etc. It has been further reported in another article that of the 2.5 percent of water on the earth surface, over two thirds is frozen in glaciers and polar ice caps, leaving only 0.007 percent which is available for human use. Freshwater is a renewable resource, yet the world's supply of clean and fresh water is decreasing. It can be unsustainable if the rate of abstraction that is, the volume per time unit abstracted exceeds the rate of replenishment of the resources. Factors such as rainfall, temperature, evaporation, and runoff have been identified as a condition which determines water availability.

Statistics on water resources in Botswana presented in this publication are confined to inland water because the country is landlocked.

4.2 Uses of water

Water is used for various purposes which include agriculture, industrial, households, recreational, as well as environmental activities. Businesses also use water for a variety of purposes, from washing dishes and flushing toilets in the offices, and manufacturing activities. The amount of water used depends on the type of business and the size of households.

In Botswana water is mainly used for human consumption, commercial, industry and institutional purpose although it varies per sector.

4.3 Sources of water

The Ministry of Mineral Resources and Water Affairs has the main responsibility for policy in the water sector. There are a number of institutions involved in water sector activities and these include, inter alia, Department of Water Affairs, Department of Geological Services (DGS), Water Utilities Corporation (WUC), Ministry of Local Government and the Ministry of Agriculture (MOA). The responsibility of water resources has been rationalized between these

[1] Freshwater is naturally occurring water having a low concentration of salts. It is generally accepted as suitable for abstraction and treatment to produce portable water

institutions for better management and planning. The country is supplied with both surface and ground water and the three main water sources in Botswana are Dams, Rivers and Boreholes.

4.3.1 Surface water -Dams

Botswana is generally an arid country, with little surface water[2] except in the far north. Surface water resources are the main source of water supply for urban areas. Water from dams and rivers contributes about one-third to national water consumption. An increasingly large proportion of the population which resides in the urban areas as a result of urban migration is supplied by water from the dams.

Water Utilities Corporation (WUC) is responsible for the supply of water to the six Urban/mining centers and other designated areas except for Orapa, which is supplied by the Debswana Company. According to the Population Projection for Botswana 2001-2031 WUC served 24 percent of the total population with water in 2007 and the population has increased by 2 percent from 2001.

Table 4.1 Major Dams in Botswana

Name of Dam	Capacity MCM	Region
Gaborone	141.4	South East
Molatedi	201.0	Outside the country
Bokaa	18.5	South East/ Kgatleng
Nnywane	2.3	South East
Letsibogo	100.0	Central
Shashe	85.0	North East

Source: Water utilities Corporation

Table 4.1 shows the major dams and their location which provide surface water to urban areas. The biggest dam so far is the Gaborone Dam with a capacity of 141.4 million cubic meters while the smallest is the Nnywane Dam with a capacity of 2.3 million cubic meters. Gaborone Dam supplies water to two towns which are Gaborone and Lobatse with a population of 213,384 and 29,951 respectively (Population Projections for Botswana 2001-2031, CSO). The dam is constructed along Notwane River and its water is supplemented by Bokaa Dam which is constructed along the Metsimotlhabe River in Kgatleng District. The development of surface water in Botswana is constrained by a number of factors such as its low and erratic run-off, lack of the availability of suitable dam sites, and high rates of evaporation.

Table 4.2 shows the amount of water stored by each dam. When there is shortage of water at Gaborone dam, water is imported from Molatedi dam which is 60 Km east of Gaborone along Marico River in South Africa.

[2] Surface water is all water naturally open to the atmosphere e.g. rivers, lakes, dams etc.

Table 4.2 Water Storage for selected dams by year ('000 000 cubic meters)

Year	Gaborone	% Full	Molatedi	% Full	Bokaa	% Full	Nnywane	% Full	Letsibogo	% Full	Shashe	% Full
1990	113.1	78.5	0.5	70.0	-	-	0.4	16.1	-	-	84.8	97.5
1991	85.6	59.4	0.1	8.6	-	-	0.1	2.2	-	-	71.7	82.4
1992	108.5	76.3	-	-	7.2	39.2	1.3	56.8	-	-	63.4	74.6
1993	102.3	71.7	-	-	10.4	56.3	1.7	73.5	-	-	71.4	83.9
1994	90.1	72.9	-	-	10.5	56.9	2.0	86.5	-	-	66.6	78.3
1995	109.1	76.3	-	-	13.6	73.4	2.0	85.3	-	-	77.3	89.3
1996	130.0	91.5	-	-	12.4	67.2	2.0	85.1	-	-	67.5	82.5
1997	126.6	89.2	-	-	11.3	61.1	2.0	86.5	7.5	7.5	67.4	79.7
1998	97.2	68.4	-	-	3.3	17.9	1.1	49.5	10.6	10.6	66.9	79.1
1999	95.8	67.0	-	-	9.6	51.6	1.4	61.9	37.2	37.2	72.4	85.0
2000	121.8	86.1	-	-	17.0	89.8	2.1	92.8	85.1	85.1	72.5	85.2
2001	125.9	89.2	-	-	17.7	74.0	1.8	76.4	67.7	67.1	73.3	86.2
2002	105.4	74.5	-	-	10.0	54.2	1.2	51.2	59.8	70.8	46.1	44.5
2003	79.5	56.2	-	-	7.4	40.0	0.9	40.0	72.7	86.2	55.0	53.0
2004	42.6	30.1	-	-	11.7	62.9	2.0	85.0	75.2	73.5	73.7	87.4
2005	50.0	35.4	-	-	7.6	40.8	1.8	77.4	67.5	81.8	85.2	82.2

Source: Water Utilities Cooperation

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4.3.2 Surface water – Rivers

There are only two perennial rivers in the country namely Okavango and Chobe Rivers and both are situated in the north of the country, the rest of the rivers are ephemeral. The ephemeral rivers are important in that they provide locations for dam sites.

The following river basins are formed by the rivers:

- The Molopo/Nossop River forms the southern border between Botswana and South Africa. The river rarely flows due to low precipitation in the area
- The Limpopo River forms the eastern border between Botswana and South Africa. Some rivers which drain into Limpopo are Notwane, Lotsane, Motloutse and Shashe Rivers. Since the rivers are situated in the eastern part of the country where majority of people live, these rivers have been dammed to provide water to the population.
- Makgadikgadi Basin is fed by Boteti, Nata, Mosetse and Mosope Rivers.
- Kwando/linyanti/Chobe River Basin originates from Angola, crosses Namibia and enters Botswana at Chobe in the north. The Savuti and Linyanti Rivers form part of the drainage basin in Botswana. From Botswana the Chobe River then flows into Zambezi in Zambia and Zimbabwe.
- Okavango River basin is composed of the Okavango River and Delta. It also feeds the Makgadikgadi Pans through the Boteti River

4.3.3 Groundwater resources

Groundwater is the main source of potable water supply in the country. Much of the country (about 76 percent) depends entirely on groundwater. Groundwater resources are essential to many individuals, companies and communities to supply water for drinking, agriculture and industry. Major issues are the rate of groundwater replenishment relative to the rate of extraction, and groundwater quality. Groundwater recharge is very limited, making the resource finite and non-renewable.

Department of Water Affairs (DWA) is responsible for supplying groundwater to 17 major villages and also supplies all smaller settlements with groundwater for their water needs through the District Councils. It is also responsible for protection of surface water resources from pollution and aquatic weeds and for administering the water legislation. On the other hand District Councils are responsible for the operation and maintenance of water schemes in medium villages and smaller settlements. These schemes are constructed by DWA and on completion they hand them over to the respective Councils. The water supply system for rural villages in north-eastern and central part of Botswana is mainly based on boreholes, which exploit deep fractured aquifers. These sources are strained due to higher demand from various users**.**

For over 38 years, communal standpipes have been the main source of household water especially in the rural areas of Botswana. The excessive amount of water wastage from this water source has been a major concern of government in recent years. The government therefore decided to install prepaid water meters in major villages and rural communities across the country in an attempt to reduce wastage of water.

4.4 Water Abstraction

Water abstraction is the removal of water from any source, either permanently or temporarily, during a specified period of time. Most water is used as fresh water, some are saline. Depending on the environmental legislation in the relevant country, controls may be placed on abstraction to limit the amount of water that can be removed. Over abstraction can lead to rivers drying up or the level of groundwater aquifers reducing unacceptably (Wikipedia).

According to a South African Geographical Journal "Water resources in Botswana with particular reference to the Savanna Regions" by du Plessis, A.J.E. and Rowntree, K.M. (2003) "Botswana is already experiencing so-called 'water stress' which is related to a number of factors such as rapidly increasing population leading to a sharp increase in water demand, low and variable rainfall, high rates of evaporation, and the high cost of exploiting existing water resources. At the current rates of abstraction, the lifetime of surface and groundwater resources is limited to decades. Botswana shares four river basins with its neighboring countries. This results in a situation where 94 percent of the fresh water resources which Botswana can theoretically access originating outside its borders, making water resource management highly complex. Transnational sharing and management of water resources therefore plays a major role in securing sustainability of water resource"

Table 4.3: Dams constructed in Botswana

Name of Dam	River	River Basin	Nearest Town	Full supply capacity MCM
Gaborone	Ngotwane	Limpopo	Gaborone	144.0
Shashe	Shashe	Limpopo	Francistown	87.9
Bokaa	Metsimotlhabe	Limpopo	Gaborone	18.5
Nnywane	Nnywane	Limpopo	Lobatse	2.3
Letsibogo	Motloutse	Limpopo	Selibe-Phikwe	100
Mopipi	Boteti	Okavango	Orapa	100

Kgathi, D.L., 1999: *Water demand, population and sustainability in Botswana: Implications for Development Policy*, A paper prepared for the Population, Development and Environment Project, International Institute for Applied Systems Analysis, Luxemburg.

Approximately 35 percent of the total water supply is from surface water, whereas the remainder (65 percent) is from groundwater. However, surface water accounts for 90 percent of the total supply of water in urban areas such as Gaborone, Lobatse, Francistown and Selibe-Phikwe. Apart from major rivers such as the Chobe and Limpopo tributaries, the Okavango Delta (one of the two most important wetlands in Botswana) forms a major part of the surface water resources in Botswana (Kgati,1999).

Table 4.4 Population for the 17 major villages

VILLAGE	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Kanye	31,354	31,918	32,493	33,078	33,673	34,202	34,852	35,515	36,189	36,877	37,495	38,170	38,857	39,557	40,269	41,051
Ramotswa	18,683	19,412	20,324	21,421	22,385	23,047	24,245	25,458	26,731	27,933	28,771	30,498	32,023	33,624	35,305	37,423
Maun	26,768	27,196	27,659	28,101	28,495	28,969	29,490	30,287	31,104	31,260	31,515	32,397	33,207	33,373	33,473	34,206
Tlokweng	12,501	13,214	13,927	14,484	15,208	16,254	17,067	17,920	18,816	19,870	20,998	21,712	22,385	23,079	23,841	24,270
Tsabong	3,352	3,443	3,535	3,631	3,729	3,820	3,916	4,014	4,114	4,217	4,332	4,440	4,551	4,665	4,781	4,889
Moshupa	11,444	11,696	11,953	12,216	12,485	12,787	13,081	13,382	13,690	14,005	14,351	14,681	15,019	15,364	15,718	16,076
Tonota	11,129	11,240	11,353	11,466	11,581	11,704	11,833	11,963	12,083	12,203	12,469	12,618	12,770	12,923	12,923	13,078
Ghanzi	5,550	5,766	5,991	6,225	6,468	6,727	6,922	7,123	7,330	7,542	7,769	7,995	8,226	8,465	8,710	8,974
Mahalapye	28,078	28,499	28,927	29,361	29,801	30,294	30,809	31,333	31,865	32,407	33,034	33,563	34,100	34,645	35,200	35,809
Palapye	17,362	17,744	18,134	18,533	18,941	19,322	19,786	20,261	20,747	21,245	21,716	22,194	22,682	23,181	23,691	24,215
Kasane	4,336	4,574	4,826	5,092	5,372	5,664	5,969	6,292	6,632	6,990	7,354	7,729	8,123	8,537	8,973	9,437
Mochudi	25,542	26,053	26,574	27,105	27,647	28,224	28,817	29,422	30,040	30,671	31,256	31,600	31,948	32,299	32,655	33,080
Molepolole	36,930	37,927	38,951	40,003	41,083	42,169	43,350	44,564	45,811	47,094	48,394	49,701	51,042	52,421	53,836	55,384
Serowe	30,264	30,567	30,872	31,181	31,493	31,782	32,163	32,549	32,940	33,335	33,809	34,181	34,557	34,937	35,321	35,784
Thamaga	13,026	13,326	13,632	13,946	14,266	14,617	14,968	15,327	15,695	16,072	16,488	16,884	17,289	17,704	18,129	18,549
Letlhakane	8,583	8,978	9,391	9,823	10,275	10,730	11,192	111,673	12,175	12,698	13,227	13,756	14,306	14,878	15,473	16,059
Mogoditshane	14,246	14,958	15,706	16,492	17,316	18,159	19,031	19,944	20,901	21,905	22,957	23,990	25,069	26,198	27,376	28,636

CSO: 1991 Population and Housing Census, Population Projection 1991-2021

Table 4.4 is the Population figures of the 17 major villages which are supplied the Department of Water Affairs.

Table 4.5: Water Production, Consumption and Losses for the 17 major villages (m^3)

Year	Production	Consumption	Losses	% Loss
1996/1997	13,277,150	9,789,922	3,487,228	26.3
1997/1998	14,178,572	11,400,259	2,778,313	19.6
1998/1999	17,347,164	13,271,364	4,075,800	23.5
1999/2000	18,162,739	14,274,201	3,888,538	21.4
2000/2001	19,721,824	15,110,723	4,611,102	23.4
2001/2002	21,714,743	16,409,409	5,305,334	24.4
2002/2003	22,997,730	17,390,400	5,607,330	24.4
2003/2004	23,683,119	17,497,448	6,185,670	26.1
2004/2005	25,176,190	18,158,147	7,018,043	27.9
2005/2006	24,423,840	17,943,215	6,480,625	26.5
2006/2007	26,778,575	19,405,993	7,372,582	27.5
2007/2008	25,621,514	18,706,183	6,915,330	27.0

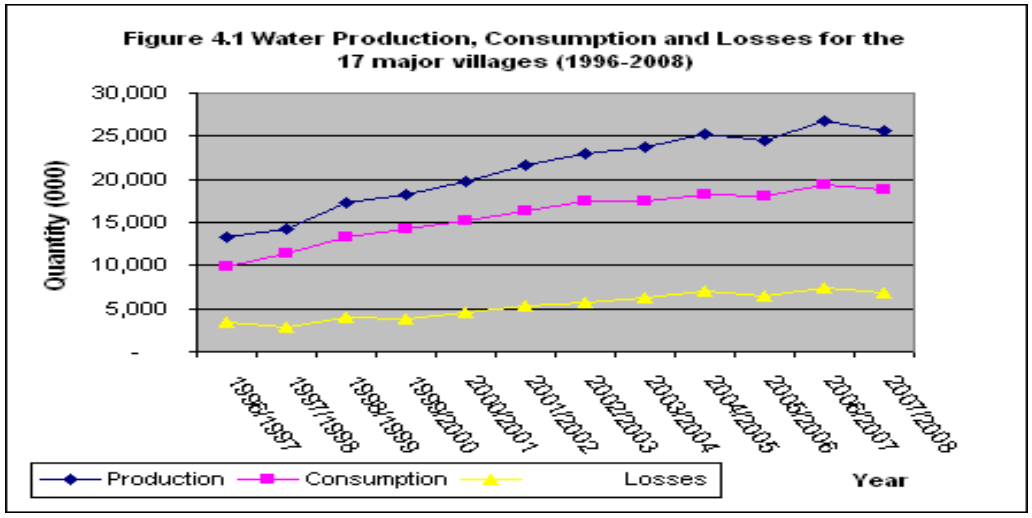


Table 4.5 and Figure 4.1 above show the combined water production, consumption and losses for the 17 major villages. It can be observed from the graph that water production has been constantly increasing from 1996/1997 to 2006/2007 except for 2005/2006 which show a slight fall and the fall in 2007/2008 was because the data recorded was for 7 months only. The graph also shows that water consumption curve has been increasing over the years and this could be caused by population growth and other activities such as construction which uses lots of water. It can also be observed that water losses increases slightly over time. Water can be lost through evaporation, leakage and wastage. WUC and DWA have started campaigns on water conservation and to make the public aware of risks involved when wasting water. They are encouraging the public to recycle water that is, using waste water.

Tables 4.5A to 4.5Q and Figures 4.1A to 4.1Q show production, consumption and losses for individual villages. They show that losses were significantly low in Mochudi in 1997/98 with 2.6 percent, Mogoditshane with 3.0 percent in 1999/2000 and Ghanzi with 4.5 percent in 2005/06. They were significantly high in Serowe where they exceeded consumption at 61.6 percent in 2004/05. They exceeded consumption again in Ramotswa from 2000/01 to 2003/04 by more than 50 percent. In Molepolole, the losses were high in 2001/02 at 45.3 percent.

Table 4.5A Kanye Water Production, Consumption & Loss (m^3)

Year	Production	Consumption	Losses	% Loss
1996/1997	1,256,224	904,327	351,897	28.0
1997/1998	1,528,754	1,084,853	443,901	29.0
1998/1999	1,479,189	1,014,326	464,863	31.4
1999/2000	1,657,291	1,003,560	653,731	39.5
2000/2001	2,187,351	1,606,587	580,764	26.6
2001/2002	2,381,510	1,687,783	693,727	29.1
2002/2003	2,568,447	1,864,072	704,375	27.4
2003/2004	2,662,739	1,614,093	1,048,646	39.4
2004/2005	2,904,969	1,813,722	1,091,247	37.6
2005/2006	2,762,456	1,581,445	1,181,011	42.8
2006/2007	3,317,585	1,895,692	1,421,893	42.9
2007/2008	3,040,021	1,738,569	1,301,452	42.8

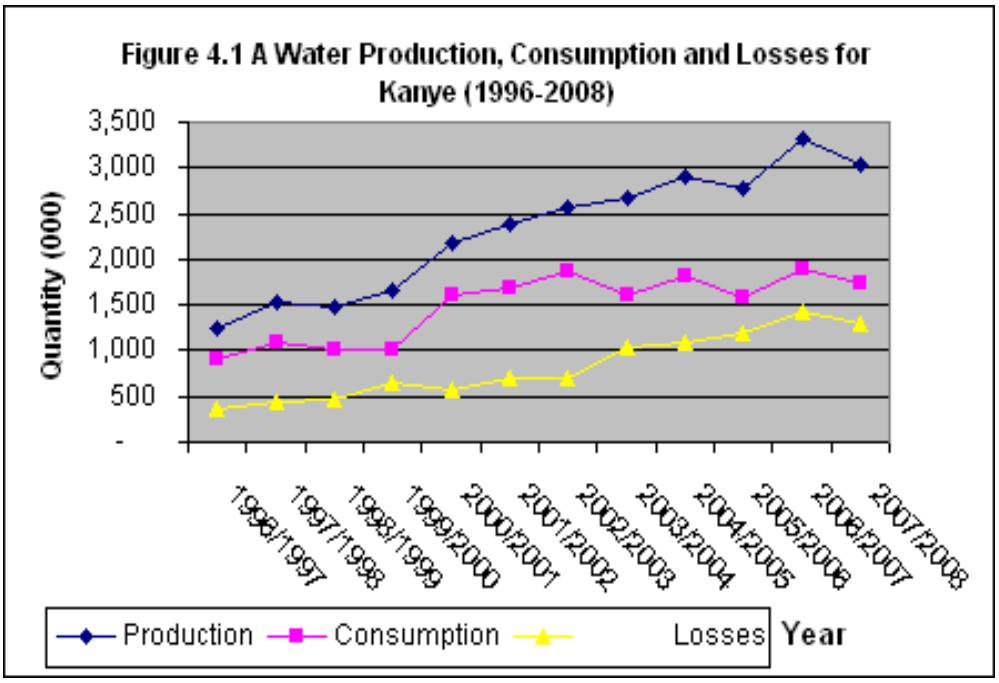


Table 4.5B Ramotswa Water Production, Consumption & Loss (m^3)

Year	Production	Consumption	Losses	% Loss
1996/1997	659,016	465,836	193,180	29.3
1997/1998	508,473	310,883	197,590	38.9
1998/1999	1,082,763	698,638	384,125	35.5
1999/2000	1,287,890	759,507	528,383	41.0
2000/2001	1,414,015	670,336	743,679	52.6
2001/2002	1,362,367	643,349	719,018	52.8
2002/2003	1,559,617	750,890	808,727	51.9
2003/2004	1,483,556	631,636	851,920	57.4
2004/2005	1,344,002	954,068	389,934	29.0
2005/2006	1,275,156	942,884	332,272	26.1
2006/2007	1,610,900	889,050	721,850	44.8
2007/2008	1,443,028	928,667	514,361	35.6

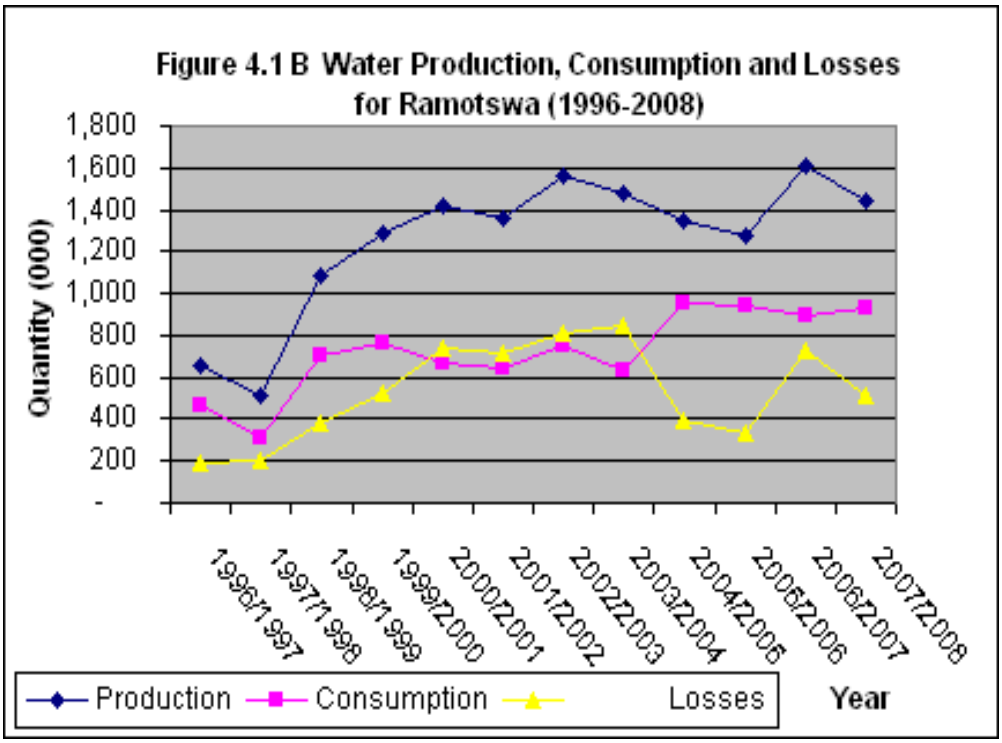


Table 4.5C: Maun Water Production, Consumption & Loss (m^3)

Year	Production	Consumption	Losses	% Loss
1996/1997	1,124,077	782887	341,190	30.4
1997/1998	1,146,090	1019172	126,918	11.1
1998/1999	1,186,971	1,029,465	157,506	13.3
1999/2000	1,218,520	980,972	237,548	19.5
2000/2001	1,157,234	908,380	248,854	21.5
2001/2002	1,610,332	1,124,519	485,813	30.2
2002/2003	1,295,582	970,020	325,562	25.1
2003/2004	1,188,079	948,483	239,596	20.2
2004/2005	1,435,451	1,065,138	370,313	25.8
2005/2006	1,682,822	1,181,793	501,029	30.0
2006/2007	1,697,088	1,305,158	391,930	23.0
2007/2008	1,689,955	1,243,476	446,480	26.0

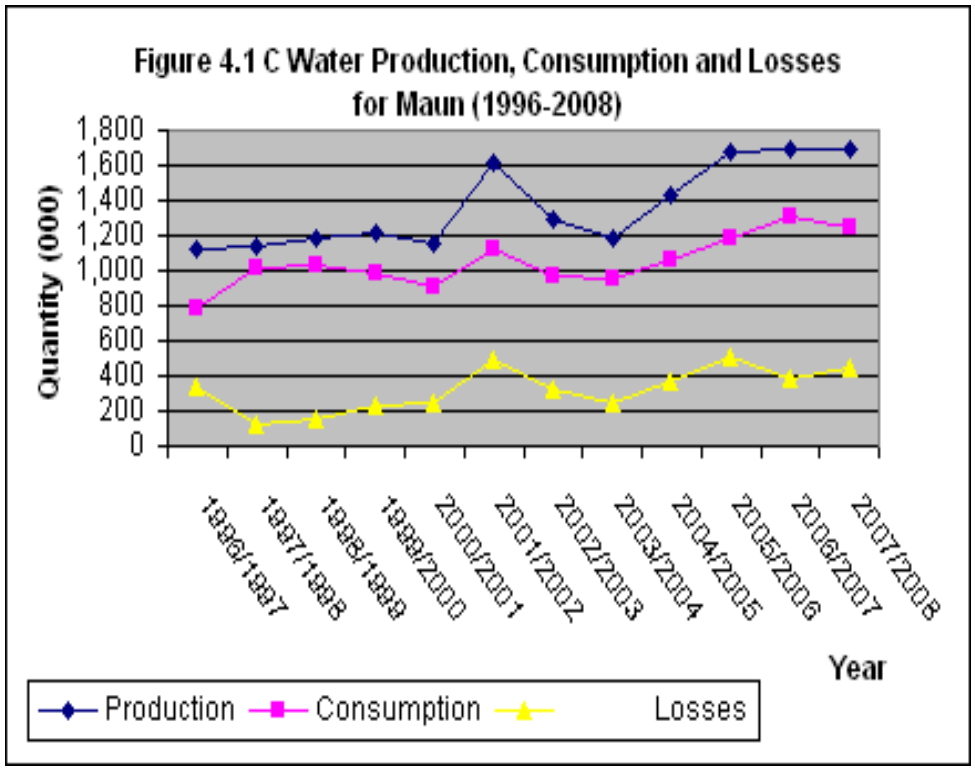


Table 4.5D Tlokweng Water Production, Consumption & Loss (m^3)

Year	Production	Consumption	Losses	% Loss
1996/1997	692,500	438,782	253,718	36.6
1997/1998	776,084	508,811	267,273	34.4
1998/1999	1,008,915	804,757	267,208	26.5
1999/2000	1,367,845	1,100,702	267,143	19.5
2000/2001	1,338,680	1,149,080	189,600	14.2
2001/2002	1,538,932	1,090,678	448,254	29.1
2002/2003	1,608,990	1,221,293	387,697	24.1
2003/2004	1,721,059	1,436,306	284,753	16.6
2004/2005	1,593,460	1,192,356	401,104	25.2
2005/2006	1,151,740	931,422	220,318	19.1
2006/2007	1,523,160	1,169,138	354,022	23.2
2007/2008	1,337,450	1,050,280	244,290	18.3

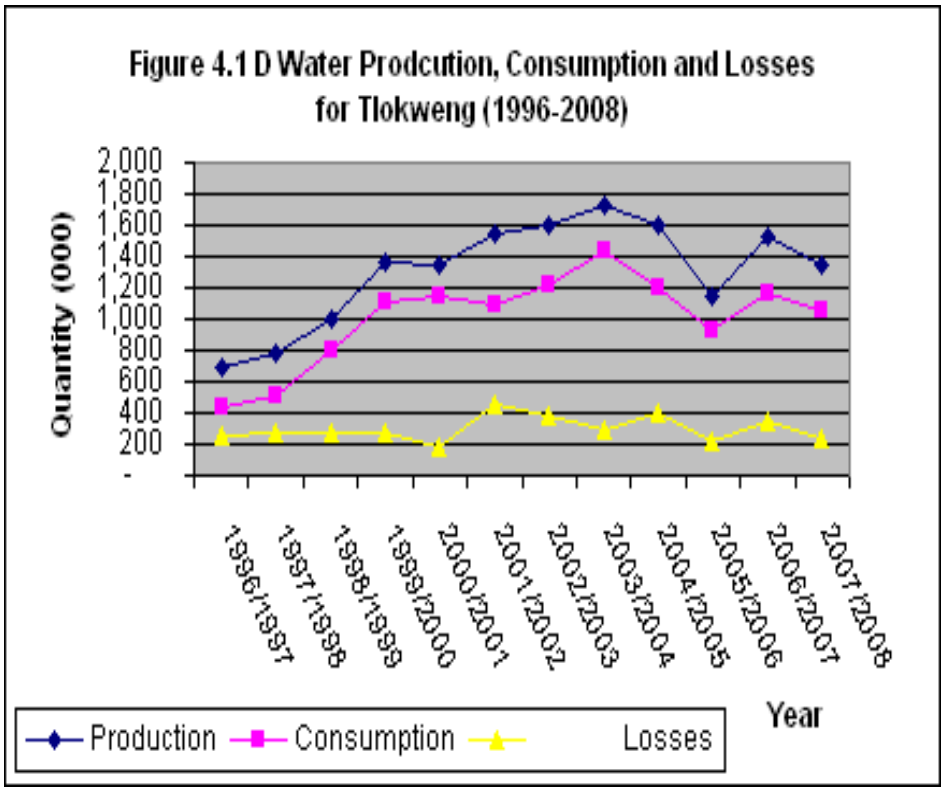


Table 4.5E Tsabong Water Production, Consumption & Loss (m^3)

Year	Production	Consumption	Losses	% Loss
1996/1997	165,078	146,217	18,861	11.4
1997/1998	162,684	139,023	23,661	14.5
1998/1999	195,740	162,377	33,363	17.0
1999/2000	224,245	185,730	38,515	17.2
2000/2001	289,508	221,960	67,548	23.3
2001/2002	284,748	218,687	66,061	23.2
2002/2003	280,786	232,421	48,365	17.2
2003/2004	320,498	250,969	69,529	21.7
2004/2005	343,266	260,821	82,445	24.0
2005/2006	380,672	277,436	103,236	27.1
2006/2007	348,905	249,570	99,335	28.5
2007/2008	364,789	263,503	101,286	27.8

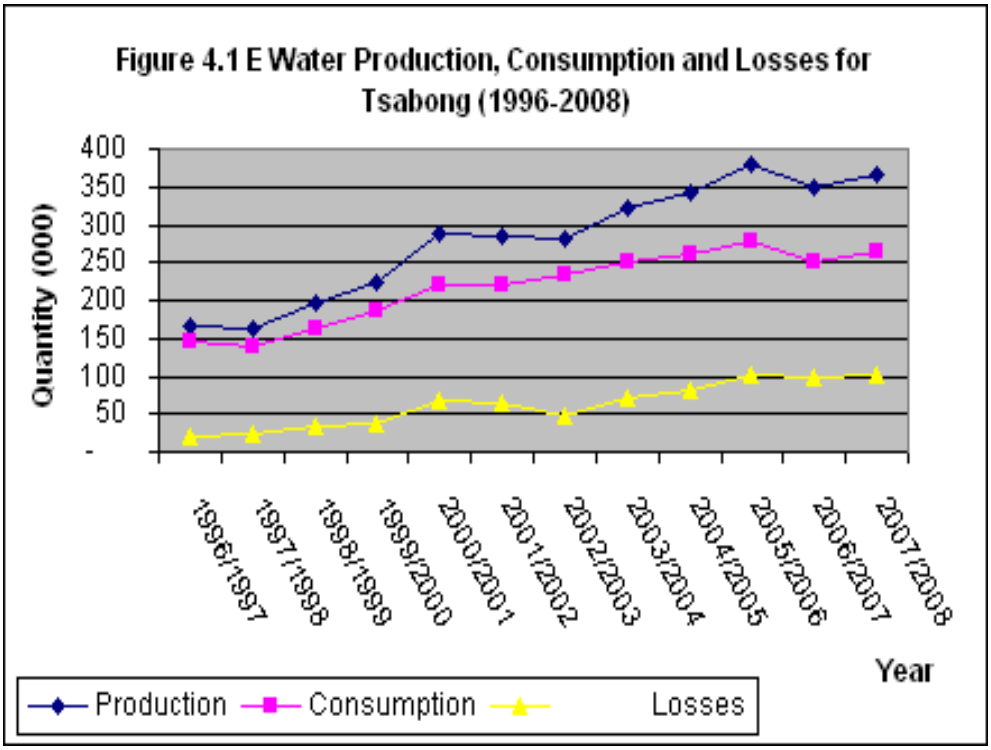


Table 4.5F Moshupa Water Production, Consumption & Loss (m^3)

Year	Production	Consumption	Losses	% Loss
1996/1997	242,251	188,659	53,592	22.1
1997/1998	265,656	190,615	75,041	28.3
1998/1999	281,761	229,645	52,116	18.5
1999/2000	336,063	262,766	73,297	21.8
2000/2001	345,872	249,663	96,209	27.8
2001/2002	386,240	277,157	109,083	28.2
2002/2003	466,551	332,407	134,144	28.8
2003/2004	496,096	316,391	179,705	36.2
2004/2005	539,560	319,310	220,250	40.8
2005/2006	458,793	311,505	147,288	32.1
2006/2007	539,650	393,952	145,698	27.0
2007/2008	499,222	352,729	146,493	29.3

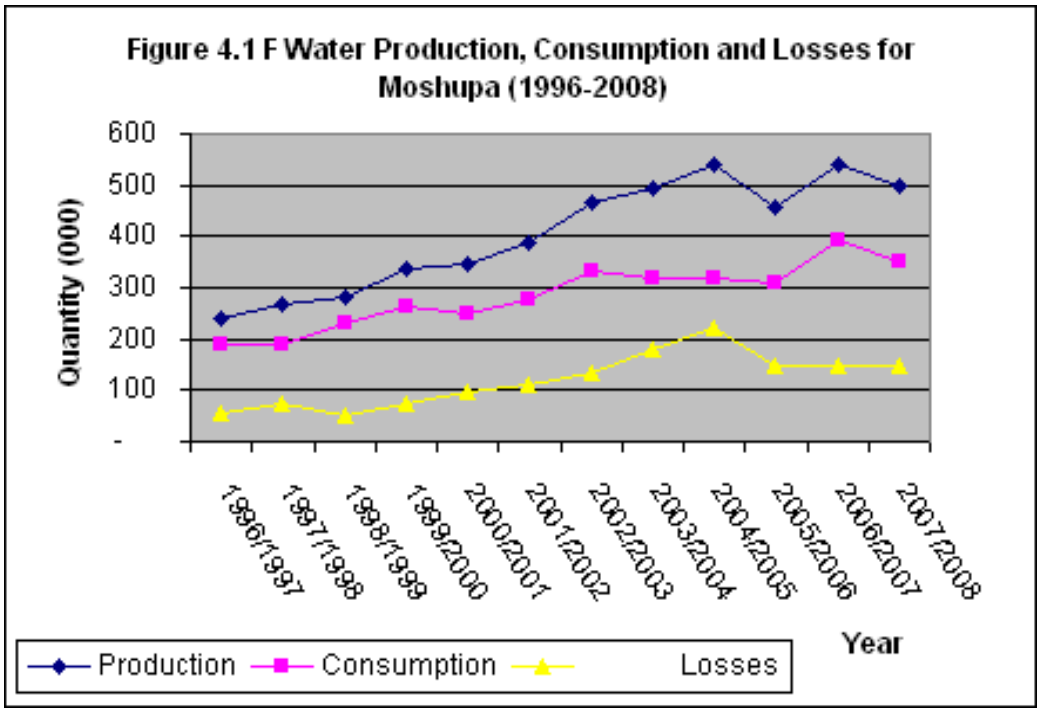


Table 4.5G Tonota Water Production, Consumption & Loss (m^3)

Year	Production	Consumption	Losses	% Loss
1996/1997	524,223	468,480	55,743	10.6
1997/1998	576,326	479,924	96,402	16.7
1998/1999	937,566	688,949	248,617	26.5
1999/2000	701,715	600,332	101,383	14.5
2000/2001	779,191	638,294	140,897	18.1
2001/2002	889,464	748,189	141,275	15.9
2002/2003	971,525	838,638	132,887	13.7
2003/2004	867,792	768,868	98,924	11.4
2004/2005	1,001,592	823,000	178,592	17.8
2005/2006	929,608	781,621	147,987	15.9
2006/2007	942,606	843,563	99,043	10.5
2007/2008	957,935	816,061	141,874	14.8

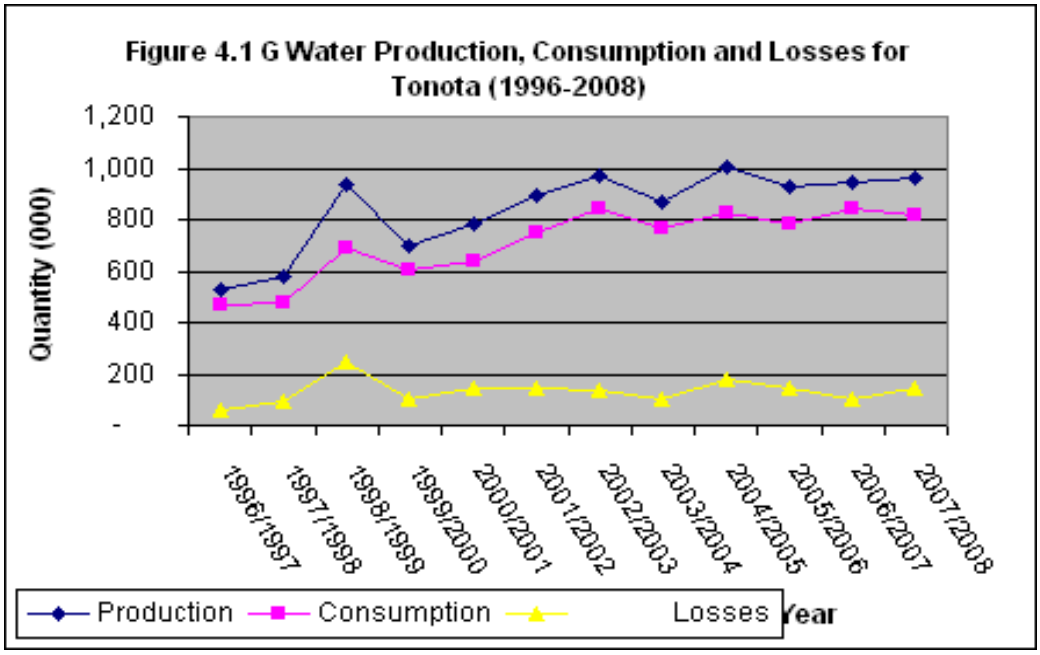


Table 4.5H Ghanzi Water Production, Consumption & Loss (m^3)

Year	Production	Consumption	Losses	% Loss
1996/1997	385,187	259,669	125,518	32.6
1997/1998	379,848	321,804	58,044	15.3
1998/1999	379,848	321,804	58,044	15.3
1999/2000	363,381	289,298	74,083	20.4
2000/2001	481,852	396,035	85,817	17.8
2001/2002	496,137	458,043	38,094	7.7
2002/2003	531,687	408,604	123,083	23.2
2003/2004	596,695	432,246	164,449	27.6
2004/2005	601,643	521,676	79,967	13.3
2005/2006	533,126	508,950	24,176	4.5
2006/2007	586,146	526,813	59,333	10.1
2007/2008	579,403	497,421	81,981	14.2

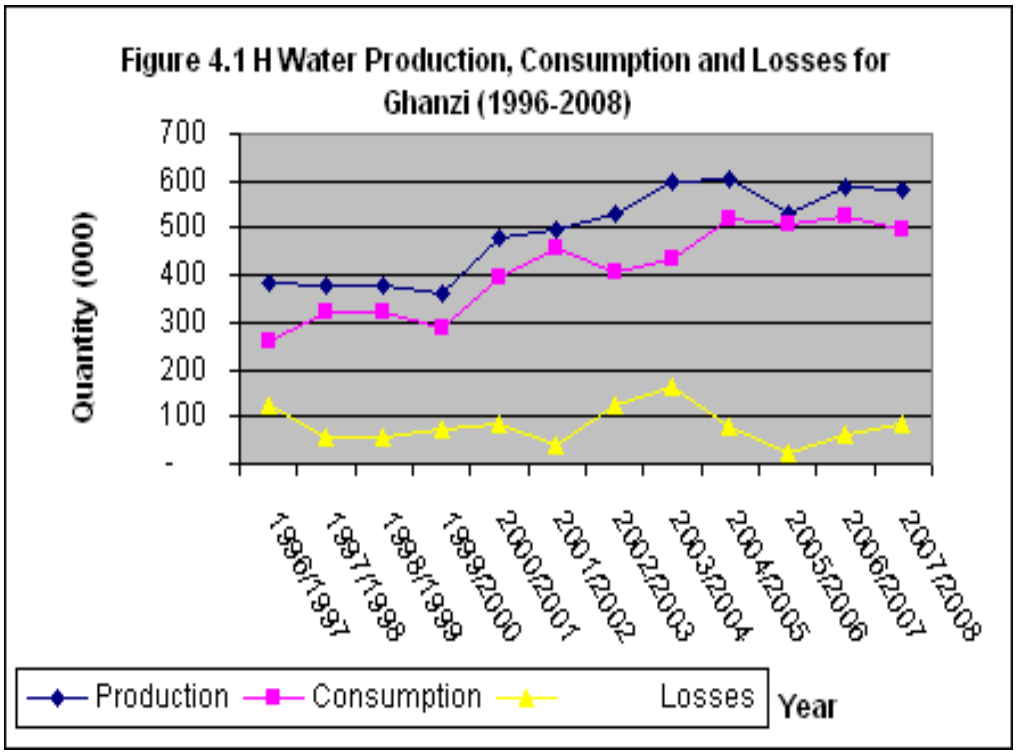


Table 4.5I Mahalapye Water Production, Consumption & Loss (m^3)

Year	Production	Consumption	Losses	% Loss
1996/1997	1,145,585	988,434	157,151	13.7
1997/1998	1,304,354	1,150,680	153,674	11.8
1998/1999	1,886,845	1,466,681	420,164	22.3
1999/2000	2,031,558	1,453,765	577,793	28.4
2000/2001	1,871,462	1,341,124	530,338	28.3
2001/2002	1,958,003	1,593,636	364,367	18.6
2002/2003	2,152,691	1,513,492	639,199	29.7
2003/2004	2,182,230	1,708,877	473,353	21.7
2004/2005	2,172,161	1,794,003	378,158	17.4
2005/2006	2,203,623	1,725,982	477,641	21.7
2006/2007	2,305,873	1,794,011	511,862	22.2
2007/2008	2,254,748	1,759,997	494,752	21.9

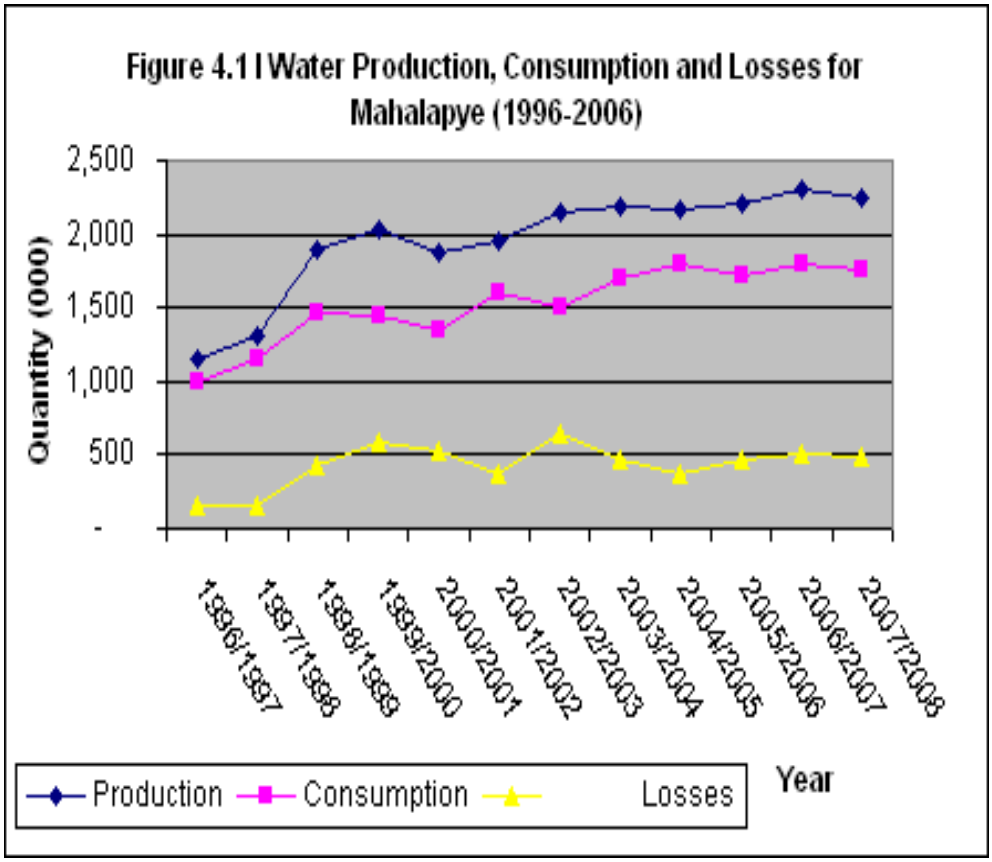


Table 4.5J Palapye Water Production, Consumption & Loss (m^3)

Year	Production	Consumption	Losses	% Loss
1996/1997	829,671	532,802	296,869	35.8
1997/1998	826,412	676,698	149,714	18.1
1998/1999	1,030,555	894,574	135,981	13.2
1999/2000	1,098,006	1,006,158	91,848	8.4
2000/2001	1,168,767	858,149	310,618	26.6
2001/2002	1,328,934	1,017,968	310,966	23.4
2002/2003	1,402,109	1,040,322	361,787	25.8
2003/2004	1,330,101	1,031,515	298,586	22.5
2004/2005	1,492,069	1,063,193	428,876	28.7
2005/2006	1,315,525	978,418	337,107	25.6
2006/2007	1,379,232	1,005,579	373,653	27.1
2007/2008	1,347,378	991,999	355,380	26.4

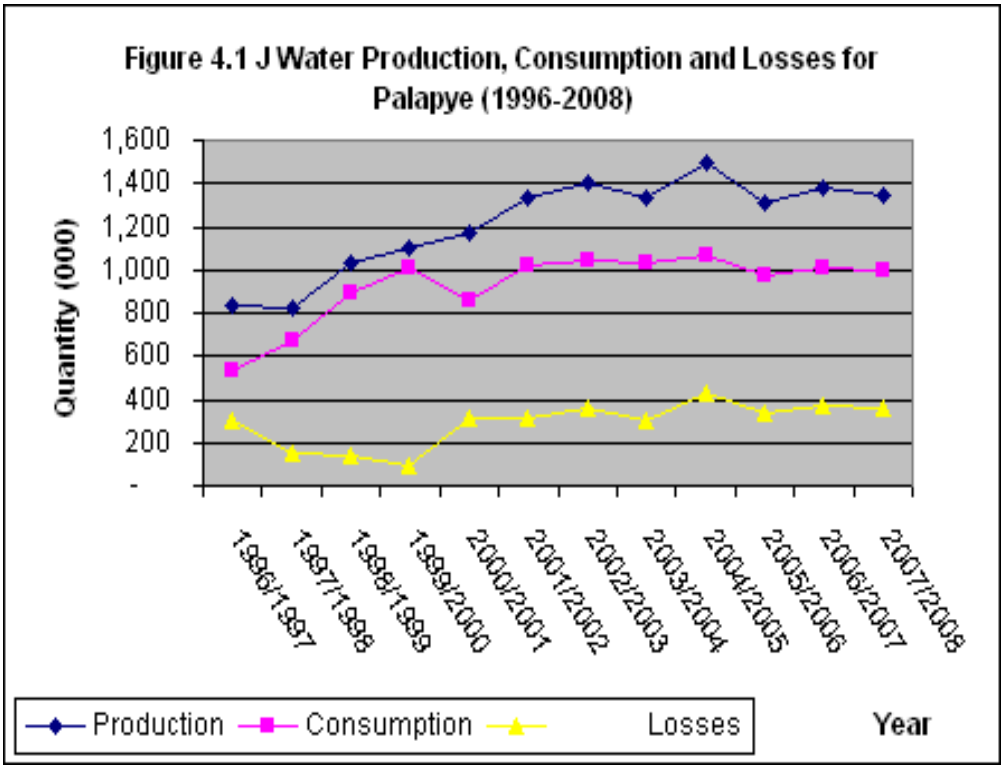


Table 4.5K Kasane Water Production, Consumption & Loss (m^3)

Year	Production	Consumption	Losses	% Loss
1996/1997	510,957	449,510	61,447	12.0
1997/1998	550,483	451,793	98,690	17.9
1998/1999	571,228	454,075	117,153	20.5
1999/2000	604,343	489,206	115,137	19.1
2000/2001	614,750	495,282	119,468	19.4
2001/2002	662,069	539,933	122,136	18.5
2002/2003	619,794	536,101	83,693	13.5
2003/2004	639,725	551,662	88,063	13.8
2004/2005	752,275	669,824	82,451	11.0
2005/2006	862,220	584,968	277,252	32.2
2006/2007	916,840	604,249	312,591	34.1
2007/2008	889,530	594,609	294,922	33.2

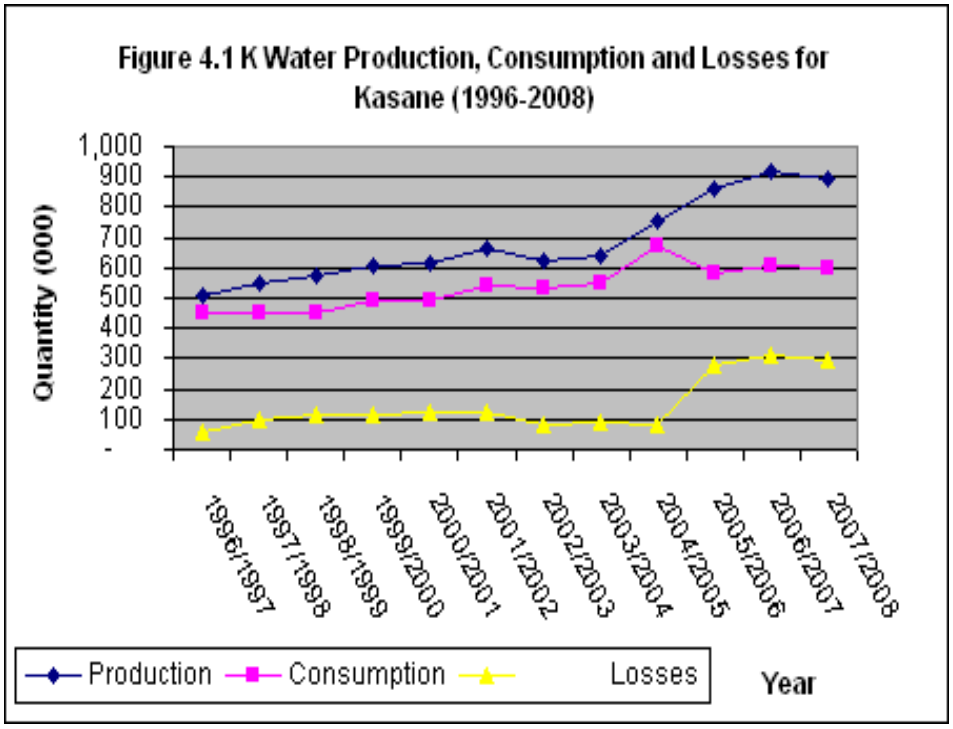


Table 4.5L Mochudi Water Production, Consumption & Loss (m^3)

Year	Production	Consumption	Losses	% Loss
1996/1997	534,381	374,654	159,727	29.9
1997/1998	743,836	724,699	19,137	2.6
1998/1999	1,174,383	863,519	310,864	26.5
1999/2000	1,111,861	940,230	171,631	15.4
2000/2001	1,229,400	1,047,943	181,457	14.7
2001/2002	1,331,558	1,152,689	178,869	13.4
2002/2003	1,675,594	1,436,692	238,902	14.3
2003/2004	1,812,310	1,466,006	346,304	19.1
2004/2005	1,949,026	1,495,320	453,706	23.3
2005/2006	1,610,411	1,349,522	260,889	16.2
2006/2007	1,836,933	1,522,301	314,632	17.1
2007/2008	1,723,672	1,435,912	287,761	16.7

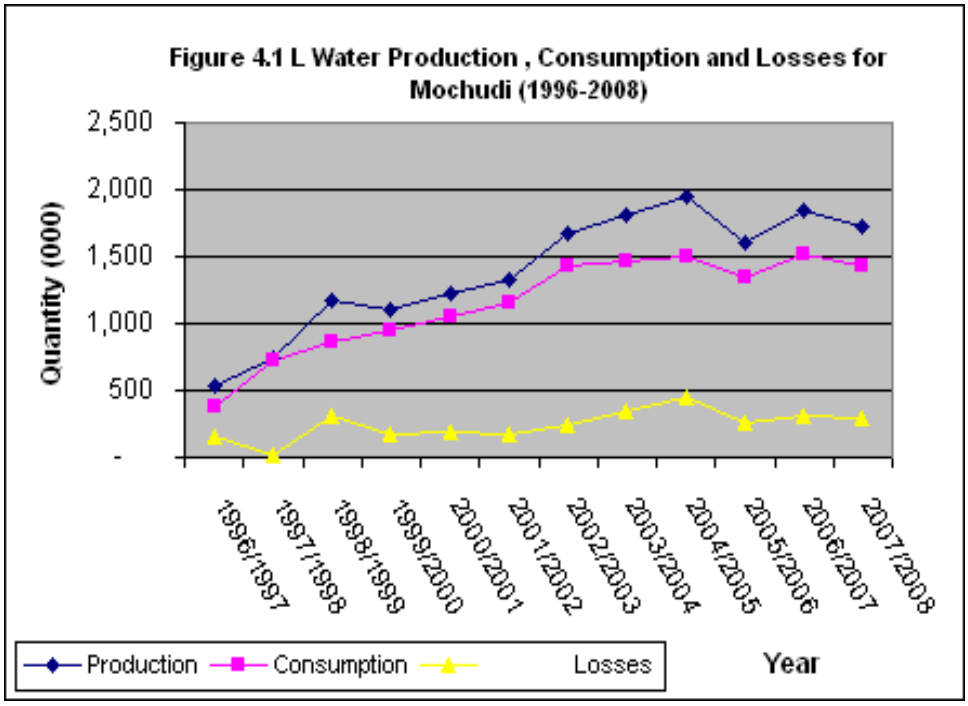


Table 4.5M Molepolole Water Production, Consumption & Loss (m^3)

Year	Production	Consumption	Losses	% Loss
1996/1997	884,566	654,149	230,417	26.1
1997/1998	1,054,996	613,072	441,924	41.9
1998/1999	1,282,401	863,108	419,293	32.7
1999/2000	1,509,807	1,113,144	396,663	26.3
2000/2001	1,701,137	1,127,229	573,908	33.7
2001/2002	1,960,554	1,072,241	888,313	45.3
2002/2003	2,160,437	1,471,880	688,557	31.8
2003/2004	2,147,724	1,566,305	581,419	27.1
2004/2005	2,519,631	1,638,659	880,972	35.0
2005/2006	2,501,041	1,827,218	673,823	26.9
2006/2007	2,672,986	1,904,696	768,290	28.7
2007/2008	2,587,014	1,865,957	721,057	27.8

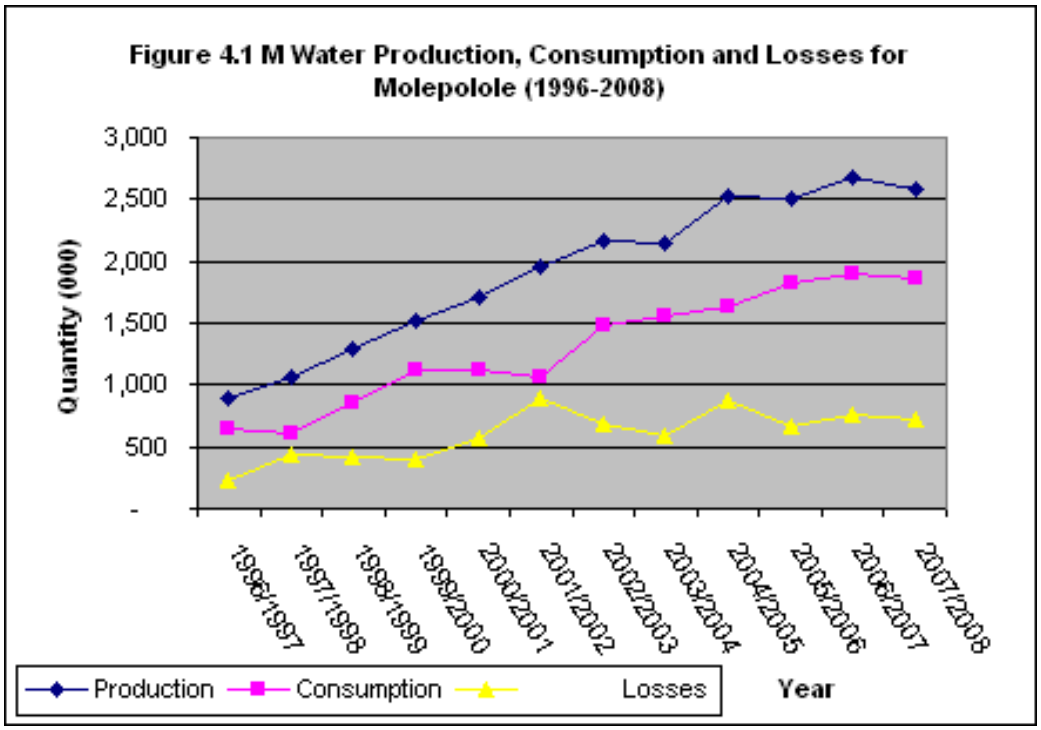


Table 4.5N Thamaga Water Production, Consumption & Loss (m^3)

Year	Production	Consumption	Losses	% Loss
1996/1997	306,060	254,621	51,439	16.8
1997/1998	362,021	282,722	79,299	21.9
1998/1999	421,199	322,622	98,577	23.4
1999/2000	338,551	247,229	91,322	27.0
2000/2001	428,537	290,893	137,644	32.1
2001/2002	428,537	326,915	101,622	23.7
2002/2003	460,789	354,821	105,968	23.0
2003/2004	512,795	354,821	157,974	30.8
2004/2005	486,308	431,791	54,517	11.2
2005/2006	550,968	445,819	105,149	19.1
2006/2007	621,320	502,497	118,823	19.1
2007/2008	586,144	474,158	111,986	19.1

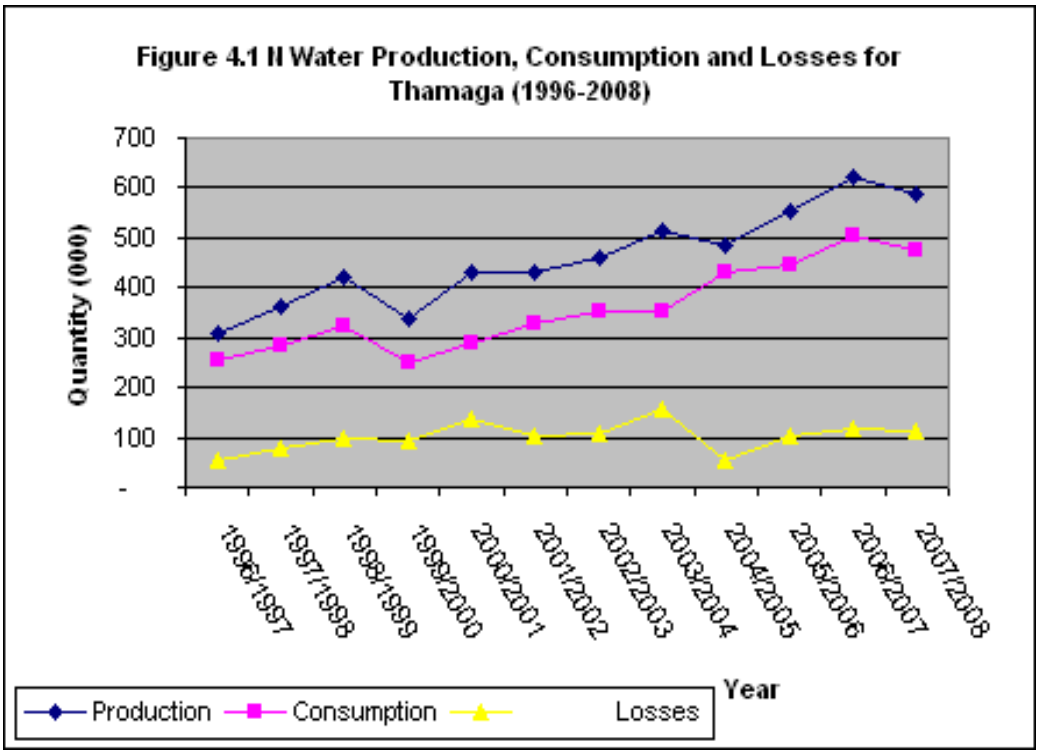


Table 4.5O Serowe Water Production, Consumption & Loss (m^3)

Year	Production	Consumption	Losses	% Loss
1996/1997	1,174,554	796,722	377,832	32.2
1997/1998	1,223,478	1,022,511	200,967	16.4
1998/1999	1,366,472	978,208	388,264	28.4
1999/2000	1,306,311	991,800	314,511	24.1
2000/2001	1,466,165	1,108,774	357,391	24.4
2001/2002	1,612,092	1,404,451	207,641	12.9
2002/2003	1,707,837	1,330,606	377,231	22.1
2003/2004	1,987,130	1,099,942	887,188	44.6
2004/2005	2,266,422	869,277	1,397,145	61.6
2005/2006	2,405,806	1,334,792	1,071,014	44.5
2006/2007	2,585,802	1,527,471	1,058,331	40.9
2007/2008	2,495,804	1,431,132	1,064,673	42.7

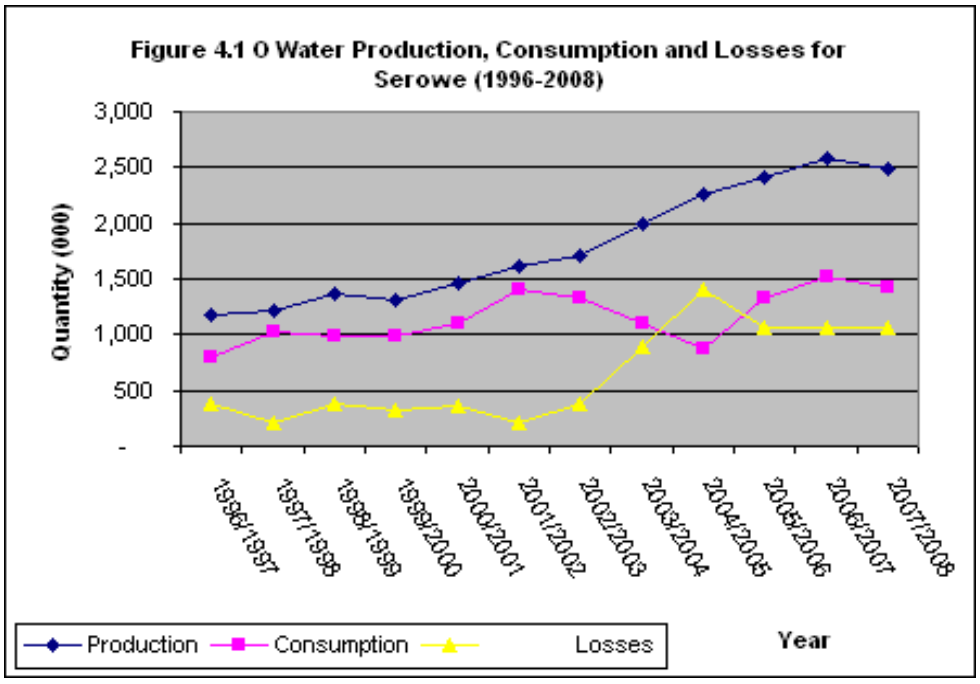


Table 4.5P Letlhakane Water Production, Consumption & Loss (m^3)

Year	Production	Consumption	Losses	% Loss
1996/1997	361,080	312,740	48,340	13.4
1997/1998	391,820	353,195	38,625	9.9
1998/1999	425,675	373,277	52,398	12.3
1999/2000	426,999	356,069	70,930	16.6
2000/2001	440,900	401,457	39,443	9.0
2001/2002	490,588	448,154	42,434	8.7
2002/2003	535,453	478,864	56,589	10.8
2003/2004	555,219	523,414	31,805	5.7
2004/2005	594,511	543,393	51,118	8.6
2005/2006	580,188	516,972	63,216	10.9
2006/2007	648,864	579,689	69,175	10.7
2007/2008	614,526	548,331	66,196	10.8

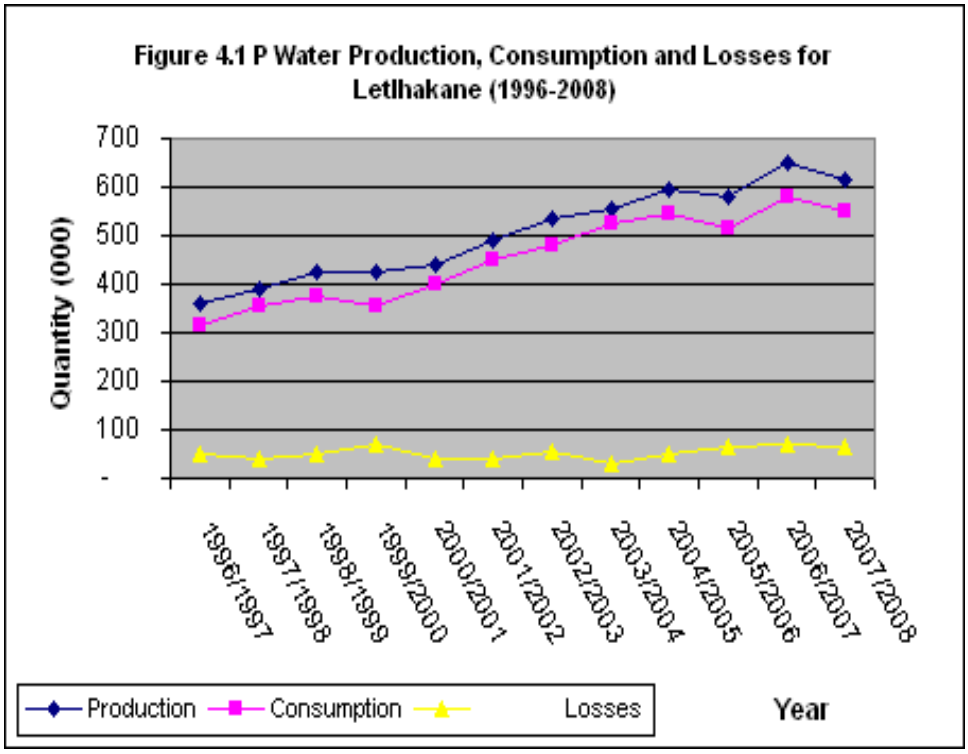
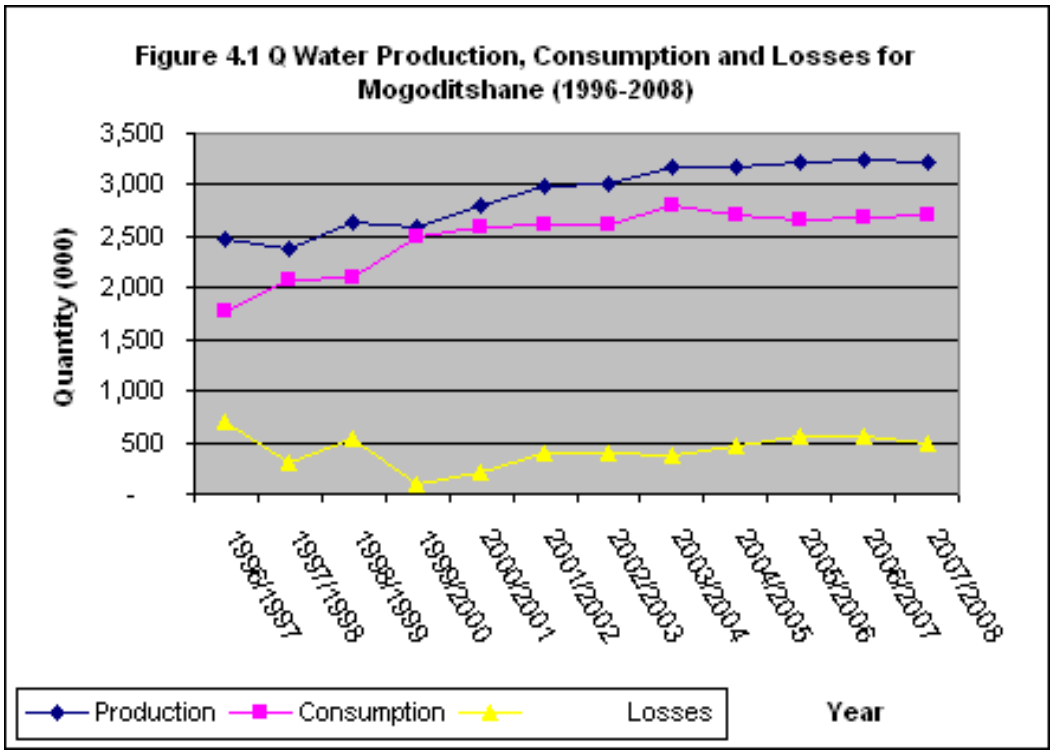


Table 4.5Q Mogoditshane Water Production, Consumption & Loss (m^3)

Year	Production	Consumption	Losses	% Loss
1996/1997	2,481,740	1,771,433	710,307	28.6
1997/1998	2,377,257	2,069,804	307,453	12.9
1998/1999	2,635,653	2,105,340	530,313	20.1
1999/2000	2,578,354	2,493,733	84,621	3.3
2000/2001	2,807,003	2,599,537	207,467	7.4
2001/2002	2,992,678	2,605,017	387,661	13.0
2002/2003	2,999,841	2,609,277	390,564	13.0
2003/2004	3,179,371	2,795,915	383,456	12.1
2004/2005	3,179,844	2,702,596	477,248	15.0
2005/2006	3,219,685	2,662,468	557,217	17.3
2006/2007	3,244,685	2,692,564	552,121	17.0
2007/2008	3,210,896	2,713,386	497,511	15.5



4.5 Water Consumption (Groundwater)

Table 4.7 shows water consumption patterns for the 17 major villages which are supplied by Department of Water Affairs. One of the factors which contribute to the increases and fall in water consumption is the use of flush toilets in households and use of technology improvements such as dish washers which uses less water.

Figure 4.2 shows water consumption by villages for ten year period (1996/97 and 2006/07). It can be observed from the graph that water consumption fluctuates on yearly basis, this might be caused by different uses of water e.g. construction and population growth. For instance, in Mogoditshane, consumption increased from 1,771,433 litres in 1996/97 to 2,692,564 litres in 2006/07.

Mogoditshane consumes the highest amount of water, in 2006/07 the village consumed 2,692,564, followed by Molepolole and then Kanye with 1,904,696, and 1,895,692 respectively.

Figure 4.2 Major Village Water Consumption in 1996/07 and 2006/07 (m^3)

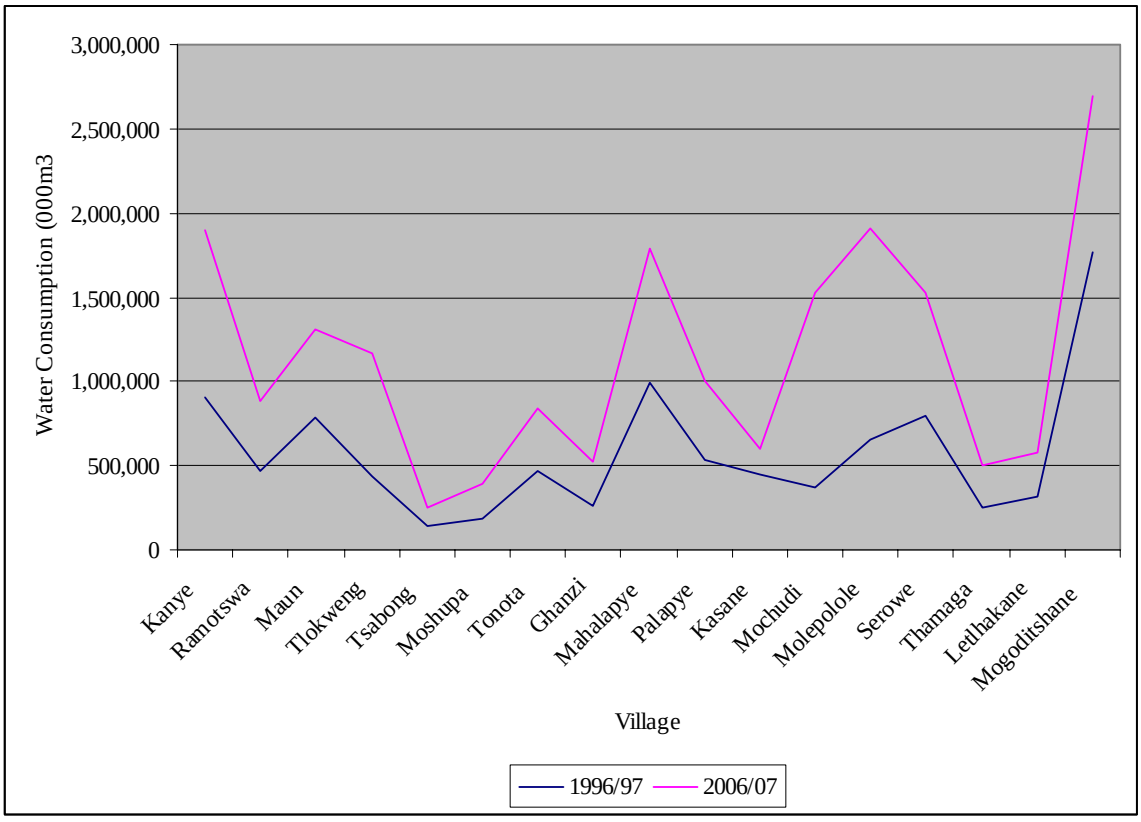


Table 4.7: Water Consumption In Major Villages (M^3)

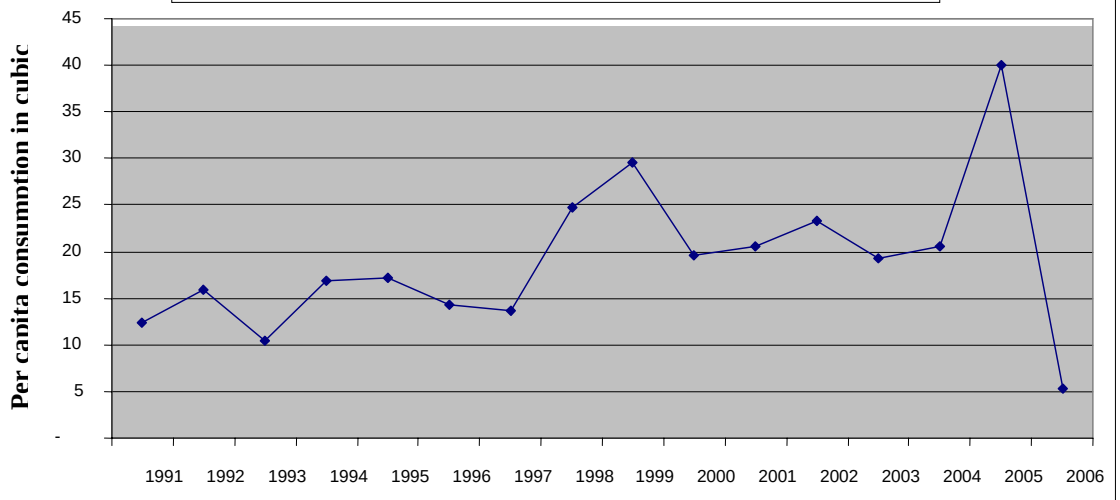
Villages	1996/97	1997/98	1998/99	1999/00	2000/01	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07
Kanye	904,327	1,084,853	1,014,326	1,003,560	1,606,587	1,687,783	1,864,072	1,614,093	1,813,722	1,581,445	1,895,692
Ramotswa	465,836	310,883	698,638	759,507	670,336	643,349	750,890	631,636	954,068	942,884	889,050
Maun	782887	1019172	1,029,465	980,972	908,380	1,124,519	970,020	948,483	1,065,138	1,181,793	1,305,158
Tlokweng	438,782	508,811	804,757	1,100,702	1,149,080	1,090,678	1,221,293	1,436,306	1,192,356	931,422	1,169,138
Tsabong	146,217	139,023	162,377	185,730	221,960	218,687	232,421	250,969	260,821	277,436	249,570
Moshupa	188,659	190,615	229,645	262,766	249,663	277,157	332,407	316,391	319,310	311,505	393,952
Tonota	468,480	479,924	688,949	600,332	638,294	748,189	838,638	768,868	823,000	781,621	843,563
Ghanzi	259,669	321,804	321,804	289,298	396,035	458,043	408,604	432,246	521,676	508,950	526,813
Mahalapye	988,434	1,150,680	1,466,681	1,453,765	1,341,124	1,593,636	1,513,492	1,708,877	1,794,003	1,725,982	1,794,011
Palapye	532,802	676,698	894,574	1,006,158	858,149	1,017,968	1,040,322	1,031,515	1,063,193	978,418	1,005,579
Kasane	449,510	451,793	454,075	489,206	495,282	539,933	536,101	551,662	669,824	584,968	604,249
Mochudi	374,654	724,699	863,519	940,230	1,047,943	1,152,689	1,436,692	1,466,006	1,495,320	1,349,522	1,522,301
Molepolole	654,149	613,072	863,108	1,113,144	1,127,229	1,072,241	1,471,880	1,566,305	1,638,659	1,827,218	1,904,696
Serowe	796,722	1,022,511	978,208	991,800	1,108,774	1,404,451	1,330,606	1,099,942	869,277	1,334,792	1,527,471
Thamaga	254,621	282,722	322,622	247,229	290,893	326,915	354,821	354,821	431,791	445,819	502,497
Letlhakane	312,740	353,195	373,277	356,069	401,457	448,154	478,864	523,414	543,393	516,972	579,689
Mogoditshane	1,771,433	2,069,804	2,105,340	2,493,733	2,599,537	2,605,017	2,609,277	2,795,915	2,702,596	2,662,468	2,692,564

Source: Department of Water Affairs

4.5.2 Water Consumption per Capita

Water consumption per capita is an indicator for the pressure that human demand places on the resources. In recent years there has been greater emphasis placed on per capita consumption data as a means of setting and measuring water conservation goals. Since 1991 per capita consumption of drinking water has been fluctuating. The major cause of these fluctuations could be climatic changes. Per capita water consumption is affected by a number of variables including climate differences; household and lot sizes; building densities. Figure 4.3 shows that water consumption per capita fell significantly in 2006 and the main change could be that people are highly sensitized about the importance of conserving and saving water, given the continuous drought spell in the country.

Figure 4.3 Water consumption per capita for major villages



Water Consumption per Capita (pula/kl) = Amount of Total Water Supplied or Consumed (pula) / Population Supplied or Consumer

Figure 4.4 Water Consumption per Capita for 17 Major Villages in 2006

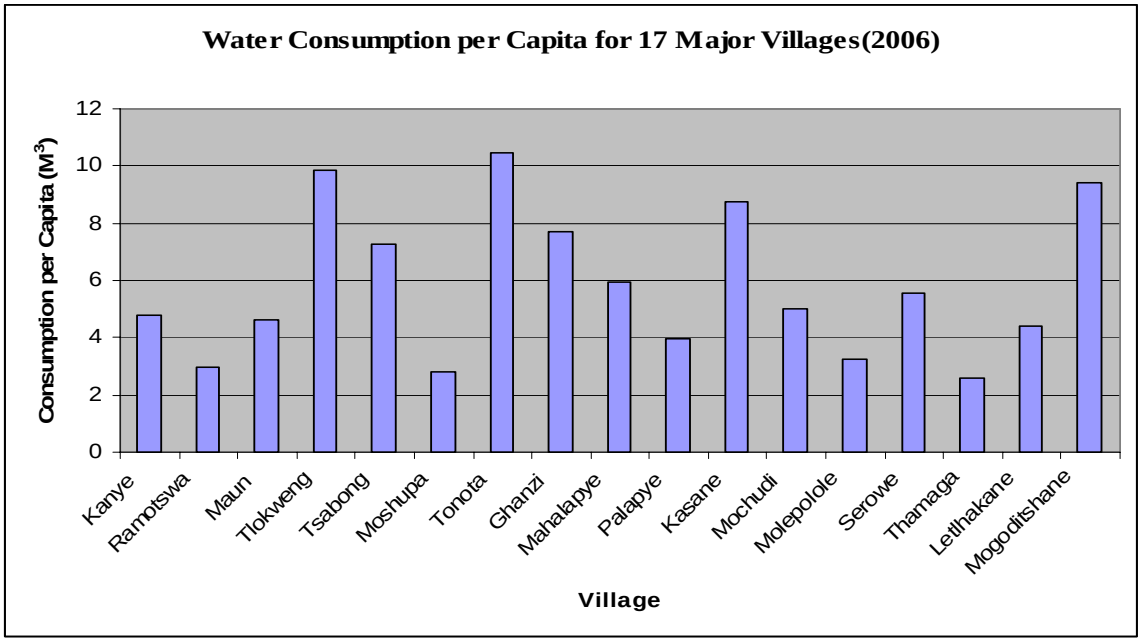


Figure 4.4 shows that in 2006, Tonota followed by Tlokweng then Mogoditshane had the highest consumption of water per capita. This could be because they act as satellite settlements to the two cities of Gaborone and Francistown, therefore the household sizes in these areas are relatively bigger.

Table 4.8 Water Consumption per Capita in the Villages (Cubic metres)

VILLAGES	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Kanye	9.06	15.59	10.11	20.72	21.94	21.64	6.53	7.21	92.90	18.73	27.97	25.88	11.06	15.65	18.20	4.80
Ramotswa	13.55	18.77	18.04	16.51	15.22	23.69	20.98	24.97	17.66	15.63	16.01	14.05	15.95	10.58	13.59	2.98
Maun	12.21	15.31	9.49	15.41	14.47	12.15	26.78	17.73	19.46	17.68	12.20	30.80	4.30	2.38	7.39	4.61
Tlokweng	23.43	34.53	11.90	30.73	24.39	27.00	18.92	5.22	18.96	36.19	42.92	42.59	39.21	34.76	29.99	9.86
Tsabong	10.60	19.07	19.56	23.44	23.10	25.27	126.17	36.60	24.76	25.83	27.45	27.91	32.26	24.65	39.62	7.27
Moshupa	7.35	9.86	10.98	10.94	22.84	12.22	10.14	12.53	13.29	13.79	13.14	12.17	9.67	18.47	14.17	2.82
Tonota	17.69	20.16	17.03	20.60	21.03	19.90	22.91	222.07	45.90	26.31	26.73	31.69	30.97	31.75	31.86	10.48
Ghanzi	15.48	18.13	15.69	22.07	22.54	21.17	13.80	26.48	25.12	23.06	25.21	28.15	24.83	26.00	28.82	7.69
Mahalapye	11.19	14.07	9.49	19.70	17.52	16.86	20.57	54.81	20.63	17.85	19.22	23.66	21.50	25.31	23.74	5.92
Palapye	21.09	17.20	15.05	16.07	14.96	16.82	16.77	34.62	30.31	26.99	27.68	17.39	22.33	31.26	24.87	3.94
Kasane	23.30	31.91	29.46	30.28	31.36	35.82	23.04	40.47	53.83	34.22	40.03	43.96	37.47	36.19	40.71	8.73
Mochudi	11.33	15.60	14.50	15.14	16.77	7.79	18.41	19.37	23.16	21.37	21.75	26.21	28.23	26.52	24.22	5.00
Molepolole	8.02	9.92	8.56	9.47	10.05	9.21	3.50	21.56	17.17	13.69	10.96	5.30	13.55	13.96	19.11	3.23
Serowe	12.42	14.27	4.89	16.45	17.18	11.78	2.88	18.00	23.55	17.99	8.60	26.72	12.96	19.64	26.15	5.54
Thamaga	7.31	9.57	6.53	10.46	11.76	9.77	7.58	14.32	13.76	12.51	11.82	14.40	14.15	15.80	15.24	2.58
Letlhakane	9.95	13.13	12.43	13.46	13.45	13.77	13.66	1.61	15.05	9.76	14.06	16.62	18.19	18.07	20.07	4.41
Mogoditshane	14.05	20.16	11.72	18.70	21.72	21.28	15.09	72.71	33.60	24.52	39.04	40.53	35.74	36.92	316.69	9.42
TOTAL	12.31	15.87	10.38	16.85	17.25	14.35	13.71	24.77	29.50	19.53	20.57	23.31	19.30	20.65	40.03	5.29

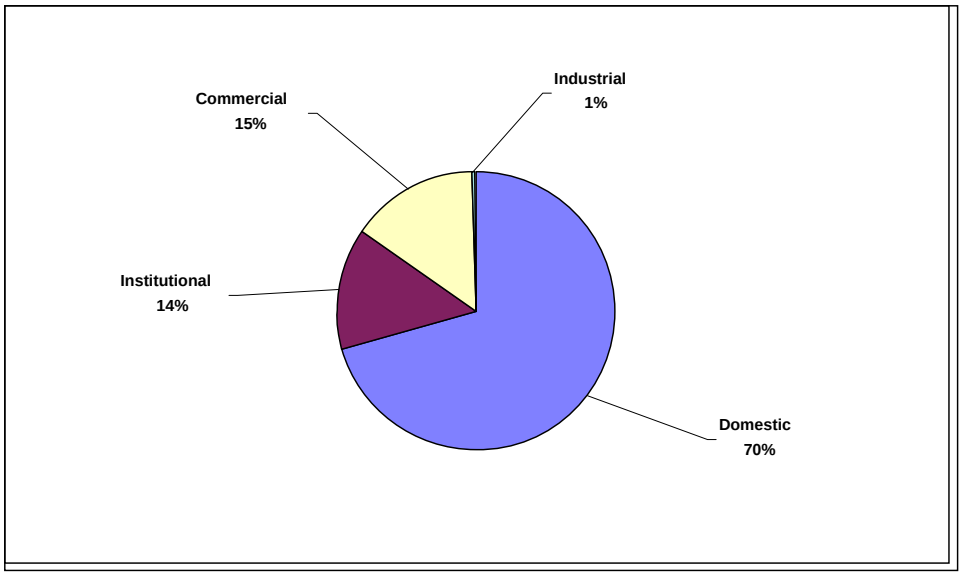
Calculated from Population & Housing census figures, CSO and Department of Water Affairs data

4.5.3 Groundwater Consumption by Sector

With population growth, demand for water has increased dramatically and its uses have become much more varied. Human settlements are consuming an ever-increasing share of water in Botswana.

The pie chart shows categorized water consumption for the 17 major villages combined. It indicates that water consumed for domestic purpose for the year 2005/2006 was the highest followed by institutional then commercial and lastly industrial. Increasing population could be the reason for the growing water consumption under domestic type. Water consumption for domestic sector includes house, yard and standpipes whilst that of institutional sector includes schools, hospitals, forces and administrative offices. Water consumption for commercial sector include shops, workshops, banks, restaurants, irrigation and others whilst industrial sector consumption includes abattoirs, brick moulding and livestock.

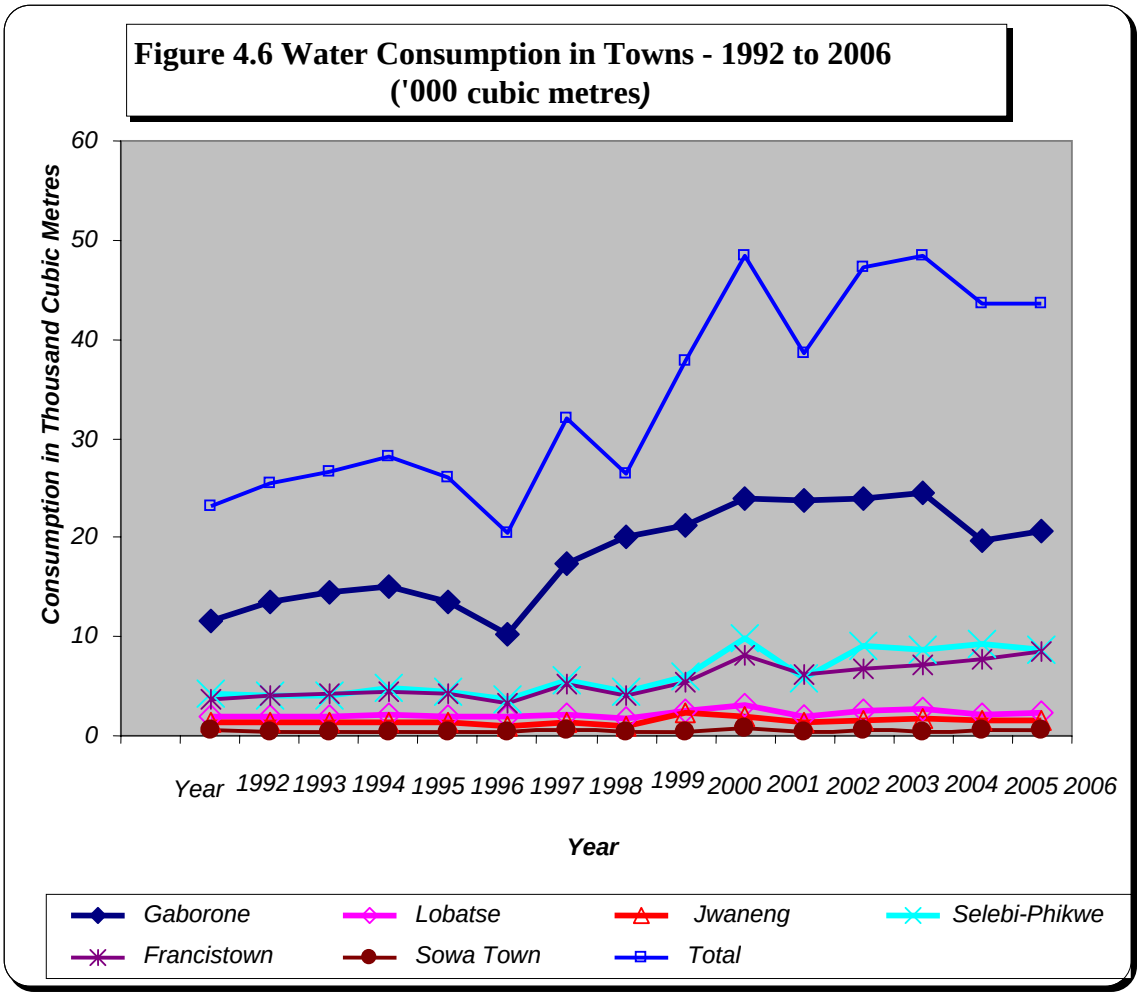
Figure 4.5 Categorized Water Consumption for the 17 major villages (2005/06)



4.6 Water Consumption (surface water)

Data used on this section comes from Water Utilities Corporation which is the supplier of water to towns/cities. Water consumption for towns/ cities is as shown in the following diagram.

Figure 4.6 Water Consumption in Towns - 1992 to 2006 ('000 cubic metres)



Source: Water Utilities Corporation
National Accounts Unit, Central Statistics Office

Water consumption patterns differ between the cities and towns. The consumption is highest in Gaborone followed by Selibe Phikwe and Francistown which in most of the years are almost the same. This might be explained by the lifestyles inherent in these towns. Urban centers have more commercial and industrial activities as compared to rural areas. Standpipe users are known to use more water and these are found mostly in town households.

Table 4.9: Water Consumption (in kl) for the different towns and the amount of sales collected from the users – 1982 to 2006

Year	Gaborone	Lobatse	Jwaneng	Selebi-Phikwe	Francistown	Sowa Town	North South Carrier	Total in ('000) Kl	Sales in Pula
1988	7,725,720	1,374,131	651,869	3,320,495	1,889,962	-	-	14,962,177	24,808,939
1989	8,937,973	1,550,579	704,793	3,584,528	2,298,109	-	-	17,075,982	29,299,049
1990	9,959,510	1,688,670	851,819	4,137,328	3,019,389	-	-	19,656,716	37,709,033
1991	10,783,468	1,734,156	978,396	4,080,258	3,352,245	-	-	20,928,523	46,473,223
1992	11,575,534	1,939,351	1,306,795	4,228,147	3,648,225	496,287	-	23,194,339	58,226,180
1993	13,517,163	1,876,089	1,337,406	4,109,582	4,119,290	476,885	-	25,436,415	65,703,460
1994	14,427,842	1,921,749	1,423,011	4,075,156	4,206,116	481,594	-	26,535,468	79,852,100
1995	15,060,407	2,136,361	1,392,724	4,750,129	4,343,907	475,083	-	28,158,611	83,691,479
1996	13,566,127	1,985,628	1,328,154	4,498,469	4,238,808	435,057	-	26,052,243	78,398,698
1997	10,203,543	1,915,338	956,630	3,598,179	3,337,781	346,692	-	20,358,163	98,170,402
1998	17,289,572	2,134,816	1,392,854	5,521,459	5,131,831	556,892	-	32,027,424	148,012,240
1999	20,061,032	1,684,635	1,045,225	4,420,634	4,098,653	337,067	-	31,647,246	133,164,012
2000	21,307,303	2,432,899	2,404,847	5,889,339	5,374,931	479,107	-	37,888,426	232,887,628
2001	23,975,888	3,032,608	1,876,308	9,896,966	8,132,476	686,945	814,753	48,415,944	387,204,438
2002	23,672,759	1,948,531	1,317,769	5,873,312	6,109,033	456,258	814,753	40,192,415	326,631,106
2003	23,977,709	2,589,689	1,594,425	9,054,474	6,759,856	536,518	2,732,679	47,245,350	430,247,650
2004	24,529,020	2,607,674	1,686,921	8,681,348	7,185,879	463,493	3,338,843	48,493,178	501,353,260
2005	19,643,169	2,168,350	1,635,758	9,305,079	7,715,038	501,959	2,538,200	43,507,553	405,119,463
2006	20,669,603	2,282,253	1,543,636	8,594,176	8,419,012	517,717	1,585,078	43,611,475	421,029,698

Source: Water Utilities Corporation and National Accounts Unit (CSO)

Table 4.9 shows different towns that are supplied with water by Water Utilities Corporation and the Total Sales in Pula collected every year. The table has been used to compute the per capita consumption indicator in all the towns as shown on Table 4.10.

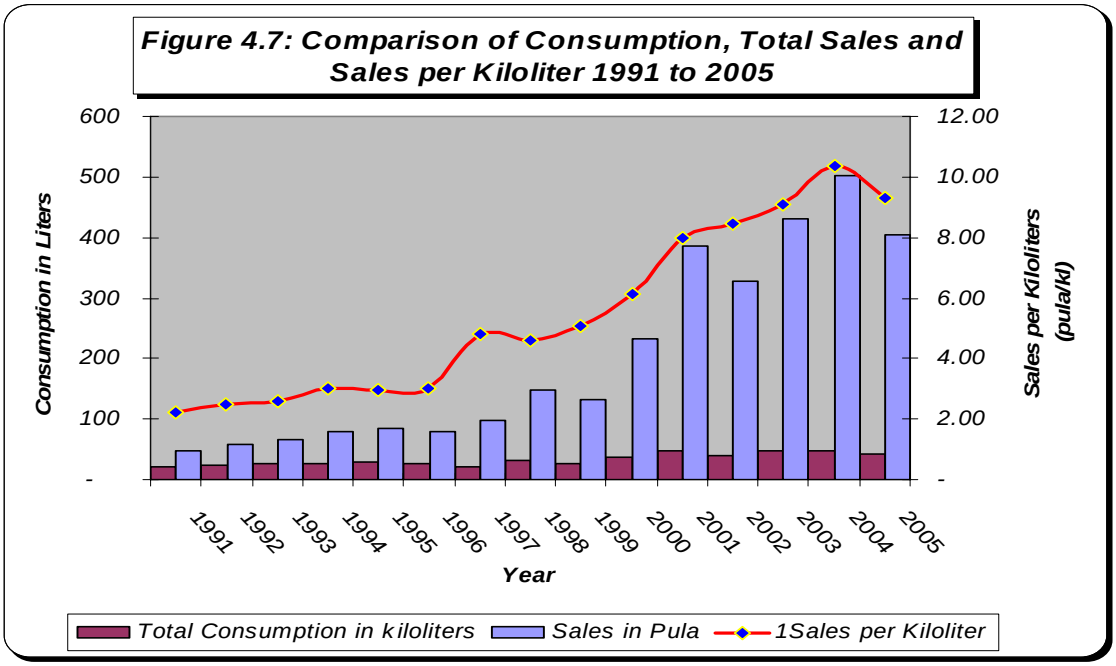
This indicator can be manipulated in many different ways. It can be used to find the amount of water needed by individuals on a daily basis or per year, depending on what one really wants to investigate.

Table 4.10: Total Water Consumption for all Towns

Year	Total Consumption in kiloliters	Sales in Pula	[1] Sales per Kiloliter	[2] Projected Population	Per Capita Consumption (k*l/day)*
1991	20,928,523	46,473,223	2.22	247,140	0.232
1992	23,194,339	58,226,180	2.51	261,933	0.243
1993	25,436,415	65,703,460	2.58	275,153	0.253
1994	26,535,468	79,852,100	3.01	289,066	0.251
1995	28,158,611	83,691,479	2.97	303,703	0.254
1996	26,052,240	78,398,698	3.01	319,246	0.224
1997	20,358,080	98,170,402	4.82	334,440	0.167
1998	32,007,424	148,012,240	4.62	350,374	0.250
1999	26,372,110	133,164,012	5.05	367,086	0.197
2000	37,888,345	232,887,628	6.15	384,616	0.270
2001	48,415,944	387,204,438	8.00	403,173	0.329
2002	38,594,328	326,631,106	8.46	421,373	0.251
2003	47,245,350	430,247,650	9.11	439,661	0.294
2004	48,493,178	501,353,260	10.34	459,152	0.289
2005	43,507,553	405,119,463	9.31	479,524	0.249

Source: WUC and Demography Report in CSO
1 "Sales per Kilolitre is derived when dividing Total Sales in Pula by Total Consumption in Kilolitres''
2 "Projected Population from the Demography Unit of CSO"

Sales per kilolitre give an indication of how the water tariffs vary from one year to the other. For the period 1991 to 2005, the sales per kiloliter have been on the increase for the five towns (see Figure 4.7).



Derived from Table 4.10

4.6.1 Water Consumption Trends for Towns

Tables 4.11 to 4.16 show consumption trends for towns and cities. It should be noted from the tables that the Sales column does not really show the tariffs for the different years. The data from WUC, is not disaggregated by how much money was collected from the different towns instead, the total for the towns was given for every year.

It is observed that Selibe Phikwe had the highest level of per capita consumption in the period 1991 to 2005.

Table 4.11: Water Consumption Trends for Gaborone

Year	Consumption Kilolitres	[1]Projected Population	Sales per kilolitre (Pula)	Per capita measure [2]kl per person
1991	10,783,468	133,468	2.22	81
1992	11,575,534	140,809	2.51	82
1993	13,517,163	148,553	2.58	91
1994	14,427,842	156,724	3.01	92
1995	15,060,407	165,343	2.97	91
1996	13,566,127	174,583	3.01	78
1997	10,203,543	183,487	4.82	56
1998	17,289,572	192,845	4.62	90
1999	20,061,032	202,680	5.05	99
2000	21,307,303	213,017	6.15	100
2001	23,975,888	224,286	1.54	107
2002	23,672,759	234,827	8.46	101
2003	23,977,709	245,864	9.11	98
2004	24,529,020	257,420	10.34	95
2005	19,643,169	269,519	9.31	73

Source: Water Utilities Corporation; Population Projections Report (CSO)
1 The data is from the Population Projections Report
2 Derived when consumption is divided by the population

Table 4.12: Water Consumption Trends for Francistown

Year	Consumption in Kilolitres	Projected Population	Sales per kilolitre (Pula)	kl per person
1991	3,352,245	65,244	2.22	51
1992	3,648,225	68,637	2.51	53
1993	4,119,290	72,206	2.58	57
1994	4,206,116	75,960	3.01	55
1995	4,343,907	79,910	2.97	54
1996	4,238,808	84,075	3.01	50
1997	3,337,781	88,195	4.82	38
1998	5,131,831	92,516	4.62	55
1999	4,098,653	97,050	5.05	42
2000	5,374,931	101,805	6.15	53
2001	8,132,476	106,553	1.54	76
2002	6,109,033	111,241	8.46	55
2003	6,759,856	116,136	9.11	58
2004	7,185,879	121,245	10.34	59
2005	7,715,038	126,580	9.31	61

Source: Water Utilities Corporation
Population Projections Report, CS

Table 4.13: Water Consumption Trends for Jwaneng

Year	Consumption in Kl	Projected Population	Sales per kilolitre (Pula)	kl per person
1991	978,396	11,188	2.22	87
1992	1,306,795	11,736	2.51	111
1993	1,337,406	12,311	2.58	109
1994	1,423,011	12,915	3.01	110
1995	1,392,724	13,547	2.97	103
1996	1,328,154	14,212	3.01	93
1997	956,630	14,866	4.82	64
1998	1,392,854	15,550	4.62	90
1999	1,045,225	16,265	5.05	64
2000	2,404,847	17,013	6.15	141
2001	1,876,308	17,787	1.54	105
2002	1,317,769	18,750	8.46	70
2003	1,594,425	19,387	9.11	82
2004	1,686,921	20,240	10.34	83
2005	1,635,758	21,130	9.31	77

Source: Water Utilities Corporation; Population Projections Report (CSO)

Table 4.14: Water Consumption Trends for Selibe-Phikwe

Year	Consumption in Kilolitres	Projected Population	Sales per kilolitre (Pula)	kl per person
1991	4,080,258	11,188	2.22	365
1992	4,228,147	11,736	2.51	360
1993	4,109,582	12,311	2.58	334
1994	4,075,156	12,915	3.01	316
1995	4,750,129	13,547	2.97	351
1996	4,498,469	14,212	3.01	317
1997	3,598,179	14,866	4.82	242
1998	5,521,459	15,550	4.62	355
1999	4,420,634	16,265	5.05	272
2000	5,889,339	17,013	6.15	346
2001	9,896,966	17,787	1.54	556
2002	5,873,312	18,750	8.46	313
2003	9,054,474	19,387	9.11	467
2004	8,681,348	20,240	10.34	429
2005	9,305,079	21,130	9.31	440

Source: Water Utilities Corporation; Population Projections Report (CSO)

Table 4.15: Water Consumption Trends for Sowa Town

Year	Consumption in Kilolitres	Projected Population	Sales per kilolitre (Pula)	kl per person
1992	496,287	2,364	2.51	210
1993	476,885	2,508	2.58	190
1994	481,594	2,661	3.01	181
1995	475,083	2,823	2.97	168
1996	435,057	2,992	3.01	145
1997	346,692	3,154	4.82	110
1998	556,892	3,324	4.62	168
1999	337,067	3,503	5.05	96
2000	479,107	3,693	6.15	130
2001	686,945	3,896	1.54	176
2002	456,258	4,153	8.46	110
2003	536,518	4,427	9.11	121
2004	463,493	4,720	10.34	98
2005	501,959	5,031	9.31	100

Source: Water Utilities Corporation; Population Projections Report (CSO)

Table 4.16: Water Consumption Trends for Lobatse

Year	Consumption in Kilolitres	Projected Population	Sales per kilolitre (Pula)	kl per person
1991	1,734,156	26,052	2.22	67
1992	1,939,351	26,651	2.51	73
1993	1,876,089	27,264	2.58	69
1994	1,921,749	27,891	3.01	69
1995	2,136,361	28,533	2.97	75
1996	1,985,628	29,172	3.01	68
1997	1,915,338	29,872	4.82	64
1998	2,134,816	30,589	4.62	70
1999	1,684,635	31,323	5.05	54
2000	2,432,899	32,075	6.15	76
2001	3,032,608	32,864	1.54	92
2002	1,948,531	33,652	8.46	58
2003	2,589,689	34,460	9.11	75
2004	2,607,674	35,287	10.34	74
2005	2,168,350	36,134	9.31	60

Source: Water Utilities Corporation; Population Projections Report (CSO)

4.7 Pressure On Water Resources

This chapter presents the effects of the human activities on water resources, including water use by man. The impact is in the form of changes both in quality and quantity of water. Water quality is indicated by concentration of chemical, biological and other pollutants in the water. The quantity aspects can include shortage of water in space and time or over supply in times of floods.

The growing pressure on water resources is a result of the increases in population, rapid urbanization and development. With more people moving into the cities and major settlements, the demand on water resources has increased, presenting a serious problem to the country which is drought prone. In response to this problem, the Government has come up with the National Water Master Plan which contains measures aimed at conserving the country's water resources.

According to State of Environment Review done by the Department of Environmental Affairs over-exploitation, pollution and aquatic weeds are the main threats to water resources. The sources of pollution are industrial and domestic effluent from settlements, human waste from pit latrines and waste disposal on the dam catchment areas and shallow aquifers. Exotic aquatic weeds are also reported to be a threat to water resources and aquatic ecosystems through excessive evapo-transpiration and reduction in the quality because they cover the water body thus preventing the circulation of air and light.

Sometimes human beings alter the natural hydrological systems to get more benefits from water and in turn these changes lead to waterborne diseases, pressures on the ecosystems, soil erosion, water logging and loss of habitats and biodiversity.

Water can be used for different activities such as transport, habitats for fish, dilution of waste and recreation for humans. In Botswana water is mainly used for human consumption, commercial, industry and institutional purpose although it varies per sector. South-eastern Botswana is experiencing rapid urbanization thereby increasing urban water usage.

The government has been committed to the protection of the environment and the concept of sustainable development which ensures that the present generation consumes a certain amount of water in a year or yield of the natural resources which are renewable, and that the ability of future generation to meet their own needs from the said resources without being compromised. In 2004 Water Utilities Cooperation and Department of Water Affairs came up with initiatives which could address issues that affect water resources and penalties which encouraged the population not to waste water because of experienced shortages and hence water charges were increased.

The government of Botswana has introduced two main legal instruments as interventionist strategies to address the water resources issues, which are **Water Act** and **Waterworks Act** and other legislation which are related to water resources such as Aquatic Weeds Control Act and Public Health Act. These are detailed out under Chapter 11.

4.7.1 Water Quality

Water availability in the environment is determined by the climate. High temperatures can lead to evaporation rates which can deplete the already low rainfall. It is reported in the "Caricom Environment in figures 2002" that clean and adequate water is vital for human health but water is often the main cause of many fatal diseases such as diarrhea, malaria or typhoid fever. It is further reported that in most developing countries people do not have access to safe drinking water and drinking water has often been contaminated because of pollution from human activities.

Water quality standards are designed to provide us with understanding the critical importance of adequate supplies of clean, available fresh water for the environment, the country's economy and the quality of life. This section will provide a national and international perspective of water availability and the challenges faced by Water Suppliers in addressing water quality issues. Without water human survival is at risk and the economy cannot survive without sufficient supplies of clean water.

Drinking water quality is an issue of concern for human health in developing and developed countries world wide. The risks arise from contaminating agents which include toxic chemicals.

Guidelines for drinking water quality are used as the basis for regulation and standard setting to ensure the safety of drinking water. Botswana Bureau of Standard (BOBS) is the only organization in Botswana responsible for setting water quality standards, their standards have been compared with World Health Organization guidelines in Table 4.17 which shows the selected water quality parameters. It is the mandate of BOBS to make provision for amendments of drinking water quality standard and guidelines. Water sources are monitored on a regular basis to assess its quality. Effluent quality is also monitored at source to ensure that it is compliant with the effluent quality standards.

BOBS has established upper limits and ranges for chemical levels allowable in drinking water. Most of these levels allow a sufficient margin of safety; it must be remembered that acceptable contaminant levels vary widely among individuals for example high sodium, which may be harmless for many people, can be dangerous for the elderly, hypertensive, pregnant women, and people having difficulty in excreting sodium.

It is believed that if these contaminants are present in your water at levels above these standards, the contaminants may cause the water to appear cloudy or colored, or to taste or smell bad. This may cause a great number of people to stop using water from their public water system even though the water is actually safe to drink.

The effect of toxic contaminants on human health can be classified as either acute or chronic. The reaction to a substance causing serious illness or death in an individual within 48 hours after exposure is considered acute toxicity. Chronic toxicity is a longer term effect on health due to frequent exposure to small amounts of a toxic substance. Examples of chronic health effects are kidney and liver disease, cancer, mental illness, etc. Possible effects of contaminants are also shown on table 4.17.

Section 4.7.2 below explains the various variables monitored by the Water Utilities Corporation to measure the level of contamination in water.

Table 4.17 Specification for Drinking Water Quality

VARIABLES **(in milligrams/litre where applicable)**	**WHO** Guidelines	**Botswana Bureau of Standards**			**Possible effects**
		Upper limits and ranges Class I (ideal)	**Class II (acceptable)**	**Class III (max.allowable)**	
PHYSICAL REQUIREMENTS					
Turbidity[3] NTU	5.0	0.5	5	10	High turbidity levels can cause Nausea, cramps, diarrhoea and headaches
Colour TCU	15	15	20	50	It makes water unpleasant for drinking and cooking and it causes staining and is corrosive to plumbing metals
Taste & Odour	Not objectionable	Not objectionable	Not objectionable	Not objectionable	Water can rapidly tarnish silver
CHEMICAL REQUIREMENTS					
Chlorine Residual CL_2	0.6	0.3-0.6	0.6-1.0	1.0	Several epidemiological studies have indicated a possible association between chlorinated drinking water and increased risks from a variety of cancers, mainly to do with the bladder, colon and rectum. However, other studies have not found such associations. Therefore, because of the limitations of the data, no definite conclusions can be based on these studies www.waterquality.crc.org.au.htm
pH [4] (potential Hydrogen)	6.0 - 9.0	6.5-8.5	5.5-9.5	5.0-10.0	Low pH can be acidic, soft and Corrosive. It can also cause damage to metal pipes. High pH can cause Scaling of metals, cause Coffee to taste bitter and can also Lower the efficiency of electric water heaters

[3] Turbidity is a measure of cloudiness of water. Turbidity can come as a result of suspended sediments in the water or from high levels of disease causing organisms.

[4] pH refers to the amount of hydrogen mixed with water

Total Hardness (as $CaCO_3$)	20 - 200	20	200	500	Same as pH properties
Total Dissolved Solids (TDS)	500	450	1000	2000	High TDS concentrations can produce laxative effects and can give an unpleasant mineral taste to water.
Sulphate (SO_4)	250	200	250	400	Taste affected, laxative effect, gastro intestinal irritation
Calcium (Ca)	75	80	150	200	Poor lathering and deterioration of the quality clothes, incrustation in pipes, scale formation
Nitrite (NO_2)	3	3.0	3.0	3.0	Forms nitrosamines which are carcinogenic
Phosphorous (PO_4)	0.3				Toxic, bio-accumulation, central nervous system affected, carcinogenic
Chloride (CL)	250	100	200	600	Taste affected, corrosive
Sodium (Na)	200	100	200	400	
Magnesium (Mg)	100	30	70	100	Same as calcium
Iron (Fe)	0.3	30	300	2000	Poor sometimes bitter taste, colour and turbidity, staining of clothes materials, iron bacteria causing **slime**
Manganese (Mn)	0.1	50	100	500	Poor taste, colour and turbidity, staining, black **slime**
Ammonium (NH_4)	1.5				Indicates pollution, growth of algae
Aluminium (Al)	0.2	100	200	200	
Copper (Cu)	1	1000	1000	1000	Liver damage, mucosal irritation renal damage and depression, restricts growth of aquatic plants
Zinc (Zn)	5	3.0	5.0	10.0	Astringent taste, opalescence in water, gastro intestinal irritation, vomiting, dehydration, abdominal pain nausea and dizziness
Toxic Substances					
Nitrate (NO_3)	45	45	45	45	Blue baby disease (methemologlobineamia), algal growth
Fluoride (F)	0.7 - 1.5	0.7	1.0	1.5	Dental and skeletal florosis, non skeleton manifestations
Lead (Pb)	0.05	10	10	10	Too much lead in the human body can cause serious damage to the brain, kidneys, nervous system, and red blood cells.
Cadmium (Cd)	0.05	3.0	3.0	3.0	Highly toxic causes “minamata” disease- painful rheumatic condition, cardio vascular system affected, gastro intestinal upset and hypertension
Cyanide (CN)	0.01	70	70	70	
Microbiological Variables					
Faecal Coliforms / 100 ml	0	Not detected	1	10	High levels of causes risk of water borne gastroenteritis such as ear infections, dysentery, typhoid fever, viral and hepatitis A
Total Coliforms / 100 ml	0	Not detected	10	100	Same as above
Organic Constituents					

Phenols	0.01	10	10	10	
Total Organic Carbon	8	8000	8000	8000	
Trihalomethanes THM	100	1000	1000	1000	
Total Pesticides	0.0005	5.0	5.0	5.0	Affects central nervous system
Poly Aromatic Hydrocarbons	0.001	100	100	100	
Disinfection by-products	0.6 - 1				
Toluene	0.02 – 0.2	700	700	700	
Chlorophyll A	0 - 5				

The data was last revised in January 2001

Source: water Utilities Corporation Water Quality Standards and Botswana Bureau of Standards-water quality Standard(drinking water)

4.7.3 Physical and organoleptic requirements

a) Turbidity

It is a measure of the degree to which the water looses its transparency due to the presence of suspended particulates. The more total suspended solids in the water, the murkier it seems and the higher the turbidity. It is considered as a good measure of the quality of water. Turbidity is caused by various variables such as-:

- Sediments from erosion
- Resuspended sediments from the bottom
- Waste discharge
- Algal growth
- Runoff

b) Total Dissolved Solids - TDS

- "Dissolved solids" refer to any minerals, salts, metals, anions[5] or cations[6] dissolved in water. This includes anything present in water other than the pure water molecule and suspended solids. (Suspended solids are any particles/substances that are neither dissolved nor settled in the water, such as wood pulp).
- Some dissolved solids come from organic sources such as leaves, silt, plankton, and industrial waste and sewage. Other sources come from runoff from urban areas, road salts used on street during the winter, and fertilizers and pesticides used on lawns and farms.

The TDS levels for the Water Utilities Corporation dams are way below the ideal water group, Class 1. The maximum level is recorded at Gaborone Dam and stands at 271.05 mg/l and this was in February 2006.

c) pH

The balance of positive hydrogen ions (H+) and negative hydroxide ions (OH-) in water determines how acidic or alkaline the water is.

In a dam, the water's pH is affected by its age and the chemicals discharged by communities and industries. Most dams are alkaline (basic) when they are first formed and become more acidic with time due to the build-up of organic materials. As organic substances decay, carbon dioxide (CO_2) forms and combines with water to produce a weak acid, called "carbonic" acid — the same stuff that is in carbonated soft drinks. Large amounts of carbonic acid lower pH for water.

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[5] An **ion** is an atom or molecule which has lost or gained one or more valence electrons, making it positively or negatively charged. A negatively charged ion, which has more electrons in its electron shells than it has protons in its nuclei, is known as an **anion**

[6] Conversely, a positively-charged ion, which has fewer electrons than protons, is known as a **cation**

Table 4.18: pH Statistics as compared to the BOS 32:2000 Standards

PH Statistic value at 25°C and BOS 32:2000	Dams				
	Gaborone	**Bokaa**	**Shashe**	**Nnywane**	**Letsibogo**
Average	6.61	6.12	6.54	4.94	6.18
Average[1]	7.95	7.91	7.70	7.93	7.44
Count	65	53	53	53	53
Count[1]	54	41	45	33	44
Max	8.53	8.44	8.27	9.19	8.45
Class 1 (Ideal) mg/l	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5
Class 2 (Acceptable) mg/l	5.5-9.5	5.5-9.5	5.5-9.5	5.5-9.5	5.5-9.5
Class 3 (Max. allowable) mg/l	5.0-10	5.0-10	5.0-10	5.0-10	5.0-10

Average - is calculated for the whole data, taking 'the not analyzed' data into the total count

Average[1] - it is calculated by summing the available data and dividing by the count

Count - is the total number of samples collected between this period

Count[1]- is the total number of samples collected monthly less the 'not analyzed' data

4.7.4 Chemical Requirements: Inorganic macro- determinants

a) Calcium

Table 4.19 shows calcium concentration in mg/l as compared to different set of standards by W.H.O, W.U.C and Botswana Bureau of Standards (Water Quality Standard BOS 32:2000. This is for the period April 2001 to August 2006

Table 4.19: Calcium Concentration data in *mg/l* for the different Dams, April to August 2006

Calcium Statistic and BOS 32:2000	Dams				
	Gaborone	**Bokaa**	**Shashe**	**Nnywane**	**Letsibogo**
	13.27	13.92	12.14	7.17	14.30
	7.17				14.30
Average[1]	14.87	15.70	13.41	10.27	16.85
Count	65	53	53	53	53
Max	59.77	48.00	26.95	25.00	29.00
Class 1 (Ideal) mg/l	80	80	80	80	80
Class 2 (Acceptable) mg/l	150	150	150	150	150
Class 3 (Max. allowable) mg/l	200	200	200	200	200

Average[1] - it is calculated by summing the available data and dividing by the count

b) Hardness as $CaCO_3$ in mg/l

Hardness is measure of polyvalent cations (ions with a charge greater than +1) in water. Hardness affects the amount of soap that is needed to produce foam or lather. Hard water can leave a film on hair, fabrics, and glassware. Hardness of the water is very important in industrial uses, because it forms scale in heat exchange equipment, boilers, and pipe lines. Some hardness is needed in plumbing systems to prevent corrosion of pipes.

Table 4.20, shows that for the period, April 2001 to August 2006, maximum hardness as $CaCO_3$ content were in the range between 200 and 500mg/l for all the five dams and one can conclude that this is Class 3 water for this particular parameter

Table 4.20: Hardness as CaCO3 against BOS 32: 2000 Standards

Hardness as $CaCO_3$ Statistic and BOS 32:2000	Dams				
	Gaborone	Bokaa	Shashe	Nnywane	Letsibogo
Average	29.31	27.19	33.01	17.09	42.60
Average[1]	57.73	40.02	79.53	26.65	62.72
Count	65	53	53	53	53
Count[1]	33	36	22	34	36
Max	118.24	233.00	109.00	100.00	115.10
Class 1 (Ideal) mg/l	20	20	20	20	20
Class 2 (Acceptable) mg/l	200	200	200	200	200
Class 3 (Max. allowable) mg/l	500	500	500	500	500

Average - is calculated for the whole data, taking 'the not analysed' data into the total count

Average[1] - it is calculated by summing the available data and dividing by the count

Count - is the total number of samples collected between this period

Count[1]- is the total number of samples collected monthly less the 'not analysed' data

c) Chlorine

Many of the most common diseases found in traumatized communities after a disaster or emergency are related to drinking contaminated water. The contamination can be from micro-organisms or natural and man made chemicals.
People who live in the same place all their lives and regularly drink contaminated water may develop some resistance to the contaminants and suffer little or no health problems. Communities affected by an emergency, however, are very different. Emergencies have three relevant effects on people, they:

- force people to move to new places where the water quality is different from what they usually drink and for which they have no immunity;
- force people to live in poor conditions such as tents or temporary buildings which make it difficult to retain good hygiene practices;
- Affect their diet, often lowering their nutritional level and making them more vulnerable to disease.

Table 4.21: Chlorine Content for the five dams against BOS 32: 2000 Standards

Chloride Statistic and BOS 32:2000	Dams				
	Gaborone	**Bokaa**	**Shashe**	**Nnywane**	**Letsibogo**
Average	5.65	7.26	1.69	3.15	3.80
Average[1]	6.44	7.70	2.08	3.71	4.38
Count	65	53	53	53	53
Count[1]	57	50	43	45	46
Max	12.90	17.80	4.24	5.77	18.12
Class 1 (Ideal) mg/l	100	100	100	100	100
Class 2 (Acceptable) mg/l	200	200	200	200	200
Class 3 (Max. allowable) mg/l	600	600	600	600	600

Average - is calculated for the whole data, taking 'the not analysed' data into the total count

Average[1] - it is calculated by summing the available data and dividing by the count

Count - is the total number of samples collected between this period

Count[1]- is the total number of samples collected monthly less the 'not analysed' data

d) Fluoride Concentration in mg/l

Fluoride is a chemical, which occurs naturally in most water supplies in concentrations ranging from 0.1 parts per metre (ppm) to 10 ppm. The chemical originates in several minerals.

As groundwater passes through the earth and is exposed to these minerals, fluoride is dissolved and enters the water. The deeper the water flows through the earth, the more fluoride-

containing minerals it will come in contact with, and the greater the fluoride concentration in the water will be.

Purpose of Fluoridation

Fluoridation is the process of adjusting the concentration of fluoride in public water supplies for the prevention of dental decay. Fluoride in water has been proven to prevent tooth decay among children and to prevent root tip rot. The chemical acts by strengthening the tooth enamel and by making the enamel more resistant to decay. This is a long-term process, with results usually being noticeable only after about 4 to 6 years.

Table 4.22: Flouride Content for the five dams against BOS 32: 2000 Standard

Fluoride Statistic and BOS 32:2000	Dams				
	Gaborone	**Bokaa**	**Shashe**	**Nnywane**	**Letsibogo**
Average	0.47	1.21	0.20	0.50	0.17
Average[1]	0.54	1.28	0.25	0.58	0.19
Count	65	53	53	53	53
Count[1]	57	50	44	46	46
Max	0.98	2.59	2.48	0.97	0.45
Class 1 (Ideal) mg/l	0.7	0.7	0.7	0.7	0.7
Class 2 (Acceptable) mg/l	1	1	1	1	1
Class 3 (Max. allowable) mg/l	1.5	1.5	1.5	1.5	1.5

Average - is calculated for the whole data, taking 'the not analysed' data into the total count

Average[1] - it is calculated by summing the available data and dividing by the count

Count - is the total number of samples collected between this period

Count[1]- is the total number of samples collected monthly less the 'not analysed' data

Source: Water Utilities Corporation

e) Potassium Concentration in mg/l for the different Dams

The mineral potassium is of critical importance to human health. It plays a major role in how well the body functions. Athletes drink special beverages to replenish the potassium lost in perspiration. Individuals who take certain heart and blood pressure drugs that cause potassium loss are advised to take potassium supplements to assure that they have adequate potassium in their bodies.

Table 4.23: Potassium Content for the five dams against BOS 32: 2000 Standard

Potassium Statistic and BOS 32:2000	Dams				
	Gaborone	Bokaa	Shashe	Nnywane	Letsibogo
Average	6.00	6.29	3.53	2.51	5.13
Average[1]	6.72	6.66	4.45	4.16	7.15
Count	65	53	53	53	53
Count[1]	58	50	42	32	38
Max	11.20	13.90	11.80	16.20	17.90
Class 1 (Ideal) mg/l	25	25	25	25	25
Class 2 (Acceptable) mg/l	50	50	50	50	50
Class 3 (Max. allowable) mg/l	100	100	100	100	100

Average - is calculated for the whole data, taking 'the not analysed' data into the total count

Average[1] - it is calculated by summing the available data and dividing by the count

Count - is the total number of samples collected between this period

Count[1]- is the total number of samples collected monthly less the 'not analysed' data

f) Sodium

When sodium levels increase, in high purity or ultra pure waters, it indicates the presence of unwanted dissolved impurities. In power plants, these impurities can have catastrophic effects when deposits occur on turbine blades or on the heat exchange surfaces of the boiler. All the dams have the right amounts of sodium in their waters; this is shown in Table 4.24.

Table 4.2.4: Sodium Content for the five dams against BOS 32: 2000 Standards

Sodium Statistic value at 25°C and BOS 32:2000	Dams				
	Gaborone	Bokaa	Shashe	Nnywane	Letsibogo
Average	8.44	9.73	4.19	12.59	5.48
Average[1]	10.76	11.82	5.29	14.19	6.76
Count	65	51	53	53	53
Count[1]	51	42	42	47	43
Max	18.81	23.30	26.50	20.40	30.10
Class 1 (Ideal) mg/l	100	100	100	100	100
Class 2 (Acceptable) mg/l	200	200	200	200	200
Class 3 (Max. allowable) mg/l	400	400	400	400	400

Average - is calculated for the whole data, taking 'the not analysed' data into the total count

Average[1] - it is calculated by summing the available data and dividing by the count

Count - is the total number of samples collected between this period

Count[1]- is the total number of samples collected monthly less the 'not analysed' data

5.0 Arable Agiculture

5.1 Introduction

Botswana is a semi-arid, landlocked country in the center of the Southern Africa, with a total area of 581,730 km^2. The country has a fragile ecosystem that is susceptible to land degradation, which is caused by several factors including human (overgrazing and overuse of wood) and climate factors. Total cultivable land area was 330,600 ha in 1983 and had dropped significantly to 210,795 ha by 2003, which comprises of 194,560 ha of smallholdings on communal land and 16,235 ha of commercial farms. The largest population is concentrated in the eastern part of the country where both climate and soil conditions are conducive to agricultural production. Mean annual rainfall is usually **500mm** in the eastern part of the country whilst in the central and southern is less than **400mm** making crop production to be very difficult in those areas. The land area under crops varies from year to year due to land degradation, drought and land use change (settlements). The government has recognized this environmental concern and has been making endless efforts to address the situation at policy level through National Conservation Strategy.

Although Agriculture is the main source of food, income and employment for majority of the rural households, its (crop production and livestock) contribution to the Gross Domestic Product (GDP) was 40 percent at independence (1966) but had fallen to 2.3 percent by 2003, whilst contribution to employment had dropped from 70 percent at independence to less than 3 percent by 2002. Since the contribution of the sector has declined, the government provides temporary relief to rural people, primarily to mitigate precipitous declines in agricultural production, income and employment (http://www.savannas.net/Botswana/ufhtrdag.htm).

Arable Agriculture in Botswana is mainly for the production of food crops for majority of Batswana. Crop yields are frequently low due to shortage of rainfall with endemic drought, which were very severe in the mid 1980 and early 1990's, however, low crop yields are sometimes due to damage from livestock, wildlife, pests & diseases. These, together with poor soil conditions and limited use of improved farming technique seriously affect crop yields. Problems mostly encountered by farmers include over dependence on high risk crops[7] such as maize, declining soil fertility, difficulties in obtaining water, insufficient infrastructure, diseases and pests' outbreak, lack of skilled manpower and information. Furthermore, due to high costs of agricultural production in the country, local farmers' outputs are more expensive than imported ones therefore local farmers face competition in the market place since they fail to meet the cost of inputs if they lower their prices.

In Botswana there are three dominant types of arable farming; the most practiced is the dryland/ rainfed farming, mostly practiced for crops like sorghum, millet, maize, sunflower and melons. The other types of arable farming are irrigated farming for various crops including vegetables, which is mostly practiced in Chobe and Tuli Block and lastly flood recession (also known as molapo farming), which is mainly practiced in the northwest part of the country (Boteti and Okavango).

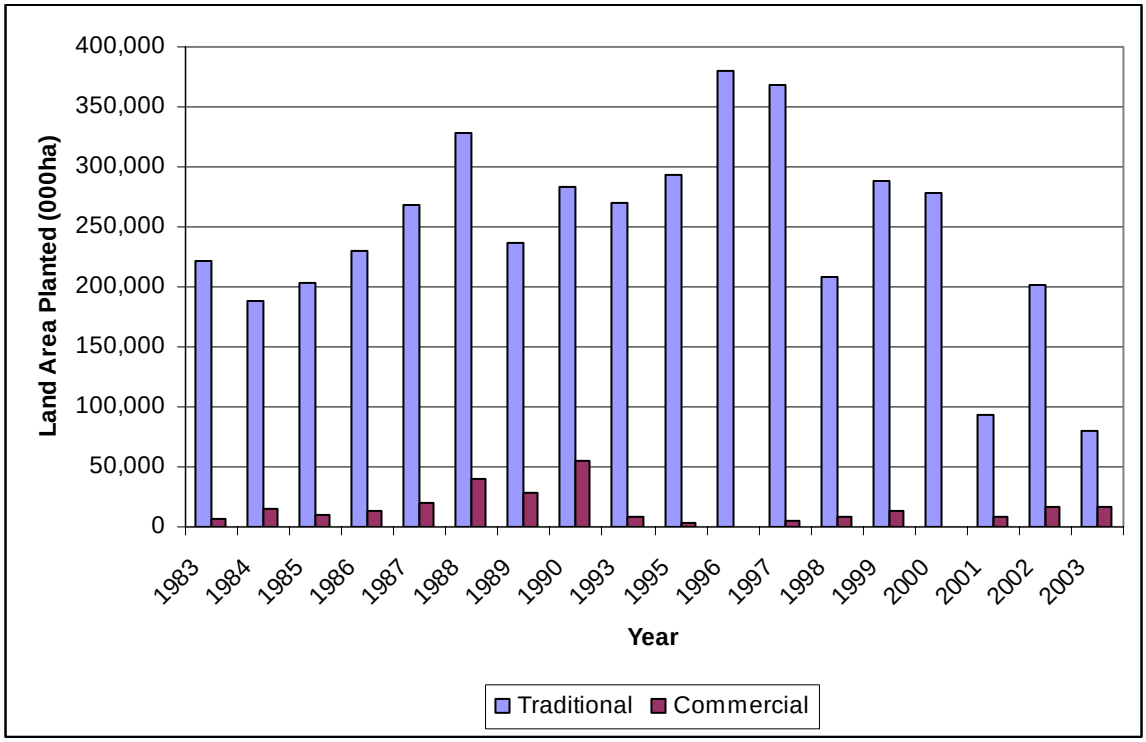
[7] Susceptibility to adverse conditions i.e. pests & diseases and moisture depression

5.2 Major Food Crops, Planted Areas and Yields

The most predominant crops grown are sorghum, maize, millet, beans & pulses, sunflower and groundnuts. There is always inequality between area planted and area harvested, since harvest depends on several factors e.g. quality of the soil and amount of rainfall during the growing season thus increasing the risks associated with dryland farming.

There are two categories of farmers, which are Traditional (Subsistence) and Commercial farmers. Subsistence farming is a mode of agriculture in which a plot of land produces only enough food to feed the family working on it. Generally, Subsistence farmers require small portion of plots depending on climate, soil conditions, agricultural practices and the crop grown. In this system farmers are more disadvantaged because most of them are not trained and it's difficult for them to adopt new farming techniques. Commercial farmers on the other hand run farms as business operations, drought does not have much effect on production since farmers practice irrigation and have access to new farming techniques therefore they are precautious. The number of commercial farms is small but they make a substantial contribution to total production compared to traditional farming which has many producers but their scale of production is relatively low (see Figure 5.1 and 5.2).

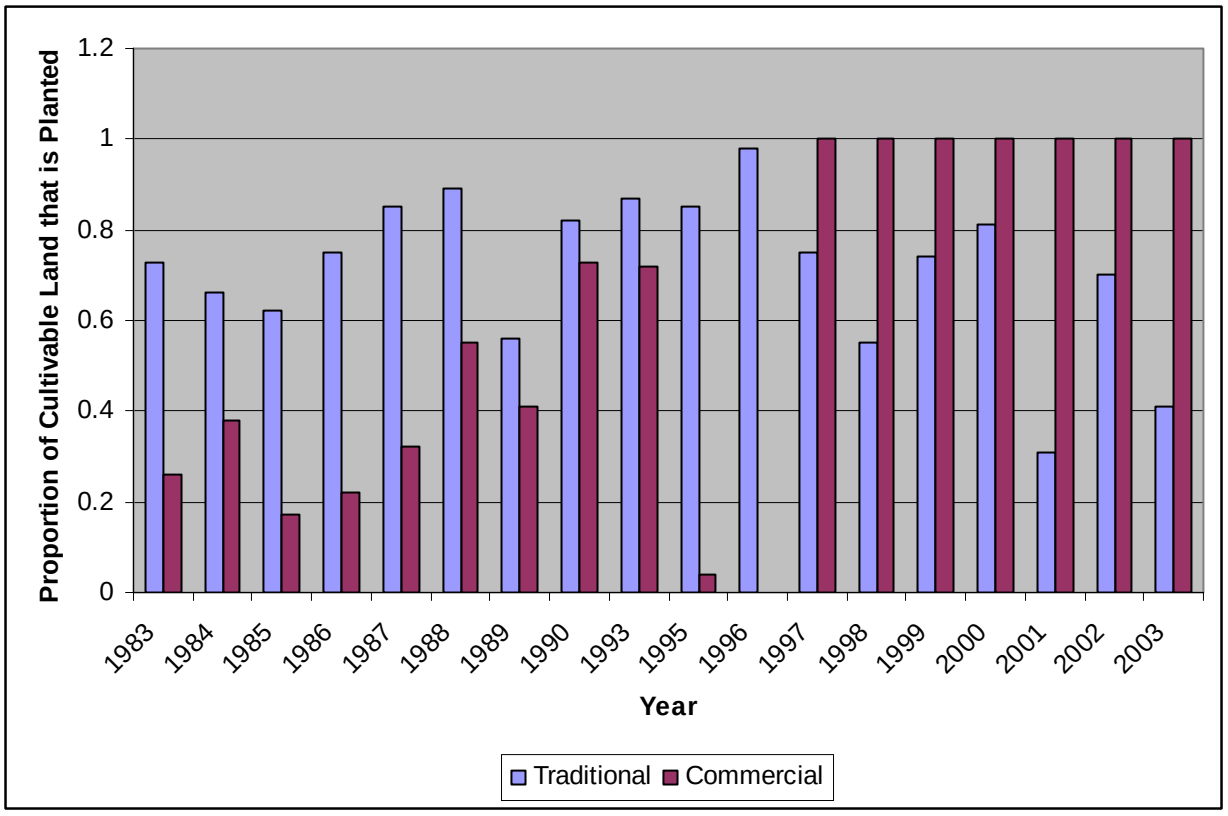
Figure 5.1 Total Land Area Planted (Ha) for Traditional and Commercial Sector



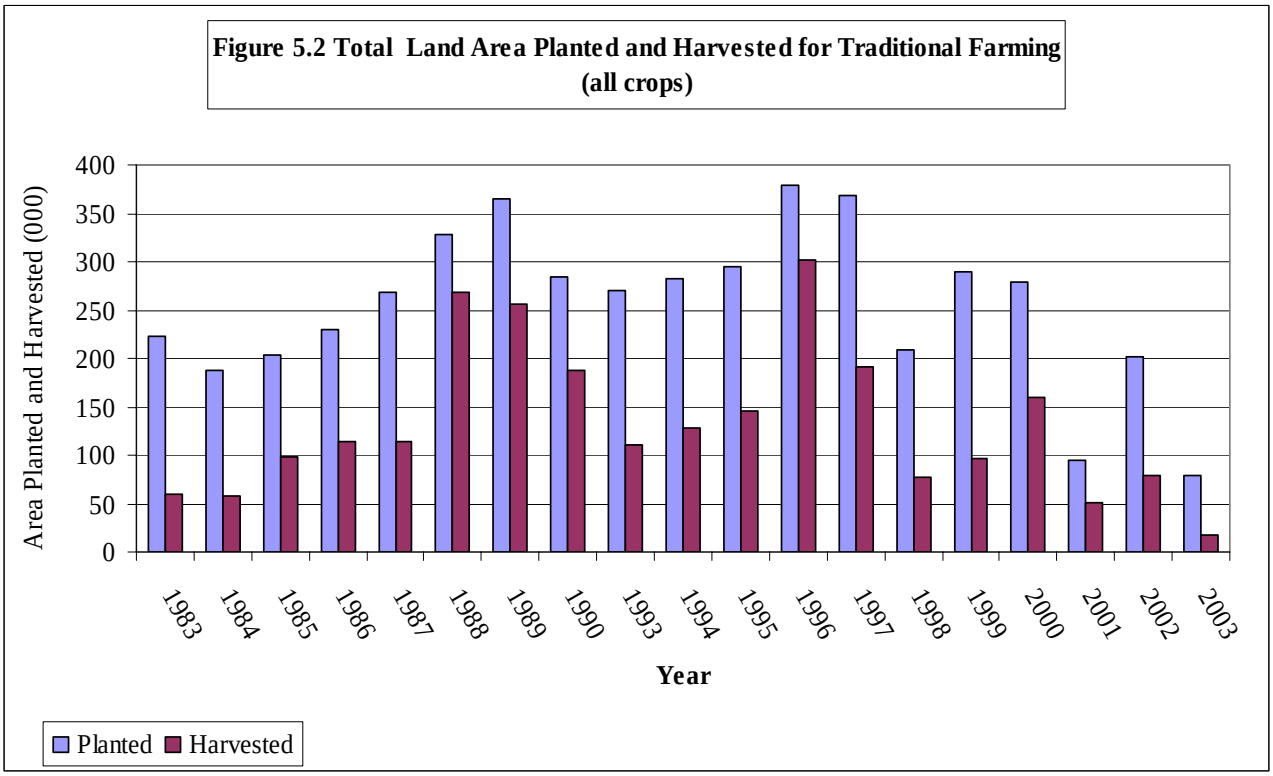
Source: Adapted from Table 5.1

Figure 5.1 shows total land area planted for traditional and commercial farming. The traditional farming is economically important as it accounts for a large proportion of the land ploughed in terms of production and the number of households involved. Commercial farming on the other hand is restricted to freehold, leasehold and TGLP farms. The commercial farming is relatively more advanced than traditional farming in terms of management practices and the use of farm inputs.

Figure 5.1A Proportion of Cultivable Land that is Planted by Year for Traditional and Commercial Sector

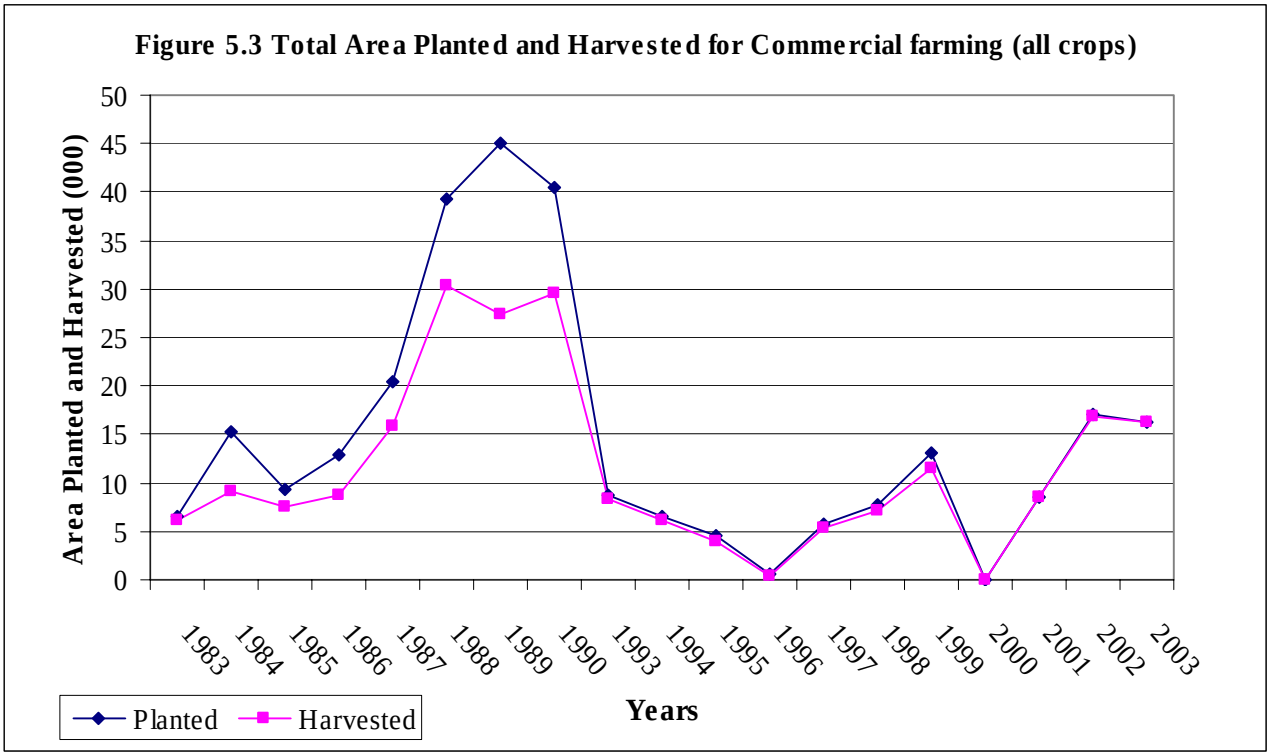


It is observed from Figure 5.1A, that the proportion of cultivable land that is planted for traditional sector has been higher than that of commercial sector from 1983 – 1996, the reason being that a large proportion of the population resides in rural areas and depend on traditional farming for their livelihoods. The graph also reveals that from 1997 to 2003 commercial sector planted the whole portion of their cultivable land mainly because they have small portion of the total land area.



NB: Area Planted and Harvested for 1994 are estimates

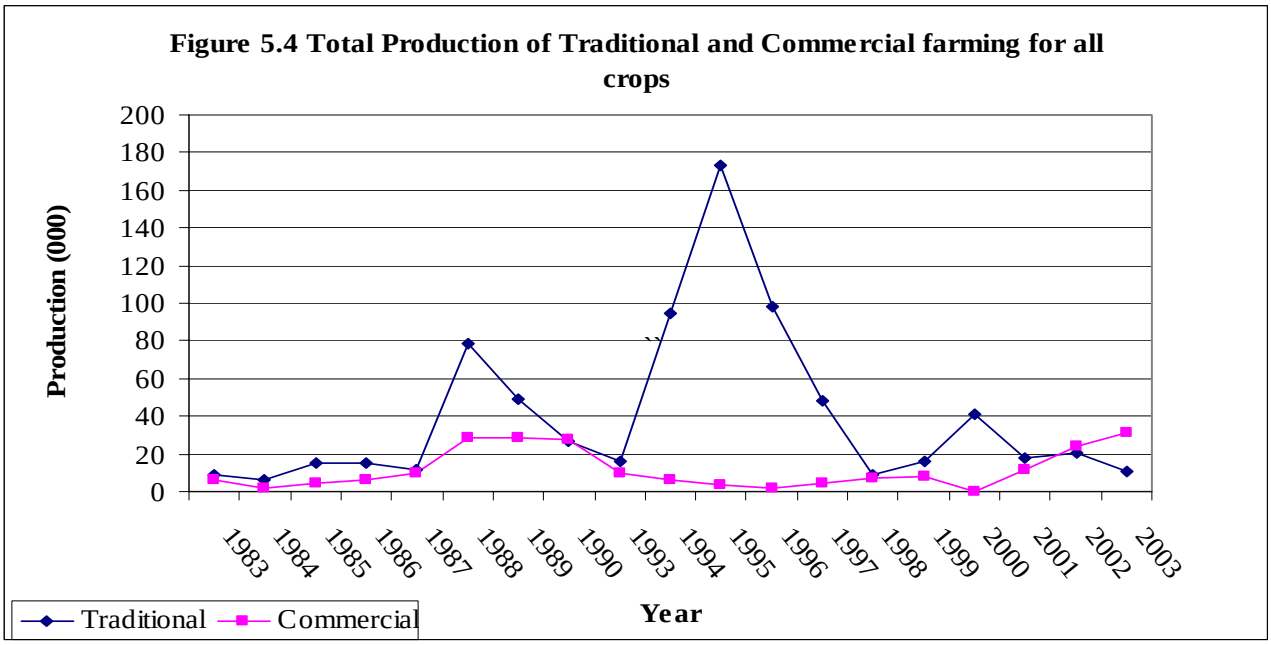
A comparison between area planted and harvested is shown on Figure 5.2 and 5.3 for traditional and commercial farming respectively. Figure 5.2 shows that area planted is higher than area harvested in all years. This is because area harvested is determined by availability of rainfall, type of soil, pests & diseases. It can be seen from figure 5.2 that land area that was planted and harvested in 1996 was higher than that of other years within the period 1983-2003.



NB: Area Planted and Harvested for 1994 and 2001 are estimates

Figure 5.3 shows that from 1983 to 1990 area planted was higher than area harvested. This observation might have been caused by water shortage, soil quality such as soil pH[8] and soil fertility[9] and drought. From 1993 to 1998 and 2003 the gap between area planted and harvested was almost equal (Agriculture Statistics Reports 1984 –2002) and from 1999 to 2002 the gap was narrow. The slight difference is brought by the fact that commercial farms might have improved the farming situation by using fertilizers, practicing irrigation, practicing cropping systems such as crop rotation and by adopting the new farming techniques (also see Table 5.3)

[8] Soil PH is degree of acidity or alkalinity of soil solution
[9] Soil fertility is the ability of the soil to supply the necessary nutrients for normal plant growth in suitable amounts and proportions



NB: Area Planted and Harvested for 1994 for both types of farming and 2001 for commercial only are estimates

Figure 5.4 shows that production of traditional farms is higher that commercial farms. This is because the former has planted vast amount of land compared to the latter. It is best to compare performance of the two sectors using ratios e.g. yields (see Figure 5.5).

Figure 5.5 Average Yield per Hectare Planted for all Crops

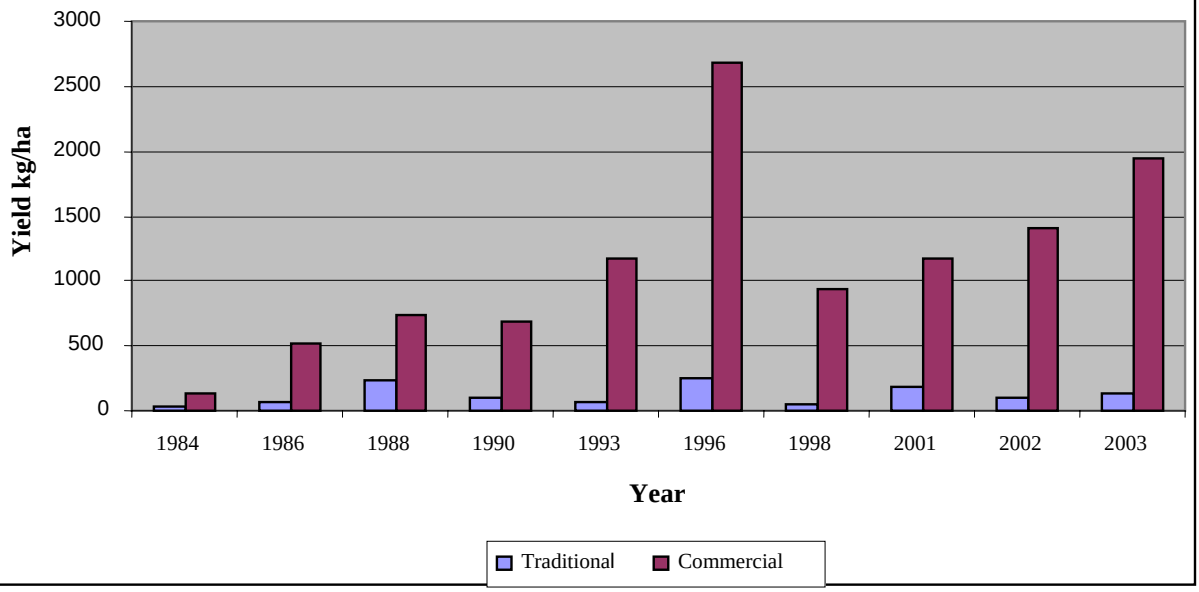


Figure 5.5 shows that in general, commercial farms have been performing above traditional farms probably because commercial farmers use better technologies and skilled manpower. The highest average yield for commercial farmers was registered in 1996 with 2689.85kg/ha whilst that for traditional farmers was only 257.88 kg/ha. It also shows that the highest average yield was recorded in 1996, 2002 and 2003 for commercial farming whilst that of traditional farming was observed in the years 1988, 1995 and 1996.

Figure 5.6 Proportion of Area Planted that is Harvested (PPH) For all Crops

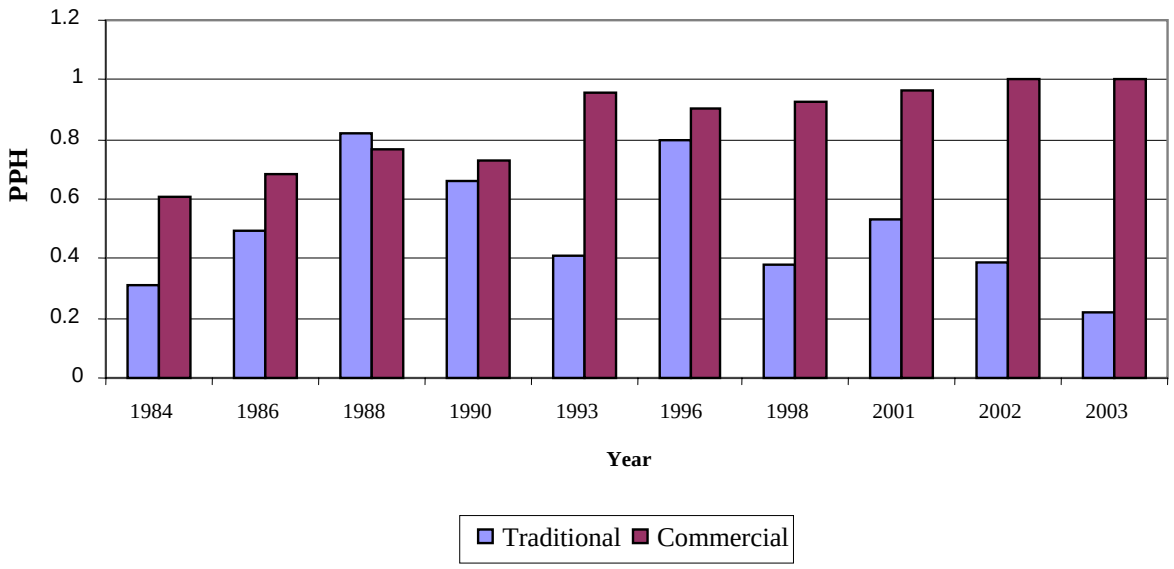


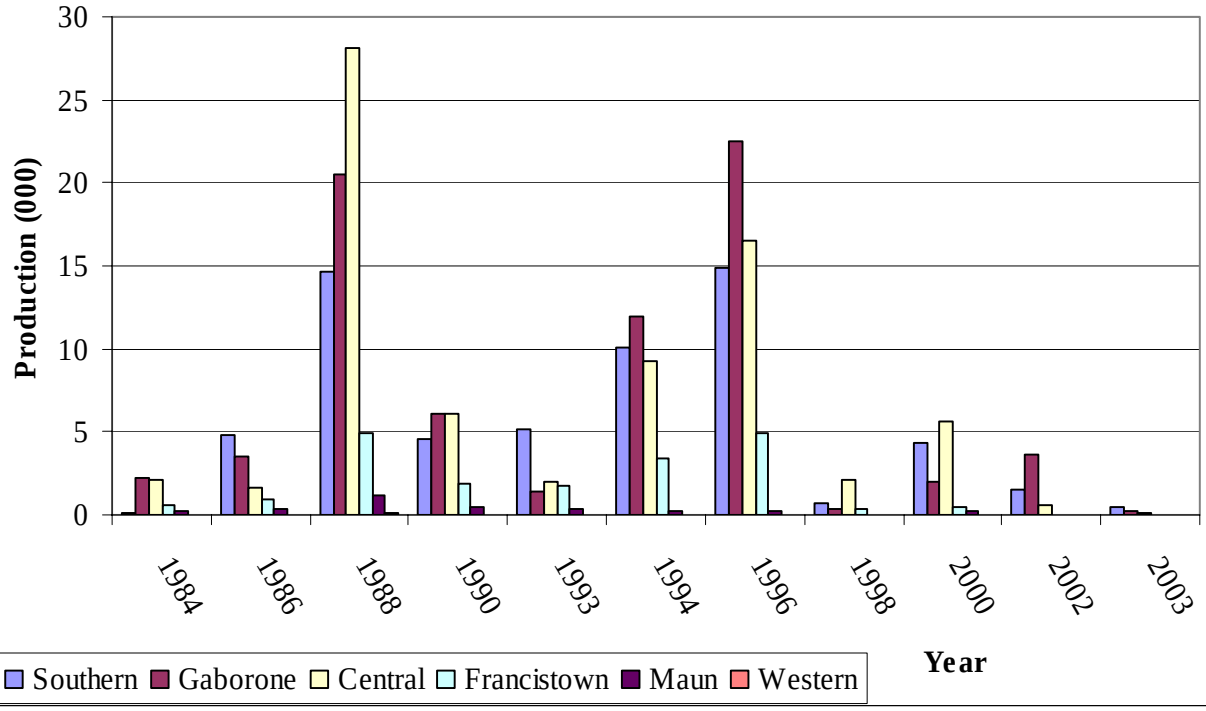
Figure 5.6 shows that the proportion of area planted that is harvested for all crops in commercial farming are good, the worrying ones are the traditional sector ones as for a considerable number of years the proportions are less than one. This may be caused by shortage of rainfall, poor soil conditions and drought. It is also clear that proportion of area planted that is harvested for commercial farms is higher than that of traditional farms for all years except for 1988 and 1989.

5.3 Production of Major Crops by Region

It is observed that production of major crops differ by region, this could be a result of variances in climatic conditions notably rainfall, temperatures and soils. The most outstanding feature of the regional crop production is the low production levels of the western part of the country where the Kalahari Desert is dominant.

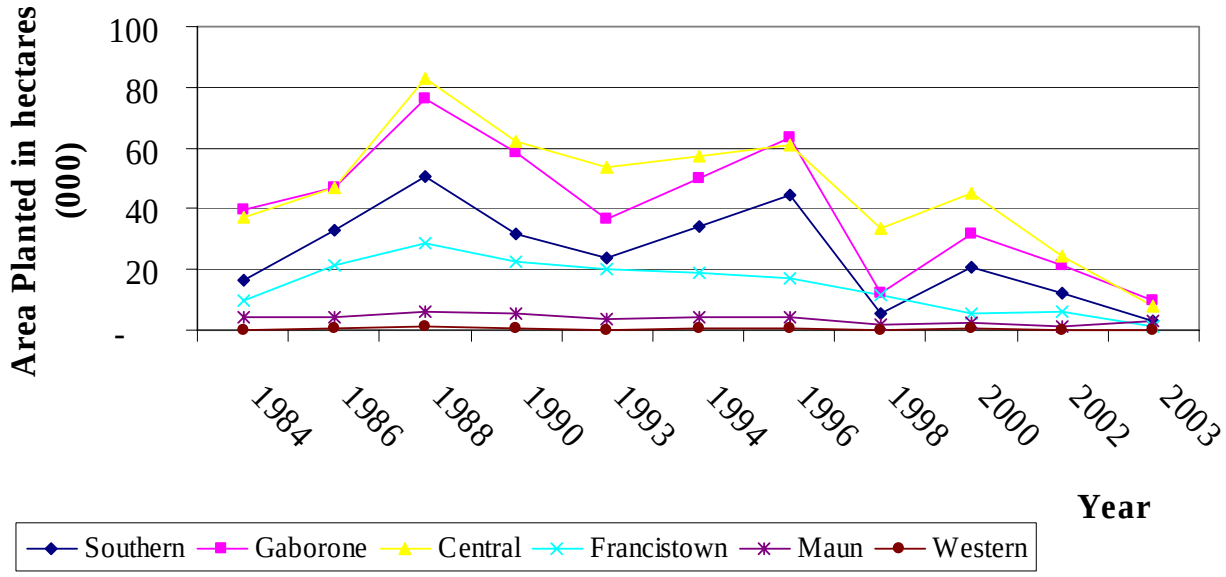
5.3.1 Sorghum Regional Production

Figure 5.7 Total Production of Sorghum by Region (Traditional Sector)



Graphical presentation of total sorghum production by region is given in Figure 5.7. It reveals that Gaborone, Central and Southern regions made the most contribution to sorghum production in most of the years. Western region recorded the lowest contribution to total production. Sorghum contributes a large proportion to total production and produces higher yields than other crops. However, it has been reported by National Food Technology Research Centre that sorghum consumption on daily basis has declined from 89 percent from 1982 to 75 percent in 1998 in selected villages of the southern district. In urban area sorghum consumption is low because households have a tendency of eating greater variety of foods as income increases. Area planted for sorghum seems to be going down as the years progress, it is also important to note that most of the sorghum produced in the SADC region is produced for human consumption and also sold in informal markets, primarily for traditional beer production (also see Figure 5.8).

Figure 5.8 Total Area Planted for sorghum by Region, 1984 - 2003 (Traditional Sector)



5.3.1 Maize Regional Production

Figure 5.9 Total Production of Maize by Regions, 1984 - 2003

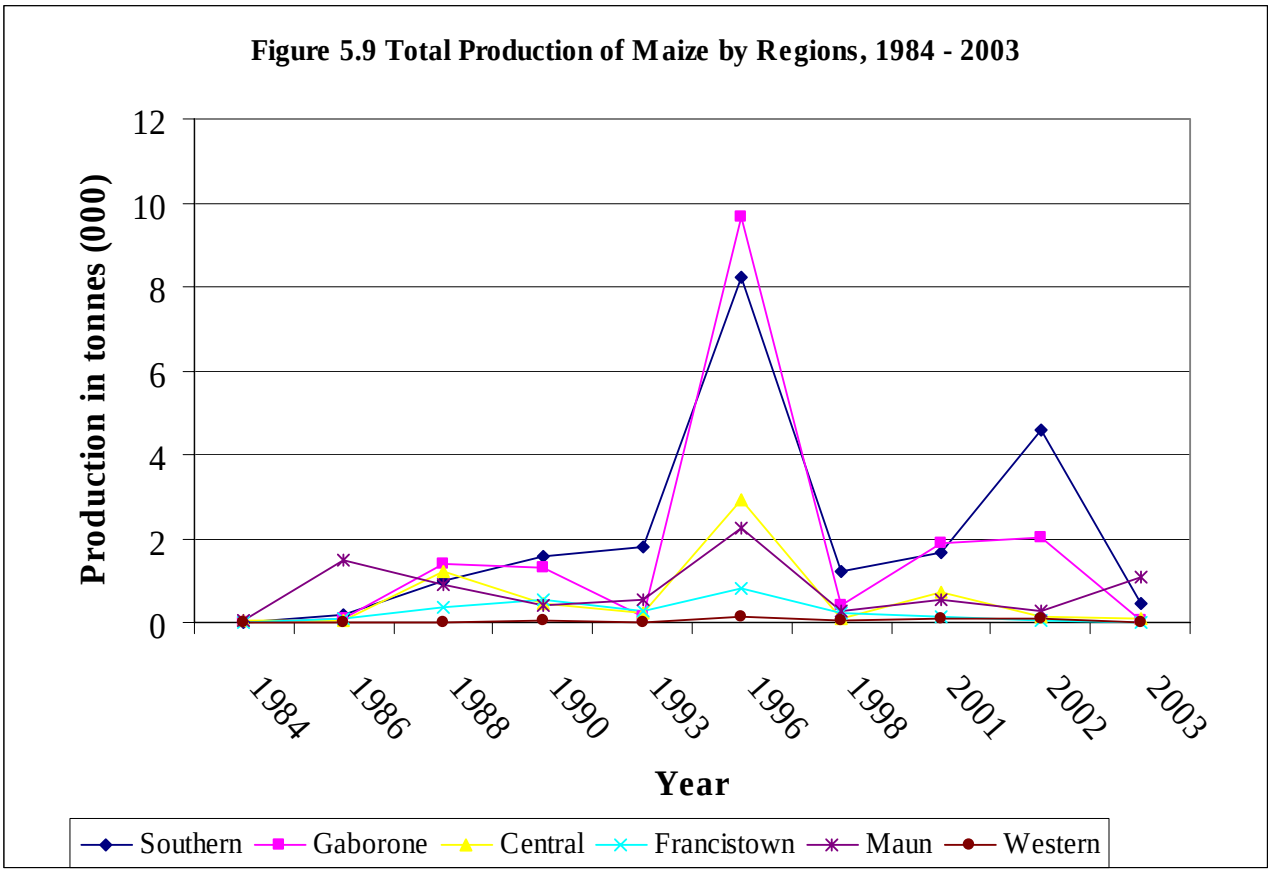


Figure 5.9 show that Gaborone, Central and Southern regions have made the most contribution to maize production. Western region recorded the lowest contribution to total production due to poor rainfall. Maize production has been fluctuating over the years due to inadequate rainfall and prolonged droughts. Maize production, which was more adversely affected by the drought than most other crops, is forecast to decline significantly in many countries, by between 29 percent in Zambia and 69 percent in Botswana (http://www.reliefweb.int/). Many factors such as demographic pressure and ecological degradation might have contributed to the unstable production of the maize.

5.4 Impact of Agriculture on the Environment

Farmers are becoming increasingly concerned about the impact agricultural practices can have on environmental and human health since the quality of the environment continues to decline in many parts of the country. Most farmers are failing to manage the environment since agricultural activities such as application of fertilizers, irrigation system etc are more cost effective, which makes farmers to ignore the limitations of physical environment.

Agriculture's long-term vitality and prosperity depend on its ability to co-exist sustainably with the natural environment. This involves blending of environmental, social, and economic opportunities that strives to meet the needs of the present without compromising the ability of future generations to meet their own needs.

5.4.1 Soil Quality

The arable land area in Botswana is small due to the low rainfall and infertile soils, which prevail over most of the country. Maintenance of the productive potential of this scarce resource is a key issue: soil erosion and bush encroachment are perceived as significant threats. Farmers depend on healthy soil for their livelihood, and therefore the government has a direct economic incentive to ensure that soil quality is sustained as a medium for growing crops since it determines the quantity and quality of food that can be produced in a country. **Soil** pH is one of the main factors influencing the solubility and availability of trace elements in arable soils. Thus pH can affect the trace element contents of agricultural crops and thereby indirectly influence human health. Factors that contribute to the failure of soil to lose its main functions are contamination (Caused by heavy metals), erosion which is caused by mismanagement and in turn it has led to desertification, decline in organic matter, decline in biodiversity, salination and continuous use of soil.

5.4.2 Water Resources

Agriculture is a significant user of water. Agriculture affects water quality and quantity, through the over withdrawal of groundwater and the pollution of the same water through agricultural runoff contaminated with herbicides, pesticides, fumigants and fertilizers (Human Geography 2nd Edition)[10]. In drought years, irrigation is practiced but it is known to have environmental impacts such as soil salination, erosion and compaction. Drought leads to water shortages, which in turn increases competition among its users. There is need to avail water, and reservoirs to agricultural projects in order to mitigate the impact of drought. The FAO estimates that only 7 percent of Africa's arable land is irrigated compared to 40 percent in Asia. Africa does not make full use of its water resources. It uses only 4 percent of available water reserves for irrigation (http//www.sahims.net).

[10] Knox P.L. and Marston S.A. (2001). Places and Regions in Global Context: Human Geography

5.4.3 Green House Gases

Climate change is a hot issue in both environmental and political circles, especially in the developed world. The issue of concern is the contribution of human activities to the Greenhouse Gas (GHG) emissions, which are believed to contribute significantly to global warming and climate change. The greenhouse gases whose emissions can be controlled are carbon dioxide, methane, nitrous oxide and chlorofluorocarbons. These gases are more efficient at absorbing long wavelength radiation of heat from the earth to the atmosphere than the incoming short-wave radiation of heat, which is from the sun.
There are three main sources of green house gases emissions from agriculture.

- N_2O (nitrous oxide) emissions from soils mainly due to nitrogen fertilization
- CH_4 and N_2O emissions from manure management
- CH_4 (methane) emissions from enteric fermentation.

The primary source of methane is mainly from cattle while secondary sources are from waste dumps, leaks from coal mining and natural gas production. Botswana is a major producer of beef, which is the major source of methane from enteric fermentation in livestock.

5.4.4 Biodiversity

Most farmers in Botswana, particularly subsistence farmers use land for crop production without proper management practices and external inputs. As a result of mismanagement, depletion of nutrients from the soil has led to lower production. Agricultural practices such as tillage, wetland drainage, irrigation and use of fertilizers and pesticides can affect biodiversity, however, when applied appropriately, the impact on wild flora and fauna is reduced (Human Geography 2nd Edition). As the population of semi arid countries (Botswana included) is more concentrated on fertile land, soil tends to lose 60-90 kilograms of nitrogen, phosphorus and potassium (NPK) per hectare each year.

5.5 Persistent Organic Pollutants (POPs)

POPs are chemical substances which are persistent in the environment and are known to accumulate in biological tissue, therefore posing a risk of adverse effects to human health and the environment. Since they accumulate in fatty tissue they are mostly found in animals than plants. Chemicals have contributed greatly to human well-being because they have raised farming yields by killing crop pests. But once released, some chemicals cause toxic reactions, persistent in the environment for years and can threaten long-term health and ecological consequences that were never anticipated.

There are dozen well-known POPs, which are referred to as the “Dirty Dozen”. The dozen comprises of Polychlorinated biphenyls (PCBs), dioxins and furans; and nine pesticides, which are:

Name Of Chemical	USE
Aldrin	Applied to soil to kill termites and other soil pests, termites attacking building material and grain storage.
Chlordane	Used to control termites and other soil pests, termites attacking building materials
DDT	It was used to control medical and veterinary vectors, such as malaria transmitting mosquitoes and trypanosomiasis- transmitting tsetse-fly
Dieldrin	Used to control locusts and termites
Endrin	Used to control mice, it can also be sprayed on leaves of crops such as cotton and grains
Heptachlor	Used to kill termites and other soil pests, termites attacking building materials
Hexachlorobenzene (HCB)	Formally used for seed treatment and fungal diseases
Mirex	The insecticide is applied mainly to combat fire ants and other types of ants and termites. It has also been used as a fire retardant in plastics rubbers and electrical goods.
Toxaphene	This insecticide, also called camphechlor, is applied to cotton, cereal grains, fruits, nuts and vegetables. It has also been used to control ticks and mites in livestock

5.5.1 Pesticides

Botswana has been experiencing a steady industrial growth since the 1970s. There has been an increase in the use of chemicals by members of the public, the private sector and the public service providers as well. This increase has been in specialized fields such as agriculture, where insects and unwanted weeds threatened animals and crops. Many organophosphates and organochlorines such as Malathion and Diazon were used to control all types of pests. Pesticides are chemicals which are designed to be toxic to living organisms. They therefore present potential risks to human health and the environment. POPs pesticides can present greater risks than new products because of their chemical composition. Understanding the hazards of pesticides and the risks they pose is important in making decisions about how to deal with POPs pesticides and how to effectively reduce risks.

Pesticides have become an integral part of agriculture. If farmers use proper measurements of pesticides they could extremely benefit human well being with higher yields, but if excessively used they could be dangerous to human health as well as the environment. This is not surprising since pesticides are designed to kill and some of them are even designed to cause genetic damage in larger animals especially birds ((Human Geography 2nd Edition)[11]. In Botswana commercial farmers like those owning the Barolong and Pandamatenga farms still use a significant amount of Atrazine (broadleaf herbicides) and other pesticides to maintain high crop yields and the practice is a threat to the quality of ground water.

[11] Knox P.L. and Marston S.A. (2001). Places and Regions in Global Context: Human Geography

Some of the banned pesticides are effective in combating malaria and other insect-borne diseases, and were applied to crops, which were later sold to the markets, this refers to circle poison. Due to movement of pesticides, people living near the farms are the ones most affected by the poisonous smell. At the moment there are no facilities to test whether crop commodities are affected by the pesticides or not, therefore it is up to the farmers to ensure that pesticides are properly applied to the plants (Plant Protection Unit)[12]. The environment can also be exposed to pesticides either during the long-term storage of pesticide stocks and during a disposal operation.

Pesticides such as Atrazine can contaminate underground water and such pesticides have been banned for health and environmental reasons in most EU countries like Denmark and Germany. Pesticides can also contaminate water through a variety of routes including leaching through soil, surface runoff or direct spillage into natural or constructed watercourses. The pesticides could then be consumed in drinking water, be applied unintentionally to crops in irrigation water, and affect natural aquatic biota. Below is Table 5.0 showing the amount of Fenthion 64% Ultra low Volume Chemicals used

Table 5.0 Amount of Fenthion 64% Ultra Low Volume Chemicals Used

Year	Total Chemical used (Litres)	Area Controlled (Ha)
1987 / 1988	12,000	2,100
1990 / 1991	3,741	1,257.10
1991 / 1992	63.5	16
1993 / 1994	4,564.20	1,401.94
1994 / 1995	6,601	1,804.15
1995 / 1996	6,413.13	2,419.54
2001 / 2002	768.5	455.58
2003 / 2004	1,557	773.35

Source: Plant Protection Unit, Ministry of Agriculture

Fenthion 64% Ultra Low Volume is used to control quelia birds (Plant Protection Unit). Fenthion is applied as a paste to perches to kill pest birds. The chemical is extremely toxic to honeybees indicating a high risk to pollinators and plants, which depend on pollination for reproduction. The use of fenthion as an avicide to control pest birds resulted in massive mortality of predatory raptors[13]. Fenthion presents a hazard to birds via direct oral and dermal routes of exposure. In some soils, fenthion residues may persist for approximately four to six weeks (Harding, 1979). Fenthion binds tightly to soil particles and is relatively immobile in most soil types (http://www.abcbirds.org/pesticides)[14]

[12] Plant Protection Unit Pamphlet, Ministry of Agriculture
[13] **raptor** is a bird that hunts its food using its curved beak and talons.
[14] http://www.abcbirds.org/Pesticides

Table 5.1 Cultivable Land Area (ha) and Total Land Area Planted (ha) for Traditional and Commercial Sector, 1983 – 2003

Year	Total Cultivable Land Area	Traditional Sector Land Area	Commercial Sector Land Area	Traditional Sector Area Planted	Commercial Sector Area Planted	Total Land Area Planted
1983	330,600	305,600	25,000	222,400	6,500	228,900
1984	322,200	282,200	40,000	187,600	15,200	202,800
1985	381,988	326,367	55,621	203,000	9,400	212,400
1986	367,200	307,200	60,000	230,200	12,900	243,100
1987	382,300	317,300	65,000	269,000	20,500	289,500
1988	442,300	370,800	71,500	328,600	39,300	367,900
1989	495,400	423,900	71,500	237,100	29,000	266,100
1990	421,000	345,400	75,600	283,800	55,000	338,800
1993	322,200	310,042	12,158	269,900	8,713	278,613
1995	425,441	346,200	79,241	294,000	3,189	297,189
1996	1,206,958	387,409	819,549	379,193	532	379,725
1997	496,953	491,146	5,807	367,973	5,807	373,780
1998	385,340	377,684	7,656	207,895	7,656	215,551
1999	401,544	388,463	13,081	289,140	13,081	302,221
2000	343,178	343,158	20	278,521	20	278,541
2001	307,478	298,978	8,500	94,161	8,500	94,161
2002	304,198	287,218	16,980	200,930	16,980	217,910
2003	210,795	194,560	16,235	79,810	16,235	96,045

Fallow land area not included for commercial farming from 1997 to 2003
Source: Agricultural Statistics Reports, CS0

Table 5.1A Proportion of Cultivable Land that is Planted by Year for Traditional and Commercial Sector, 1983 – 2003

Year	Proportion of Cultivable Land that is Planted for Traditional Sector	Proportion of Cultivable Land that is Planted for Commercial Sector
1983	0.73	0.26
1984	0.66	0.38
1985	0.62	0.17
1986	0.75	0.22
1987	0.85	0.32
1988	0.89	0.55
1989	0.56	0.41
1990	0.82	0.73
1993	0.87	0.72
1995	0.85	0.04
1996	0.98	0.00
1997	0.75	1.00
1998	0.55	1.00
1999	0.74	1.00
2000	0.81	1.00
2001	0.31	1.00
2002	0.70	1.00
2003	0.41	1.00

Derived from Table

Table 5.2 Area Planted (ha), Area Harvested (ha), Production (Tonnes) and Yield per hectare planted (kg/ha) for Traditional Sector. Sector

	Years									
Crops	**1984**	**1986**	**1988**	**1990**	**1993**	**1996**	**1998**	**2001**	**2002**	**2003**
Sorghum										
Planted	107,600.00	152,900.00	245,700.00	180,700.00	138,394.00	190,646.00	64,508.00	23,204.00	65,876.00	24,994.00
Harvested	45,500.00	90,400.00	219,400.00	131,900.00	66,561.80	164,299.00	27,254.00	13,409.00	30,804.00	5,043.00
Production	5,170.00	11,330.00	69,340.00	19,180.00	10,797.00	59,048.00	3,560.00	1,583.00	5,863.00	922.00
Yield	48.05	74.10	282.21	106.14	78.02	309.73	55.19	68.22	89.00	36.89
Maize										
Planted	43,900.00	41,600.00	50,800.00	68,600.00	83,956.00	133,864.00	88,116.00	47,637.00	95,210.00	37,833.00
Harvested	1,500.00	7,600.00	29,900.00	34,200.00	22,185.70	100,225.00	23,989.00	24,977.00	34,976.00	7,610.00
Production	100.00	1,910.00	4,840.00	4,280.00	2,976.00	24,034.00	2,233.00	4,976.00	7,147.00	1,597.00
Yield	2.28	45.91	95.28	62.39	35.45	179.54	25.34	104.46	75.07	42.21
Millet										
Planted	16,600.00	17,400.00	13,000.00	12,100.00	15,106.00	11,037.00	9,281.00	3,352.00	3,488.00	2,509.00
Harvested	8,300.00	10,100.00	9,000.00	8,900.00	10,502.90	8,921.00	4,575.00	1,709.00	444.00	1,125.00
Production	715.00	1,290.00	2,865.00	1,625.00	1,546.00	2,508.00	507.00	472.00	54.00	91.00
Yield	43.07	74.14	220.38	134.30	102.34	227.24	54.63	140.81	15.48	36.27
Beans/Pulses										
Planted	16,300.00	15,700.00	17,100.00	18,500.00	27,007.00	35,560.00	31,725.00	14,699.00	30,220.00	11,168.00
Harvested	2,500.00	4,600.00	9,900.00	11,500.00	9,247.80	24,838.00	12,532.00	8,251.00	10,698.00	2,778.00
Production	335.00	490.00	1,725.00	1,600.00	691.00	3,882.00	1,190.00	1,280.00	1,901.00	453.00
Yield	20.55	31.21	100.88	86.49	25.59	109.17	37.51	87.08	62.91	40.56
Sunflower										
Planted	200.00	600.00	700.00	400.00	2,249.00	399.00	221.00	962.00	152.00	252.00
Harvested	-	100.00	300.00	300.00	861.00	247.00	67.00	734.00	50.00	179.00
Production	-	100.00	50.00	40.00	113.00	26.00	7.00	150.00	13.00	6.00
Yield	-	166.67	71.43	100.00	50.24	65.16	31.67	155.93	85.53	23.81

Table 5.2
Continued

Crops										
	1984	**1986**	**1988**	**1990**	**1993**	**1996**	**1998**	**2001**	**2002**	**2003**
Groundnuts										
Planted	1,900.00	700.00	700.00	1,400.00	1,383.00	2,294.00	11,338.00	1,464.00	1,866.00	477.00
Harvested	-	200.00	400.00	600.00	566.70	1,438.00	9,243.00	526.00	601.00	27.00
Production	-	70.00	130.00	140.00	89.00	551.00	119.00	147.00	120.00	11.00
Yield	-	100.00	185.71	100.00	64.35	240.19	10.50	100.41	64.31	23.06
Other crops										
Planted	1,100.00	1,300.00	600.00	2,100.00	1,805.00	5,393.00	2,706.00	2,843.00	4,118.00	2,577.00
Harvested	200.00	400.00	200.00	200.00	97.40	2,065.00	394.00	523.00	1,745.00	453.00
Production	-	-	-	-	257	7,737.00	1,755.00	8,962.00	5,186.00	7,434.00
Yield	-	-	-	-	142	1,434.64	648.56	3,152.30	1,259.35	2,884.75
Total										
Planted	187,600.00	230,200.00	328,600.00	283,800.00	269,900.00	379,193.00	207,895.00	94,161.00	200,930.00	79,810.00
Harvested	58,000.00	113,400.00	269,100.00	187,600.00	110,023.30	302,033.00	78,054.00	50,129.00	79,318.00	17,215.00
Production	6,320.00	15,190.00	78,950.00	26,865.00	16,469.00	97,786.00	9,371.00	17,570.00	20,284.00	10,514.00
Yield	33.69	65.99	240.26	94.66	61.02	257.88	45.08	186.60	100.95	131.74

Source: Agriculture Statistics Reports, CSO

Table 5.3 **Area Planted (ha), Area Harvested (ha), Production (Tonnes) and Yield per hectare planted (kg/ha) for Commercial Sector**

Crops	YEARS 1984	1986	1988	1990	1993	1996	1998	2002	2003
Sorghum									
Planted	6,800.00	8,500.00	33,500.00	25,400.00	5,924.00	128.00	2,414.00	6,670.00	14,184.00
Harvested	3,600.00	6,200.00	24,300.00	20,800.00	5,821.00	109.00	2,342.00	6,670.00	14,173.00
Production	550.00	4,700.00	25,000.00	19,000.00	5,730.00	152.00	183.00	9,942.00	22,579.00
Yield	80.88	552.94	746.27	748.03	967.25	1,187.50	75.81	1,490.55	1,591.86
Maize									
Planted	4,000.00	2,000.00	3,500.00	11,300.00	1,301.00	281.00	1,950.00	6,290.00	27.00
Harvested	1,800.00	1,200.00	3,000.00	6,500.00	1,197.90	256.00	1,767.00	6,275.00	7.00
Production	390.00	1,650.00	2,800.00	7,500.00	1,278.00	595.00	111.00	9,300.00	36.00
Yield	97.50	825.00	800.00	663.72	982.32	2,117.44	56.92	1,478.54	1,333.33
Millet									
Planted	100.00	100.00	100.00	100.00	-	-	-	-	-
Harvested	-	-	100.00	100.00	-	-	-	-	-
Production	-	-	80.00	25.00	-	-	-	-	-
Yield	-	-	800.00	250.00	-	-	-	-	-
Beans/Pulses									
Planted	1,000.00	500.00	1,000.00	1,500.00	196.00	42.00	42.00	46.00	15.00
Harvested	300.00	400.00	1,000.00	800.00	141.90	42.00	35.00	31.00	14.00
Production	15.00	50.00	600.00	350.00	27.00	32.00	8.00	6.00	7.00
Yield	15.00	100.00	600.00	233.33	137.76	761.90	190.48	130.43	466.67
Sunflower									
Planted	1,300.00	300.00	300.00	400.00	472.00	42.00	2,500.00	3,240.00	1,850.00
Harvested	1,300.00	200.00	200.00	200.00	468.20	42.00	2,260.00	3,240.00	1,850.00
Production	390.00	90.00	150.00	200.00	214.00	13.00	1,260.00	2,237.00	954.00
Yield	300.00	300.00	500.00	500.00	453.39	309.52	504.00	690.43	515.68

Table 5.3 continued

Crops	YEARS								
	1984	1986	1988	1990	1993	1996	1998	2002	2003
Groundnuts									
Planted	1,800.00	1,000.00	400.00	700.00	176.00	-	129.00	27.00	22.00
Harvested	1,800.00	500.00	200.00	400.00	147.20	-	129.00	24.00	22.00
Production	590.00	150.00	180.00	400.00	34.00	-	2.00	17.00	4.00
Yield	327.78	150.00	450.00	571.43	193.18	-	15.50	629.63	181.82
Other crops									
Planted	200.00	500.00	500.00	1,000.00	644.00	39.00	621.00	707.00	137.00
Harvested	400.00	300.00	1,500.00	800.00	621.00	30.00	619.00	681.00	132.00
Production	-	-	-	-	2,867	639.00	5,569.00	2,508.00	7,950.00
Yield	-	-	-	-	4,451.86	16,384.62	8,967.79	3,547.38	58,029.20
Total									
Planted	15,200.00	12,900.00	39,300.00	40,400.00	8,713.00	532.00	7,656.00	16,980.00	16,235.00
Harvested	9,200.00	8,800.00	30,300.00	29,600.00	8,397.20	479.00	7,152.00	16,921.00	16,198.00
Production	1,935.00	6,640.00	28,810.00	27,475.00	10,150.00	1,431.00	7,133.00	24,010.00	31,530.00
Yield	127.30	514.73	733.08	680.07	1,164.93	2,689.85	931.69	1,414.02	1,942.10

Table 5.4 **Area Planted (AP, '000 ha), Area Harvested (AH, '000 ha) and Proportion of Area Planted that is Harvested (PPH) for Traditional Farming.**

CROPS	YEAR									
	1984	1986	1988	1990	1993	1996	1998	2001	2002	2003
Sorghum										
AP	107.60	152.90	245.70	180.70	138.39	190.65	64.51	23.20	65.88	24.99
AH	45.50	90.40	219.40	131.90	66.56	164.30	27.25	13.41	30.80	5.04
PPH	0.42	0.59	0.89	0.73	0.48	0.86	0.42	0.58	0.47	0.20
Maize										
AP	43.90	41.60	50.80	68.60	83.96	133.86	88.12	47.64	95.21	37.83
AH	1.50	7.60	29.90	34.20	22.19	100.23	23.99	24.98	34.98	7.61
PPH	0.03	0.18	0.59	0.50	0.26	0.75	0.27	0.52	0.37	0.20
Millet										
AP	16.60	17.40	13.00	12.10	15.11	11.04	9.28	3.35	3.49	2.51
AH	8.30	10.10	9.00	8.90	10.50	8.92	4.58	1.71	0.44	1.13
PPH	0.50	0.58	0.69	0.74	0.70	0.81	0.49	0.51	0.13	0.45
Beans/Pulses										
AP	16.30	15.70	17.10	18.50	27.01	35.56	31.73	14.70	30.22	11.17
AH	2.50	4.60	9.90	11.50	9.25	24.84	12.53	8.25	10.70	2.78
PPH	0.15	0.29	0.58	0.62	0.34	0.70	0.40	0.56	0.35	0.25
Sunflower										
AP	0.20	0.60	0.70	0.40	2.25	0.40	0.22	0.96	0.15	0.25
AH	-	0.10	0.30	0.30	0.86	0.25	0.07	0.73	0.05	0.18
PPH	-	0.17	0.43	0.75	0.38	0.62	0.30	0.76	0.33	0.71
Groundnuts										
AP	1.90	0.70	0.70	1.40	1.38	2.29	11.34	1.46	1.87	0.48
AH	-	0.20	0.40	0.60	0.57	1.44	9.24	0.53	0.60	0.03
PPH	-	0.29	0.57	0.43	0.41	0.63	0.82	0.36	0.32	0.06

Table 5.4 continued

Crops	YEAR 1984	1986	1988	1990	1993	1996	1998	2001	2002	2003
Other crops										
AP	1.10	1.30	0.60	2.10	1.81	5.39	2.71	2.84	4.12	2.58
AH	0.20	0.40	0.20	0.20	0.10	2.07	0.39	0.52	1.75	0.45
PPH	0.18	0.31	0.33	0.10	0.05	0.38	0.15	0.18	0.42	0.18
Total										
AP	187.60	230.20	328.60	283.80	269.90	379.19	207.90	94.16	200.93	79.81
AH	58.00	113.40	269.10	187.60	110.02	302.03	78.05	50.13	79.32	17.22
PPH	0.31	0.49	0.82	0.66	0.41	0.80	0.38	0.53	0.39	0.22

Source: Agricultural Statistics Reports, CSO

Table 5.5 **Area Planted (AP, '000 ha), Area Harvested (AH, '000 ha) and Proportion of Area Planted that is Harvested (PPH) for Commercial Farming.**

Crops	1984	1986	1988	1990	1993	1996	1998	2002	2003
Sorghum									
AP	6.80	8.50	33.50	25.40	5.92	0.13	2.41	6.67	14.18
AH	3.60	6.20	24.30	20.80	5.82	0.11	2.34	6.67	14.17
PPH	0.53	0.73	0.73	0.82	0.98	0.85	0.97	1.00	1.00
Maize									
AP	4.00	2.00	3.50	11.30	1.30	0.28	1.95	6.29	0.03
AH	1.80	1.20	3.00	6.50	1.20	0.26	1.77	6.28	0.01
PPH	0.45	0.60	0.86	0.58	0.92	0.91	0.91	1.00	0.26
Millet									
AP	0.10	0.10	0.10	0.10	-	-	-	-	-
AH	-	-	0.10	0.10	-	-	-	-	-
PPH	-	-	1.00	1.00	-	-	-	-	-
Beans/Pulses									
AP	1.00	0.50	1.00	1.50	0.20	0.04	0.04	0.05	0.02
AH	0.30	0.40	1.00	0.80	0.14	0.04	0.04	0.03	0.01
PPH	0.30	0.80	1.00	0.53	0.72	1.00	0.83	0.67	0.93
Sunflower									
AP	1.30	0.30	0.30	0.40	0.47	0.04	2.50	3.24	1.85
AH	1.30	0.20	0.20	0.20	0.47	0.04	2.26	3.24	1.85
PPH	1.00	0.67	0.67	0.50	0.99	-	-	-	-

Table 5.5 continued

Crops	1984	1986	1988	1990	1993	1996	1998	2002	2003
Groundnuts									
AP	1.80	1.00	0.40	0.70	0.18	-	0.13	0.03	0.02
AH	1.80	0.50	0.20	0.40	0.15	-	0.13	0.02	0.02
PPH	1.00	0.50	0.50	0.57	0.84	-	1.00	0.89	-
Other crops									
AP	0.20	0.50	0.50	1.00	0.64	0.04	0.62	0.71	0.14
AH	0.40	0.30	1.50	0.80	0.62	0.03	0.62	0.68	0.13
PPH	2.00	0.60	3.00	0.80	0.96	0.77	1.00	0.96	0.96
Total									
AP	15.20	12.90	39.30	40.40	8.71	0.53	7.66	16.98	16.24
AH	9.20	8.80	30.30	29.60	8.40	0.48	7.15	16.92	16.20
PPH	0.61	0.68	0.77	0.73	0.96	0.90	0.93	1.00	1.00

Source: Agriculture Statistics Reports, CSO

Table 5.7 Area Planted and Harvested (ha) and Production (Tonnes) of Sorghum by Region, 1984 - 2003 (Traditional Farming)

Region		Year									
		1984	1986	1988	1990	1993	1996	1998	2001	2002	2003
Southern	Planted	16,500	32,900	50,400	31,700	24,000	44,380	5,218	2,015	12,069	3,126
	Harvested	5,000	23,000	41,900	25,300	14,813	38,293	3,055	1,043	7,943	1,611
	Production	150	4,850	14,595	4,545	5,213	14,861	675	183	1,532	417
Gaborone	Planted	39,400	47,000	76,300	58,500	36,482	63,256	12,280	5,084	21,545	9,495
	Harvested	15,300	33,300	70,300	43,100	13,060	55,513	3,056	1,244	13,166	1,327
	Production	2,225	3,500	20,510	6,050	1,416	22,527	330	271	3,669	256
Central	Planted	37,400	46,800	82,800	62,100	53,682	60,742	33,608	12,996	24,544	8,225
	Harvested	18,300	20,000	76,800	43,600	21,610	53,773	14,726	9,333	9,160	1,388
	Production	2,070	1,650	28,100	6,130	2,022	16,533	2,143	888	636	172
Francistown	Planted	9,900	21,600	28,400	22,300	20,313	17,110	11,698	1,928	6,084	977
	Harvested	5,500	12,000	23,500	16,700	14,426	15,191	6,222	937	464	327
	Production	540	950	4,920	1,910	1,778	4,930	393	107	15	29
Maun	Planted	4,100	4,200	6,400	5,400	3,705	4,438	1,597	1,056	1,464	3,122
	Harvested	1,400	2,000	6,000	2,900	2,623	1,314	186	739	68	390
	Production	185	370	1,155	515	368	186	19	127	11	48
Western	Planted	300	400	1,400	700	212	720	107	125	170	49
	Harvested	-	100	900	300	31	215	9	113	3	-
	Production	-	10	60	30	-	11	-	7	-	-
Total	Planted	107,600	152,900	245,700	180,700	138,394	190,646	64,508	23,204	65,876	24,994
	Harvested	45,500	90,400	219,400	131,900	66,562	164,299	27,254	13,409	30,804	5,043
	Production	5,170	11,330	69,340	19,180	10,797	59,048	3,560	1,583	5,863	922

Source: Agriculture Statistics Reports, CSO

Table 5.8 Area Planted and Harvested ('000 ha) and Production (tonnes) of Maize by Region, (1984 - 2003)

		Year									
Regional		**1984**	**1986**	**1988**	**1990**	**1993**	**1996**	**1998**	**2001**	**2002**	**2003**
Southern	Planted	6,600	6,100	6,600	18,300	20,981	42,411	15,761	11,406	40,596	12,420
	Harvested	200	2,000	3,700	11,600	10,052	35,918	9,704	7,231	23,645	3,858
	Production	5	170	970	1,585	1,812	8,246	1,210	1,666	4,586	437
Gaborone	Planted	13,800	10,100	17,800	16,100	22,386	41,685	15,837	10,199	21,296	10,452
	Harvested	300	1,000	10,600	9,300	2,454	34,930	4,115	6,248	6,687	988
	Production	10	80	1,380	1,290	134	9,657	384	1,871	2,025	23
Central	Planted	14,700	10,700	11,900	17,200	24,417	31,390	17,214	12,979	20,684	7,411
	Harvested	400	500	7,300	5,200	3,050	18,253	1,577	8,205	2,840	268
	Production	40	50	1,230	455	214	2,928	100	703	151	71
Francistown	Planted	6,000	9,900	7,800	7,900	11,634	8,018	12,299	1,752	6,445	947
	Harvested	100	1,200	4,200	4,900	4,316	5,535	5,862	997	214	53
	Production	5	110	345	535	278	830	214	130	44	4
Maun	Planted	2,300	4,400	5,600	7,600	4,071	8,113	25,264	10,269	5,361	6,295
	Harvested	500	2,800	3,500	2,900	2,284	4,221	2,136	1,802	1,197	2,443
	Production	40	1,490	895	390	536	2,240	270	536	268	1,062
Western	Planted	500	400	1,100	1,500	468	2,247	1,741	1,032	828	308
	Harvested	-	100	600	300	30	1,368	595	494	393	-
	Production	-	10	20	25	2	133	55	70	73	-
Total	Planted	43,900	41,600	50,800	68,600	83,956	133,864	88,116	47,637	95,210	37,833
	Harvested	1,500	7,600	29,900	34,200	22,186	100,225	23,989	24,977	34,976	7,610
	Production	100	1,910	4,840	4,280	2,976	24,034	2,233	4,976	7,147	1,597

Source: Agriculture Statistics Reports, CSO

6.0 Livestock Production

6.1 Introduction

It is reported in the National Water Master Plan Review (2001- 2002) Volume 8 that 47 percent of the land in Botswana is used for communal grazing and that beef production comes from this land. The cultivable land area dropped sharply by 36.2 percent from 1983 – 2003, which increases land used for grazing. The semi-arid climate in the western region combined with its low population density provides a great opportunity for livestock production. The infertile area, which covers large portion of lands in the western part of the country, is the one suitable for animal production.

In 1966, Botswana was one of the poorest countries in the world and livestock rearing was the backbone of the national economy. Today it still remains the mainstay of the rural economy. An overwhelmingly rural population depended on agriculture and livestock for a livelihood, which contributed 40 percent to the Gross Domestic Product. The contribution made by Agriculture as a whole at the time of independence to Gross Domestic Product diminished significantly from 40 percent to 2.3 percent in 2003 of which livestock sub sector has contributed 66 percent (National Accounts Statistics of Botswana Quarterly Gross Domestic Product 1993/94 – 2002/03). Livestock today is a substantial source of income for the rural population even though employment in this industry is on the decline. However, livestock industry is still seen as the best vehicle for alleviation of poverty, which is estimated to be as high as 40-45 percent (National Water Master Plan Review Volume 8).

In Botswana livestock is kept for social and cultural purposes, for example, livestock can be used to pay dowry / brides price (lobola), slaughtered during ceremonies, inheritance (uncles giving nephews heifers to start breeding nucleus), used as a source of draught power and are also used as a sign of prestige (the number of cattle one has, is a measure of wealth and determines ones status).

Beef export is regarded as one of the major contributor to Botswana's economy which has made improvements on the country's development and at the same time it has generated socio-economic and environmental problems. Most serious are the continuing skewness of livestock holdings and accelerated overgrazing of rangelands due to overstocking of cattle by both subsistence and commercial farmers.

The major problems faced by livestock production is the continuous threat of diseases such as Foot and Mouth disease and Contagious Bovine Pleuropneumonia which are difficult to control especially in communal areas where animals graze in large numbers. Due to European import restriction on meat veterinary cordon fences were built to prevent the spread of diseases and to allow expansion of the cattle industry to meet export demands. Other constraints to livestock production are nutritional problems especially lack of phosphorus in pastures, and unreliable rainfall and hot climate.

To minimise the challenges farmers face, the government has developed schemes aimed at supporting the agricultural sector in various ways such as the Livestock Management Infrastructure Development (LIMID).

6.2 Livestock Farming Methods

6.2.1 Subsistence / Traditional Farming Method

Under traditional system, livestock are kept to meet the basic needs of food and shelter. In this system, production of animal product is usually low, this is partially caused by poor quality stock and mostly is due to parasites and diseases, poor feeding, shortage of water, harsh climate and strong cultural and social attachment to livestock. In order to improve this situation of low animal products Government needs to assist farmers in improving the quality of stock, improve standard of livestock husbandry, install permanent water supplies and educate farmers on animal husbandry. It is common for traditional farmers to pump water from a borehole, but in areas where there is shallow water such as in pans and dry riverbeds, water is taken from hand-dug wells. In this system the community owns the grazing land therefore every farmer is allowed to keep any number of cattle in that area. The problem encountered in this system is that of overstocking which will definitely lead to overgrazing, soil erosion and degradation. It can also become difficult for farmers to control feeding and breeding due to uncontrolled movement of livestock.

6.2.2 Commercial Farming Method

Commercial farms on the other hand aim to produce animal products in large quantities and higher quality, which are meant for sale both locally and in international markets markets. They keep animals in well-managed farms and with capital investment in quality stock, machinery, fencing, labour, watering facilities and disease control measures. As a result of this investment, output of animal products is very high unlike in subsistence farming (East African Agriculture)[15]. Some farmers in this system use freehold land therefore have rights over the utilisation of water resources and natural resources in that particular area. This system is characterised by low stocking rate relative to the traditional sector. The major problems encountered by commercial farmers are poor infrastructure, lack of telecommunications, and electricity in most livestock farms and also the distance from major market and abattoirs, which hikes transport cost. Commercial farming in Botswana is at a low scale.

6.3 Livestock Breeding

Breeding is the process of mating selected males and females in order to pass those traits uniformly to their offspring. The main purpose of a beef farmer is to produce young animals, fatten them and sell them for slaughter. In the case of cattle, farmers need a breeding herd of cows and a few bulls to produce desirable traits in one individual animal. This breeding process must be managed in such a way that each year it produces a calf, therefore the process should be

[15] Nguni D. N, Karau P.K. and Nguyo W. (1990). East African Agriculture

continuous. Most Batswana keep different kinds of breeds such as Tswana, Brahman, Tuli and Simmental, but these are dominated by Tswana breed. However, the type and breed of livestock found in any part of the country is determined by factors such as feeds, management, climatic conditions and diseases that an animal is exposed to.

6.4 Impacts of Livestock on the Environment

In spite of their growing global importance, livestock are increasingly being held responsible for various effects on the environment such as loss of vegetative cover, reduced biodiversity, soil erosion and compaction, and excessive run-off. High concentrations of livestock contribute to contamination of ground water, **eutrophication**[16], and soil pollution. The processing of animal products in developing countries generates waste materials creating disposal problems. However, most criticism of livestock agriculture do not take into account the fact that negative effects are frequently related to underlying driving forces such as inappropriate land use policies, population pressures, rural poverty and inappropriate technology (http://www.fao.org/WAIRDOCSS/LEAD/X6 130E/X6130E02.htm).

Ruminant animals, such as cattle, sheep and goats have a special digestive system which enables them to convert unusable plant materials into nutritious food and fiber. This special digestive system however produces methane, a potent greenhouse gas that can contribute to global climate change. Livestock production system can also emit other greenhouse gases such as nitrous oxide and carbon dioxide. Climate affects animal production in four ways:

- the impact of changes in livestock feed-grain availability and price
- impacts on livestock pastures and forage crop production and quality
- changes in the distribution of livestock diseases and pests
- the direct effects of weather and extreme events on animal health, growth and reproduction[17]

It has been reported in UNDP report that Botswana contributes 7 percent of Africa's greenhouse gas emissions (http://www.unbotswana.org.bw/undp/environment.htm). The major sources of greenhouse gas from agriculture are enteric fermentation, manure management and emissions from agricultural soils. It has also been reported in Eurostat news release 113/2005 - dated 9 September 2005 that cattle accounted for 84 percent of greenhouse gas emissions from enteric fermentation and 35 percent of greenhouse gas emissions from manure management in the European Union 15. Dairy cows are also reported to produce one third of greenhouse gas emissions from enteric fermentation and one sixth of those from manure management. Pigs are also said to be the other major source of greenhouse gas emissions from both enteric fermentation and manure management.

[16] **Eutrophication** is the enrichment of an ecosystem with chemical nutrients, typically compounds containing nitrogen or phosphorus. Eutrophication is considered a form of pollution because it promotes plant growth, favoring certain species over others and forcing a change in species composition.

[17] http://animalsciences.missouri.edu/research/bec/Brody%20Lecture%20-%20Valtora.pdf

6.4.1 Soil

a) Physical impacts

Heavy livestock such as cattle compact soil structure and destroy vegetation on parts of a field that they tread most often. This is usually apparent around drinking water troughs, entrances to fields and other parts of the land where the animals congregate. Destruction of soil structure can be seen to be harmful because restoration of vegetation does not always occur spontaneously once the grazing animal is withdrawn but can take months to recover. Compacted soil therefore becomes hard making it difficult for new shoots to penetrate the soil and emerge; structure-less soil is unlikely to drain well and will pond after moderate rainfall (Warren et al., 1986).

Pig production is also known for its destructive effects on vegetation. It is known that pigs usually dig into soil with the snout, and this obviously has effect on soil and vegetation.

b) Chemical and biological impacts

The amount of urine delivered to soil by a grazing cow is estimated to be 2 litres and can be spread to an area of about 0.4 m^2 (Addiscott *et al*, 1991). Such an amount burns vegetation and is often toxic to plant roots which cannot immediately recover (full recovery can take up to 12 months and the problem is worse in areas where animals congregate). Both Calcium and Magnesium are also lost in substantial amounts from urine patches on pasture soils (Early et al., 1998).

6.4.2 Water resources

Intensive operations such as cattle feedlots (more than 500 head of cattle) can have a large impact on water quality. High population densities of livestock can generate large quantities of animal waste which is considered to be a source of pollution for surface water and ground water. In addition manure mismanagement, poor holding structures or human error can cause surface water contamination. Non intensive operations such as pasture and watering sites for cattle can also have negative impacts on water quality. Direct access to water sources for cattle allows for direct deposition of wastes and increased erosion.

6.5 Trends of Livestock Population

The objective of this topic is to show trends in major livestock namely cattle, goats and sheep found in Botswana. Figure 6.1 shows that cattle population has been higher than that of goats and sheep except in the years 1993 to 1995 and 1997 when goat population exceeded cattle population. Both cattle and goats population were characterized by fluctuations. Sheep in comparison has been consistently lower than the cattle and the goats.

Figure 6.1 Combined Traditional & Commercial Livestock Population (1983 - 2003)

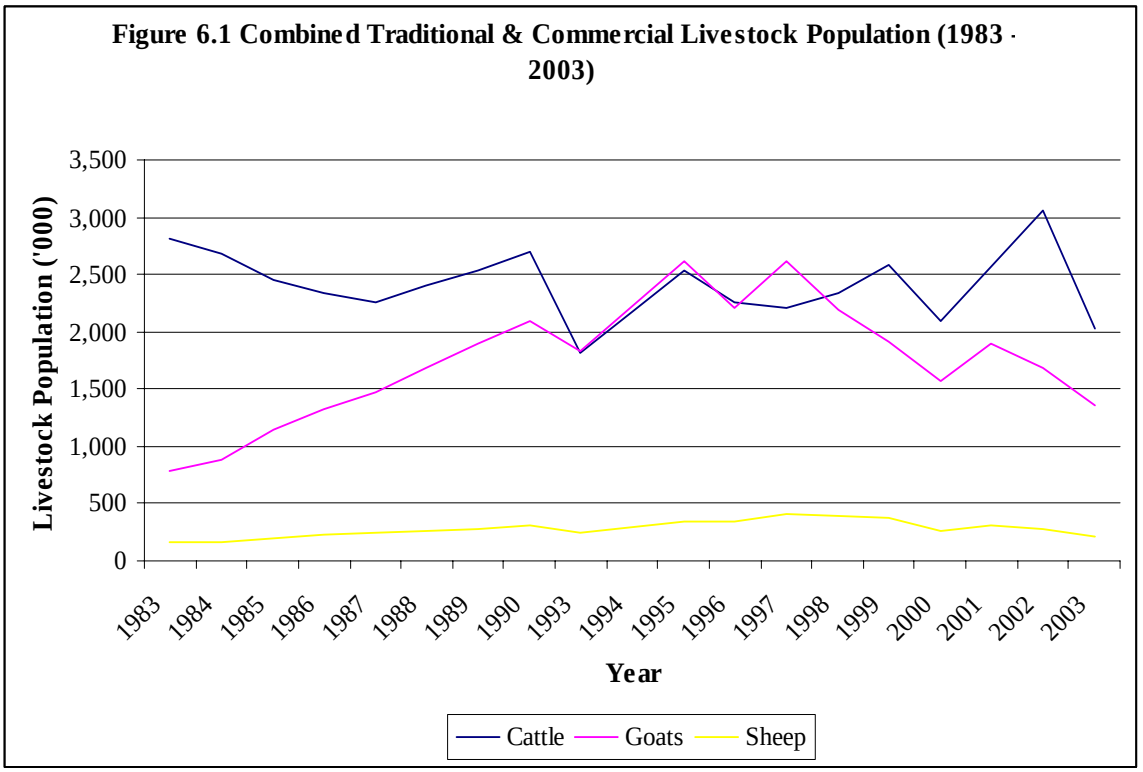


Figure 6.2 Livestock Population for Traditional Farming, 1983 - 2003

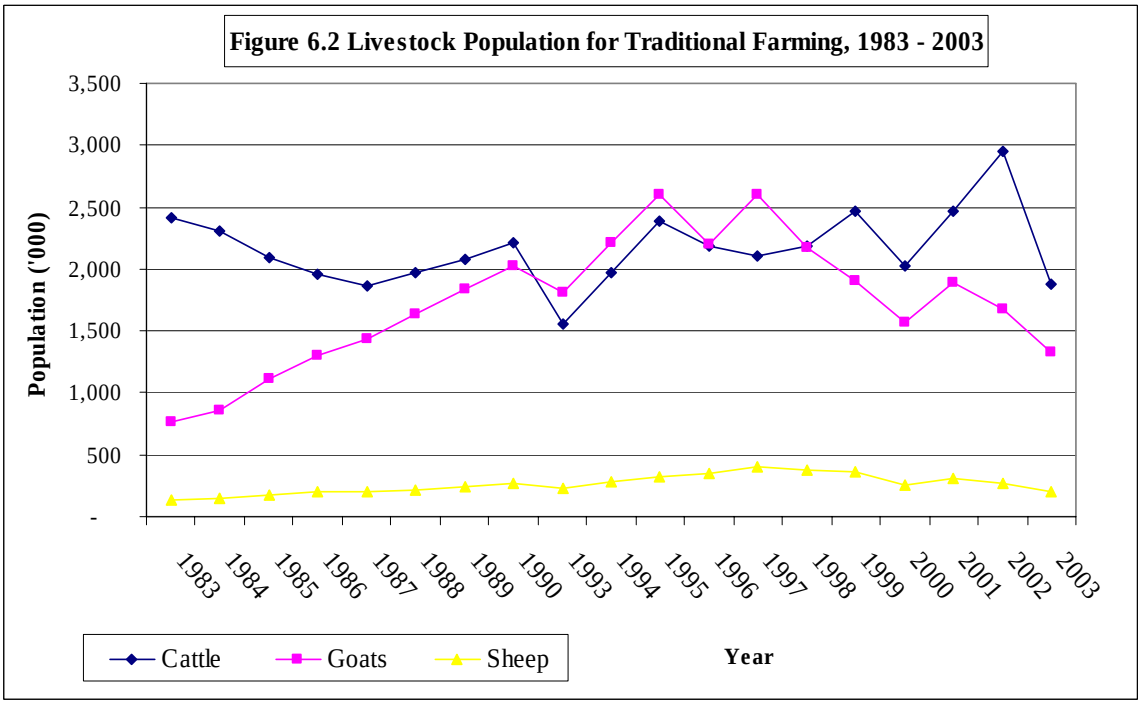


Figure 6.2 shows trends in livestock commonly found in Botswana. Cattle are the most prevalent livestock, followed by goats, and sheep (also see Table 6.1). It is evident from the graph that cattle population has been fluctuating over the years. In 1995 - 1996 the drop in cattle population was due to the outbreak of cattle lung disease **(**Contagious Bovine Pleuropneumonia), therefore the government initiated slaughter of all cattle in Ngamiland in order to eradicate the spread of disease. It can also be observed from the graph that the year 2002 recorded the highest number of cattle than the previous years.

In 2003, foot and mouth disease affected North East District (Matsiloje) and that also led to a decrease in cattle population. Goats and sheep (small stock) are not as highly regarded as cattle but they play a very important role by providing meat and milk. Figure 6.2 shows that the population of sheep and goats has been increasing gradually except 1998 to 2003 when small stock started diminishing for unknown reasons. The constraints to small stock production are mostly related to management and these are characterized by high mortality caused by internal and external parasites and tick borne disease e.g. heart water (National Water Master Plan Review 2001-2002 Volume No. 8).

Even though donkeys are just few in Botswana they are mostly used for transport and can also generate additional income from sales of agricultural products in rural areas, and during ploughing seasons as they are used as draught power. Donkeys are cheap to keep and easy to feed as they have small food requirements. They are mostly known to have more stamina than oxen, and also they require relatively little attention when working with them. In most cases there is no off take for slaughter or sales because it is uncommon to slaughter them for human consumption.

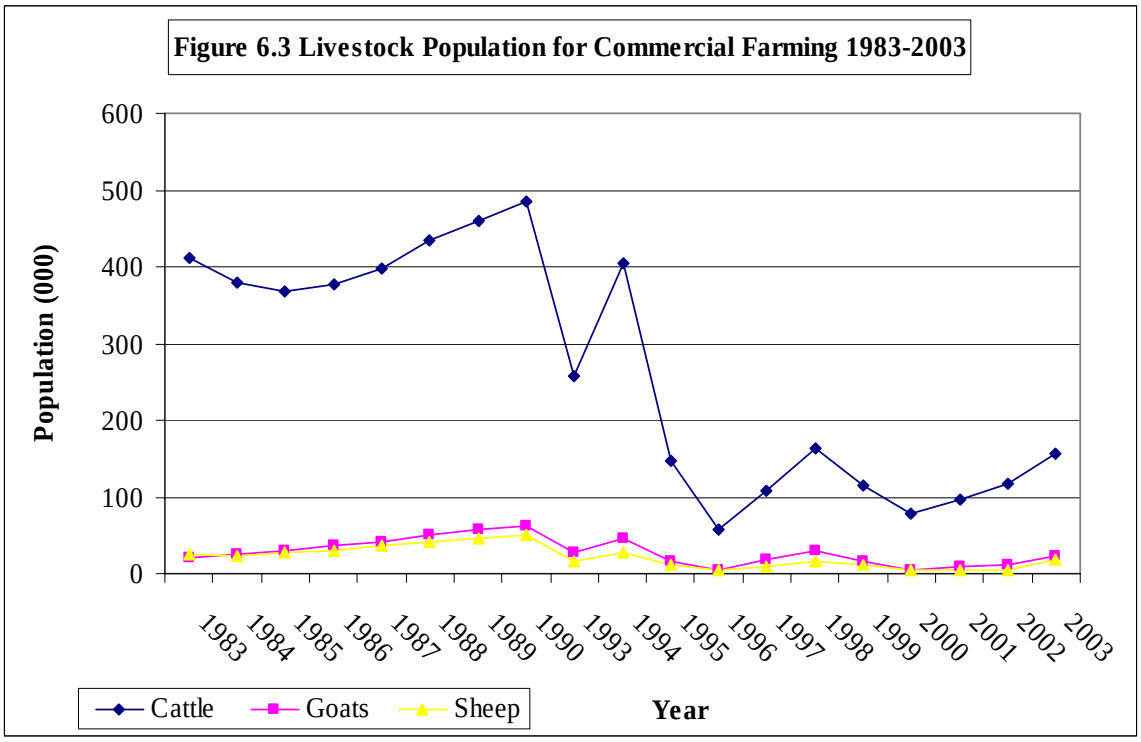
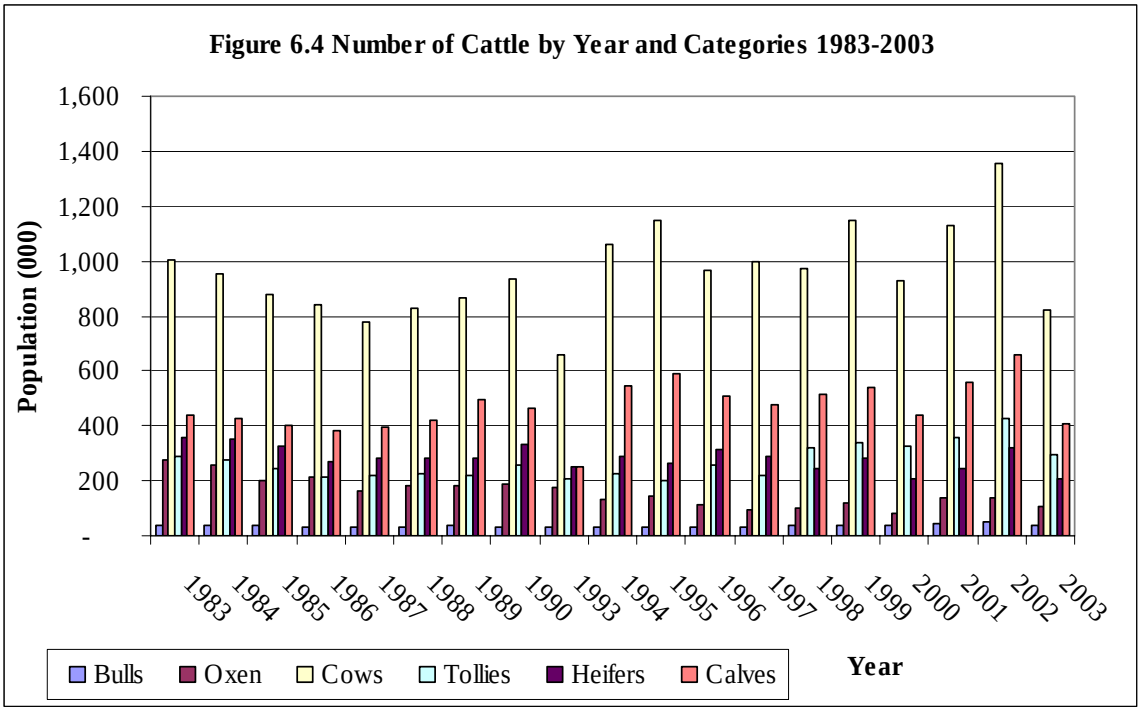


Figure 6.3 shows that in commercial farms, cattle are the most dominant livestock followed by goats and sheep. It can also be observed from Table 6.1 that livestock population in commercial farms is much lower than that of traditional farms because the former has small number of farms compared to the latter, which has a substantial number of cattle holdings (also see Table 6.3). It can be observed from Figure 6.3 that 1990 recorded the highest number of cattle in commercial sector.



It is evident from Figure 6.4 that Cows are the most dominant type of cattle followed by Calves, Heifers, Tollies, Oxen and lastly Bulls. The higher number of cows basically means that the cattle population will increase and will therefore generate additional income and employment and thereby improve the welfare of the rural population.

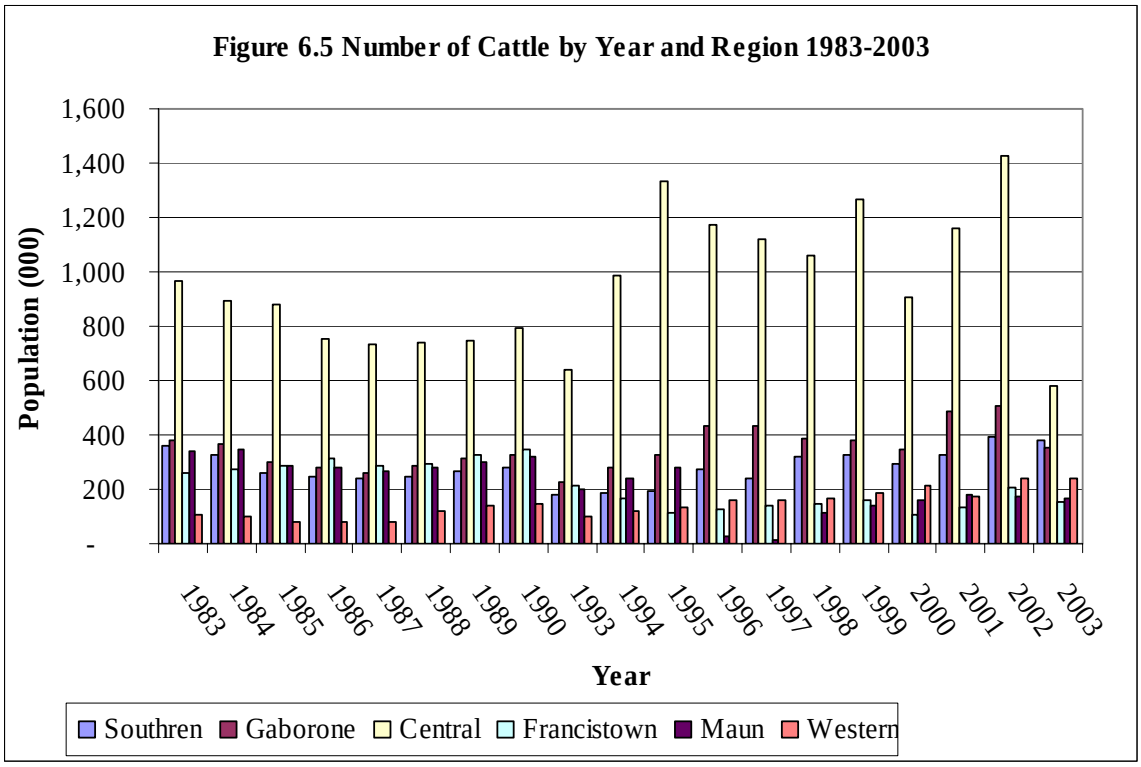


Figure 6.5 shows the number of cattle in different agricultural regions and reveals that the Central Region has a large number of livestock followed by Gaborone and Southern Regions. In 2003 the number of cattle dropped significantly because there was an enormous drought in the country and also there was an outbreak of foot and mouth disease in Matlopi and North East.

6.5.1 Cattle: Births, Deaths and Offtake Rates

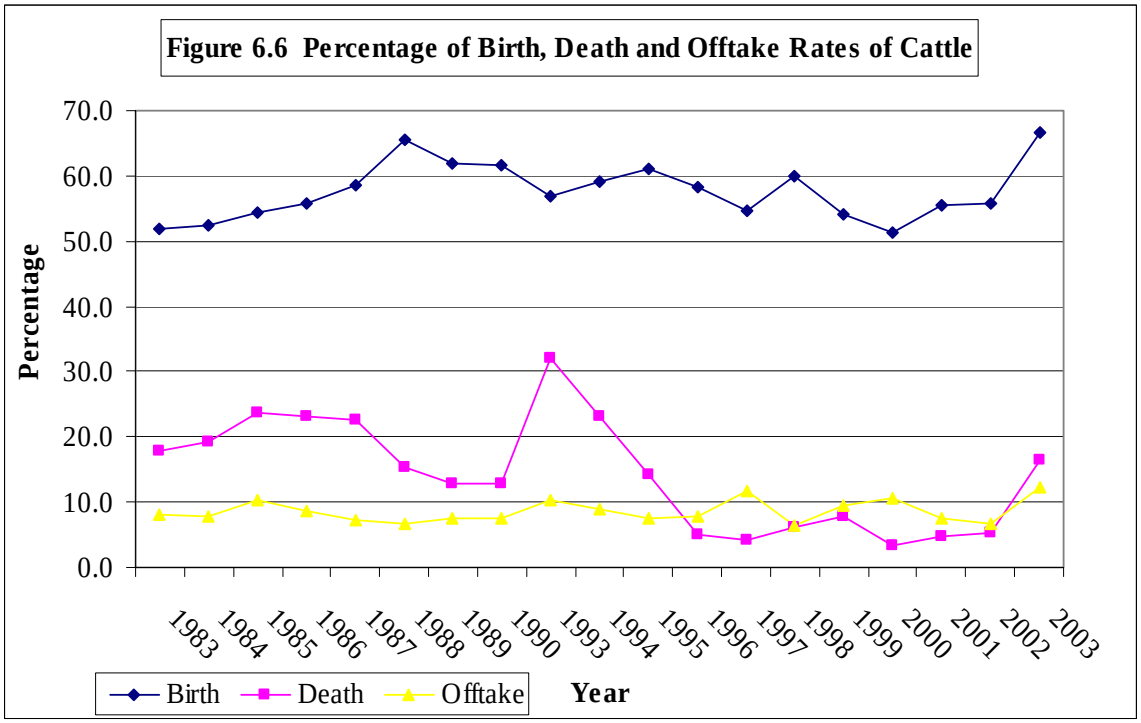


Figure 6.6 shows percentage of births to total female flock, deaths to total flock and offtake rates. The graph basically shows the relationship between these three parameters. Even with high birth rates, offtake remains low, this accounts for the growing livestock population. High percentage of death rates was seen in 1993 and this was caused by severe drought in Central district and Foot and Mouth disease in Tati Siding.

6.5.2 Other livestock

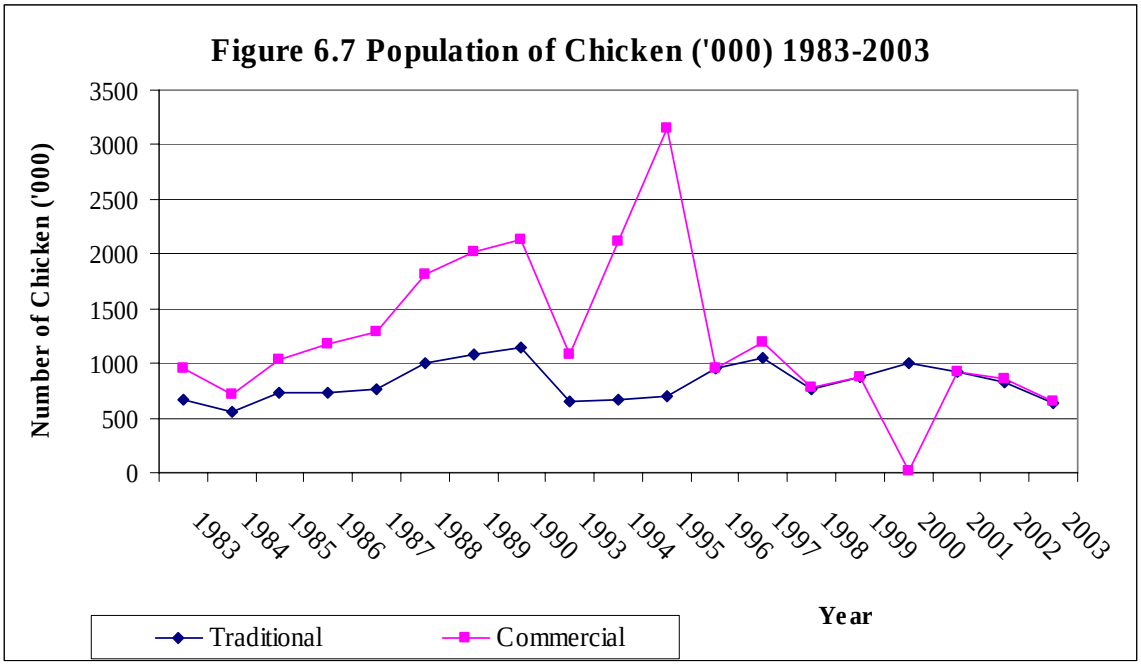


Figure 6.7 shows the number of chickens in traditional and commercial sectors. The commercial sector uses exotic breeds of chickens, improved housing and nutrition whilst the traditional sector (known as village system) mostly uses indigenous Tswana chickens. It is observed from the graph that the commercial sector had the highest number of chickens in almost all the years except over the period of 1998-2003 (excluding the year 2000) when chicken population was equal for both sectors. Research has been conducted by Animal Production Division in 15 villages which involved 1 000 rearers of village chickens and the study showed that chickens accounted for 94 percent of the poultry species reared, while pigeons and ducks accounted for the remaining 6 percent. The researcher has found out that most people keep chickens mainly for meat, as a source of income and for healing rituals. It was further discovered that they use the money from sales of chicken to purchase small ruminants (sheep and goats), which were later sold to buy cattle to provide draught power and milk. This indicates that village chickens play an important role in alleviating poverty in the rural economy of Botswana (http://www.fao.org/DOCREP/006/Y3970E/Y3970e0c4.htp).

Ostrich farming is realized in commercial sector only. In 2001, there were 5,347 pigs under traditional farming, the highest number achieved since 1993 whilst commercial farmers had nothing for that year. In 2002 pigs populations decreased by 63.6 percent in traditional farming because the government decided to kill pigs which were affected by foot and mouth in Matsiloje in order to eliminate the spread of the disease (Botswana Daily News, May 8, 2002). Farmers affected were compensated P350 for each pig killed.

Table 6.1 Livestock Population for Traditional and Commercial Farming (000) 1983 - 2003

	Traditional					Commercial					Total				
Year	Cattle	Goats	Sheep	Donkey	Horse	Cattle	Goats	Sheep	Donkey	Horse	Cattle	Goats	Sheep	Donkey	Horse
1983	2,407	762	140	140	17	411	21	25	3	5	2,818	783	165	142	22
1984	2,306	865	145	137	18	380	25	23	1	5	2,685	889	167	138	23
1985	2,092	1,108	172	141	19	368	29	27	2	5	2,459	1,138	200	143	24
1986	1,954	1,296	199	142	20	378	36	30	2	4	2,332	1,332	229	144	24
1987	1,867	1,429	204	145	20	397	41	36	2	4	2,263	1,470	240	147	24
1988	1,973	1,639	218	146	24	436	52	41	2	5	2,408	1,691	259	148	29
1989	2,083	1,840	240	149	27	460	57	46	2	6	2,543	1,897	286	151	32
1990	2,211	2,030	267	155	28	485	62	50	3	6	2,696	2,092	317	158	34
1993	1,562	1,809	233	229	28	259	28	17	2	3	1,821	1,838	250	231	31
1994	1,973	2,207	279	266	31	203	23	14	1	2	2,176	2,230	294	267	33
1995	2,384	2,605	325	303	35	147	17	12	0	0	2,530	2,622	337	303	35
1996	2,190	2,199	345	335	4	59	6	4	1	1	2,249	2,205	349	336	5
1997	2,104	2,596	399	403	4	108	18	10	1	2	2,212	2,615	409	404	7
1998	2,182	2,169	377	397	4	163	30	16	3	3	2,345	2,199	393	400	8
1999	2,467	1,901	358	369	5	114	15	12	3	2	2,581	1,916	369	373	7
2000	2,020	1,572	253	318	47	78	4	4	0	1	2,099	1,576	256	318	48
2001	2,468	1,887	306	409	5	97	8	4	1	1	2,566	1,895	311	410	6
2002	2,944	1,671	267	404	44	116	12	5	1	2	3,060	1,683	273	405	46
2003	1,872	1,332	202	481	38	156	23	18	13	3	2,028	1,355	220	493	41

-: data not given

Source: Agriculture Statistics Reports, CSO

Table 6.2 Other Livestock in Botswana ('000) 1983 – 2003

Year	Traditional				Commercial				Total			
	Chicken	Ostriches	Pigs	Others	Chicken	Ostriches	Pigs	Others	Chicken	Ostriches	Pigs	Others
1983	660.80	-	-	-	300.00	-	-	-	960.80	-	5.00	-
1984	558.60	-	-	-	150.00	-	-	-	708.60	-	-	-
1985	728.50	-	-	-	300.00	-	-	-	1028.50	-	9.00	-
1986	729.50	-	-	-	449.10	-	-	-	1,178.60	-	11.00	-
1987	757.70	-	-	-	525.00	-	-	-	1,282.70	-	11.00	-
1988	1,009.80	-	-	-	800.00	-	-	-	1,809.80	-	13.00	-
1989	1,088.00	-	-	-	925.00	-	-	-	2,013.00	-	15.00	-
1990	1,145.60	-	-	-	980.60	-	-	-	2,126.20	-	16.00	-
1993	647.10	-	3.50	-	430.20	-	0.50	5.30	1,077.30	-	4.00	5.30
1994	670.14	-	2.21	0.00	1447.01	-	0.28	4.65	2117.14	-	2.49	4.65
1995	693.17	-	0.92	-	2,463.81	-	0.06	4.00	3,156.98	-	0.98	4.00
1996	959.81	-	2.60	20.59	-	-	-	-	959.81	-	2.60	20.59
1997	1,055.53	-	2.18	7.94	135.60	4.12	0.11	3.79	1,191.13	4.12	2.28	11.73
1998	767.96	-	3.85	5.47	8.45	1.28	0.02	0.47	776.41	1.28	3.87	5.94
1999	869.63	-	4.04	6.51	4.18	0.50	0.04	1.82	873.81	0.50	4.08	8.33
2000	999.14	-	1.06	47.07	16.07	-	0.00	0.90	1,015.21	0.00	1.06	47.98
2001	928.24	-	5.35	8.14	-	-	-	-	928.24	-	5.35	8.14
2002	833.49	-	1.95	4.62	32.09	0.51	0.12	3.06	865.58	0.51	2.06	7.68
2003	629.99	-	3.95	3.94	19.59	2.80	0.04	12.70	649.58	2.80	3.99	16.64

-: data not available e.g. breakdown of some Livestock for both Traditional and Commercial was unavailable

Source: Agriculture Statistics Reports, CSO

Table 6.3 Total Numbers of Farms by Animals and Year 1983 - 2003

	Cattle Farms			Goats			Sheep		
Year	Traditional	Commercial	Grand Total	Traditional	Commercial	Grand Total	Traditional	Commercial	Grand Total
1983	58,300	345	58,645	49,000	200	49,200	11,700	170	11,870
1984	57300	340	57,640	49,600	200	49,800	12,100	190	12,290
1985	53,200	490	53,690	53,000	270	53,270	12,300	240	12,540
1986	52,900	510	53,410	57,900	300	58,200	13,550	250	13,800
1987	51,000	500	51,500	62,500	350	62,850	14,350	270	14,620
1988	53,100	500	53,600	64,400	380	64,780	14,950	300	15,250
1989	55,400	500	55,900	67,500	390	67,890	15,850	350	16,200
1990	55,900	520	56,420	68,900	400	69,300	17,750	350	18,100
1993	53,897	452	54,349	78,888	301	79,189	18,993	221	19,214
1995	60,780	223	61,003	93,200	162	93,362	23,250	123	23,373
1996	59,509	79	59,588	89,546	57	89,603	27,236	41	27,277
1997	64,707	180	64,887	99,088	164	99,252	28,046	122	28,168
1998	68,446	472	68,918	95,630	316	95,946	27,159	194	27,353
1999	66,962	246	67,208	92,330	156	92,486	25,382	94	25,476
2001	66,113	-	66,113	81,316	-	81,316	23,011	-	23,011
2002	77,871	270	78,141	82,510	155	82,665	22,773	97	119,773
2003	70,805	389	71,194	75,081	247	75,328	19,501	169	19,670

-: data not available

Table 6.4 Cattle Population ('000) by Agricultural Region and Year 1983 – 2003

Year	Southern	Gaborone	Central	F/town	Maun	Western	Total	Commercial	Grand Total
1983	359	379	964	262	340	104	2,407	411	2,818
1984	324	370	891	273	347	101	2,306	380	2,685
1985	258	298	883	286	288	79	2,092	368	2,459
1986	248	282	755	312	279	79	1,954	378	2,332
1987	240	261	736	284	265	80	1,867	397	2,263
1988	249	286	743	294	282	118	1,973	436	2,408
1989	267	311	746	325	298	137	2,083	460	2,543
1990	282	329	793	344	318	146	2,211	485	2,696
1993	180	225	639	216	200	102	1,562	259	1,821
1994	185	277	987	165	240	119	1,973	203	2,176
1995	190	328	1,336	114	279	136	2,384	147	2,530
1996	271	431	1,176	128	24	160	2,190	59	2,249
1997	242	434	1,118	138	15	158	2,104	108	2,212
1998	317	387	1,058	144	110	165	2,182	163	2,345
1999	323	381	1,270	161	141	190	2,467	114	2,581
2000	291	345	905	110	157	213	2,020	78	2,098
2001	328	490	1,162	133	183	173	2,468	97	2,468
2002	393	505	1,424	208	176	238	2,944	116	3,060
2003	381	352	578	152	169	241	1,872	156	2,028

Source: Agriculture Statistics Reports, CSO

Table 6.5 Number of Cattle (000) by Category and Year 1983 - 2003

Year	Bulls	Oxen	Cows	Tollies	Heifers	Calves	Traditional	Commercial	Grand Total
1983	39	277	1,007	291	355	439	2,407	411	2,818
1984	37	256	956	277	350	430	2,306	380	2,685
1985	40	200	879	244	327	402	2,092	368	2,459
1986	34	216	838	215	269	382	1,954	378	2,332
1987	32	160	780	218	284	393	1,867	397	2,263
1988	33	184	831	223	283	419	1,973	436	2,408
1989	38	183	868	217	282	496	2,083	460	2,543
1990	34	187	937	255	335	464	2,211	485	2,696
1993	29	173	656	206	250	249	1,562	259	1,821
1994	31	160	903	203	257	418	1,973	203	2,176
1995	32	147	1,151	200	265	588	2,384	147	2,530
1996	34	114	966	256	312	508	2,190	59	2,249
1997	31	95	996	219	288	476	2,104	108	2,212
1998	37	99	972	320	242	512	2,182	163	2,345
1999	38	118	1,151	341	283	537	2,467	114	2,581
2000	39	84	929	324	208	437	2,020	78	2098
2001	42	136	1,132	358	243	557	2,468	97	2,468
2002	49	141	1,357	424	317	656	2,944	116	3,060
2003	37	107	822	294	206	406	1,872	156	2,028

Source: Agriculture Statistics Reports,

Table 6.6 a Percentages of Births to Total Female Flock, Death to Total Flock and Offtake Rates for Traditional Sector

	Cattle			Goats			Sheep		
Year	**Birth**	**Death**	**Offtake**	**Birth**	**Death**	**Offtake**	**Birth**	**Death**	**Offtake**
1979	58.4	10.9	8.8	42.1	45.9	9.3	33.7	38.9	7.9
1980	58.4	13.8	6.8	45.0	34.7	7.1	45.4	32.1	16.7
1981	57.5	13.6	7.2	44.0	32.1	7.0	36.0	25.6	8.8
1982	59.4	17.0	7.1	42.1	27.6	8.2	39.8	38.1	7.8
1983	52.8	17.8	8.0	44.6	22.5	6.2	36.2	22.2	9.9
1984	52.5	19.3	7.2	41.9	25.4	6.8	35.8	23.9	10.5
1985	54.3	23.6	10.3	40.6	19.7	5.7	33.1	20.6	11.1
1986	55.7	23.2	8.7	40.9	18.2	6.3	33.9	13.1	4.8
1987	58.5	22.7	7.2	40.3	20.9	7.2	33.9	14.9	6.8
1988	65.5	15.4	6.8	42.9	19.7	9.0	34.8	20.0	7.5
1989	61.9	12.9	7.6	41.4	19.5	10.9	38.8	19.8	10.1
1990	61.6	12.7	7.6	40.2	19.7	11.1	42.6	21.3	11.3
1993	57.0	32.0	10.2	49.6	38.4	9.8	40.9	36.5	8.5
1995	61.0	14.3	7.4	43.7	18.6	6.5	35.0	17.2	6.2
1996	58.4	4.9	7.9	43.3	22.7	7.7	32.2	13.8	6.7
1997	54.6	4.3	11.8	42.7	23.6	6.8	32.8	16.6	6.6
1998	59.9	6.1	6.3	46.4	30.6	9.0	37.9	19.5	5.4
1999	54.0	7.9	9.6	45.5	37.4	8.8	41.9	28.3	5.9
2000	51.3	6.0	10.6	80.5	23.3	15.5	63.5	13.1	5.9
2001	55.5	4.9	7.7	43.8	17.7	5.7	33.4	15.0	5.6
2002	54.4	5.4	6.8	42.6	26.8	6.5	33.5	18.2	5.0
2003	66.6	16.4	12.2	46.7	23.9	8.6	37.2	20.3	9.4

Source: Agriculture Statistics Reports, CSO

Table 6.6 b Percentages of Births to Total Female Flock, Death to Total Flock and Off-take Rates for Commercial Sector

	Cattle			Goats			Sheep		
Year	**Birth**	**Death**	**Offtake**	**Birth**	**Death**	**Offtake**	**Birth**	**Death**	**Offtake**
1979	63.4	3.6	17.7	36.7	17.5	15.8	33.8	15.4	13.8
1980	60.3	3.9	13.4	40.7	20.7	8.9	39.3	16.6	5.5
1981	54.1	4.0	12.1	40.1	24.7	13.2	36.4	19.3	11.8
1982	61.0	5.9	13.7	42.2	16.2	14.6	29.6	17.5	10.0
1983	56.2	8.9	24.7	38.5	23.1	12.0	34.1	19.3	18.1
1984	61.5	10.0	23.0	39.0	22.4	18.7	38.3	26.0	26.4
1985	56.0	6.2	22.4	37.3	19.2	12.0	36.6	11.0	17.2
1986	62.1	8.8	14.5	42.2	16.8	11.5	39.9	21.5	9.2
1987	49.4	6.3	14.9	37.8	18.0	14.9	37.5	27.2	7.8
1988	67.7	5.1	13.4	44.9	13.3	15.3	34.3	13.1	19.3
1989	65.0	5.0	16.0	47.2	11.6	23.1	40.3	11.8	16.8
1990	69.8	4.2	17.9	44.2	17.4	18.2	38.5	18.1	14.3
1993	56.1	6.7	58.4	42.5	22.8	12.4	38.7	17.9	8.9
1995	59.6	8.2	3.9	42.4	23.3	10.2	37.2	18.4	22.0
1996	64.0	3.5	23.4	41.6	27.9	17.4	48.0	24.9	15.0
1997	15.1	3.6	1.7	40.5	21.1	10.0	32.9	14.9	11.4
1998	51.5	4.5	13.9	34.7	21.3	12.8	35.4	17.3	12.4
1999	55.9	3.6	14.1	39.0	23.1	14.5	31.1	12.4	5.0
2000	33.2	2.6	1.6	79.5	17.2	7.1	59.4	16.7	1.7
2001	-	-	-	-	-	-	-	-	-
2002	45.8	4.8	15.0	38.4	27.7	10.7	34.5	21.2	15.1
2003	49.1	4.7	15.4	37.1	20.8	13.8	31.4	11.9	13.4
2004	49.4	4.8	12.3	37.9	20.7	9.7	30.7	15.5	13.3

-: data not available

Source: Agriculture Statistics Reports, CSO

Table 6.7 Draught Power used to Plough Fields: Percentage of Crop Farms

Year	Oxen	Donkeys/ Mules	Cattle& Donkeys	Tractors	Tractors & animals	Others
1983	63.8	9.7	2.7	19.5	4.1	0.2
1984	54.2	14.0	2.9	26.0	2.7	0.2
1985	44.4	13.8	5.5	34.1	1.2	1.0
1986	38.8	14.6	4.0	39.4	2.1	1.1
1987	37.8	16.1	4.9	39.2	1.4	0.6
1988	33.2	15.4	5.0	42.8	3.2	0.5
1989	37.3	17.6	3.7	37.7	3.2	0.6
1990	33.4	17.4	4.3	39.3	4.4	1.3

Source: Agriculture Statistics Reports, CSO

Table 6.8 Number of Slaughtered Cattle by Botswana Meat Commission (1983 – 2003)

Year	Lobatse	Francistown	Maun	Total
1983	219,221	-	14,679	233,900
1984	221,790	-	17,493	239,283
1985	173,760	-	16,447	190,207
1985/86	176,057	-	17,786	193,843
1986/87	126,886	-	18,653	145,539
1987/88	97,202	-	15,296	112,498
1988/89	119,494	-	15,064	134,558
1989/90	98,742	35,100	12,887	146,729
1990/91	-	-	-	158,457
1991/92	-	-	-	213,635
1992/93	124,604	42,024	14,607	181,235
1993/94	-	-	-	158,624
1994/95	-	-	-	166,531
1995/96	-	-	-	145,462
1996/97	-	-	-	127,151
1997/98	97,170	65,391	-	162,561
1998/99	84,694	55,551	-	140,245
1999/00	92,090	68,322	-	160,412
2001	97,553	71,200	-	168,753
2002	84,739	28,826	-	113,564
2003	100,197	53,301	-	153,498
2004	75,698	54,333	-	130,031
2005	74,107	43,855	-	117,962

Source: Botswana Meat Commission

7.0 Wildlife

7.1 Introduction

Wildlife is one of the most important sectors of the economy in Botswana. In fact NDP 9 cites this sector as an alternative engine of growth to diversify the economy from being predominantly mineral based. Nonetheless wildlife management has proved to be a complex undertaking that requires careful planning and balancing especially given that it has a bearing on the upliftment of rural livelihoods. If the management of the resource is not sustained, these livelihoods would be adversely affected so too would the habitat on which the wildlife exist. In addition, other sectors like agriculture would be affected as they compete with each other for land, water and other resources.

In Botswana, some of the wildlife management tools include erection of game-proof fences to reduce human wildlife conflict as well as the use of chilli pepper to control problem elephants. Furthermore, management plans are developed for Protected Areas (PAs), and species specific strategies are also progressed. In addition to PAs established to conserve wildlife, Wildlife Management Areas (WMAs) were set up from the Tribal Grazing Land Policy (TGLP) of 1975 to serve as corridors for migratory species between PAs. The WMAs were also set up to act as buffer zone between human settlements and PAs. They are also used through the Community Based Natural Resource Management (CBNRM) Programme to benefit rural communities living in close proximity to PAs by sustainable managing the wildlife. CBNRM is thus an approach tailored to put a human face in natural resource management as it promotes conservation and management of resources by communities living side by side with the resources.

Wildlife is managed under the Wildlife Conservation and National Parks Act of 1992 and the Fish Protection Act of 1975 and associated policies and regulations, examples of which are the CBNRM Policy, Hunting and Licensing Regulations and the Game Ranching Policy.

Given the broad spectrum of issues found in the wildlife sector, this chapter presents statistics on the following aspects on wildlife population estimates, and illegal off-take incidences.

7.2 Wildlife Population Estimate

Population estimates should be used with care because the confidence limits for species like buffalo are large and therefore the trends for the species are not precise hence the big fluctuations. In addition, the jackal population are likely to be a great underestimation due to the same reason.

Table 7.1 shows population estimates for wildlife species in Botswana. It is reflected from the table that population of most wildlife species in Botswana was stable over the years from 1989/91 to 2003. A significant change was however noted for springbok which declined by 72 percent on average between 1989/91 and 2003. Another decline was observed for the tsessebe which decreased by 50 percent on average in the same period. Throughout the years, the population was relatively low. In addition, sitatunga experienced a 90 percent decline in population between 1989/91 and 2003 on average. These apparent declines are mainly

attributed to drought conditions. On the other hand, the elephant population increased by 80 percent between 1989/91 and 2003. It is worth noting that this population is only confined to the northern parts of the country (Chobe and Ngamiland) and to a small extent, the Central District. Elephants are known to cause damage to environment and human property where they are locally abundant.

It should be noted that 1994 and 2003 were countrywide surveys. 1996, 1999, 2001, 2002, 2003, 2004 and 2005 covered the important wildlife areas i.e. Kgalagadi, Ghanzi, Ngamiland, Chobe, Kweneng and northern Central districts. In 2006, only the northern elephant range was covered. In 2007, Kgalagadi, Ghanzi and parts of Kweneng were covered. This fact should be taken into consideration when looking at the trends indicated in Table 7.1 below.

Table 7.1 Botswana Wildlife Population Estimates

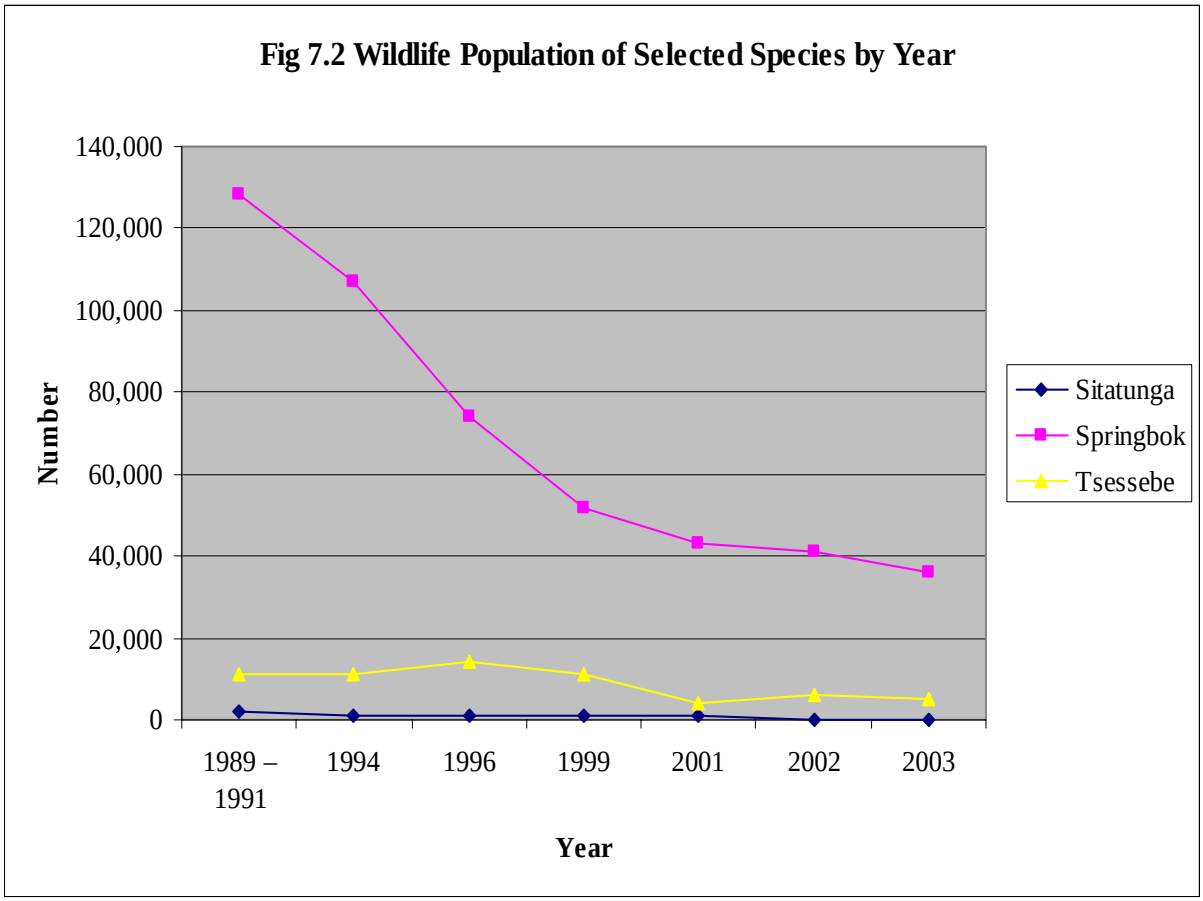
Species	1989–1991*	1994	1996	1999	2001	2002	2003	2004	2005	2006	2007
Baboon	-	10,291	10,683	9,710	5,591	4,291	3,720	3,415	2,715	1,905	164
Bat Eared Fox	-	765	379	388	213	323	96	394	410	16	163
Buffalo	41,382	29,037	40,041	93,766	73,251	40,871	33,305	31,615	48,802	59,396	-
Crocodile	209	864	381	361	204	1,023	400	373	368	543	-
Duiker	20,589	28,107	17,920	8,991	6,093	11,173	9,786	3,892	4,753	560	3,361
Eland	19,724	15,339	21,987	15,163	29,607	24,957	31,598	21,711	43,976	4,700	6,820
Elephant	60,902	79,305	100,538	120,604	116,988	123,152	109,471	151,000	88,626	154,658	-
Gemsbok	91,710	138,338	135,047	127,143	112,488	106,865	101,522	96,943	112,361	11,851	56,850
Giraffe	11,706	14,049	14,134	14,698	12,056	10,290	9,463	11,090	6,779	10,871	1,183
Hartebeest	36,431	51,790	31,942	31,114	44,950	59,297	49,978	39,553	46,941	1,277	18,354
Hippopotamus	2,921	3,388	1,299	2,147	2,310	3,120	1,466	3,094	2,434	3,680	-
Impala	60,747	62,079	59,627	45,183	28,355	69,188	67,040	42,694	30,156	54,482	-
Jackal	-	6,242	2,189	1,399	2,302	2,524	1,985	1,319	2,541	159	915
Kudu	20,411	34,470	25,759	19,514	18,203	40,997	27,440	28,075	18,102	8,427	3010
Lechwe	69,785	69,613	77,876	78,330	56,318	70,183	48,983	35,722	37,947	38,059	-
Ostrich	62,359	58,297	37,541	32,488	75,546	77,226	49,406	43,229	32,749	13,055	20,689
Reedbuck	-	2,276	1,244	709	128	695	67	-	18	208	-
Roan antelope	970	934	1,327	884	1,056	837	188	391	70	665	-
Sable antelope	3,424	4,682	3,379	2,052	3,394	2,254	2,877	2,249	841	1,999	-
Sitatunga	1,803	843	1,128	1,234	819	201	167	12	249	160	-
Springbok	128,468	107,101	73,833	51,792	42,990	41,204	35,811	50,332	22,863	6,426	13,200
Steenbok	36,296	72,235	41,204	33,282	38,809	57,972	36,368	26,617	23,992	4,185	10,702
Tsessebe	10,935	11,301	14,198	11,389	3,864	6,050	5,119	2,361	3,109	3,209	-
Warthog	7,829	11,962	10,918	5,300	5,304	12,525	4,154	2,919	3,618	3,075	498
Waterbuck	-	1,805	967	428	628	2,051	950	944	298	1,278	-
Wildbeest	45,798	48,125	36,958	46,741	26,870	46,681	45,858	35,088	23,825	15,251	4,530
Zebra	47,310	48,011	39,817	55,406	34,818	38,780	39,308	52,162	21,071	49,151	-

**** Figures are an average for the three year period***

-.: Data Unavailable

Source:DWNP, Aerial Census of Animals in Botswana, Reports of indicated years.

Figures 7.1 and 7.2 pictorially show the above statistics



7.3 Population Estimates by District

The wildlife population distribution by district is shown on Tables 7.2 to 7.7 in the Appendix. More than 50 percent of total elephant population in Botswana is found in Ngamiland District. The population of buffalo has been between 60 percent and 90 percent of total buffalo population. Within the district therefore the elephant followed by the buffalo had consistently high population estimates over the reported years. High population estimates were also recorded for impala and lechwe. Figures 7.3 to 7.5 depict the population trend of some species in Ngamiland.

As in the national estimates, sitatunga and tsessebe showed a marked decline in numbers. The same trend is seen for wildebeest numbers. Its density actually fell from 0.57 in 1989/91 to only 0.049 animals per square kilometers in 2006, on the other hand, the zebra showed a fluctuating pattern. However, areas of different sizes were flown during the various surveys and that may have affected the densities.

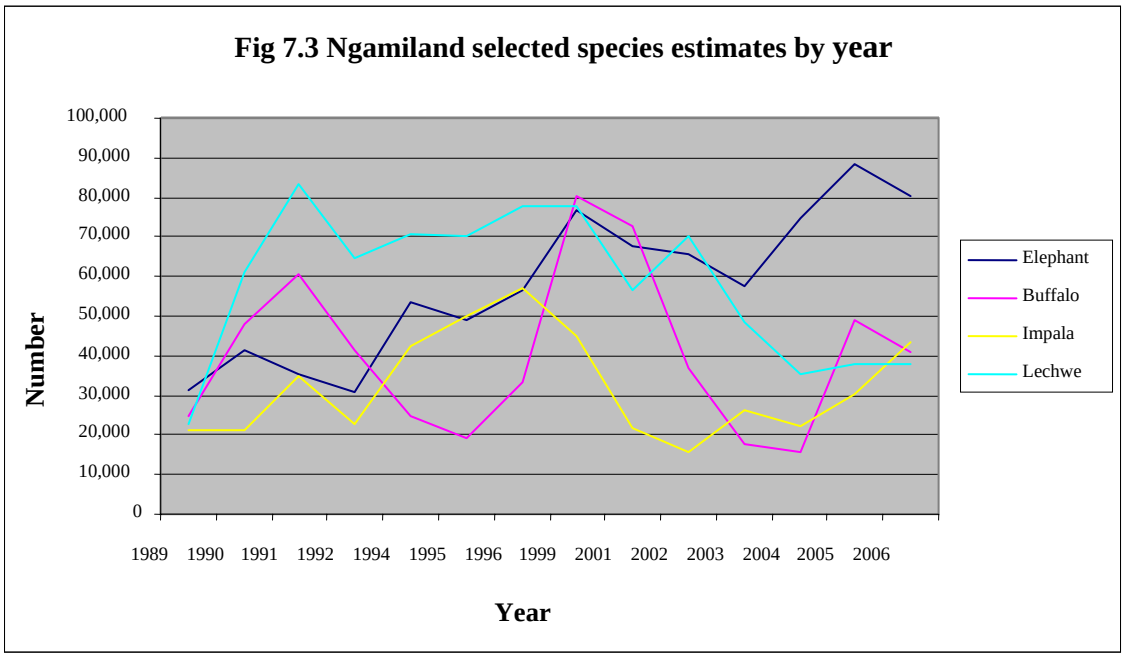


Fig 7.3 Ngamiland selected species estimates by year
100,000
90,000
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
Number
1989 1990 1991 1992 1994 1995 1996 1999 2001 2002 2003 2004 2005 2006
Year
Elephant
Buffalo
Impala
Lechwe

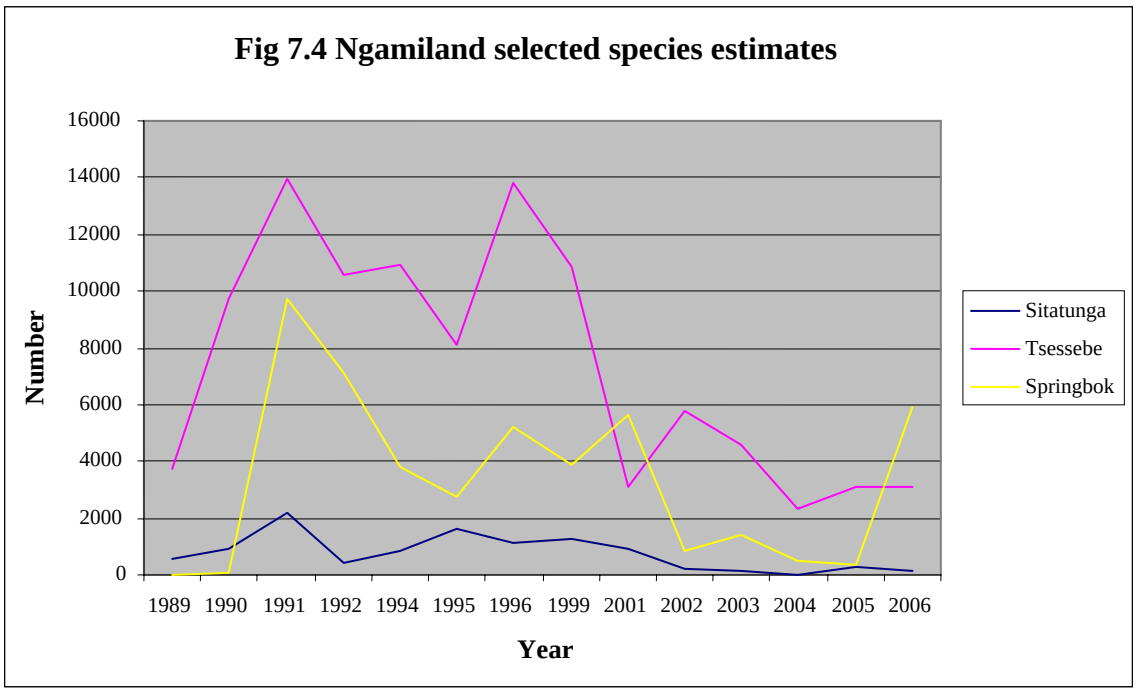
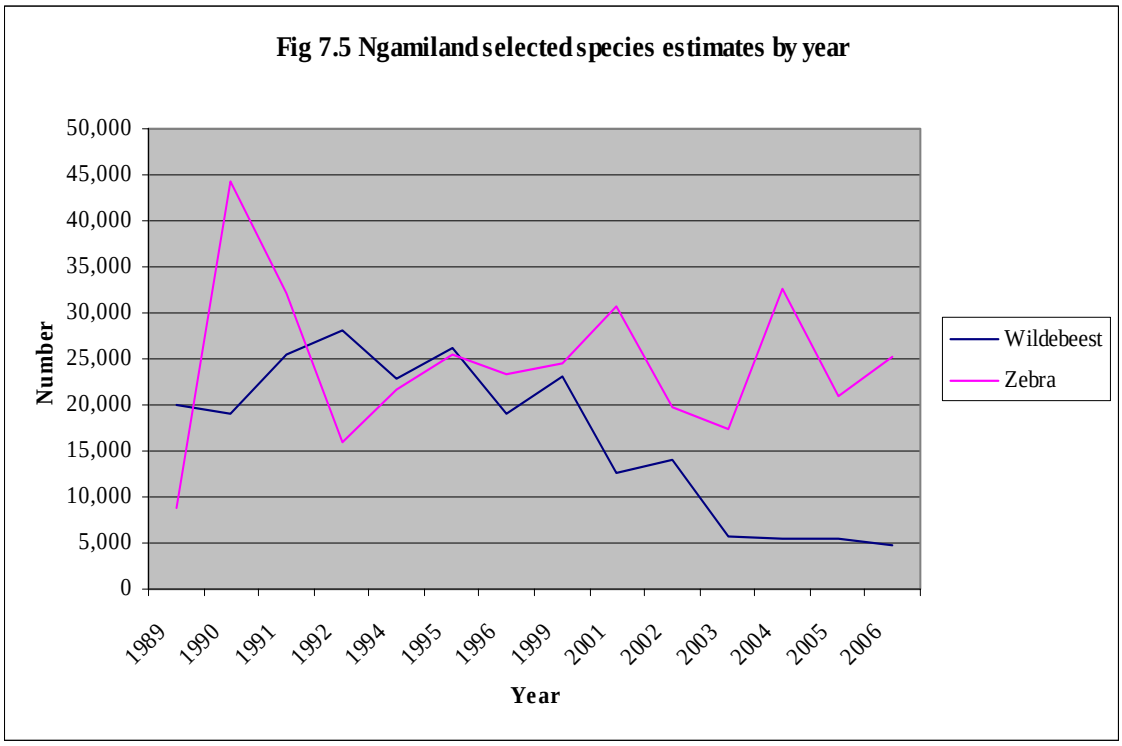


Fig 7.4 Ngamiland selected species estimates
16000
14000
12000
10000
8000
6000
4000
2000
0
Number
1989 1990 1991 1992 1994 1995 1996 1999 2001 2002 2003 2004 2005 2006
Year
Sitatunga
Tsessebe
Springbok



About 40 percent of the elephant population is found in Chobe District making elephant density the highest in this relatively small district as shown on Figure 7.6 (See also Tables 7.3a and 7.3b in the Appendix). Over the years, the elephant population showed an increasing trend. At the same time, about 10 percent of total buffalo population in Botswana is found in Chobe. Although the trend displayed was quite erratic, the buffalo population was generally on the increase.

The impala population was also found to be comparatively high. It followed a generally upward trend but with a lot of fluctuations. At the same time, the zebra displayed a stable population over the years, experiencing a low in 1992 and a high in 1996.

Chobe is a district where a considerable number of sable antelope is found (about 60 percent of the total sable population). The population has been somewhat stable reaching its highest in 1991 and lowest in 1992. Other species like the giraffe also showed a stable population. The information on selected species is portrayed on Figures 7.7 and 7.8.

Fig 7.6 Elephant Population in Chobe District

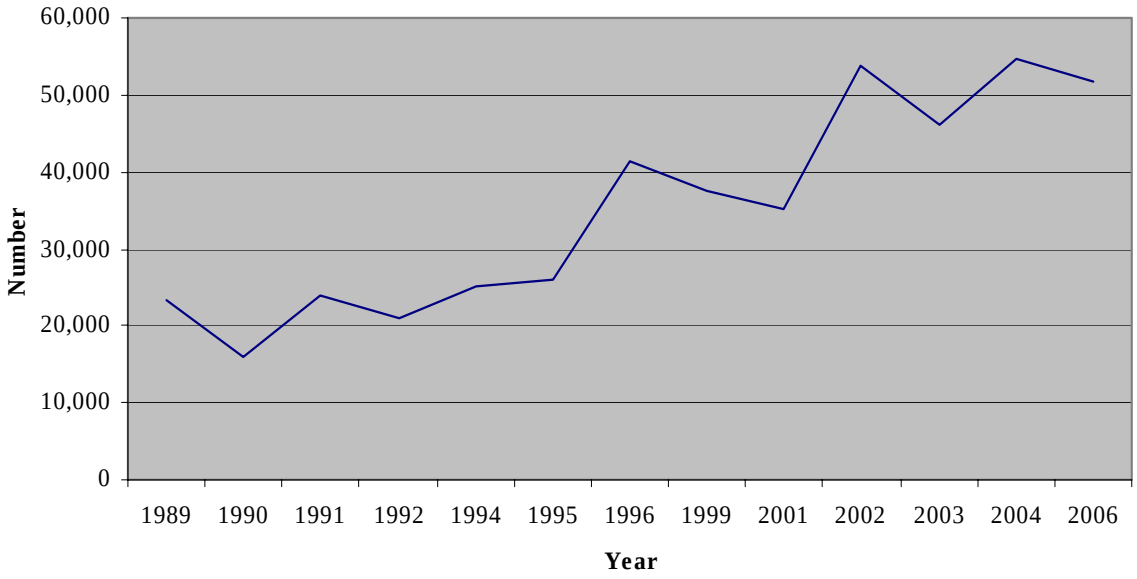
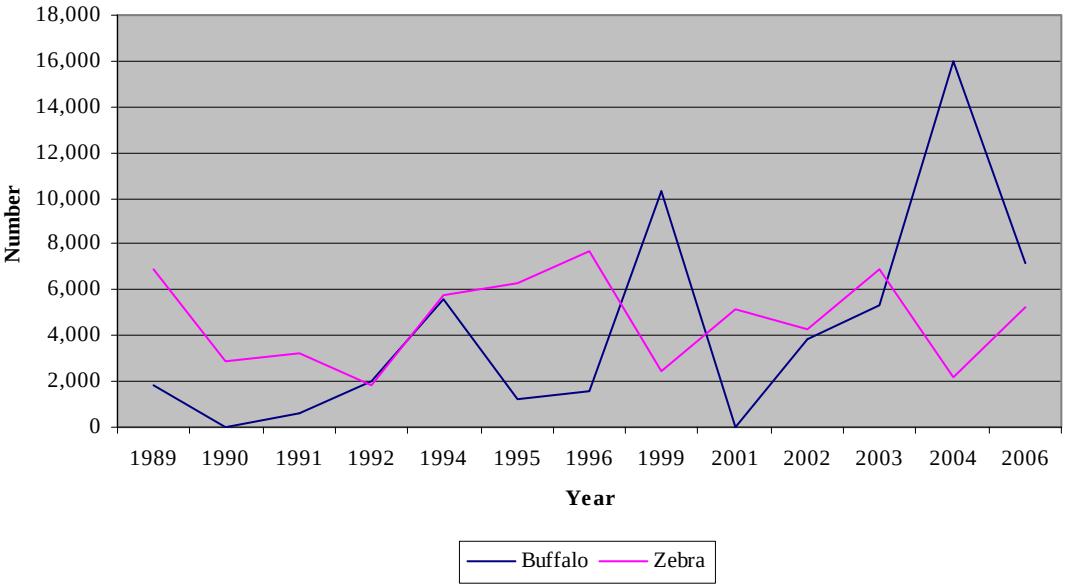
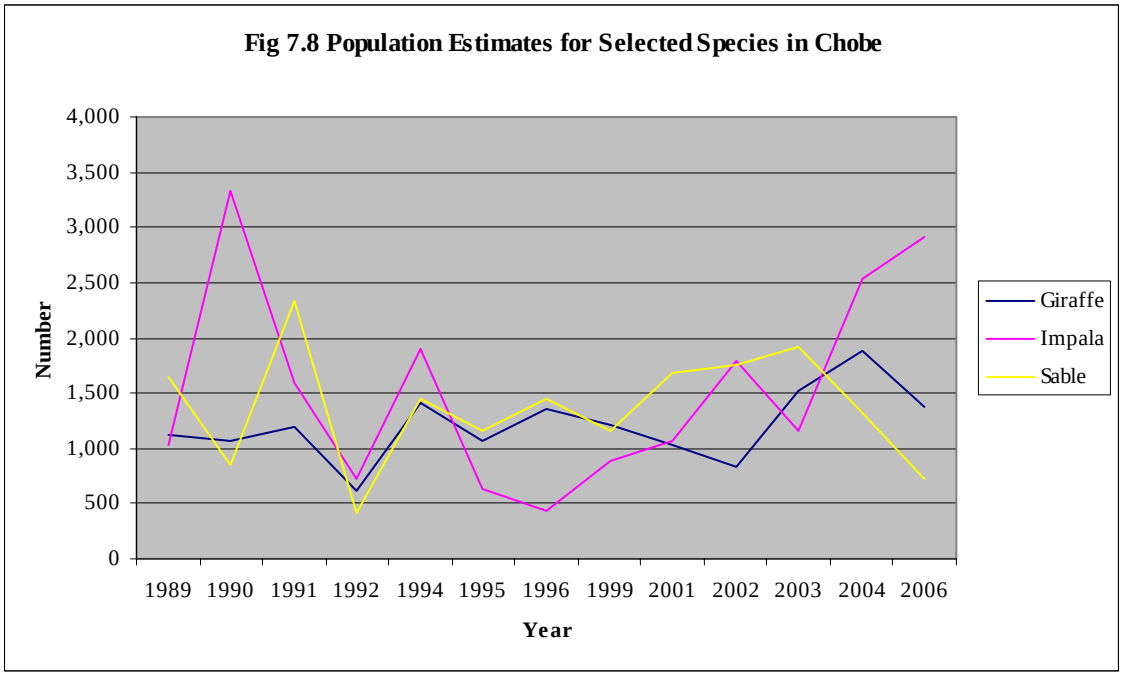


Fig 7.7 Buffalo and Zebra Population Estimates in Chobe





The remaining 8 percent of the elephant population is found in the predominantly agricultural Central District. The population is located around Mmadinare and Mathathane areas and is a constant source of human wildlife conflict. A generally increasing trend is noted over the years with the highest population reached in 2001 (See Figure 7.9). In addition, the district has large numbers of gemsbok and hartebeest. The former population showed an erratic pattern while the latter population was relatively stable.

The district also hosts the largest number of impala in the country. On the whole, the population was high over the years with outliers in 1987, 1990 to 1991 and 1995 to 2001. The buffalo species was only sighted in the district from 2001. The appearance of the species from 2001 may be a result of migrating species from Zimbabwe and Ngamiland due to drought. For the three years on which sightings were made, the numbers were not consistent. Like in the other districts, springbok numbers have been declining since 1989. The population trend for selected species is shown in Fig 7.10 and 7.11.

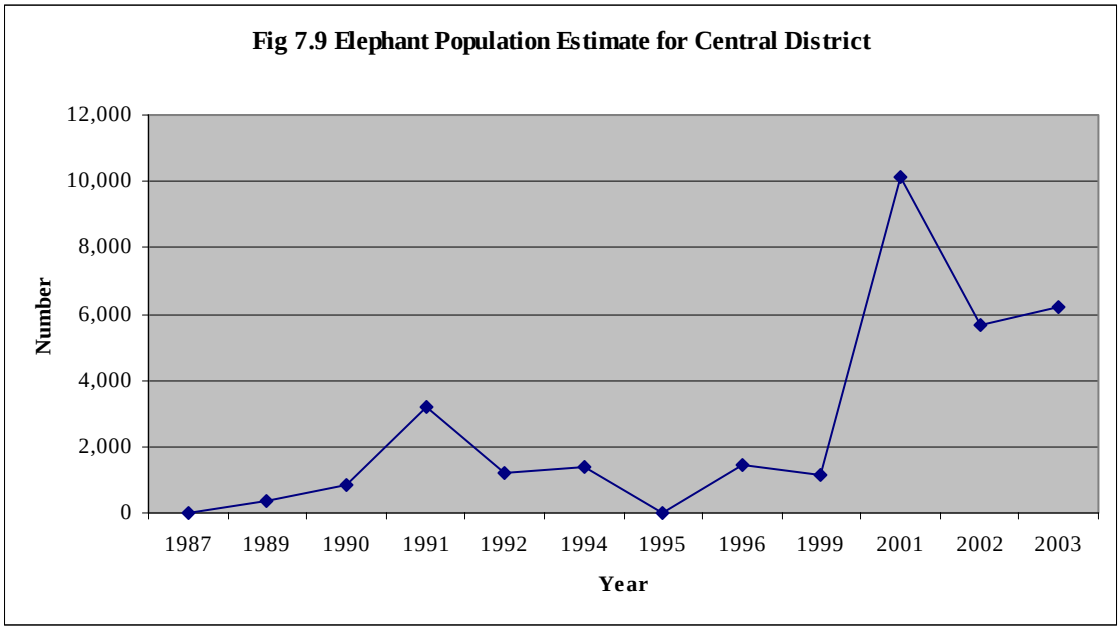


Fig 7.9 Elephant Population Estimate for Central District
12,000
10,000
8,000
6,000
4,000
2,000
0
Number
1987
1989
1990
1991
1992
1994
1995
1996
1999
2001
2002
2003
Year

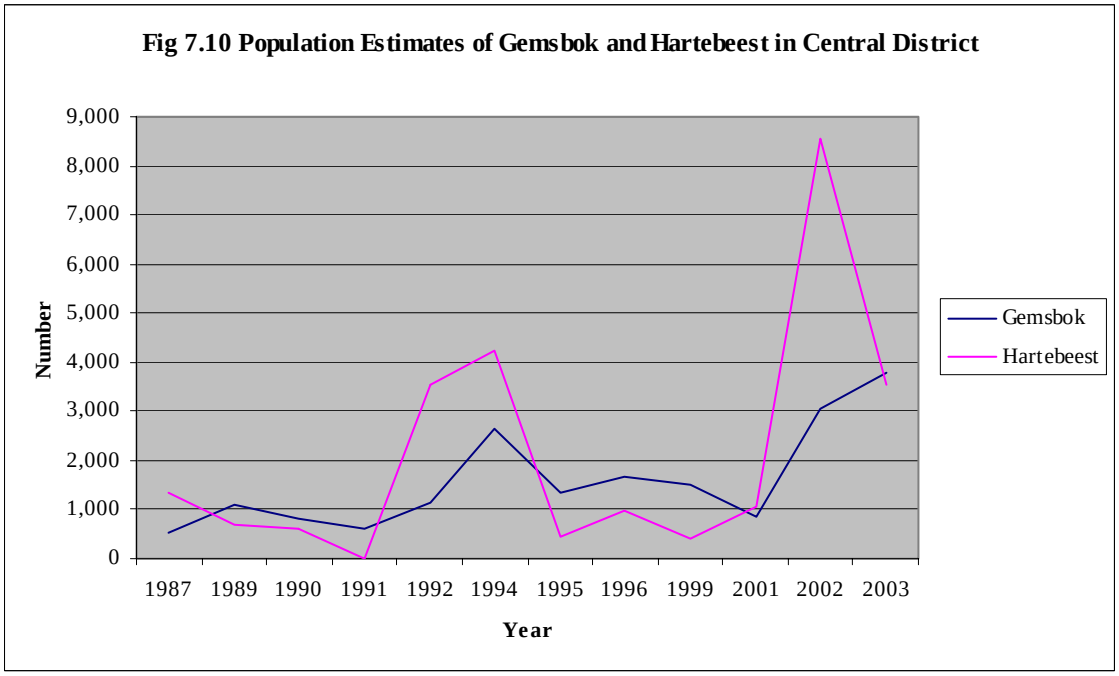
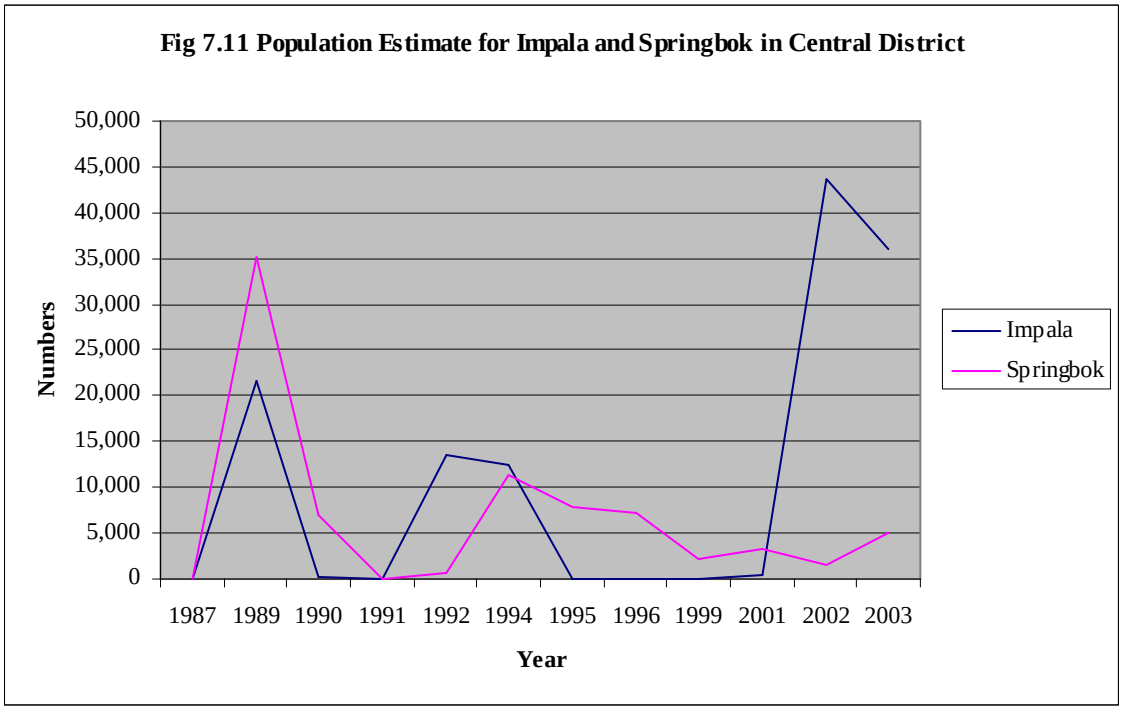


Fig 7.10 Population Estimates of Gemsbok and Hartebeest in Central District
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
Number
1987
1989
1990
1991
1992
1994
1995
1996
1999
2001
2002
2003
Year
Gemsbok
Hartebeest



The Ghanzi and Kgalagadi Districts are home to the largest population of gemsbok. The Ghanzi District alone accounted for about 35 percent of gemsbok population on average in the recorded years while the Kgalagadi District accounted for 49 percent of the gemsbok population on average. Over the recorded years, the population in Ghanzi was fluctuating with an overall increasing trend, noting outliers in 1989, 1991 and 2003. For Kgalagadi, the gemsbok population had an upward trend until 1999 when it fell slightly to pick up again in 2005.

One other species found in large numbers in Ghanzi and Kgalagadi is the hartebeest which declined heavily in Ghanzi over the period, it is noted that it was high in the Kgalagadi though with fluctuations. On the other hand, the springbok population experienced fluctuations from 1987 to 1995 after which the population more or less stabilized. The fluctuation however was experienced throughout the period in the Kgalagadi with an overall declining trend. The springbok population showed a generally declining trend (See Fig 7.12 and 7.13).

Fig 7.12 Selected Species Population Estimates for Ghanzi District

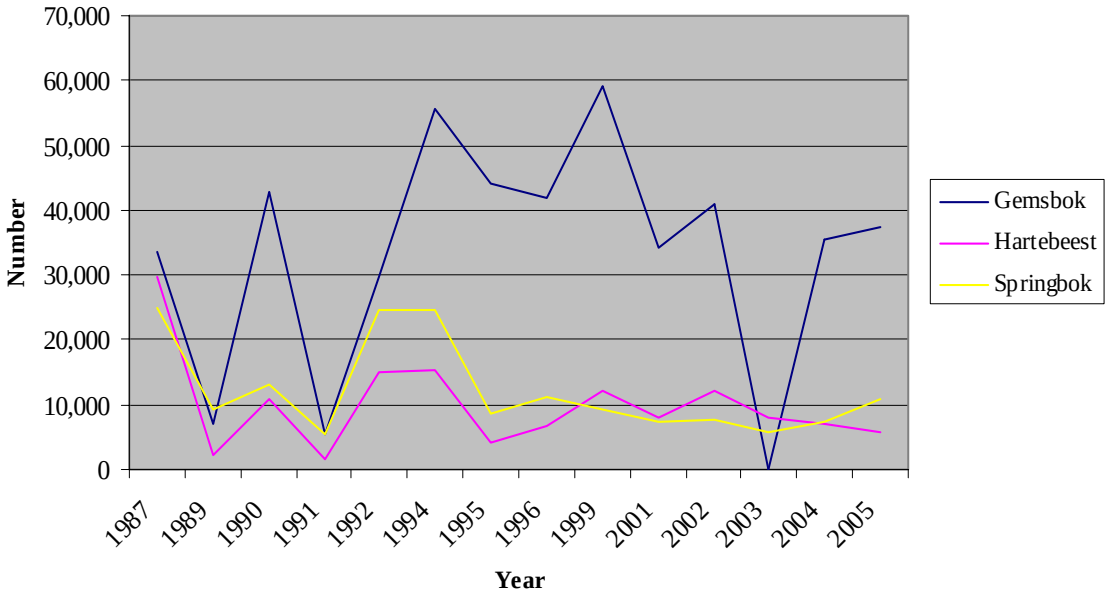
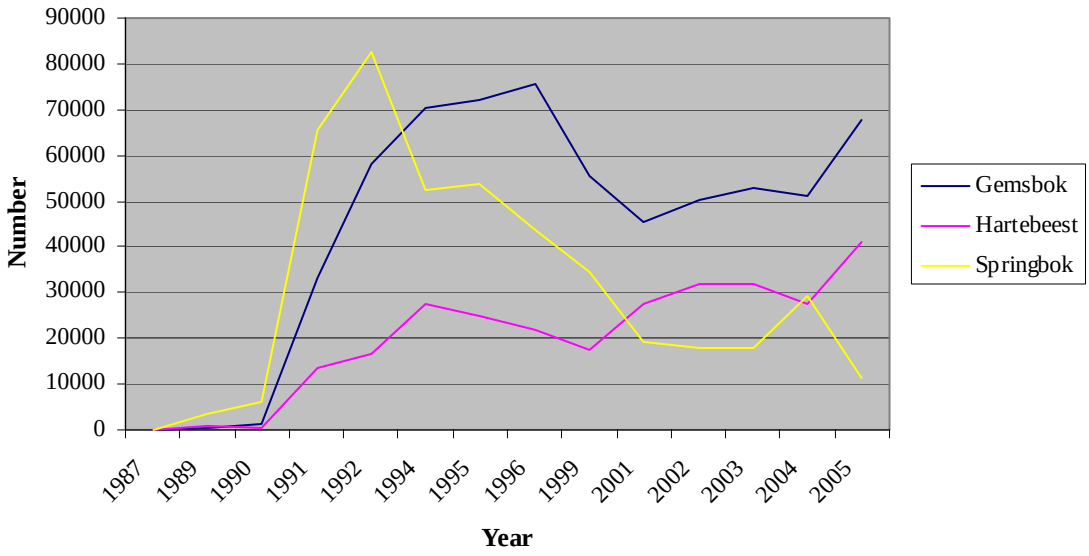


Fig 7.13 Population Estimates of Selected Species in Kgalagadi District



7.4 Population Estimates in Protected Areas

There are six wildlife national parks and game reserves in the country herein referred to as Protected Areas (PAs). In a wider context, PAs would include Wildlife Management Areas and Forestry Reserves but for purposes of this chapter, PAs will be used to refer strictly to National Parks and Game Reserves. From Table 7.14 it is evident that the Central Kgalagadi Game Reserve (CKGR) in the Ghanzi District is the largest, the smallest being Khutse Game Reserve in Kweneng District. The Kgalagadi Trans-fronteir Park (KTP) is the first trans-boundary park in Africa and it is managed by Botswana and South Africa. There are two more trans-fronteir conservation areas (TFCA) envisaged in Tuli area (Shalimpo) between Botswana, South Africa and Zimbabwe, and the Kavango-Zambezi TFCA (KAZA) between Angola, Botswana, Namibia, Zambia and Zimbabwe. TFCAs facilitate joint management of parks by relevant countries and free movement of wildlife between the countries for increased efficiency.

Table 7.14 Game Reserves and National Parks in Botswana

Protected Area	Area in Sq.km	% National area	District
Central Kgalagadi Game Reserve	52,800	9.07	Ghanzi
Chobe National Park	10,589	1.82	Chobe
Kgalagadi Transfronteir Park	28,000	4.81	Kgalagadi
Khutse Game Reserve	2,500	0.43	Kweneng
Makgadikgadi/Nxai Pans Park	7,400	1.27	Ngamiland
Moremi Game Reserve	4,800	0.82	Ngamiland
Total	106, 089	18.23	

Source: Department of Wildlife and National Parks

By virtue of the nature of their ecological systems, the northern parks (Chobe, Moremi and Makgadikgadi/Nxai) have a concentration of species that is dissimilar in type to the concentration in the southern parks consisting of Central Kgalagadi (CKGR), Kgalagadi Trans-frontier (KTP), and Khutse. In this regard, the elephant population is found in the northern parks only.

Among the PAs, the Chobe National Park hosts the largest number of elephants. The density is however highest in Makgadikgadi/Nxai Pan ostensibly because of the relatively small size of the park. The highest density was in 2006 at 18 animals per square kilometer. It is worth noting that the density in Chobe and Moremi was also very high as it was consistently above 1 animal per square kilometre throughout the years. This brings into question the sustainability of maintaining such large concentrations in the parks. Figures 7.14 – 7.16 show the population estimates of elephants in the PAs. In all the three parks, the population showed an increasing tre

Fig 7.14 Combined Elephant Population in Protected Areas

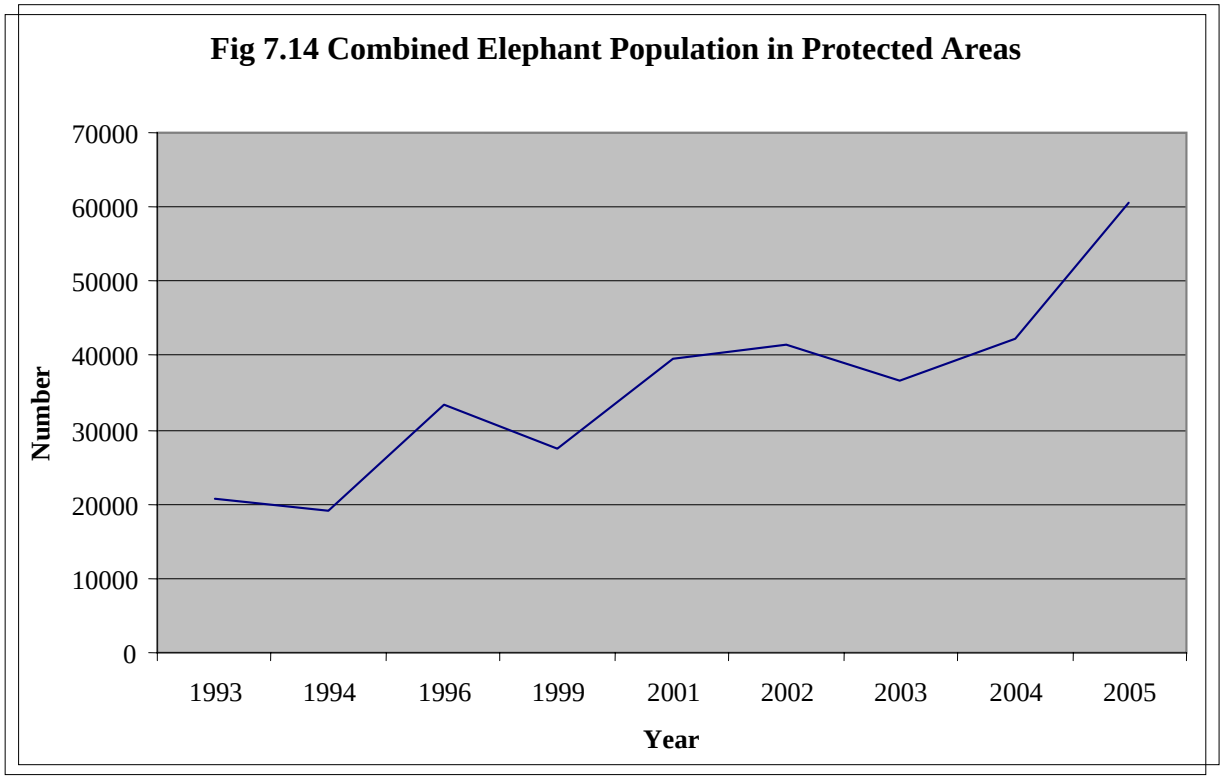
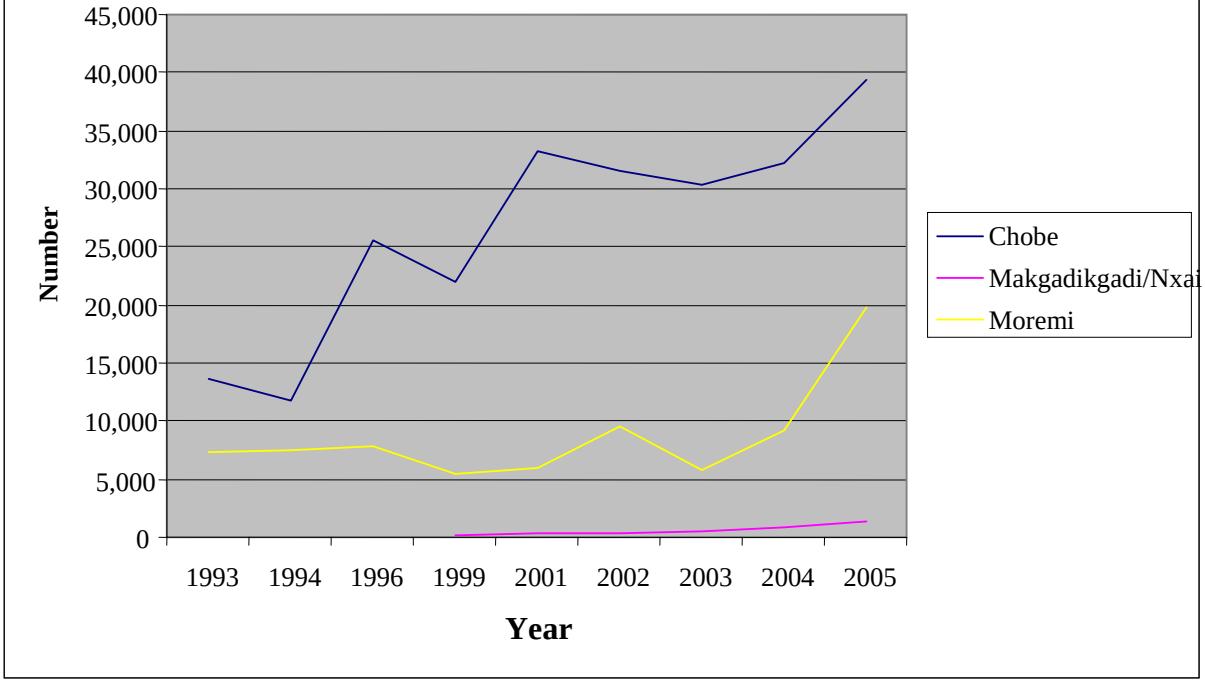
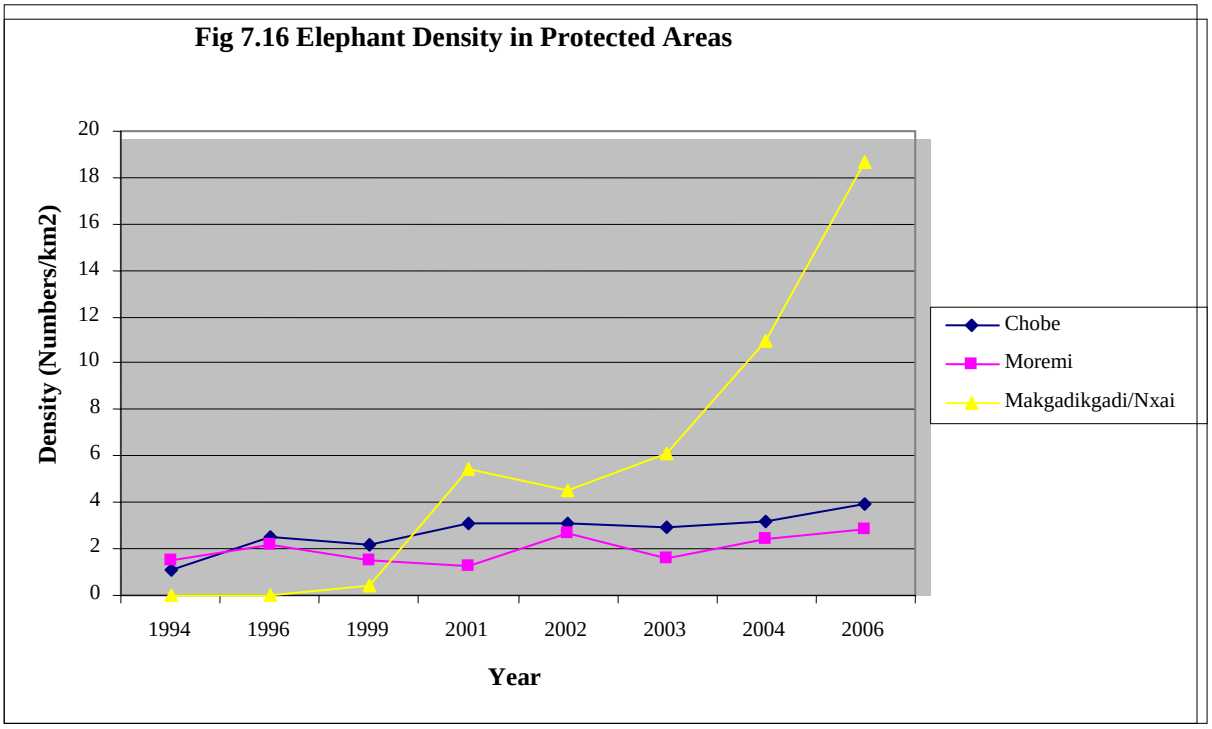


Fig 7.15 Elephant Population by Protected Area





Buffalo are also found in the northern parks of Chobe and Moremi only. In Moremi, the population was highest in 1999 and lowest in 2006. The trend followed is erratic with a generally downward movement. The population in Chobe National Park is also erratic over the years with no definite direction of growth.

However as mentioned earlier, confidence limits for species like buffalo are large and therefore the trends for the species are not precise hence the big fluctuation

Impala is another species that is found in the northern parks. On the whole, population estimates followed a downward trend between 1994 and 2002 before picking up slightly from 2004 onwards (See Figure 7.19). The highest population was recorded in the years 1994 and 1999. On average, about 90 percent of all impala in PAs was found in Moremi Game Reserve while Chobe accounted for approximately 9 percent on average through out the years (See Table 7.15). No sightings were made in Makgadikgadi/Nxai Pans Park for all the years except for the year 2001 when 2.5 percent of total impala population in PAs was recorded.

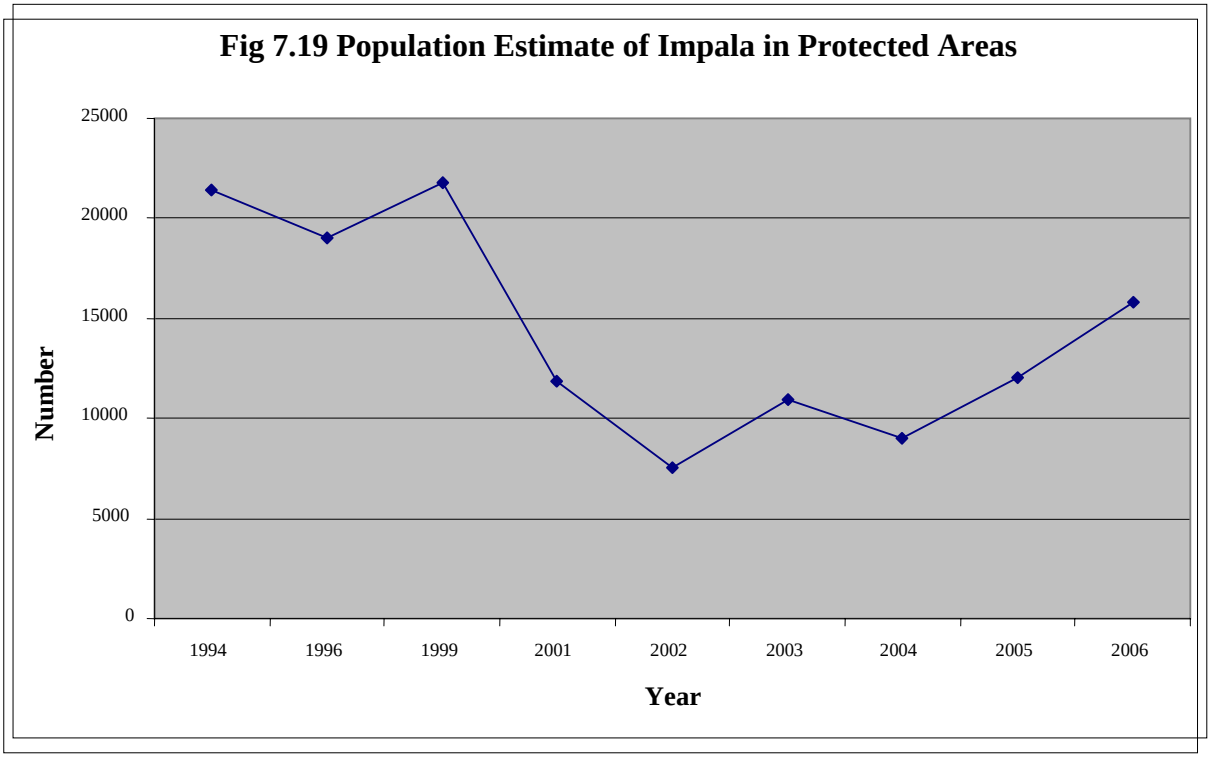


Table 7.15 Percentage Distribution of Impala by Protected Area

	1994	1996	1999	2001	2002	2003	2004	2005	2006
Chobe	9.38	2.03	2.57	12.71	19.06	7.93	18.31	0.00	12.83
Makgadikgadi/Nxai	-	-	-	2.51	-	-	-	-	-
Moremi	90.62	97.97	97.43	84.78	80.94	92.07	81.69	100.00	87.17
Total	100	100	100	100	100	100	100	100	100

Source: Research Division Aerial Survey Reports, Department of Wildlife and National Parks

Gemsbok is a large animal found mainly in the southern parks. The overall population in all the PAs has been consistently high from 1994 to 2005 as depicted on Figure 7.20. There was a slight decline of the populationbetween 1999 and 2002 with a steep dip in 2003 after which it started climbing steadily.

The highest population was found in the Central Kgalagadi Game Reserve (CKGR) in the years 1994, 1999 and 2003, but in the years 1996, 2001 and 2005 it was highest in the Kgalagadi Transfronteir Park (KTP) as shown on Table 7.16 in the Appendix.

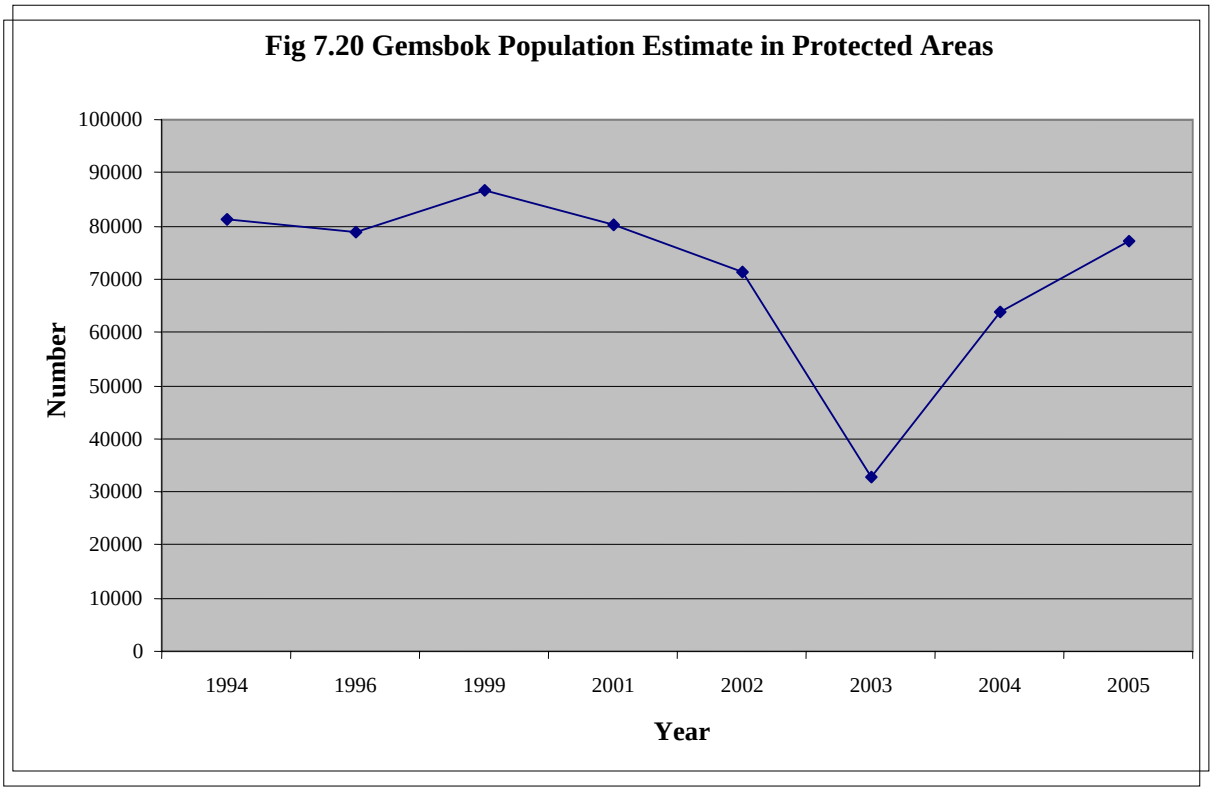


Table 7.16 Percentage Distribution of Gemsbok by Protected Area

Protected Area	1994	1996	1999	2001	2002	2003	2004	2005
Chobe	0.0	-	-	0.0	-	0.2	-	n.a
CKGR	55.2	41.5	63.5	44.1	48.7	90.8	47.9	37.8
KTP	43.6	55.4	33.2	50.8	45.7	n.a	47.4	61.3
Khutse	n.a	1.8	2.7	3.2	2.8	3.8	1.0	0.9
Makgadikgadi/Nxai	1.1	1.2	0.7	1.8	2.7	5.3	3.6	n.a
Total	100	100	100	100	100	100	100	100

Source: Research Division Aerial Survey Reports, Department of Wildlife and National Parks

The springbok is one of the species that has been declining rapidly in the country. Among the PAs, it is found in the southern parks of KTP and CKGR, the Makgadikgadi/Nxai Pans Park and to some extent the Khutse Game Reserve. Overall, the springbok population in PAs dropped drastically between 1994 and 1996 before rising slightly in 2001, then falling again in 2002. Another marginal rise was noted between 2004 and 2005. This is illustrated by Figure 7.21. On a general note, the population of springbok in PAs showed a downward trend from 1994 to 2004.

Table 7.17 shows that the largest proportion of springbok population was recorded in 1994 in KTP. However, this figure dropped from 62 percent of all springbok in PAs in 1994 to about 10 percent in 2005. The reverse was true for the CKGR, which accounted for about 34 percent of all springbok in PAs in 1994 but climbed steadily reaching a high of 87 percent in 2005. The Makgadikgadi/Nxai

population has been fluctuating heavily with 3 percent recorded in 1994 which climbed to 40 percent in 2001, and then plummeting to 0.3 percent in 2002 before rising again to 11 percent in 2004. This inconsistent behavior may be an indication of a difficulty in obtaining precise estimate for this species. Khutse Game Reserve accounted for only 3 percent on average of total population in PAs between 2003 and 2005.

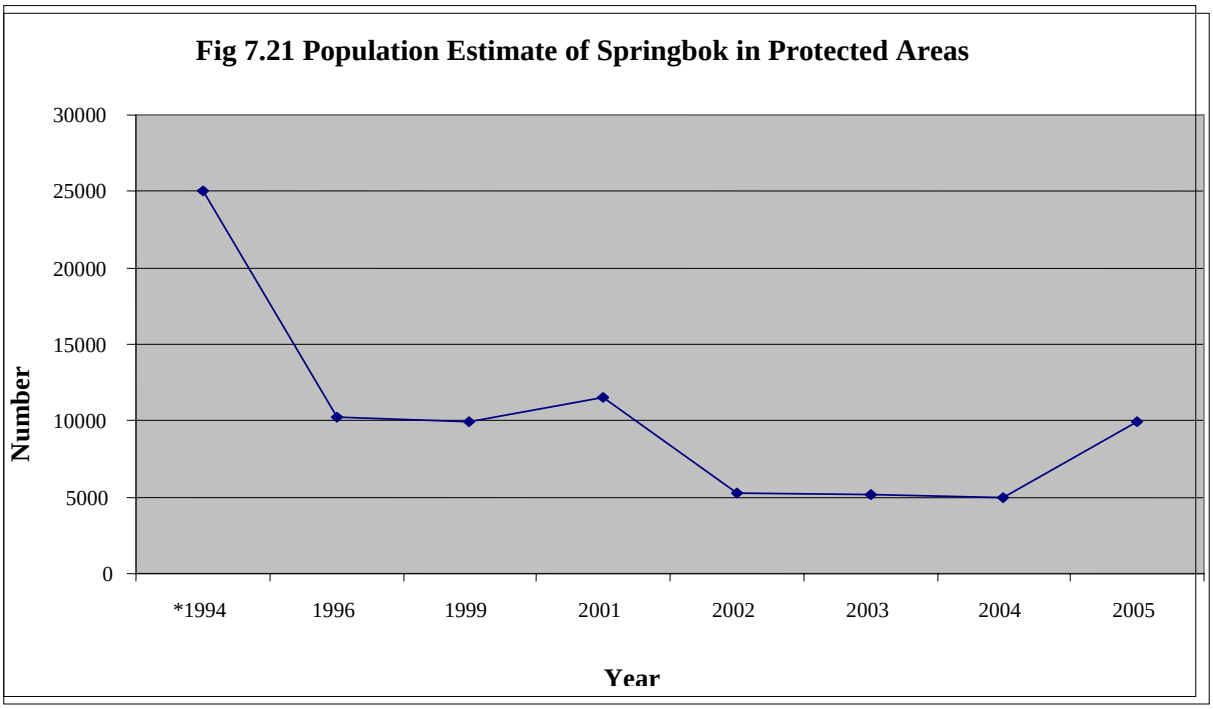


Table 7.17 Percentage Distribution of Springbok by Protected Area

Protected Area	*1994	1996	1999	2001	2002	2003	2004	2005	2006
CKGR	34.84	47.09	45.19	45.39	52.95	78.08	78.00	87.58	0.00
KTP	62.24	22.75	42.66	13.95	46.78	n.a	8.09	10.49	0.00
Khutse	-	-	-	-	-	6.04	2.08	1.93	0.00
Makgadikgadi/Nxai	2.93	30.16	12.14	40.65	0.27	15.88	11.83	n.a	100.00
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

**** : Population for Khutse and CKGR were lumped together***

Source: Research Division Aerial Survey Reports, Department of Wildlife and National Parks

7.4 Poaching Status

Poaching is the illegal offtake of animal species. In Botswana, these incidences are monitored and controlled by the Anti Poaching Unit of Department of Wildlife and National Parks. The statistics quoted in this chapter reflect the number of recorded poaching incidences in the country which give an indication of the level of poaching. On the whole poaching levels are very low. On the aggregate, elephant followed by kudu then gemsbok had higher incidences of poaching between 1999 and 2007 compared to other species as shown on Table 7.18. Other species which were poached in higher numbers are eland and impala. It should be noted that the actual number of incidences reported are quite insignificant in relation to the total population.

Most elephants were poached in the year 2001 followed by the year 2005. On the other hand, the kudu was mostly poached in 2002 and 2005 followed by 2001. Gemsbok was poached most significantly in 2000 followed by 2005 and then 2001.

Tables 7.19 – 7.21 in the Appendix present distribution of poaching incidences per district. In 2005, about 32 percent of the cases were recorded in the Central District. The species involved were kudu and impala. This was followed by about 17 percent from Ghanzi and Ngamiland Districts respectively, the species involved were gemsbok and eland in Ghanzi and elephant and impala in Ngamiland.

In 2006, Kgalagadi District registered the highest number of poaching incidences with about 22 percent cases; this was followed by Ngamiland with about 17 percent cases. Gemsbok was poached in large numbers in the former, impala in the latter. Most incidences occurred in the winter months from April to July, an exception was however noted in June when the incidences recorded went down to five.

In 2007, the District that registered the highest number of cases was Kgalagadi with about 30 percent followed by Ghanzi with about 23 percent and then Central with about 17 percent. The species involved were gemsbok and eland in Kgalagadi and Ghanzi while for Central it was impala. Most incidences were in winter months of June, April and July in that order.

Table 7.18 Poaching Statistics (1999 – 2007)

Species	1999	2000	2001	2002	2003	2004	2005	2006	2007
Aardvark	0	0	0	2	1	-	1	0	0
Buffalo	0	2	6	5	0	-	8	6	4
Caracal	0	0	0	3	0	-	0	0	0
Cheetah	0	0	0	2	4	-	3	0	1
Chobe bush buck	0	1	0	1	0	-	0	0	0
Duiker	0	0	0	7	0	-	1	5	2
Eland	10	10	5	3	2	-	24	13	23
Elephant	3	19	57	14	1	-	34	27	6
Francolin	0	0	1	0	0	-	0	0	0
Gemsbok	1	29	20	7	8	-	25	23	31
Giraffe	0	4	4	4	0	-	1	2	3
Guinea Fowl	0	6	9	3	0	-	4	0	0
Hartebeest	0	1	0	8	0	-	1	3	1
Hippo	0	0	0	0	1	-	0	0	0
Impala	0	8	8	9	7	-	21	19	12
Jackal	0	3	0	2	4	-	0	1	3
Kudu	0	9	23	34	21	-	33	11	16
Lechwe	0	12	0	1	1	-	0	2	0
Leopard	2	2	1	0	6	-	1	0	0
Lion	0		3	4	0	-	5	2	1
Ostrich	1	5	8	4	1	-	2	2	0
Ostrich Shell	0	1	0	8	2	-	5	0	0
Pangolin	0	0	1	0	0	-	1	0	0
Python	0	6	3	6	0	-	5	0	1
Reedbuck	0	0	1	0	0	-	1	0	0
Rhinoceros	0	0	1	0	0	-	2	0	0
Sable	0	0	0	0	0	-	0	0	0
Springbok	1	6	3	33	0	-	1	2	2
Steenbok	0	1	5	4	0	-	8	9	11
Tsessebe	0	0	0	0	0	-	0	0	2
Warthog	0	1	7	8	2	-	3	2	1
Waterbuck	0	0	0	0	0	-	0	1	
Wildbeest	0	2	1	3	1	-	4	3	4
Zebra	0	0	2	2	0	-	3	3	1
Others	0	1	3	16	3	-	9	3	8
Total	18	129	172	193	65	-	206	139	133

- ***means data not available***

Source: Anti Poaching Unit Annual Reports, Department of Wildlife and National Parks

Table 7.19: National Poaching Statistics, January -December 2005

Species	Central	Southern	Kweneng	Kgatleng	Ngamiland	Chobe	Kgalagadi	Ghanzi	Gaborone	Total	%
Aardwolf	1	0	0	0	0	0	0	0	0	**1**	**0.5**
Buffalo	0	0	0	0	8	0	0	0	0	**8**	**3.9**
Cheetah	1	2	0	0	0	0	0	0	0	**3**	**1.5**
Duiker	1	0	0	0	0	0	0	0	0	**1**	**0.5**
Eland	1	0	6	0	0	1	6	10	0	**24**	**11.7**
Elephant	3	0	0	0	12	17	0	0	2	**34**	**16.5**
Forest Genet	0	0	0	0	0	2	0	0	0	**2**	**1.0**
Gemsbok	1	0	0	0	1	0	12	11	0	**25**	**12.1**
Genet	1	0	0	0	0	0	0	0	0	**1**	**0.5**
Giraffe	0	0	0	0	1	0	0	0	0	**1**	**0.5**
Guinea fowl	3	0	0	0	0	0	0	1	0	**4**	**1.9**
Hartebeest	0	0	0	0	0	0	1	0	0	**1**	**0.5**
Impala	11	0	0	2	7	1	0	0	0	**21**	**10.2**
Kudu	21	3	2	0	1	1	0	5	0	**33**	**16.0**
Leopard	1	0	0	0	0	0	0	0	0	**1**	**0.5**
Lion	0	0	0	0	0	0	3	2	0	**5**	**1.5**
Lion (Live)	0	0	0	0	0	0	2	0	0	**2**	**1.0**
Ostrich	1	0	0	0	0	1	0	0	0	**2**	**1.0**
Ostrich (eggs)	0	0	0	0	0	0	0	5	0	**5**	**2.4**
Pangolin	0	0	0	0	0	0	1	0	0	**1**	**0.5**
Python	5	0	0	0	0	0	0	0	0	**5**	**2.4**
Reedbuck	0	0	0	0	1	0	0	0	0	**1**	**0.5**
Rhino (horn)	2	0	0	0	0	0	0	0	0	**2**	**1.0**
Serval	0	0	0	0	0	3	0	0	0	**3**	**1.5**
Springbok	0	1	0	0	0	0	0	0	0	**1**	**0.5**
Springhare	3	0	0	0	0	0	0	0	0	**3**	**1.5**
Steenbok	4	0	0	0	3	0	0	1	0	**8**	**3.9**
Warthog	3	0	0	0	0	0	0	0	0	**3**	**1.5**
Wildebeest	0	2	0	0	0	0	2	0	0	**4**	**1.9**
Zebra	3	0	0	0	0	0	0	0	0	**3**	**1.5**
Total	**66**	**8**	**8**	**2**	**34**	**26**	**25**	**35**	**2**	**206**	**100.0**

Source: Anti Poaching Unit, Department of Wildlife and National Parks

Table 7.20(a) National Poaching Statistics January – December 2006

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total
Baboon	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Buffalo	0	0	0	0	1	0	0	0	2	0	0	3	**6**
Bush buck	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Cheetah	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Duiker	0	0	0	0	0	1	0	2	0	0	1	1	**5**
Eland	0	1	3	1	0	0	4	1	1	1	0	1	**13**
Elephant	1	6	1	11	6	1	1	0	0	0	0	0	**27**
Gemsbok	0	4	4	0	0	0	8	2	2	2	0	1	**23**
Giraffe	0	0	0	0	0	0	0	0	1	1	0	0	**2**
Hartbeest	0	0	0	1	1	0	0	0	0	0	1	0	**3**
Hyena	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Impala	1	0	0	4	5	3	1	1	2	2	0	0	**19**
Jackal	0	0	0	0	0	0	1	0	0	0	0	0	**1**
Kudu	1	0	1	2	2	0	2	0	1	2	0	0	**11**
Lechwe	0	0	0	0	0	0	1	0	1	0	0	0	**2**
Lion	0	0	0	0	0	0	0	0	0	2	0	0	**2**
Ostrich	0	0	0	0	1	0	0	0	0	0	1	0	**2**
Python	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Sable	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Springbok	0	0	0	0	0	0	0	0	0	0	2	0	**2**
Steenbok	2	0	0	0	0	0	0	3	0	2	2	0	**9**
Tsessebe	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Warthog	0	2	0	0	0	0	0	0	0	0	0	0	**2**
Waterbuck	0	0	1	0	0	0	0	0	0	0	0	0	**1**
Wildebeest	0	0	0	0	1	0	1	0	0	0	0	1	**3**
Zebra	0	0	0	0	0	0	0	0	1	1	0	1	**3**
Others	0	0	0	0	1	0	1	0	0	1	0	0	**3**
Total	**5**	**13**	**10**	**19**	**18**	**5**	**20**	**9**	**11**	**14**	**7**	**8**	**139**

Source: Anti Poaching Unit, Department of Wildlife and National Parks

Table 7.20 (b) National Poaching Statistics 2006 by District

Species	Central	Chobe	Gaborone	Ghanzi	Kgatleng	Kweneng	Kgalagadi	North West	Southern	Total
Baboon	0	0	0	0	0	0	0	0	0	**0**
Buffalo	0	2	0	0	0	0	1	3	0	**6**
Bush buck	0	0	0	0	0	0	0	0	0	**0**
Cheetah	0	0	0	0	0	0	0	0	0	**0**
Duiker	1	0	0	0	0	0	2	0	2	**5**
Eland	0	1	0	3	0	3	6	0	0	**13**
Elephant	2	12	5	0	0	4	0	3	1	**27**
Gemsbok	0	1	0	4	0	0	18	0	0	**23**
Giraffe	0	0	0	0	0	0	0	2	0	**2**
Hartbeest	0	0	0	1	1	0	0	0	1	**3**
Hyena	0	0	0	0	0	0	0	0	0	**0**
Impala	4	1	0	1	3	1	0	9	0	**19**
Jackal	0	0	0	0	0	0	0	0	0	**0**
Kudu	4	1	0	0	3	0	0	2	1	**11**
Lechwe	0	0	0	0	0	0	0	1	0	**1**
Lion	0	0	0	0	0	0	2	0	0	**2**
Ostrich	1	0	0	0	0	0	1	0	0	**2**
Sable	0	0	0	0	0	0	0	0	0	**0**
Springbok	0	0	0	2	0	0	0	0	0	**2**
Steenbok	3	0	0	1	2	0	0	1	2	**9**
Tsessebe	0	0	0	0	0	0	0	0	0	**0**
Warthog	1	0	0	1	0	0	0	0	0	**2**
Waterbuck	0	0	0	0	0	0	0	0	0	**0**
Wildebeest	0	0	0	1	0	0	1	0	1	**3**
Zebra	0	1	0	0	0	0	0	2	0	**3**
Others	3	1	0	1	0	1	0	0	0	**6**
Total	**19**	**20**	**5**	**15**	**9**	**9**	**31**	**23**	**8**	**139**

Source: Anti Poaching Unit, Department of Wildlife and National Parks

Table 7.21 (a) National Poaching Statistics 2007 by Distict

Species	Central	Chobe	Gaborone	Ghanzi	Kgatleng	Kweneng	Kgalagadi	North-West	Southern	Total	%
Baboon	0	0	0	0	0	0	0	0	0	**0**	**0.0**
Buffalo	0	0	0	0	0	0	0	4	0	**4**	**3.0**
Bush buck	0	0	0	0	1	0	0	0	0	**1**	**0.8**
Cheetah	0	0	0	0	0	0	1	0	0	**1**	**0.8**
Duiker	0	0	0	0	1	0	1	0	0	**2**	**1.5**
Eland	1	1	0	11	0	1	9	0	0	**23**	**17.3**
Elephant	2	3	0	0	0	0	0	1	0	**6**	**4.5**
Gemsbok	1	0	0	15	0	2	13	0	0	**31**	**23.3**
Giraffe	0	0	0	1	0	1	0	1	0	**3**	**2.3**
Hartbeest	0	0	0	0	0	0	1	0	0	**1**	**0.8**
Hyena	0	0	0	0	0	0	1	0	0	**1**	**0.8**
Impala	8	0	0	0	2	0	0	2	0	**12**	**9.0**
Jackal	0	0	0	0	0	0	3	0	0	**3**	**2.3**
Kudu	4	1	0	4	4	0	1	2	0	**16**	**12.0**
Lion	1	0	0	0	0	0	0	0	0	**1**	**0.8**
Ostrich	0	0	0	0	0	0	0	0	0	**0**	**0.0**
Python	1	0	0	0	0	0	0	0	0	**1**	**0.8**
Sable	0	0	0	0	0	0	0	0	0	**0**	**0.0**
Springbok	0	0	0	0	0	0	2	0	0	**2**	**1.5**
Steenbok	2	1	0	0	0	0	4	4	0	**11**	**8.3**
Tsessebe	0	2	0	0	0	0	0	0	0	**2**	**1.5**
Warthog	0	1	0	0	0	0	0	0	0	**1**	**0.8**
Waterbuck	0	0	0	0	0	0	0	0	0	**0**	**0.0**
Wildebeest	1	0	0	0	3	0	0	0	0	**4**	**3.0**
Zebra	0	0	0	0	0	0	0	1	0	**1**	**0.8**
Others	1	0	0	0	1	0	4	0	0	**6**	**4.5**
Total	**22**	**9**	**0**	**31**	**12**	**4**	**40**	**15**	**0**	**133**	**100.0**
%	**16.5**	**6.8**	**0.0**	**23.3**	**9.0**	**3.0**	**30.1**	**11.3**	**0.0**	**100.0**	

Source: Anti Poaching Unit, Department of Wildlife and National Parks

Table 7.21 (b) National Poaching Statistics January - September 2007

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Total
Buffalo	0	1	0	1	2	0	0	0	0	**4**
Bush buck	0	0	0	0	1	0	0	0	0	**1**
Cheetah	0	0	1	0	0	0	0	0	0	**1**
Duiker	0	0	0	1	0	0	1	0	0	**2**
Eland	0	2	4	2	4	5	2	3	1	**23**
Elephant	1	1	2	0	1	1	0	0	0	**6**
Gemsbok	1	3	1	3	2	12	7	0	2	**31**
Giraffe	0	0	0	2	0	1	0	0	0	**3**
Hartbeest	0	0	1	0	0	0	0	0	0	**1**
Hyena	0	0	0	0	0	1	0	0	0	**1**
Impala	0	1	1	0	2	1	2	5	0	**12**
Jackal	0	0	2	1	0	0	0	0	0	**3**
Kudu	1	1	0	1	1	4	4	1	3	**16**
Lion	0	1	0	0	0	0	0	0	0	**1**
Ostrich	0	0	0	0	0	0	0	0	0	**0**
Python	0	0	1	0	0	0	0	0	0	**1**
Sable	0	0	0	0	0	0	0	0	0	**0**
Springbok	0	0	2	0	0	0	0	0	0	**2**
Steenbok	0	1	0	4	1	0	1	1	3	**11**
Tsessebe	0	1	0	0	0	0	1	0	0	**2**
Warthog	1	0	0	0	0	0	0	0	0	**1**
Waterbuck	0	0	0	0	0	0	0	0	0	**0**
Wildebeest	1	0	0	1	0	1	1	0	0	**4**
Zebra	0	0	0	0	1	0	0	0	0	**1**
Others	0	0	1	4	1	0	0	0	0	**6**
Total	**5**	**12**	**16**	**20**	**16**	**26**	**19**	**10**	**9**	**133**

Source: Anti Poaching Unit, Department of Wildlife and National Parks

Table 7.2a Ngamiland District Wildlife Numbers

Species	1989	1990	1991	1992	1994	1995	1996	1999	2001	2002	2003	2004	2005	2006
Baboon	0	1,517	1,652	3,509	6,993	5,616	9,612	9,242	-	3,322	3,037	2314	2,715	1245
BEF	-	-	-	-	-	-	198	88	-	-	24	-	76	16
Brnhyaena	0	0	177	-	12	-	-	77	-	-	-	-	-	-
Buffalo	24,881	47,811	60,614	41,612	24,643	19,162	33,209	80,440	72,533	36,985	17,697	15457	48,802	40832
Crocodile	81	128	395	406	850	487	381	331	0	958	384	373	368	433
Duiker	0	24	2,354	1,166	2,157	2,986	2,571	2,381	1,207	468	973	434	467	379
Eland	481	118	1,237	990	610	325	383	1,205	725	625	360	209	1,912	868
Elephant	31,079	41,280	35,534	30,867	53,652	49,095	56,744	77,003	67,568	65,438	57,381	74885	88,626	80262
Gemsbok	147	664	7,869	10,876	10,408	14,412	14,466	16,312	7,092	9,452	7,191	7487	6,494	8110
Giraffe	4,245	4,437	7,299	4,579	10,179	7,933	10,109	9,511	7,217	6,985	5,517	6566	5,262	6763
Hartebeest	-	-	771	525	1,479	1,103	1,065	817	126	1,025	414	318	201	768
Hippo	1,342	3,444	2,161	509	3,399	1,728	1,614	2,132	2,398	3,079	1,362	3010	2,434	3408
Impala	21,391	20,991	34,724	22,631	42,601	49,876	57,014	45,006	21,960	15,880	26,419	22382	30,156	43292
Jackal	-	13	106	-	210	177	459	240	-	-	13	96	59	32
Kudu	1,687	3,539	13,570	6,696	14,188	11,896	9,579	6,631	5,131	6,471	3,693	4780	5,552	4779
Lechwe	22,818	60,919	83,181	64,823	70,499	70,421	77,985	77,917	56,390	70,030	48,628	35509	37,947	37725
Lion	-	78	223	339	121	87	682	1,237	88	231	91	258		370
Ostrict	786	896	10,476	9,019	9,642	7,023	10,068	7,441	9,010	8,681	4,868	5887	6,644	6716
Reedbuck	2,431	1,342	4,731	523	2,281	1,656	1,180	703	127	695	67	0	18	208
Rhino (W)	-	-	-	-	-	-	-	-	-	-	-	24	-	16
Roan	737	232	746	287	585	1,521	780	538	548	529	64	374	70	111
Sable	2,211	284	1,131	1,594	3,338	2,501	1,908	819	1,516	498	949	975	841	1264
Sitatunga	580	893	2,200	408	850	1,624	1,133	1,255	909	201	167	12	249	160
Springbok	-	53	9,749	7,146	3,776	2,765	5,183	3,890	5,668	856	1,417	515	318	5892
Spthyaena	20	-	27	52	49	16	282	82	-	15	27	-	35	-
Steenbok	605	452	3,613	2,025	8,846	10,531	6,606	7,977	3,079	3,840	3,391	1949	2,365	3072
Tsessebe	3,720	9,699	13,962	10,550	10,915	8,108	13,834	10,832	3,079	5,812	4,560	2330	3,109	3128
Warthog	2,844	4,721	12,423	5,756	10,449	13,087	10,006	4,634	2,451	2,866	1,148	1008	1,529	2167
Waterbuck	103	729	810	39	1,009	1,246	801	423	1,386	574	590	446	298	555
Wildbeest	20,025	19,027	25,388	28,042	22,788	26,178	18,990	22,992	12,675	14,065	5,765	5359	5,367	4663
Wild dog	-	-	417	-	-	-	294	-	-	31	-	-	-	64
Zebra	8,899	44,357	32,141	15,920	21,643	25,499	23,324	24,595	30,769	19,734	17,447	32514	21,042	25137

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Table 7.2b Ngamiland District Wildlife Densities (Animals/km^2)

Species	1989	1990	1991	1992	1994	1995	1996	1999	2001	2002	2003	2004	2005	2006
Baboon	0.00	0.04	0.01	0.03	0.06	0.05	0.09	0.08	0.00	0.03	0.03	0.02	0.028	0.013
Buffalo	0.70	1.18	0.55	0.38	0.22	0.17	0.30	0.74	0.67	0.36	0.16	0.137	0.507	0.430
Crocodile	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.030	0.004	0.005
Duiker	0.00	0.00	0.02	0.01	0.02	0.03	0.02	0.02	0.01	0.01	0.01	0.004	0.005	0.004
Eland	0.01	0.00	0.01	0.01	0.01	0.00	0.00	0.01	0.01	0.01	0.00	0.002	0.02	0.009
Elephant	0.88	1.02	0.32	0.28	0.49	0.45	0.51	0.70	0.62	0.64	0.53	0.663	0.921	0.845
Gemsbok	0.00	0.02	0.07	0.10	0.09	0.13	0.13	0.15	0.07	0.92	0.07	0.066	0.067	0.085
Giraffe	0.12	0.11	0.07	0.04	0.09	0.07	0.09	0.09	0.07	0.07	0.05	0.058	0.055	0.071
Hartebeest	0.00	0.00	0.01	0.00	0.01	0.01	0.01	0.01	0.00	0.01	0.00	0.003	0.002	0.008
Hippo	0.04	0.09	0.02	0.00	0.03	0.02	0.01	0.02	0.02	0.03	0.01	0.027	0.025	0.036
Impala	0.60	0.52	0.31	0.21	0.39	0.45	0.52	0.41	0.20	0.16	0.24	0.198	0.313	0.456
Jackal	-	-	-	-	-	-	-	-	-	-	-	0.001	0.001	0.000
Kudu	0.05	0.09	0.12	0.06	0.13	0.11	0.09	0.06	0.05	0.06	0.03	0.042	0.058	0.05
Lechwe	0.64	1.50	0.75	0.59	0.64	0.64	0.71	0.71	0.52	0.00	0.45	0.314	0.394	0.397
Lion	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.002	0.000	0.004
Ostrich	0.02	0.02	0.09	0.08	0.09	0.06	0.09	0.07	0.08	0.09	0.05	0.052	0.069	0.071
Reedbuck	0.07	0.03	0.04	0.00	0.02	0.02	0.01	0.01	0.00	0.00	0.00	0.000	0.000	0.002
Roan	0.02	0.01	0.01	0.00	0.01	0.01	0.01	0.00	0.01	0.00	0.00	0.003	0.001	0.001
Sable	0.06	0.01	0.01	0.01	0.03	0.02	0.02	0.01	0.01	0.00	0.01	0.009	0.009	0.013
Sitatunga	0.02	0.02	0.02	0.00	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.000	0.003	0.002
Springbok	0.00	0.00	0.09	0.07	0.03	0.03	0.05	0.04	0.05	0.01	0.01	0.005	0.003	0.062
Steenbok	0.02	0.01	0.03	0.02	0.08	0.10	0.06	0.07	0.03	0.04	0.03	0.017	0.025	0.032
Tsessebe	0.11	0.24	0.13	0.10	0.10	0.07	0.13	0.10	0.03	0.00	0.04	0.021	0.032	0.033
Warthog	0.08	0.12	0.11	0.05	0.10	0.12	0.09	0.04	0.02	0.03	0.01	0.009	0.016	0.023
Waterbuck	0.00	0.02	0.01	0.00	0.01	0.01	0.01	0.00	0.01	0.00	0.01	0.004	0.003	0.006
Wildbeest	0.57	0.47	0.23	0.26	0.21	0.24	0.17	0.21	0.00	0.14	0.05	0.047	0.056	0.049
Wild dog	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.00	0.00	0.000	0.000	0.001
Zebra	0.25	1.10	0.29	0.15	0.20	0.23	0.21	0.22	0.28	0.19	0.16	0.288	0.219	0.265

Calculated by CSO from Table 7.2 (a)

Table 7.3a Chobe District Wildlife Numbers

Species	1989	1990	1991	1992	1994	1995	1996	1999	2001	2002	2003	2004	2006
Baboon	0	0	0	0	185	0	243	176	0	126	0	282	158
Buffalo	1,817	26	592	2,051	5,611	1,247	1,543	10,329	0	3,874	5,304	15,976	7,153
Bushbuck	0	0	0	0	0	0	0	0	5,802	0	0		
Bushpig	0	0	2,888	0	0	0	0	0	0	0	0		
Crocodile	0	0	0	0	26	0	0	31	0	11	4		26
Duiker	0	0	0	21	22	30	200	0	0	15	0		50
Eland	125	214	1,087	530	490	165	1,390	2,264	585	2,202	1,458	691	1,824
Elephant	23,362	15,991	23,827	21,112	25,133	26,118	41,262	37,411	35,309	53,862	46,144	54,744	51,799
Gemsbok	310	27	79	21	93	165	182	334	365	76	265	321	203
Giraffe	1,117	1,065	1,194	623	1,405	1,070	1,358	1,218	1,028	835	1,528	1,885	1,379
Hippo	40	160	27	0	306	0	6	36	83	41	103	85	272
Impala	1,023	3,337	1,589	732	1,894	625	429	884	1,076	1,784	1,154	2,532	2,920
Jackal	0	0	0	0	0	0	16	0	0	0	0		
Kudu	42	496	482	145	795	131	265	448	0	260	314	813	414
Lechwe	0	0	0	0	261	0	284	48	746	154	355	213	335
Lion	0	0	0	0	11	58	0	32	0	73	0	46	
Ostrich	411	106	382	42	289	459	500	525	597	535	492	200	485
Roan	63	0	489	0	364	550	642	392	298	308	124	21	460
Sable	1,644	850	2,336	423	1,456	1,154	1,456	1,150	1,689	1,758	1,920	1,327	731
Sitatunga	0	0	54	0	0	0	0	0	0	0	0		
Spottedhyaena	0	0	0	0	0	45	0	0	0	0	28	15	
Steenbok	312	80	82	63	152	150	174	288	96	165	54	166	223
Tsessebe	212	993	5,515	0	498	672	376	889	239	239	553	32	78
Warthog	119	0	54	64	464	61	53	131	149	299	267	220	97
Waterbuck	0	27	0	87	93	59	203	0	83	0	27	197	
Wild dog	0	0	0	0	11	0	265	0	0	0	0		
Wildebeest	0	0	0	0	470	0	1,106	527	196	266	109	152	237
Zebra	6,885	2,846	3,241	1,809	5,771	6,292	7,716	2,482	5,156	4,259	6,900	2,184	5,219

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Table 7.3b Chobe District Wildlife Densities (Animals/km^2)

Species	1989	1990	1991	1992	1994	1995	1996	1999	2001	2002	2003	2004	2006
Baboon	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.01	0.00	0.01	0.00	0.013	0.008
Buffalo	0.09	0.00	0.03	0.10	0.27	0.06	0.07	0.50	0.28	0.18	0.25	0.760	0.342
Bushpig	0.00	0.00	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bushbuck	0.00	0.02	0.00	0.00	0.02	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00
Crocodile	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.001
Duiker	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.002
Eland	0.01	0.01	0.05	0.03	0.02	0.01	0.07	0.11	0.03	0.10	0.07	0.033	0.087
Elephant	1.13	0.79	1.13	1.03	1.20	1.30	1.97	1.82	1.72	2.53	2.17	2.606	2.478
Gemsbok	0.02	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.02	0.00	0.01	0.015	0.010
Giraffe	0.05	0.05	0.06	0.03	0.07	0.05	0.06	0.06	0.05	0.04	0.07	0.090	0.066
Hippo	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.004	0.013
Impala	0.05	0.16	0.08	0.04	0.09	0.03	0.02	0.04	0.05	0.08	0.05	0.121	0.140
Kudu	0.00	0.02	0.02	0.01	0.04	0.01	0.01	0.02	0.01	0.01	0.02	0.039	0.020
Lechwe	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.04	0.01	0.02	0.010	0.016
Ostrich	0.02	0.01	0.02	0.00	0.01	0.02	0.02	0.03	0.03	0.03	0.02	0.010	0.023
Roan	0.00	0.00	0.02	0.00	0.02	0.03	0.03	0.02	0.01	0.01	0.01	0.001	0.022
Sable	0.08	0.04	0.11	0.02	0.07	0.06	0.07	0.06	0.08	0.08	0.09	0.063	0.035
Sheep_Goats	0.00	0.02	0.10	0.08	0.11	0.05	0.09	0.05	0.04	0.00	0.03	0.026	0.054
Spotted	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.001	0.00
Steenbok	0.02	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.00	0.01	0.00	0.008	0.011
Tsessebe	0.01	0.05	0.26	0.00	0.02	0.03	0.02	0.04	0.01	0.01	0.03	0.002	0.004
Warthog	0.01	0.00	0.00	0.00	0.02	0.00	0.00	0.01	0.01	0.01	0.01	0.010	0.005
Waterbuck	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.009	0.00
Wild dog	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Wildebeest	0.00	0.00	0.00	0.00	0.02	0.00	0.05	0.03	0.01	0.01	0.01	0.007	0.011
Zebra	0.33	0.14	0.15	0.09	0.28	0.31	0.37	0.12	0.25	0.20	0.33	0.107	0.250

Calculated by CSO from Table 7.3 (a)

Table 7.4a Central District Wildlife Numbers

Species	1987	1989	1990	1991	1992	1994	1995	1996	1999	2001	2002	2003
Baboon	0	0	0	0	14	421	0	0	0	0	474	584
Brnhyaena	0	0	0	0	0	88	0	0	26	0	0	0
Buffalo	0	0	0	0	0	0	0	0	0	4,264	30	10,304
Bush pig	0	0	0	295	0	0	0	0	0	0	0	0
Bushbuck	0	124	0	0	0	0	0	0	0	0	0	0
Crocodile	0	0	0	0	0	11	0	0	0	0	0	0
Duiker	206	3,393	438	78	537	8,832	755	1,535	595	219	2,057	2,313
Eland	0	197	248	132	281	627	60	1,031	0	59	2,867	2,440
Elephant	0	361	826	3,197	1,214	1,381	0	1,450	1,121	10,110	5,691	6,235
Gemsbok	537	1,086	830	625	1,127	2,640	1,360	1,659	1,513	874	3,048	3,802
Giraffe	21	1,084	1,518	636	468	1,167	208	1,156	955	1,627	604	821
Hartbeest	1,342	683	601	0	3,534	4,229	434	988	388	1,039	8,533	3,551
Impala	0	21,588	128	0	13,449	12,449	0	0	0	389	43,736	35,954
Jackal	21	548	0	0	0	1,764	30	0	189	0	129	556
Kudu	83	2,472	1,294	626	1,915	7,757	1,790	3,396	2,077	0	10,214	8,329
Lion	0	0	0	0	0	184	0	0	0	0	292	0
Ostrich	186	15,258	3,883	2,513	3,416	15,368	4,524	4,942	3,124	6,960	21,756	11,435
Sable	0	85	25	0	47	0	0	0	0	32	30	552
Springbok	83	35,214	6,882	54	565	11,319	7,843	7,182	2,228	3,255	1,466	5,042
Spthyaena	0	0	25	0	0	7	0	0	16	0	0	65
Steenbok	248	4,927	1,251	1,533	1,399	14,995	2,219	2,449	2,860	663	10,514	7,856
Tsessebe	0	0	0	0	0	58	0	0	0	0	121	449
Warthog	0	341	0	79	253	165	15	132	0	324	3,515	1,473
Waterbuck	0	0	0	0	275	562	0	0	0	0	1,477	333
Wild dog	0	0	0	27	0	0	0	0	0	0	0	0
Wildebeest	0	4,416	7,312	1,797	8,348	7,061	672	2,069	14,815	1,880	26,466	22,839
Zebra	0	62	3,199	10,731	14,698	18,244	19,317	8,359	26,126	4,472	13,685	15,832

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Table 7.4b Central District Wildlife Density (Animals/km^2)

Species	1987	1989	1990	1991	1992	1994	1995	1996	1999	2001	2002	2003
Baboon	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Buffalo	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08
Bush pig	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Duiker	0.06	0.03	0.01	0.00	0.01	0.06	0.01	0.03	0.01	0.00	0.02	0.02
Eland	0.00	0.00	0.01	0.00	0.01	0.00	0.00	0.02	0.00	0.00	0.02	0.02
Elephant	0.00	0.00	0.03	0.12	0.02	0.01	0.00	0.03	0.02	0.20	0.05	0.05
Gemsbok	0.16	0.01	0.03	0.02	0.02	0.02	0.03	0.03	0.03	0.02	0.03	0.03
Giraffe	0.01	0.01	0.05	0.02	0.01	0.01	0.00	0.02	0.02	0.03	0.01	0.01
Hartbeest	0.40	0.01	0.02	0.00	0.06	0.03	0.01	0.02	0.01	0.02	0.07	0.03
Horse	0.02	0.02	0.01	0.07	0.04	0.05	0.11	0.06	0.12	0.00	0.17	0.16
Impala	0.00	0.20	0.00	0.00	0.24	0.09	0.00	0.00	0.00	0.01	0.36	0.28
Jackal	0.01	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Kudu	0.02	0.02	0.04	0.02	0.03	0.05	0.03	0.06	0.04	0.04	0.08	0.07
Ostrich	0.06	0.14	0.13	0.09	0.06	0.11	0.08	0.09	0.06	0.14	0.18	0.09
Sable	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sheep_Goats	0.42	4.26	0.34	0.83	1.33	4.29	0.69	0.32	0.57	0.69	0.00	1.45
Springbok	0.02	0.33	0.22	0.00	0.01	0.08	0.15	0.13	0.04	0.07	0.01	0.04
Steenbok	0.07	0.05	0.04	0.06	0.03	0.10	0.04	0.05	0.05	0.01	0.09	0.06
Tsessebe	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Warthog	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.03	0.01
Waterbuck	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.00
Wildebeest	0.00	0.04	0.24	0.07	0.15	0.05	0.01	0.04	0.28	0.04	0.22	0.18
Zebra	0.00	0.00	0.10	0.39	0.27	0.13	0.36	0.16	0.50	0.09	0.11	0.12

Calculated by CSO from Table 7.4 (a)

Table 7.5a Ghanzi District Wildlife Numbers

Species	1987	1989	1990	1991	1992	1994	1995	1996	1999	2001	2002	2003	2004	2005
Baboon	0	0	0	0	0	0	58	0	0	0	0	0	0	0
BEF	0	0	0	0	0	509	56	128	113	0	236	0	0	95
Black Hyena	41	0	26	52	130	113	89	154	144	0	0	0	54	
Brown Hyaena														29
Cheetah	82	0	0	0	28	0	119	30	55	188	28	0	202	
Duiker	8,385	6,604	6,786	7,402	4,993	9,798	7,846	7,488	2,368	3,482	2,862	3,368	2,194	3,036
Eland	10,164	81	18,890	622	4,500	9,931	2,929	9,924	7,804	7,488	8,664	9,347	11,545	15,968
Gemsbok	33,691	7,108	42,687	5,309	29,736	55,581	44,077	41,740	59,048	34,266	40,856	0	35,543	37,330
Giraffe	2,390	0	2,370	0	1,467	1,137	630	909	2,596	1,370	1,374	703	1,148	1,298
Hartebeest	29,639	2,280	10,759	1,538	15,101	15,307	4,259	6,640	12,059	8,015	12,275	8,141	7,179	5,782
Horse	7,005	6,546	3,979	6,263	9,989	11,053	10,977	11,236	10,636	0	11,345	0	13,695	11,375
Impala	0	0	0	0	0	148	0	0	0	336	0	519		
Jackal	618	162	0	283	342	1,488	570	914	391	0	583	444	503	1,040
Kudu	2,287	1,734	5,829	2,105	4,318	9,713	7,732	10,055	8,270	6,473	15,564	8,173	12,836	8,770
Leopard	62	0	0	0	0	0	0	0	0	0	0	0		
Lion	206	0	260	0	259	61	64	360	143	237	147	149	208	36
Ostrich	7,884	4,329	12,375	3,309	8,853	15,409	9,877	6,595	9,548	9,209	10,947	6,797	10,918	9,300
Springbok	24,915	9,241	13,124	5,303	24,693	24,627	8,745	11,070	9,272	7,199	7,568	5,681	7,459	10,809
Steenbok	11,455	4,912	17,513	7,015	8,757	28,741	15,721	16,910	7,974	16,107	16,865	6,917	9,395	8,724
Tsessebe	0	0	0	0	0	0	0	0	0	233	0	0		
Warthog	103	158	123	203	438	925	924	582	272	1,209	2,375	938	1,095	1,988
Whiterhino	0	0	0	0	0	0	0	0	59	0	0	0		
Wilddog	41	0	0	0	0	0	0	962	373	5,983	0	0		289
Wildebeest	1,875	8,123	7,638	1,051	2,625	8,364	4,276	7,072	3,356	0	5,737	9,583	9,176	7,295
Zebra	0	0	0	229	0	272	297	128	329	817	706	813	1,519	29

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Table 7.5b Ghanzi Wildlife Density (Animals/km^2)

Species	1987	1989	1990	1991	1992	1994	1995	1996	1999	2001	2002	2003	2004	2005
BEF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	0.001
Brown Hyena	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	0.000
Donkey	0.05	0.11	0.02	0.06	0.06	0.11	0.08	0.10	0.08	0.00	0.00	0.07	0.002	0.068
Duiker	0.07	0.11	0.06	0.11	0.04	0.09	0.07	0.07	0.02	0.03	0.03	0.03	0.019	0.026
Eland	0.09	0.00	0.17	0.01	0.04	0.09	0.03	0.09	0.07	0.07	0.08	0.08	0.100	0.139
Gemsbok	0.30	0.11	0.37	0.08	0.26	0.49	0.40	0.37	0.52	0.30	0.36	0.30	0.309	0.325
Giraffe	0.02	0.00	0.02	0.00	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.010	0.011
Hartebeest	0.26	0.04	0.09	0.02	0.13	0.13	0.04	0.06	0.11	0.07	0.11	0.07	0.062	0.050
Horse	0.06	0.11	0.03	0.10	0.09	0.10	0.10	0.10	0.09	0.00	0.00	0.08	0.119	0.099
Jackal	0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.00	0.00	0.01	0.00	0.004	0.009
Kudu	0.02	0.03	0.05	0.03	0.04	0.09	0.07	0.09	0.07	0.06	0.14	0.07	0.111	0.076
Lion	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.002	0.000
Ostrich	0.07	0.07	0.11	0.05	0.08	0.14	0.09	0.06	0.08	0.08	0.10	0.06	0.095	0.081
Sheep_Goats	0.13	1.16	0.26	0.67	0.37	0.47	0.49	0.40	0.50	1.03	0.00	0.51	0.696	0.465
Springbok	0.22	0.15	0.12	0.08	0.22	0.22	0.08	0.10	0.08	0.06	0.07	0.05	0.065	0.094
Steenbok	0.10	0.08	0.15	0.11	0.08	0.25	0.14	0.15	0.07	0.14	0.15	0.06	0.082	0.076
Warthog	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.00	0.01	0.02	0.01	0.010	0.017
Wilddog	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00		0.003
Wildebeest	0.02	0.13	0.07	0.02	0.02	0.07	0.04	0.06	0.03	0.05	0.05	0.08	0.080	0.064
Zebra	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.013	0.000

Calculated by CSO from Table 7.5 (a)

Table 7.6a Kgalagadi District Wildlife Numbers

Species	1987	1989	1990	1991	1992	1994	1995	1996	1999	2001	2002	2003	2004	2005
Baboon	0	0	0	0	0	353	478	129	103	0	318	0	149	
BEF	0	0	0	0	0	242	502	0	189	0	87	48	394	239
Brown hyaena	0	0	24	49	50	48	78	65	29	0	0	24	0	102
Cheetah	0	0	0	0	71	-99	165	0	104	0	0	0	107	
Duiker	102	154	915	1,101	1,895	4,942	4,850	4,731	2,573	743	3,571	1,724	356	1,222
Eland	0	0	0	3,435	2,085	3,096	4,003	8,703	5,670	11,836	6,229	16,619	6,265	25,959
Gemsbok	162	366	1,402	33,122	58,299	70,407	72,086	75,588	55,645	45,633	50,279	52,953	50,919	67,880
Hartebeest	0	729	525	13,416	16,709	27,657	24,825	21,735	17,341	27,492	31,760	32,103	27,342	40,876
Jackal	0	0	24	324	156	2,003	1,860	791	398	0	1,507	799	593	1,443
Kudu	0	78	480	1,439	1,907	1,324	1,465	2,055	1,851	2,538	2,776	2,447	2,525	3,752
Lion	0	0	0	150	394	240	209	94	148	0	0	50	56	277
Ostrich	41	615	3,495	14,116	12,089	11,117	10,724	11,121	11,150	12,043	14,203	12,751	14,085	16,696
Springbok	61	3,399	6,169	65,389	82,705	52,275	53,949	43,680	34,398	19,432	17,735	17,697	29,286	11,544
Steenbok	81	288	893	3,208	12,759	15,276	15,871	12,356	10,152	12,413	14,678	1,357	10,362	12,793
Warthog	0	0	0	0	22	67	52	59	56	219	2,252	146	258	101
Wildebeest	0	172	139	8,531	1,375	6,263	3,702	7,459	4,340	6,679	3,281	4,571	10,887	11,163

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Table 7.6b Kgalagadi District Wildlife Density (Animals/km^2)

Species	1987	1989	1990	1991	1992	1994	1995	1996	1999	2001	2002	2003	2004	2005
Baboon	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.001	0.00
BFX	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.004	0.002
BRN HYAENA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.001
Cattle	0.01	2.60	0.71	0.99	1.15	1.32	1.20	1.10	1.53	1.99	0.00	1.54	1.558	0.00
Cheetah	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.001	0.00
Donkey	0.00	0.13	0.02	0.09	0.08	0.13	0.13	0.11	0.13	0.00	0.00	0.13	0.189	0.00
Duiker	0.01	0.01	0.03	0.01	0.02	0.05	0.05	0.05	0.02	0.01	0.03	0.02	0.003	0.013
Eland	0.00	0.00	0.00	0.03	0.02	0.03	0.04	0.08	0.05	0.12	0.06	0.16	0.061	0.270
Gemsbok	0.02	0.03	0.05	0.34	0.55	0.66	0.69	0.72	0.53	0.45	0.49	0.51	0.496	0.705
Hartebeest	0.00	0.06	0.02	0.14	0.16	0.26	0.24	0.21	0.16	0.27	0.31	0.31	0.266	0.424
Horse	0.00	0.11	0.01	0.03	0.04	0.03	0.04	0.06	0.06	0.00	0.00	0.05	0.065	0.086
Jackal	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.01	0.00	0.00	0.02	0.01	0.006	0.015
Kudu	0.00	0.01	0.02	0.01	0.02	0.01	0.01	0.02	0.02	0.02	0.03	0.02	0.025	0.039
LION	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.003
Ostrich	0.00	0.05	0.13	0.14	0.11	0.10	0.10	0.11	0.11	0.12	0.14	0.12	0.137	0.173
Sheep_Goats	0.00	0.42	0.43	0.71	0.44	0.52	0.44	0.59	0.79	0.96	0.00	1.14	0.736	1.451
Springbok	0.01	0.26	0.23	0.66	0.78	0.49	0.51	0.42	0.33	0.19	0.17	0.17	0.285	0.120
Steenbok	0.01	0.02	0.03	0.03	0.12	0.14	0.15	0.12	0.10	0.12	0.14	0.13	0.101	0.133
Warthog	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.003	0.001
Wildebeest	0.00	0.01	0.01	0.09	0.01	0.06	0.04	0.07	0.04	0.07	0.03	0.04	0.106	0.116

Calculated by CSO from Table 7.6 (a)

Table 7.7a Kweneng District Wildlife Numbers

Species	1987	1989	1990	1991	1992	1994	1995	1996	1999	2001	2002	2003	2004
Impala	0	0	0	0	0	0	0	0	0	0	996	0	0
Baboon	0	301	0	0	0	0	620	0	0	0	83	0	0
BEF	0	0	0	0	0	22	59	51	0	0	0	0	0
Brnhyaena	0	0	0	0	0	0	30	0	0	0	0	0	0
Cheetah	0	0	28	0	0	0	0	0	0	0	0	0	0
Duiker	41	887	28	0	228	1,516	409	1,443	696	172	501	565	230
Eland	123	40	828	0	3,486	1,518	4,875	829	652	8,454	4,619	1,462	293
Gemsbok	41	2,434	2,604	0	2,538	3,244	2,035	2,326	4,002	3,064	3,041	2,191	1104
Giraffe	0	0	0	0	128	65	0	82	0	325	0	0	154
Hartebeest	0	1,594	1,152	0	8,140	1,037	2,152	972	2,983	1,481	1,684	1,649	2321
Jackal	0	40	0	0	31	154	123	51	110	0	55	26	73
Kudu	143	358	212	0	306	356	0	365	242	79	1,479	692	1675
Lion	0	0	0	0	0	53	32	0	27	0	0	0	51
Ostrich	0	2,704	189	0	3,489	2,786	525	1,707	2,075	2,348	1,969	1,408	2697
Springbok	0	275	0	23	2,753	2,979	2,658	2,119	3,581	490	1,376	314	663
Steenbok	20	1,728	384	76	780	4,732	1,123	2,990	2,323	2,253	2,935	1,559	1755
Warthog	0	0	0	0	0	21	32	0	27	29	83	51	0
Wildebeest	0	0	524	0	529	0	1,232	274	0	87	772	0	370

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Table 7.7b Kweneng District Wildlife Density (Animals/km^2)

Species	1987	1989	1990	1991	1992	1994	1995	1996	1999	2001	2002	2003	2004
Baboon	0.00	0.01	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00
BEF	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Duiker	0.01	0.02	0.00	0.00	0.01	0.04	0.05	0.06	0.03	0.00	0.02	0.02	0.006
Eland	0.04	0.00	0.15	0.00	0.20	0.04	0.54	0.04	0.03	0.23	0.14	0.00	0.008
Gemsbok	0.01	0.07	0.47	0.00	0.15	0.09	0.23	0.10	0.17	0.08	0.09	0.07	0.031
Giraffe	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.004
Hartebeest	0.00	0.04	0.21	0.00	0.47	0.03	0.24	0.04	0.13	0.04	0.05	0.05	0.065
Kudu	0.05	0.01	0.04	0.00	0.02	0.01	0.00	0.02	0.01	0.00	0.04	0.02	0.047
Ostrich	0.00	0.08	0.03	0.00	0.20	0.07	0.06	0.07	0.09	0.06	0.06	0.05	0.076
Springbok	0.00	0.01	0.00	0.02	0.16	0.08	0.30	0.09	0.15	0.01	0.04	0.01	0.019
Steenbok	0.01	0.05	0.07	0.07	0.04	0.12	0.13	0.13	0.10	0.06	0.09	0.05	0.049
Wild dog	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Wildebeest	0.00	0.00	0.09	0.00	0.03	0.00	0.14	0.01	0.00	0.00	0.02	0.00	0.01
Warthog	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Impala	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.01	0.00
Jackal	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.002

Calculated by CSO from Table 7.7(a)

Table 7.8a Estimated Population of Selected Wildlife Species in Chobe National Park

Species	1993	1994	1996	1999	2001	2002	2003	2004	2006
Baboon	-	14	286	331	217	-	-	282	-
Buffalo	31	736	5,319	4,903	1,788	252	3,773	10,603	6,922
Crocodile	-	7	-	11	-	-	-		-
Duiker	21	12	131	-	-	-	-		35
Eland	-	100	239	225	27	166	115	218	240
Elephant	13,565	11,682	25,532	22,053	33,219	31,598	30,348	32,263	39,404
Gemsbok	-	31	-	-0	14	-	55	-	16
Giraffe	364	1,107	666	850	692	540	999	1,044	793
Hippo	83	145	6	-	90	-	50	85	271
Impala	1,697	2,008	386	560	1,502	1,439	868	1,645	2,024
Kudu	-	497	114	260	123	156	205	434	254
Lechwe	52	138	172	63	245	0	362	197	333
Ostrich	291	43	344	416	173	300	369	78	362
Reedbuck	21	-	-	-	-	177	-	-	-
Roan	31	195	160	148	144	1,533	68	20	421
Sable	448	868	951	1,119	857	-	1,117	116	427
Steenbok	10	134	135	72	28	59	42	93	16
Tsessebe	1,322	270	253	960	43	103	77	-	-
Warthog	104	337	114	63	153	184	170	167	16
Waterbuck	10	12	172	-	-	-	27	175	-
Wildebeest	-	-	777	-	188	147	-	145	236
Zebra	479	1,762	2,490	1,504	1,359	338	2,121	1,151	1,728

-: Zero

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Table 7.8b Densities of Selected wildlife species in Chobe National Park (Animals/km^2)

Species	1994	1996	1999	2001	2002	2003	2004	2006
Baboon	0.001	0.028	0.033	0.020	-	-	-	-
Buffalo	0.038	0.522	0.482	0.169	0.025	0.368	1.050	0.694
Duiker	0.001	0.013	-	-	-	-		0.003
Eland	0.010	0.023	0.022	0.003	0.016	0.011	0.022	0.024
Elephant	1.126	2.507	2.170	3.131	3.080	2.960	3.196	3.949
Gemsbok	0.003	-	-	0.001	-	0.005	-	0.002
Giraffe	0.017	0.065	0.084	0.065	0.053	0.097	0.103	0.080
Hippo	0.014	0.001	-	0.009	0.003	0.005	0.008	0.027
Impala	0.193	0.038	0.055	0.142	0.140	0.085	0.163	0.203
Kudu	0.048	0.011	0.026	0.012	0.015	0.020	0.043	0.026
Lechwe	0.013	0.017	0.006	0.023	0.015	0.035	0.020	0.033
Ostrich	0.004	0.034	0.041	0.016	0.029	0.036	0.008	0.036
Roan	0.019	0.016	0.015	0.014	0.017	0.007	0.002	0.042
Sable	0.084	0.093	0.110	0.081	0.149	0.109	0.011	0.043
Steenbok	0.013	0.013	0.007	0.003	0.006	0.004	0.009	0.002
Tsessebe	0.026	0.025	0.094	0.004	0.010	0.008	-	-
Warthog	0.032	0.011	0.006	0.014	0.018	0.017	0.017	0.002
Waterbuck	0.001	0.017	-	-	-	0.003	0.017	-
Wildebeest	-	0.076	-	0.018	0.014	-	0.014	0.024
Zebra	0.170	0.244	0.148	0.128	0.033	0.207	0.114	0.173

-: Less than 0.001 up to zero
Calculated by CSO from Table 7.8 (a)

Table 7.9a Estimated Population of Selected Wildlife Species in Moremi Game Reserve

Species	1993	1994	1996	1999	2001	2002	2003	2004	2005	2006
Baboon	-	2,435	2,205	2,871	2,436	638	667	629	591	272
Buffalo	8,248	10,768	22,510	40,160	23,044	4,585	597	1089	4,296	176
Crocodile	-	318	17	75	-	-	-	-	-	-
Eland	-	-	-	-	-	-	-	-	448	-
Elephant	7,261	7,525	7,758	5,442	6,048	9,562	5,862	9143	19,852	10,146
Giraffe	1,309	1,334	1,691	1,370	1,777	1,233	958	1101	1,629	1,088
Hippo	696	551	812	507	717	1,320	458	593	913	432
Impala	12,424	19,406	18,615	21,262	10,017	6,109	10,071	7341	12,029	13,747
Kudu	-	710	1,028	563	430	392	458	85	251	192
Lechwe	18,906	29,636	11,752	10,978	17,513	4,759	6,682	5793	6,498	3,825
Ostrich	114	184	232	131	86	174	125	-	107	32
Reedbuck	686	808	365	94	100	203	28	-	-	-
Roan	125	61	116	-	14	-	-	-	-	-
Sable	156	147	116	225	-	-	56	-	18	-
Sitatunga	114	281	83	56	143	-	28	-	-	-
Steenbok	52	-	17	-	43	15	-	12	-	-
Tsessebe	3,002	1,872	3,033	2,928	1,089	1,074	778	665	1,128	1,200
Warthog	2,867	4,001	1,542	854	616	218	208	206	36	192
Waterbuck	125	392	215	244	3,970	218	111	157	90	272
Wildbeast	1,618	2,288	1,310	4,429	-	6,109	236	980	1,736	848
Zebra	2,233	1,786	1,674	1,633	4,256	2,220	1,500	810	4,547	992

-: Zero

Source: Research Division, Department of Wildlife and National Parks.

Table 7.9b Densities of Selected wildlife species in Moremi Game Reserve (Animals/km^2)

Species	1994	1996	1999	2001	2002	2003	2004	2005	2006
Baboon	0.494	0.612	0.797	0.491	0.177	0.185	-	0.158	0.076
BEF	-	6.247	-	-	-	-	-	-	-
Buffalo	2.186	-	11.146	4.642	1.273	0.166	0.291	1.148	0.049
Crocodile	-	0.005	0.021	-	-	-	-	-	-
Eland	-	-	-	-	-	-	-	0.120	-
Elephant	1.528	2.153	1.510	1.218	2.654	1.627	2.443	5.304	2.816
Giraffe	0.271	0.469	0.380	0.358	0.342	0.266	0.294	-	0.302
Hippo	0.112	0.225	0.141	0.144	0.366	0.127	0.158	0.244	0.120
Impala	3.939	5.166	5.901	2.018	1.695	2.795	1.961	3.214	3.815
Kudu	0.144	0.285	0.156	0.087	0.109	0.127	0.023	0.067	0.053
Lechwe	6.016	3.262	3.047	3.528	1.321	1.854	1.458	1.736	1.062
Ostrich	0.037	0.064	0.036	0.017	0.048	0.035	-	0.029	0.009
Reedbuck	0.164	0.101	0.023	0.020	0.056	0.008	-	-	-
Roan	0.012	0.032	-	0.003	-	-	-	-	-
Sable	0.030	0.032	0.062	-	-	0.015	-	0.005	-
Sitatunga	0.057	0.023	0.016	0.029	-	0.008	-	-	-
Steenbok	-	0.005	-	0.009	0.004	-	0.003	-	-
Tsessebe	0.380	0.842	0.812	0.219	0.298	0.216	0.178	0.301	0.333
Warthog	0.812	0.428	0.237	0.124	0.060	0.058	0.055	0.010	0.053
Waterbuck	0.079	0.060	0.068	0.092	0.060	0.031	0.042	0.024	0.076
Wildbeast	0.464	0.363	1.229	0.800	1.695	0.066	0.262	0.464	0.235
Zebra	0.363	0.465	0.453	0.857	0.616	0.416	0.216	1.215	0.275

-: Less than 0.001 up to zero
Calculated by CSO from Table 7.9 (a)

Table 7.10a Estimated Population of Selected Wildlife Species in Central Kgalagadi Game Reserve (CKGR)

Species	*1994	1996	1999	2001	2002	2003	2004	2005
Duiker	3,182	1,678	514	680	676	571	506	557
Eland	8,118	9,234	6,185	5,155	7,065	6,344	8,321	1,937
Gemsbok	44,740	32,713	55,067	35,463	34,801	29,609	30,601	29,196
Giraffe	1,115	893	2,661	1,416	1,253	703	1,148	1,210
Hartebeest	10,916	4,267	5,032	5,722	5,759	3,617	5,699	2,396
Kudu	4,525	6,253	5,014	2,096	4,609	2,941	5,762	2,907
Ostrich	9,734	3,505	4,614	5,920	4,986	3,807	4,527	4,264
Springbok	8,723	4,814	4,485	5,212	2,783	4,057	3,864	8,721
Steenbok	11,856	6,382	4,171	5,467	5,319	2,940	3,590	2,970
Warthog	359	263	-	368	988	23	89	84
Wildebeest	5,349	3,835	1,203	2,153	833	989	1,521	446

Population estimates for CKGR and Khutse GRs were lumped together in 1994
Source: Research Division, Department of Wildlife and National Parks

Table 7.10b Densities of Selected wildlife species in Central Kgalagadi Game Reserve (Animals/km^2)

Species	1996	1999	2001	2002	2003	2004	2005
Duiker	0	0.01	0.013	0.013	0.011	0.010	0.011
Eland	-	-	0.099	0.135	0.121	0.159	0.037
Gemsbok	1	1	0.682	0.665	0.565	0.584	0.561
Giraffe	0.02	0	0.027	0.024	0.013	0.022	0.023
Hartbeest	-	0.10	0.11	0.110	0.069	0.109	0.046
Kudu	0.119	0.10	0.04	0.088	0.056	0.110	0.037
Ostrich	0.067	0.088	0.114	0.095	0.073	0.086	0.082
Springbok	0.092	0.09	0.1	0.053	0.077	0.074	0.168
Steenbok	0.122	0.08	0.105	0.102	0.056	0.069	0.057
Warthog	0.005	-	0.007	0.019	-	0.002	0.002
Wildebeest	0.073	0.023	-	0.016	0.019	0.029	0.009

-: Less than 0.001 up to zero.
Calculated by CSO from Table 7.10 (a)

Table 7.11a Estimated Population of Selected Wildlife Species in Gemsbok and Kgalagadi Transfronteir NP

Species	*1994	*1996	*1999	*2001	*2002	#2004	#2005
Duiker	765	491	715	248	891	86	410
Eland	1,362	8,877	3,980	3,230	4,364	4,133	25,237
Gemsbok	35,397	43,684	28,777	40,818	32,656	30,262	47,307
Hartebeest	13,026	6,589	7,283	9,602	17,882	7,861	13,676
Kudu	96	-	204	177	715	345	594
Ostrich	3,466	3,176	3,029	1,807	5,784	2,889	5,015
Springbok	15,584	2,326	4,234	, 602	2,459	401	1,045
Steenbok	3,466	3,210	2,173	5,634	4,697	4,242	5,226
Wathog	-	-	57	-	315	-	67
Wildbeast	4,446	554	3,011	177	1,814	2,523	4,385

**** Estimated population is for Gemsbok and Mabuasehube NPs***
 # Estimates are for Kgalagadi Transfrontier Park
-: Less than 0.001 up to zero
Research Division Aerial Survey Reports, Department of Wildlife and National Parks

Table 7.11b Densities of Selected wildlife species in Gemsbok NP (Animals/km2)

Species	*1996	*1999	*2001	*2002	#2004	#2005
Duiker	0.019	0.030	0.008	0.034	-	-
Eland	0.347	0.169	0.104	0.165	0.1	0.9
Gemsbok	1.707	1.223	-	1.233	1.1	1.7
Hartebeest	0.257	0.310	1.301	0.675	0.3	0.5
Jackal	-	-	0.306	-	-	-
Kudu	-	0.009	0.006	0.027	0.1	0.2
Ostrich	0.124	0.129	0.058	0.218	-	-
Springbok	0.091	0.180	0.019	0.093	0.2	0.2
Steenbok	0.125	0.092	0.180	0.177-		0.0
Warthog	-	0.002	-	0.012	0.1	0.2
Wildbeast	0.022	0.128	0.006	0.068	-	-

-: Less than 0.001 up to zero
****: Densities for Gemsbok and Mabuasehube Parks***
#: densities for Kgalagadi Transfronteir Park
Calculated by CSO from Table 7.11 (a)

Table 7.12a Combined Population Estimates for Nxai Pan NP and Makgadikgadi Pan GR

Species	1993	1994	1996	1999	2001	2002	2003	2004	2006
Duiker	15	53	-	33	-	28	-	68	-
Elephant	-	-	-	99	403	337	453	810	1,384
Gemsbok	1,053	925	979	594	1,482	1,941	1,717	2,326	1,963
Giraffe	214	390	475	200	206	524	327	867	129
Hartebeest	-	126	-	131	-	295	95	34	64
Impala	-	-	-	-	296	-	-	-	-
Kudu	-	1,510	739	394	592	365	514	1,029	418
Ostrich	1,237	768	1,181	854	1,122	2,926	1,165	530	1,062
Springbok	5,420	733	3,083	1,205	4,668	14	825	586	3,015
Steenbok	244	-	-	788	477	202	352	199	-
Wildbeast	-	1,721	2,016	17,113	3,155	3,625	4,609	1,371	6,242
Zebra	-	18,119	9,541	28,019	15,640	9,976	11,415	20,257	19,345

-: Zero

Source: Research Division, Department of Wildlife and National Parks.

Table 7.12b Combined Population Densities for Nxai PanNP and Makgadikgadi Pan GR(Animals/km^2)

Species	1993	1994	1996	1999	2001	2002	2003	2004	2006
Duiker	-	-	-	-	-	-	-	0.009	-
Elephant	-	-	-	-	0.1	-	0.1	0.105	0.279
Gemsbok	0.1	0.1	0.1	0.1	0.2	0.3	0.2	0.300	0.396
Giraffe	-	0.1	0.1	-	-	0.1	-	0.112	0.026
Hartebeest	-	0.0	-	-	-	-	-	0.004	0.013
Impala	-	-	-	-	-	-	-	-	-
Kudu	-	0.2	0.1	0.1	0.1	-	0.1	0.133	0.084
Ostrich	0.2	0.1	0.2	0.1	0.2	0.4	0.2	0.068	0.071
Springbok	0.7	0.1	0.4	0.2	0.6	-	0.1	0.076	1.355
Steenbok	-	-	-	0.1	0.1	-	-	0.026	-
Wildbeast	-	0.2	0.3	2.3	0.4	0.5	0.6	0.177	1.261
Zebra	-	2.4	1.3	3.8	2.1	1.3	1.5	2.615	3.301

-: Less than 0.001 up to zero
Calculated by CSO from Table 7.12 (a)

Table 7.13a Estimated Population of Selected Wildlife Species in Khutse Game Reserve

Species	1996	1999	2001	2002	2003	2004	2005
Baboon	-	-	144	-	-	-	-
Duiker	79	27	-	-	-	51	27
Eland	686	107	4,615	2,908	943	51	137
Gemsbok	1,425	2,331	2,596	2,022	1,232	642	657
Giraffe	53	-	317	-	-	154	219
Hartebeest	-	-	202	138	131	745	82
Kudu	132	54	-	138	288	-	27
Ostrich	238	241	404	111	157	205	110
Springbok	-	-	-	-	314	103	192
Steenbok	317	161	865	166	367	51	110
Wildbeast	53	-	87	194	-	128	-

-: Less than 0.001 up to zero

Source: Research Division, Department of Wildlife and National Parks

Table 7.13b Densities of Selected wildlife species in Khutse Game Reserve (Animals/km^2)

Species	1996	1999	2001	2002	2003	2004	2005
Duiker	0.029	0.010	-	-	0.03	-	0.01
Eland	0.252	0.039	1.740	1.096	0.356	0.019	0.05
Gemsbok	0.524	0.857	0.978	0.762	0.464	0.242	0.26
Giraffe	0.019	-	0.120	-	-	0.058	0.09
Hartebeest	-	-	0.076	0.052	0.049	0.281	0.03
Kudu	0.049	0.020	-	0.052	0.109	-	0.01
Ostrich	0.087	0.089	0.152	0.042	0.059	0.077	0.04
Springbok	-	-	-	-	-	0.039	0.08
Steenbok	0.117	0.059	0.326	0.063	0.138	0.019	0.04
Wildbeast	0.019	-	0.033	0.073	-	0.048	0.00

Calculated by CSO from Table 7.13 (a)

8.0 FORESTRY

8.1 Introduction

Forest is used in this chapter to refer to all forms of wood resources. Forests are a source of life on earth because they produce food, medicinal plants, construction material and energy. They are also habitats for animals, and are a regulator for carbon. In addition, they possess intangible value of aesthetes as such they are used for recreational and cultural purposes. It would therefore be ideal to have up to date information on forest and its value.

In addition to these uses, the clearing of land for arable agriculture places a pressure on the forests which leads to depletion and degradation. The situation is exacerbated by adverse climatic conditions and bush fires. The increase in the number of wild and domestic animals also compounds the problem. This depletion was identified as one of the major environmental problems in the country by the National Conservation Strategy of 1980.

The deforestation in Botswana is largely due to harvesting of construction and fencing material, clearing land for arable agriculture and to some extent, collection of fuel wood. However, fuel wood has been traditionally collected as dead wood unlike construction poles which target live trees, Thus fuel wood collection is not seen as a key factor in deforestation. But where the wood is being collected for commercial purposes then there is room for depletion. The clearing of land for arable agriculture was pronounced during the Accelerated Rainfed Arable Agriculture Programme (ARAP) which paid farmers for destumping their fields regardless of whether they would plough and plant. This led to about 74000ha of wood resources being cleared (Department of Crop Production and Forestry, 2003).

8.2 Desertification

Botswana is a drought prone country due to the low precipitation and high temperatures experienced. As a result, the country signed and ratified the UN Convention to Combat Desertification (UNCCD) in 1995 and 1996 respectively in order to combat desertification and mitigate effects of drought. The Convention focuses on improved productivity of land, the rehabilitation, conservation and sustainable management of land resources. In this context, desertification is defined as a process of "land degradation in arid, semi-arid and dry sub-humid areas resulting from various factors, including climatic variations and human activities" (Department of Environmental Affairs, 2006). This process has implications on community livelihoods as it affects their economic base.

It has been reported elsewhere that given Botswana's arid to semi-arid conditions, the vegetation has limited capacity to provide fuel wood; the country is characterized by sand veld vegetation. But according to the Botswana National Action Programme to Combat Desertification of 2006, Botswana is still considered a net carbon sink because the vast majority of the population is using fuelwood as a source of energy although the trend is shifting more and more towards use of electricity as shown on Table 8.1. Carbon dioxide emitted from burning of fuel wood is not significant as long as the standing trees are not over-exploited.

Table 8.1 Percentage of households by principal source of energy for cooking in Botswana (1981, 1991 & 2001)

Source of Energy	1981	1991	2001
Electricity	1.8	2.7	4.86
Gas	5.4	21.6	40.59
Paraffin	6.4	10.7	7.53
Wood	85.8	64.3	45.68
Coal	0.4	0.1	0.12
Solar Power	-	-	0.19
Bio Gas	-	-	0.57
Cow dung	-	-	0.11
Crop waste	-	-	0.08
Charcoal	-	-	0.04
Others	0.2	0.3	0.11
Not Stated	-	0.2	0.12
Total	**100**	**100.0**	**100**

Source: Census Analytical Reports, Central Statistics Office

In order to control use of forests and its products, the Government of Botswana through the Department of Forestry and Range Resources is reviewing the 1968 Forestry Act to cater even for emerging issues.

8.3 Wildland Fires (veld fires)

One of the phenomena that affect forests is the incidence of veld fire. In some cases, the fire is caused by natural factors such as lightning while at other times it is human induced. Large tracts of rangeland are burned each year depleting the land of its cover. This aides soil erosion as the land is left bare. It also deprives some living organisms of their habitat thus being a threat to biodiversity.

Figure 8.1 shows that the number of fires was highest in Ngamiland and Chobe Districts in 1993/94. This is due to high fuel loads because elephants break down trees. Also, in these areas fire is used as a rangeland management tool, hence there are usually more fires. These were followed by Central District. It is shown that even though the number of fires in Kweneng was fewer than in Central the hectarage covered was much higher in Kweneng than in Central as shown on Table 8.2. This is because there is also increased human activity in Kweneng District such as hunting. Most fires start in or outside Khutse Game Reserve and spreads into the CKGR.

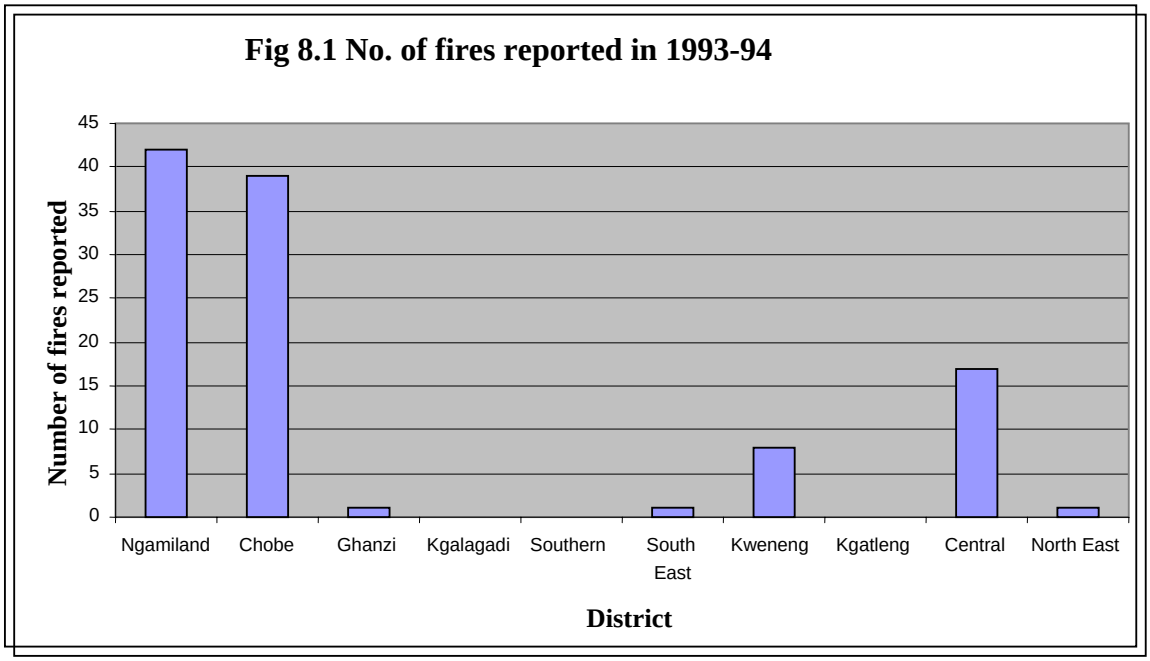


Fig 8.1 No. of fires reported in 1993-94
Number of fires reported
45
40
35
30
25
20
15
10
5
0
Ngamiland
Chobe
Ghanzi
Kgalagadi
Southern
South East
Kweneng
Kgatleng
Central
North East
District

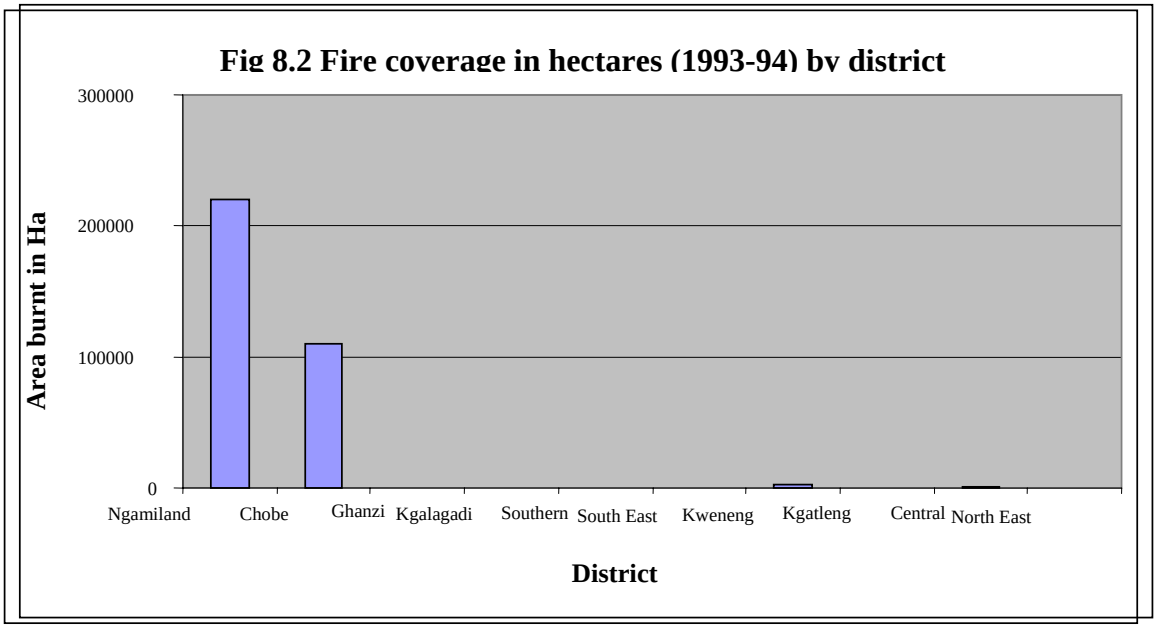


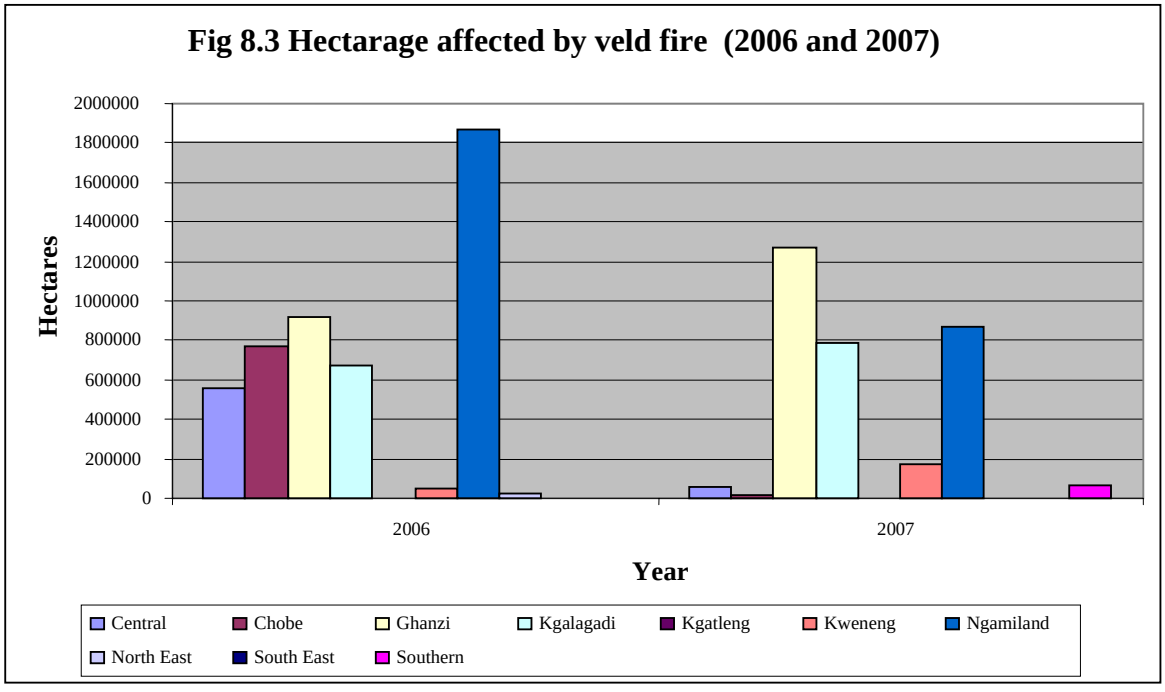
Fig 8.2 Fire coverage in hectares (1993-94) by district
Area burnt in Ha
300000
200000
100000
0
Ngamiland
Chobe
Ghanzi
Kgalagadi
Southern
South East
Kweneng
Kgatleng
Central
North East
District

Table 8.2 Bush Fire Outbreaks (1993-94)

District	No. of fires reported	Coverage in hectares
Ngamiland	42	219,877
Chobe	39	109,937
Ghanzi	1	0
Kgalagadi	0	0
Southern	0	0
South East	1	0
Kweneng	8	2,183.1
Kgatleng	0	0
Central	17	481.97
North East	1	3
Total	**109**	**332,482.07**

Department of Forestry and Range Resources

Figure 8.3 shows that Ngamiland had the largest area affected by fire in 2006. In 2007, the district most affected was Ghanzi District. Figure 8.4 shows that in the same year, the largest hectarage was burned in March; no fire was recorded in April.



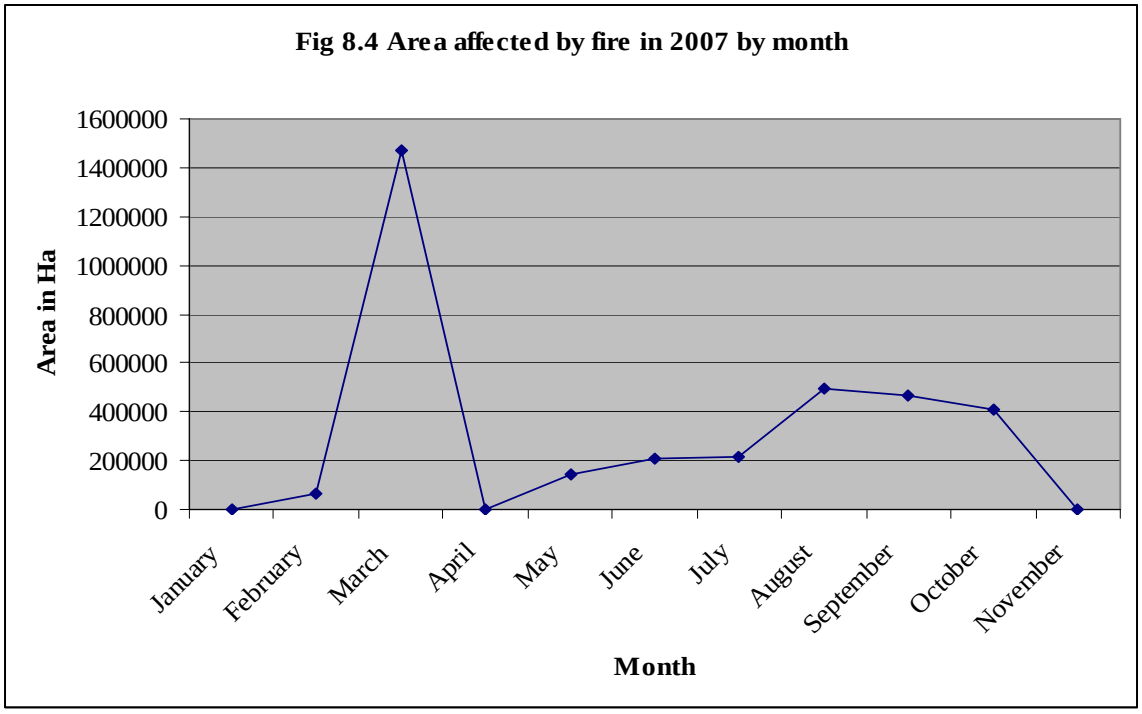


Table 8.3 Hectares affected by fire in 2006 & 2007 by district

District	2006	2007
Central	558,600	55,720
Chobe	771,400	20,220
Ghanzi	916,400	1,268,790
Kgalagadi	670,904	789,180
Kgatleng	2,620	0
Kweneng	49,055	172,365
Ngamiland	1,869,200	865,100
North East	28,155	1,140
South East	1,142	0
Southern	2,090	64,650

Department of Forestry and Range Resources

Table 8.4 Hectare affected by fire in 2007 by month

Month	Ha
January	2,020
February	64,000
March	1,472,120
April	0
May	142,840
June	204,530
July	213,110
August	497,965
September	464,800
October	410,730
November	1,905

8.4 Reforestation

In response to the growing concern of deforestation, in the early 1940's Botswana introduced community woodlots to address domestic energy needs by providing a source of fuel wood, and also providing construction material.

The initiative gained momentum in the 1970's and 1980's. Woodlots are simply defined as "a small scale plantation of less than 20 hectares established to provide fuel wood and poles" (DCPF, 2003).

Table 8.5 Total area (ha) of community woodlots (2000)

Region	Area Allocated	Area Utilised
Central	19.30	4.05
Gaborone	85.90	78.20
North West	16.25	7.05
Southern	46.10	12.05
Western	53.55	30.75
Total	**221.10**	**132.10**

Department of Forestry and Range Resources, 2007

However, the initiative has not borne any significant fruits as the communities have not been able to sustainably manage the woodlots. In addition, the woodlots were based on exotic tree species mainly *eucalyptus spp* a species which is unfriendly to our climate and soil conditions. It has also since emerged that eucalyptus are not the preferred species for fire wood (DCPR, 2003). It is noted further that when the wood lots were introduced, there was wide clearing of indigenous trees.

Government through the Department of Forestry and Range Resources (DFRR) has also established a number of plantations for the production of fuel wood and poles. The plantations are also planted with eucalyptus species.

Table 8.6 Government plantations (2003-2007)

Agricultural Region	No. of Plantations	Total Area (ha)	Average Size (ha)
Southern	5.0	73.0	14.6
Central	1.0	7.0	7.0
Gaborone	4.0	68.0	17.0
Maun	2.0	12.0	6.0
Francistown	4.0	116.0	29.0
Western	2.0	4.0	2.0
Total	**18.0**	**280.0**	**15.6**

Department of Forestry and Range Resources, 2007

8.5 Forest Management

Owing to the relatively high rainfall, forest exists mainly in Chobe District of northern Botswana. It is in this part of the country where six (6) Forest Reserves were established and gazetted in 1976. The total area for the Reserves was originally 419,800ha. Some parts of the Chobe, Kazuma and Kasane Reserves were later degazetted resulting in total area of 409,600 ha. This constitutes a reduction of about 2.4 percent of the total Forest Reserves area. Another chunk of the forest area is managed as a national park (Chobe National Park).

The following table shows the six forest reserves.

Table 8.7 Chobe Forest Reserves

Forest Reserve	Area in Ha (Original)	Area in Ha after Degazettment
Sibuyu	116,100	116,100
Maikaelelo	54,300	54,300
Kazuma	16,800	15,600
Kasane Extension	64,111	64,111
Chobe	148,500	148,500
Kasane Forest Reserve	13,989	10,989
Total Area	**419,800**	**409,600**

Chobe Forests Inventory and Management Plan, Norwegian Forestry Society, 1992

A Forest Management Plan commissioned by the Department of Forestry and Range Resources was drawn up in 1992 for sustainable management of the Forest Reserves. The objective of the plan was to improve socio economic conditions in Chobe District through optimal multiple use sustained yield management of the Reserves and participation of local communities" (Norwegian Forestry Society, 1992). The Plan has eight (8) management objectives as follows:

- Development of the surrounding communities
- Sustainable production of forest products
- Conservation of the resource base
- Environment and cultural education
- Ecotourism/recreation
- Grazing/range management
- Wildlife utilization
- Research and monitoring

These eight objectives outline the current uses of the forest reserves.

8.6 Endangered species

The flora of Botswana is largely uniform due to the homogeneity of the landscape and climate. Climate only somewhat differs from the north to the south giving rise to a certain level of endemism in the south. According to the Southern African Programme Red Data List of (SAPRDL) 2002, livestock grazing is the main threat to plants because most of the rangelands are used for communal grazing. Where they occur, elephants also cause damage to forests.

SAPRDL states that out of the 2,151 identified plant species, 43 are on the Red Data List and 15 are endemic.
Invasive species are a potential threat to plants but are not yet a major problem in the country. However, they affect yield in pastureland. For example *Prosopis glandulosa* as shown on Table 8.5 is found along the dry beds of Molopo and Matsheng villages in the Kgalagadi District Bush cover is usually undesirable because invasive species often negatively impact on the original vegetation, reducing their potential to produce as they tend to deplete the

nutritional value of the soils, hence they out compete indigenous plants. They usually survive with the little moisture available in the soil.

Table 8.8 Estimated Coverage in Areas Affected by Invasive Species (Prosopis)

District	Location	Area (ha)
Central	Mmadikola	5
Ghanzi	Gantsi Township	1,095
Kgalagadi	Kgalagadi/Bokspits Road	945
	Bokspits/Vaalhoek	1,100
	Gakhibana	273
	Khuis	220
	Rappelspan	75
	Struizendam	320
	Welwerdiend	13
	Werda	200
Total		**4,246**

8.7 Veld Products

Veld products here include wood, grass, Grapple Plant (Sengaparile), *phane* and other wild fruits. Scanty information exists on the exploitation rate of these products. Table 8.9 shows amount of grapple Plant sold in 1993/94 and amount harvested in 2006/07.

A lot more was sold from Southern District in 1993/94 while more was harvested from Kgalagadi in 2006/07. At national level, a lot more was harvested in 2006/07 as compared to the amount sold in 1993/94.

Table 8.9 Harvest for Grapple Plant

Region	1993-94 Weight sold in KG	2006-07 Total Harvest (Kg)
Ghanzi	66.0	1,312
Kweneng	7,164.2	..
Kgalagadi	1,135.5	18,200
Southern	2,805.25	12,297
Total	**11,170.95**	**31,809**

.. means no harvest recorded
Department of Forestry and Range Resources

9.0 Energy Inventory

9.1 Introduction

Both traditional and conventional energy sources are used in Botswana. The most prevalent traditional energy source is fuel wood while prevalent conventional energy sources are many and vary from sector to sector with the main ones being gas (LPG) and paraffin for households, diesel for Agriculture, coal for Industry and petrol for Transport and Government sectors (see Table 9.19).

Botswana Power Corporation (BPC) is a parastatal whose mandate is to generate and supply electricity to the public. Up to the year 1995, electricity generation by BPC contributed more than 50 percent to the Net Electricity Supply in the country after which the BPC contribution started declining up to 32 percent in 2004. Two other sources of electricity supply are imports and local generation from diesel and coal. Electricity generation from diesel is mainly used by the Department of Building and Engineering Services, while that from coal is by the Botswana Ash (BOTASH) for own use.

9.2 Available Energy Carriers

9.2.1 Fuel wood

Fuel wood is mainly used for food preparation and is still an indispensable fuel for many households. In 1991, 46 percent of households nationally used wood as principal energy source for cooking; of which 77 percent of households were located in rural areas (see Table 9.1). When compared to statistics of the previous population census years, its dominance has been on the decline nationally as shown on Figure 9.1.

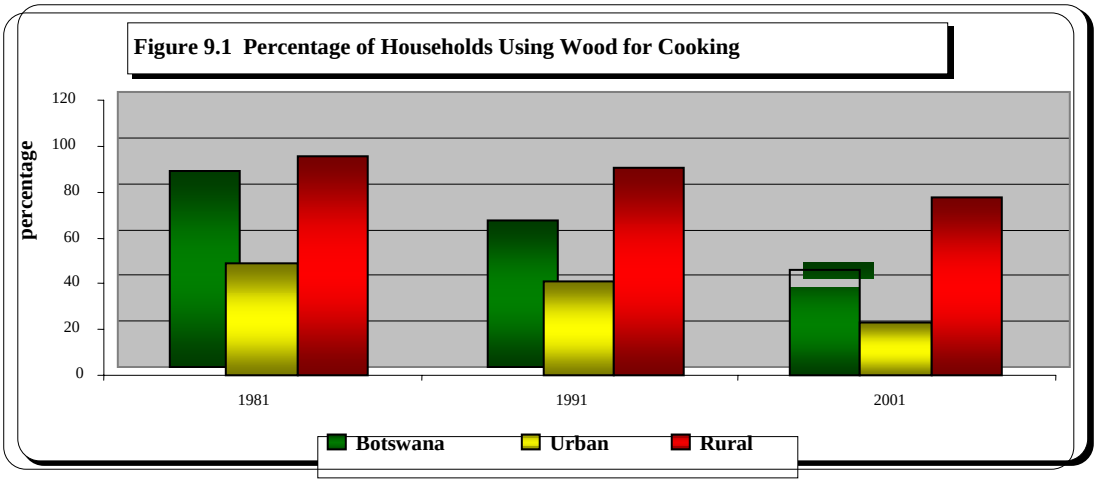


Table 9.1: Proportion of all Households in Towns, Urban Villages and Rural by Principal Energy Source for Cooking (2001)

Principal Source of Energy Used for Cooking	Urban Areas	Rural Areas											Total Botswana
		Villages with a Population of					Locality Type					Total Rural	
		< 500	500-999	1000-4999	5000+	Villages Sub-Total	Lands	Cattle Posts	Farms	Others	Localities Sub-Total		
Households	234,757	8,487	19,299	76,413	1,200	105.399	30,304	18,270	4,550	11,426	64,550	169,949	404,706
Electricity	7.60	0.11	0.17	1.09	4.92	0.88	0.59	0.00	7.63	3.26	1.39	1.08	4.86
Solar Power	0.28	0.02	0.08	0.08	0.08	0.08	0.06	0.05	0.24	0.11	0.08	0.08	0.19
Gas (LPG)	57.65	13.47	13.87	23.63	53.08	21.36	8.54	1.27	15.63	25.15	9.92	17.01	40.59
Bio Gas	0.66	0.35	0.32	0.57	0.33	0.50	0.30	0.36	0.51	0.34	0.34	0.44	0.57
Wood	22.81	83.07	82.35	69.72	31.17	72.67	86.98	96.97	71.41	64.90	84.80	77.28	45.68
Parrafin	10.47	1.98	2.37	4.26	9.67	3.79	3.12	0.83	3.67	5.50	2.93	3.47	7.53
Cow-Dung	0.02	0.75	0.47	0.26	0.08	0.33	0.06	0.06	0.07	0.03	0.06	0.23	0.11
Coal	0.12	0.07	0.17	0.12	0.17	0.13	0.10	0.07	0.15	0.06	0.09	0.11	0.12
Crop Waste	0.10	0.04	0.06	0.06	-	0.05	0.05	0.08	0.11	0.05	0.06	0.06	0.08
Charcoal	0.02	0.00	0.01	0.02	0.42	0.02	0.04	0.14	0.35	0.28	0.13	0.06	0.04
Other	0.12	0.05	0.07	0.10	0.08	0.09	0.07	0.10	0.22	0.10	0.09	0.09	0.11
Not Stated	0.14	0.09	0.07	0.10	-	0.09	0.11	0.07	0.02	0.23	0.11	0.10	0.12
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Source: National Population and Housing Census 2001, Central Statistics Office

Table 9.2: Proportion of all Households in Urban* and Rural Areas by Principal Energy Source for Lighting (2001)

Principal Source of Energy for Lighting	*Urban Areas	Rural Areas											Total Botswana
		Villages with a Population of					Locality Type					Total Rural	
		< 500	500-999	1000-4999	5000+	Villages Sub-Total	Lands	Cattle Posts	Farms	Others	Localities Sub-Total		
Total Number of Households in the Area	234,757	8,487	19,299	76,413	1,200	105,399	30,304	18,270	4,550	11,426	64,550	169,949	404,706
Electricity	36.97	1.41	2.41	10.70	32.50	8.69	3.25	0.02	23.01	22.28	7.10	8.08	24.84
Solar Power	0.11	0.66	0.64	0.42	0.17	0.48	0.13	0.23	0.64	0.62	0.28	0.40	0.23
Gas (LPG)	0.69	0.20	0.33	0.42	0.58	0.38	0.30	0.19	0.29	0.46	0.30	0.35	0.55
Bio Gas	0.05	0.02	0.07	0.06	-	0.06	0.06	0.03	0.02	0.04	0.04	0.05	0.05
Wood	0.57	14.39	9.53	3.30	0.25	5.30	19.10	38.69	12.95	19.04	24.20	12.48	5.57
Paraffin	49.22	55.19	59.81	66.29	39.25	63.90	62.09	45.04	31.10	41.59	51.45	59.17	53.40
Candle	6.98	18.18	17.99	10.72	15.33	12.70	7.23	5.74	19.52	8.80	7.95	10.90	8.62
Paraffin/Candle	5.19	9.05	8.81	7.72	11.58	8.07	6.49	3.83	6.48	5.33	5.53	7.11	6.00
Other	0.14	0.60	0.25	0.27	0.33	0.29	1.11	5.91	5.91	1.65	2.90	1.28	0.62
Not stated	0.09	0.29	0.16	0.11	-	0.13	0.23	0.33	0.09	0.19	0.24	0.17	0.13
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

In Botswana, all settlements that have a population of more than 5000 people and at least 75% of their economically active population engaged in non-agricultural economic activities are referred to as "urban" settlements. Consequently, all towns and cities are urban settlements and some districts have both urban and rural settlements/villages, while others are strictly rural

Source: National Population and Housing Census 2001, Central Statistics Office

Table 9.2 shows that paraffin was the principal source of energy for lighting nationally at 53.4 percent, followed by electricity at 24.8 percent. Paraffin still dominates in urban areas at 49.2 percent followed by electricity at 37 percent. At rural level, paraffin still dominates at 59.2 percent; other sources of energy were wood at 12.5 percent and candle at 10.9 percent.

The 1981, 1991 and 2001 Population and Housing Censuses results indicate an increase in electricity uptake with the proportion of households that use electricity for lighting rising from 5.4 percent in 1981 to 24.8 percent in 2001 at national level (see Table 9.3 below). This may be a result of the introduction of significant rural electrification programs by Government. The proportion of households with gas as principal source of energy for cooking also increased from 5.4 percent in 1981 to 40.6 percent in 2001 nationally; while that for wood declined from 85.8 percent in 1981 to 45.7 percent in 2001 at national level as shown on Table 9.4

Table 9. 3: Percentage Distribution of Households by Principal Source of Energy Source Used for Lighting in 1981, 1991 and 2001

	1981			1991			2001		
Energy Source	**Total**	**Urban**	**Rural**	**Total**	**Urban**	**Rural**	**Total**	**Urban**	**Rural**
Number of Households	135,966	34,966	70,262	276,209	145,106	131,103	404,706	234,757	169,949
Percentage of Households	100.0	20.5	79.5	100.0	52.5	47.5	100.0	58.0	42.0
Electricity	5.4	21.7	1.2	10.1	17.5	2.0	24.8	37.0	8.1
Solar	-	-	-	-	-	-	0.2	0.1	0.4
Gas (LPG)	0.6	1.4	0.4	0.8	1.2	0.3	0.5	0.7	0.4
Biogas	-	-	-	-	-	-	0.1	0.1	0.1
Wood	24.5	1.4	30.5	11.4	0.8	23.1	5.6	0.6	12.5
Paraffin	53.8	34.5	58.8	64.5	65.7	63.1	53.4	49.2	59.2
Candle	14.8	40.5	8.1	11.8	14.1	9.3	8.6	7.0	10.9
Paraffin/Candle	-	-	-	-	-	-	6.0	5.2	7.1
Other	0.8	0.5	0.9	1.4	0.7	2.1	0.6	0.1	1.3
Not Stated	-	-	-	-	-	-	0.1	0.1	0.2

Table 9.4: Percentage Distribution of Households by Principal Source of Energy Source Used for Cooking in 1981, 1991 and 2001

		1981			1991			2001	
	Total	**Urban**	**Rural**	**Total**	**Urban**	**Rural**	**Total**	**Urban**	**Rural**
Number of Households	135,966	34,966	7,262	276,209	145,106	131,103	404,706	234,757	169,949
Percentage of Households	100.00	20.50	79.50	100.00	52.50	47.50	100.00	58.01	41.99
Electricity	1.80	7.70	0.20	2.70	4.80	0.30	4.86	7.60	1.08
Solar	-	-	-	-	-	-	0.19	0.28	0.08
Gas (LPG)	5.40	18.90	1.90	21.60	35.60	6.30	40.59	57.65	17.01
Bio-gas	-	-	-	-	-	-	0.57	0.66	0.44
Wood/charcoal	85.80	48.80	95.40	64.30	40.60	90.60	45.72	22.83	77.34
Paraffin	6.40	23.30	2.00	10.70	18.20	2.50	7.53	10.47	3.47
Cow dung	-	-	-	-	-	-	0.11	0.02	0.23
Coal	0.30	1.10	0.10	0.10	0.10	0.50	0.12	0.12	0.11
Crop Waste	-	-	-	-	-	-	0.08	0.10	0.06
Other	0.20	0.10	0.20	0.50	0.60	-	0.11	0.12	0.09
Not Stated	-	-	-	-	-	-	0.12	0.14	0.10

Source: National Population and Housing Census 2001, Central Statistics Office

9.2.2 Coal Resources

Botswana has over 212,383 million tonnes of coal resources out of which 48,576 million tonnes are classified as measured, indicated or inferred reserves and the rest are either hypothetical or speculative resources (see Table 9.5). Local annual coal production is still under a million tonnes. More than half of the locally produced coal (60 percent in both 2004 and 2005) is used to fire the Botswana Power Corporation (BPC's) public thermal plant (see Table 9.1).

Table 9.5 Estimated Botswana Coal Inventory (Million Tonnes) before Coal Mining Started in 1973[18].

Coalfield	Reserves				Resources			Total Coal Inventory
	Measured	Indicated	Inferred	Sub Total	Hypothetical	Speculative	Sub Total	
Morupule	2,846	2,706	4,272	9,824	4,851	3,397	8,248	18,072
Moijabana	-	-	2,406	2,406	-	648	648	3,054
Mmamabula	494	20,215	2,504	23,213	-	-	-	23,213
Letlhakeng	-	-	7,213	7,213	23,340	39,800	63,140	70,353
Ncojane	-	-	-	-	2,025	2,700	4,725	4,725
Dukwi	-	32	1,572	1,604	-	-	-	1,604
Mmamantswe	-	-	598	598	-	2,300	2,300	2,898
Serule	-	307	1,341	1,648	1,766	6,270	8,036	9,684
Dutlwe	-	-	2,070	2,070	60,875	8,795	69,670	71,740
Foley	-	-	-	-	6,860	-	6,860	6,860
Bobonong	-	-	-	-	-	179	179	179
Total	3,340	23,260	21,976	48,576	99,717	64,089	163,806	212,382

The terms "reserves" and "resources" have been applied to conform to definitions proposed by the United Nations Solid Fuels Framework

Measured reserves - delineated by closely spaced observation points (such as drill holes); judged accurate to +/- 20 percent; spacing should generally not exceed 0.8 km.
indicated reserves - delineated by observation points which are 0.8 to 2.4 km apart.
inferred reserves - few observation points, spacing generally ranging from 2.4 to 9.6 km; but estimates may vary depending on complexity of geological formations.
hypothetical resources - essentially undiscovered but occurring in same geological environment as the areas explored in detail.
speculative resources - undiscovered, but may, by geological inference, be projected over unexplored ground with a reasonable degree of confidence.
- Zero or less than 1 unit
Source: Department of Geological Survey

[18] Data that was released in the Environment Statistics Publication (2000) has been revised.

9.2.3. Electricity Production and Utilization by Botswana Power Corporation

The observation from Table 9.6 below shows that the total electricity production was 991,137 MWh in 2004 and went up to 1,082,036 MWh in 2005.

The percentage contribution of electricity production from Botswana Power Cooperation (BPC) power plant to total electricity supply has followed a downward trend since 1993 at 81.1 percent and stood at 32 percent in 2004 (see Table 9.7). In the same year (2004), imported electricity contributed 64.6 percent from 12.9 percent in 1993 and private generation from BOTASH contributed only 3.4 percent total electricity supply in the country in 2004.

Table 9.6 Total Electricity Generation (2004 and 2005)

Month	BPC* (Public Producer)		BOTASH* (Self Producer)		2005 Percentage Contribution to Electricity Generated		Total Electricity Production	
	Electricity Generated MWh, 2004	Electricity Generated MWh, 2005	Electricity Generated MWh, 2004	Electricity Generated MWh, 2005	BPC	BOTASH	Electricity Generated MWh, 2004	Electricity Generated MWh, 2005
January	71,340	91,722	6,886	8,102	91.88	8.12	78,226	99,824
February	67,255	71,621	9,299	7,373	90.67	9.33	76,554	78,994
March	50,617	76,487	8,294	9,440	89.01	10.99	58,911	85,927
April	61,646	89,451	5,754	2,742	97.03	2.97	67,400	92,193
May	73,205	73,076	9,363	10,106	87.85	12.15	82,568	83,182
June	69,832	91,891	9,722	9,350	90.76	9.24	79,554	101,241
July	77,706	92,976	9,802	9,680	90.57	9.43	87,508	102,656
August	78,061	73,815	9,126	9,814	88.26	11.74	87,187	83,629
September	88,559	82,481	7,344	8,976	90.19	9.81	95,903	91,457
October	83,819	88,613	8,605	10,042	89.82	10.18	92,424	98,655
November	87,420	67,609	8,362	9,228	87.99	12.01	95,782	76,837
December	81,587	78,206	7,533	9,235	89.44	10.56	89,120	87,441
Total	891,047	977,948	100,090	104,088	90.38	9.62	991,137	1,082,036

Source: Energy Affairs Department, Ministry of Minerals, Energy and Water Resources

Table 9.7 Net Electricity Supply (Percentages), 1979 – 2004

Year	Net Electricity Supply (Percentages)*						Total Public and Private
	Public Supply			Private Generation			
	BPC[1]	Imports	Sub Total	BMC[2]	Botash[3]	Sub Total	
1979	84.1	..	84.1	15.9	..	15.9	100
1980	81.7	..	81.7	18.3	..	18.3	100
1981	78.6	1.8	80.4	19.6	..	19.6	100
1982	70.6	13.6	84.1	15.9	..	15.9	100
1983	63.4	25.7	89.1	10.9	..	10.9	100
1984	62.4	28.1	90.5	9.5	..	9.5	100
1985	64.5	31.4	95.8	3.1	1.1	4.2	100
1986	68.8	28.7	97.4	1.2	1.4	2.6	100
1987	91.1	7.4	98.4	0.8	0.8	1.6	100
1988	92.9	6.4	99.3	0.7	..	0.7	100
1989	93.1	6.6	99.7	0.3	..	0.3	100
1990	91.5	8.5	100.0	..	..	..	100
1991	79.6	17.3	96.9	-	3.1	3.1	100
1992	83.4	11.0	94.3	-	5.7	5.7	100
1993	81.1	12.9	93.9	-	6.1	6.1	100
1994	71.6	21.2	92.8	-	7.2	7.2	100
1995	68.6	24.3	93.0	-	7.0	7.0	100
1996	46.6	47.7	94.3	-	5.7	5.7	100
1997	43.0	51.6	94.6	-	5.4	5.4	100
1998	53.1	41.3	94.4	-	5.6	5.6	100
1999	49.4	46.6	96.0	-	4.0	4.0	100
2000	46.3	50.2	96.5	-	3.5	3.5	100
2001	43.7	52.0	95.7	-	4.3	4.3	100
2002	35.2	60.5	95.7	-	4.3	4.3	100
2003	29.0	67.5	96.6	-	3.4	3.4	100
2004	32.0	64.6	96.6	-	3.4	3.4	100

- Zero or less than 0.1

** This excludes unavailable data on generation from diesel engines for the following purposes:*

(i) Private Generation for businesses or domestic that is not reported and

(ii) Public Generation in educational, health and other Government institutions/offices that are in locations around the country that are not connected to the National Grid.

1: Generation by Botswana Power Corporation for public use

2: Generation by the Botswana Meat Commission for own use

3: Generation by Botswana Ash (Pty) for own use

Source: Energy Affairs Department , Ministry of Minerals, Energy and Water Resources

Table 9.8 Local Primary Energy Production and Imports, 1981-2003 (Original Units)

Year	Primary Production				Imports									
	Coal	Wood	Solar	Other RE	Coal	LPG	AvGas	Jet A	Petrol	Paraffin	Diesel	Fuel Oil	Lubes	Electricity
	kt	kt	TJ	TJ	kt	t	kl	kl	Kl	kl	kl	kl	kl	GWh
1981	381	966	2	0	22	2,100	1,730	1,750	52,194	3,173	93,196	3,022	3,628	10
1982	415	999	5	0	20	1,780	1,652	2,000	59,427	3,894	102,329	1,230	4,080	82
1983	395	1,033	9	0	30	2,040	1,569	1,898	64,342	3,844	98,956	610	3,971	160
1984	393	1,068	12	0	27	2,270	1,792	2,275	74,153	4,315	95,956	455	3,770	186
1985	437	1,105	16	0	29	3,030	1,909	2,896	85,521	4,460	87,815	320	3,688	223
1986	490	1,143	16	0	32	3,880	2,200	3,272	96,984	6,631	110,918	466	4,210	240
1987	487	1,113	19	0	45	4,950	2,560	3,808	115,379	7,484	108,365	470	4,670	72
1988	609	1,289	20	0	29	5,980	2,500	9,200	124,830	9,125	116,070	3,500	5,000	55
1989	663	1,323	18	1	36	6,969	2,852	8,852	144,715	11,011	135,000	3,600	5,808	60
1990	794	1,101	21	1	36	8,017	2,521	14,260	169,769	12,059	160,001	3,600	6,357	84
1991	..	..	..	..	..	..	..	..	..	..	..	..	..	196
1992	903	1,265	34	1	36	7,606	3,094	9,693	223,103	13,423	187,467	62,223	6,583	138
1993	890	1,313	34	1	10	5,260	1,723	5,398	239,258	10,378	172,315	56,333	7,238	166
1994	900	1,339	35	1	13	13,734	2,000	5,781	237,638	19,973	157,253	2,737	5,975	293
1995	898	1,323	21	1	14	10,612	3,063	7,773	260,855	20,962	177,864	4,108	6,633	334
1996	763	1,315	21	1	14	12,032	3,087	6,730	266,192	23,046	182,221	4,335	8,634	691
1997	779	1,341	21	1	20	16,138	3,087	7,414	281,091	23,137	207,148	6,043	7,146	818
1998	928	1,420	21	1	93	12,611	2,593	8,518	305,468	35,797	231,130	3,663	9,169	744
1999	924	1,420	21	1	93	15,401	4,936	9,747	325,997	24,082	263,458	90,616	9,169	744
2000	948	1,420	21	1	93	16,138	3,087	7,414	343,587	24,484	294,568	6,043	7,146	809
2001	895	1,420	21	1	24	23,856	4,936	8,306	391,962	25,738	314,137	6,475	6,186	1,123
2002	955	1,391	21	1	25	25,048	5,182	8,721	411,560	27,025	329,843	6,798	6,495	1,179
2003	824	1,363	21	1	26	26,300	5,441	9,157	432,138	28,376	343,036	7,138	6,819	1,238

- Zero or less than 0.1

.. Data unavailable

Source: Energy Affairs Department, Ministry of Minerals, Energy and Water Affairs Energy Balances.

Table 9.9 Local Primary Energy Production and Imports, 1981-2003 (Terajoules)

Year	Primary Production					Imports											Grand Total
	Coal	Wood	Solar	Other RE	Sub-total	Coal	LPG	Av-Gas	Jet A	Petrol	Para-ffin	Diesel	Fuel Oil	Lubes	Elect-ricity	Sub total	
1981	9,137	15,456	2	-	24,595	538	95	57	61	1,702	111	3,355	116	132	36	6,204	30,799
1982	9,955	15,984	5	-	25,945	487	81	55	70	1,937	137	3,684	47	149	295	6,942	32,886
1983	9,482	16,528	9	-	26,019	715	93	52	66	2,098	135	3,562	23	145	576	7,465	33,485
1984	9,430	17,088	12	-	26,530	653	103	59	79	2,417	151	3,454	18	138	670	7,743	34,272
1985	10,490	17,680	16	-	28,186	696	138	63	101	2,788	157	3,161	12	135	803	8,053	36,240
1986	11,748	18,288	16	-	30,052	768	176	73	114	3,162	233	3,993	18	154	864	9,554	39,606
1987	11,688	17,808	19	-	29,515	1,080	225	85	133	3,761	263	3,901	18	170	259	9,895	39,410
1988	14,618	20,624	20	-	35,262	696	271	83	321	4,069	320	4,179	135	183	198	10,455	45,717
1989	15,913	21,168	18	1	37,100	864	316	94	309	4,718	386	4,860	139	212	216	12,115	49,215
1990	19,056	17,616	21	1	36,694	864	364	83	498	5,534	423	5,760	139	232	302	14,200	50,894
1991	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
1992	21,672	20,240	34	1	41,947	864	345	102	338	7,273	471	6,749	2,396	240	497	19,276	61,223
1993	21,360	21,008	34	1	42,403	240	239	57	188	7,800	364	6,203	2,169	264	598	18,122	60,525
1994	21,600	21,424	35	1	43,060	312	624	66	202	7,747	701	5,661	105	218	1,055	16,691	59,751
1995	21,552	21,168	21	1	42,742	336	482	101	271	8,504	736	6,403	158	242	1,202	18,436	61,178
1996	18,318	21,040	21	1	39,380	336	546	102	235	8,678	809	6,560	167	315	2,488	20,236	59,615
1997	18,696	21,456	21	1	40,174	490	733	102	259	9,164	812	7,457	233	261	2,945	22,454	62,628
1998	22,272	22,720	21	1	45,014	2,232	573	86	297	9,958	1,256	8,321	141	335	2,678	25,877	70,891
1999	22,176	22,720	21	1	44,918	2,232	699	163	340	10,628	845	9,484	3,489	335	2,678	30,894	75,812
2000	22,752	22,720	21	1	45,494	2,232	733	102	259	11,201	859	10,604	233	261	2,912	29,396	74,890
2001	21,480	22,720	21	1	44,222	564	1,083	163	290	12,778	903	11,309	249	226	4,043	31,608	75,830
2002	22,920	22,256	21	1	45,198	593	1,137	172	304	13,417	949	11,874	262	237	4,244	33,189	78,387
2003	19,776	21,808	21	1	41,606	629	1,194	180	320	14,088	996	12,349	275	249	4,457	34,736	76,342

- Zero or less than 0.1

.. Data unavailable

Source: Energy Affairs Division, Ministry of Minerals, Energy and Water Affairs Energy Balances.

Table 9.10 Local Primary Energy Production and Imports, 1981-2003 (Percentages)

Year	Local Production						Imports											Grand Total
	Coal	Wood	Electr-icity	Solar	Other RE	Sub-total	Coal	LPG	AvGas	Jet A	Petrol	Paraffin	Diesel	Fuel Oil	Lubes	Electr. icity	Sub-total	
1981	29.7	50.2	-	-	-	79.9	1.7	0.3	0.2	0.2	5.5	0.4	10.9	0.4	0.4	0.1	20.1	100.0
1982	30.3	48.6	-	-	-	78.9	1.6	0.2	0.2	0.2	5.9	0.4	11.2	0.1	0.5	0.9	21.1	100.0
1983	28.3	49.4	-	-	-	77.7	2.3	0.3	0.2	0.2	6.3	0.4	10.6	0.1	0.4	1.7	22.3	100.0
1984	27.5	49.9	-	-	-	77.4	2.1	0.3	0.2	0.2	7.1	0.4	10.1	0.1	0.4	2.0	22.6	100.0
1985	28.9	48.8	-	-	-	77.8	2.3	0.4	0.2	0.3	7.7	0.4	8.7	0.0	0.4	2.2	22.2	100.0
1986	29.7	46.2	-	-	-	75.9	2.5	0.4	0.2	0.3	8.0	0.6	10.1	0.0	0.4	2.2	24.1	100.0
1987	29.7	45.2	-	-	-	74.9	3.5	0.6	0.2	0.3	9.5	0.7	9.9	0.0	0.4	0.7	25.1	100.0
1988	32.0	45.1	-	-	-	77.1	2.3	0.6	0.2	0.7	8.9	0.7	9.1	0.3	0.4	0.4	22.9	100.0
1989	32.3	43.0	-	-	-	75.4	2.8	0.6	0.2	0.6	9.6	0.8	9.9	0.3	0.4	0.4	24.6	100.0
1990	37.4	34.6	-	-	-	72.1	2.8	0.7	0.2	1.0	10.9	0.8	11.3	0.3	0.5	0.6	27.9	100.0
1991	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
1992	35.4	33.1	-	-	-	68.5	2.8	0.6	0.2	0.6	11.9	0.8	11.0	3.9	0.4	0.8	31.5	100.0
1993	35.3	34.7	-	-	-	70.1	0.8	0.4	0.1	0.3	12.9	0.6	10.2	3.6	0.4	1.0	29.9	100.0
1994	36.2	35.9	-	-	-	72.1	1.0	1.0	0.1	0.3	13.0	1.2	9.5	0.2	0.4	1.8	27.9	100.0
1995	35.2	34.6	-	-	-	69.9	1.1	0.8	0.2	0.4	13.9	1.2	10.5	0.3	0.4	2.0	30.1	100.0
1996	30.7	35.3	-	-	-	66.1	1.1	0.9	0.2	0.4	14.6	1.4	11.0	0.3	0.5	4.2	33.9	100.0
1997	29.9	34.3	-	-	-	64.1	1.6	1.2	0.2	0.4	14.6	1.3	11.9	0.4	0.4	4.7	35.9	100.0
1998	31.4	32.0	-	-	-	63.5	3.1	0.8	0.1	0.4	14.0	1.8	11.7	0.2	0.5	3.8	36.5	100.0
1999	29.3	30.0	-	-	-	59.2	2.9	0.9	0.2	0.4	14.0	1.1	12.5	4.6	0.4	3.5	40.8	100.0
2000	30.4	30.3	-	-	-	60.7	3.0	1.0	0.1	0.3	15.0	1.1	14.2	0.3	0.3	3.9	39.3	100.0
2001	28.3	30.0	-	-	-	58.3	0.7	1.4	0.2	0.4	16.9	1.2	14.9	0.3	0.3	5.3	41.7	100.0
2002	29.2	28.4	-	-	-	57.7	0.8	1.5	0.2	0.4	17.1	1.2	15.1	0.3	0.3	5.4	42.3	100.0
2003	25.9	28.6	-	-	-	54.5	0.8	1.6	0.2	0.4	18.5	1.3	16.2	0.4	0.3	5.8	45.5	100.0

- Zero or less than 0.1

.. Data unavailable

Source: Energy Affairs Division, Ministry of Minerals, Energy and Water Affairs Energy Balances

9.2.4 Sectoral Energy Consumption

The main consumer of electricity is mining as shown by Table 9.11 and Figure 9.2. Electricity consumption by the mining industry has been on the increase from the financial year 2001/02 to 2005/06.

Table 9.11 Sectoral Consumption of Electricity Supplied by Botswana Power Corporation from 2001/02 to 2005/06

Electricity (GWh) Production and Imported by BPC	Financial Year				
Source	2005/06	2004/05*	2003/04	2002/03	2001/02
Morupule	977.10	941.70	823.10	935.60	1,044.30
Station Usage	110.80	108.80	96.30	105.90	116.00
Sent Out	866.30	832.90	726.80	829.70	928.30
Purchased	2,050.40	1,898.30	1,915.20	1,605.70	1,241.60
Total Sent Out and purchased	2,916.70	2,731.20	2,642.00	2,435.40	2,169.90
Sales disposition (GWh)					
Mining	1,184.30	1,046.60	1,077.10	1,001.10	919.60
Commercial	631.10	613.10	572.80	533.10	478.10
Domestic	584.40	539.30	489.40	419.70	370.50
Government	226.60	216.90	227.10	196.20	186.60
Total Sales	2,626.40	2,415.90	2,366.40	2,150.10	1,954.80
Transmission and distribution losses	290.30	315.30	275.60	285.30	215.10
System losses (%)	9.95	11.54	10.43	11.71	9.91
Total Consumers	151,800	136,216	122,625	108,985	96,961
Average Selling price (thebe)	26.30	25.30	23.60	23.60	21.90

S***ource: Botswana Power Corporation Annual Report 2006***

Figure 9.2: Electricity Consumption by User and Year

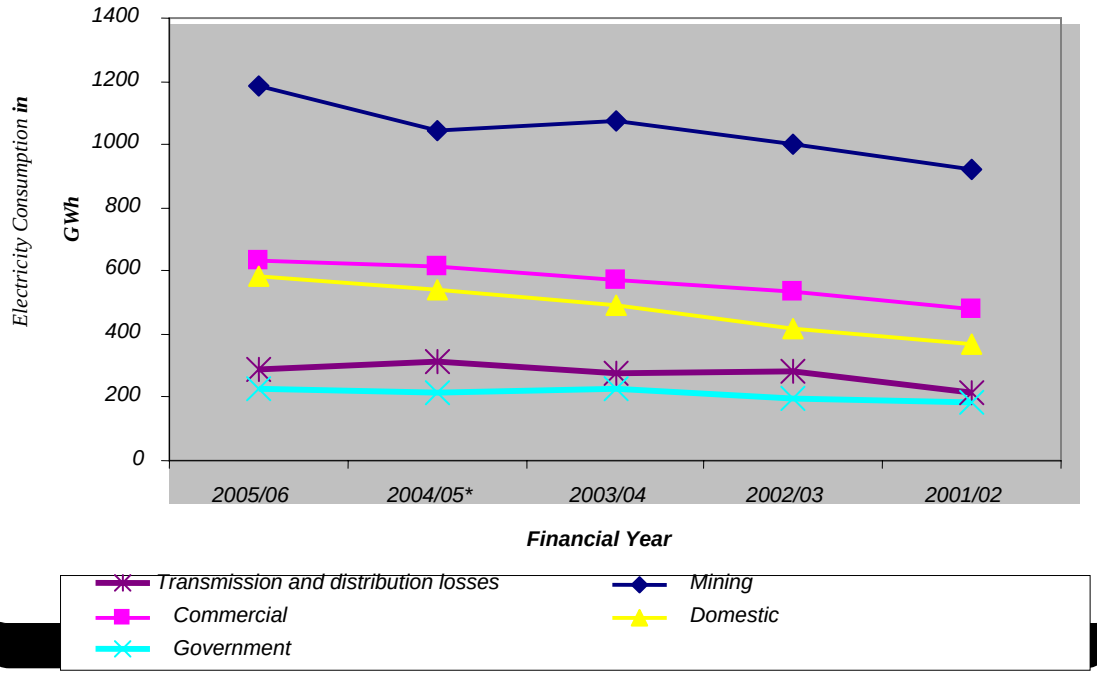


Table 9.12 Final Energy Consumption by Sector (Terajoules, Summarised)

Year	Households	Industry	Transport	Others	Totals
1981	15,481	6,590	3,517	893	26,481
1982	16,049	6,607	3,840	909	27,405
1983	16,623	6,654	4,255	931	28,463
1984	17,234	7,036	4,535	1,002	29,807
1985	17,916	7,518	4,700	1,007	31,142
1986	18,606	7,685	5,437	1,115	32,842
1987	18,171	7,757	6,021	1,167	33,116
1988	21,191	8,276	6,737	1,246	37,449
1989	22,035	8,244	7,367	2,106	39,752
1990	18,584	8,633	8,499	2,106	37,823
1991	..	..	..	..	..
1992	21,023	10,518	11,160	3,436	46,137
1993	21,733	9,941	10,683	3,983	46,340
1994	22,534	8,229	10,329	3,840	44,932
1995	22,126	7,451	12,376	3,448	45,402
1996	22,719	9,246	12,472	3,246	47,682
1997	23,231	9,587	13,409	3,128	49,354
1998	24,715	13,842	13,744	6,588	58,889
1999	24,490	13,121	14,672	5,011	57,295
2000	24,548	13,445	15,822	6,786	60,601
2001	25,016	15,925	16,204	8,109	65,254
2002	24,725	18,231	15,923	8,387	67,267
2003	24,497	16,596	16,249	7,353	64,696

Source: Energy Affairs Division, Ministry of Minerals, Energy and Water Affairs.

Table 9.13: Final Energy Consumption by Sector (Percentages, Summarized)

Year	Households	Industry	Transport	Others	Totals
1983	58.4	23.4	14.9	3.3	100
1984	57.8	23.6	15.2	3.4	100
1985	57.5	24.1	15.1	3.2	100
1986	56.7	23.4	16.6	3.4	100
1987	54.9	23.4	18.2	3.5	100
1988	56.6	22.1	18.0	3.3	100
1989	55.4	20.7	18.5	5.3	100
1990	49.1	22.8	22.5	5.6	100
1991	47.4	22.8	23.3	6.5	100
1992	45.6	22.8	24.2	7.4	100
1993	46.9	21.5	23.1	8.6	100
1994	50.2	18.3	23.0	8.5	100
1995	48.7	16.4	27.3	7.6	100
1996	47.6	19.4	26.2	6.8	100
1997	47.1	19.4	27.2	6.3	100
1998	42.0	23.5	23.3	11.2	100
1999	42.7	22.9	25.6	8.7	100
2000	40.5	22.2	26.1	11.2	100
2001	38.3	24.4	24.8	12.4	100
2002	36.8	27.1	23.7	12.5	100
2003	37.9	25.7	25.1	11.4	100

Source: Energy Affairs Division, Ministry of Minerals, Energy and Water Affairs

9.3 Final Energy Demand

The total Final Energy Demand (FED) in Botswana has shown an upward trend since 1981, from 26,481TJ in 1981 to 64,696 TJ in 2004 (see Table 9.14), The most prevalent energy sources at the FED level were wood, petrol, coal, diesel and electricity. Wood is the leading contributor to FED. However, its proportional contribution dropped from 58.3 percent in 1981 to 33.7 percent in 2003 (Table 9.15). During the period 1981 - 2003, the contribution of petrol, diesel and electricity rose from 6.6 to 21.8 percent, 10.4 to 18.6 percent and 6.9 to 11.8 percent respectively; while that of coal followed a haphazard pattern. The increase of FED is due to growth in various economic sectors as shown on Table 9.16.
The dominant contributors to FED are Households, Transport and Industry sectors. The household sector remained the main user of final energy in the country throughout the period.

The main factors leading to the decline in fuelwood contributions to FED is rural-to-urban migration; and increases in commercial energy consumption in the industry and transport sectors corresponding to growth in the production activities of the sectors.

The share of the transport sector in FED is growing and rose from 13.3 percent in 1981 to 25.1 percent in 2003 (see table 9.16). The principal energy sources used in the sector are petrol and

diesel. Economic Development, increase in urban populations and corresponding expansion of urban settlements have all led to increased transport fuel consumption.

The share of the industry sector was 24.9 percent in 1981 and 25.7 percent in 2003. The main energy sources consumed under this sector are coal, electricity, and diesel in that order. Total energy used in the sector increased, however, indicating an expansion of industrial activities. The little change observed in the proportional contribution of the sector to fed can be attributed to the higher rates of increases in the quantities of energy sources that are used in other sectors.

Table 9.14 Final Energy Demand (Terajoules) by Source, 1981 - 2003

Year	Coal	LPG	AvGas	Jet A	Petrol	Paraffin	Diesel	Fuel Oil	Lubes	Electri -city	Wood	Solar	Other RE	Total
1981	4,241	86	56	55	1,744	142	2,745	32	112	1,826	15,440	2	-	26,481
1982	4,135	95	56	57	1,978	144	2,767	24	122	2,038	15,984	5	-	27,405
1983	4,162	114	51	60	2,235	146	2,836	23	112	2,187	16,528	9	-	28,463
1984	4,613	130	59	74	2,511	148	2,847	10	109	2,205	17,088	12	-	29,807
1985	4,949	146	63	88	2,766	150	2,923	9	119	2,233	17,680	16	-	31,142
1986	4,949	164	73	114	3,161	224	3,392	9	121	2,330	18,288	16	-	32,842
1987	4,949	205	85	133	3,743	243	3,373	9	142	2,411	17,808	16	-	33,116
1988	5,224	283	83	322	4,071	319	3,678	32	134	2,664	20,624	16	-	37,449
1989	5,5023	464	94	309	4,718	415	4,473	159	200	2,711	21,168	18	1	39,752
1990	4,460	505	83	498	5,534	446	5,373	203	220	2,862	17,616	21	1	37,823
1991														
1992	4,452	540	102	338	7,273	468	6,307	2,395	227	3,600	20,400	34	1	46,137
1993	4,344	555	57	188	7,800	490	5,776	2,076	251	3,758	21,008	34	1	46,340
1994	4,344	598	66	202	7,747	512	5,368	52	209	4,374	21,424	35	1	44,932
1995	3,322	523	101	271	8,504	489	6,106	108	233	4,546	21,175	21	1	45,402
1996	4,785	550	102	235	8,678	490	6,266	114	306	5,094	21,040	21	1	47,683
1997	4,325	567	102	259	9,164	505	7,164	171	252	5,369	21,456	21	1	49,354
1998	10,632	826	86	297	9,958	490	8,015	88	326	5,429	22,720	21	1	58,889
1999	6,864	583	163	340	10,678	502	9,158	171	326	5,767	22,720	21	1	57,295
2000	7,440	565	102	259	11,201	507	10,311	171	252	7,052	22,720	21	1	60,601
2001	8,935	1,083	163	290	12,778	922	11,032	150	218	6,939	22,720	22	1	65,254
2002	9,746	1,137	172	304	13,417	968	11,586	148	230	7,280	22,256	21	1	67,267
2003	5,981	1,194	180	320	14,088	1,017	12,047	154	241	7,644	21,808	21	1	64,696

Source: Energy Affairs Division, Ministry of Minerals, Energy and Water Affairs Energy Balances

Table 9.15 Final Energy Demand (Percentages) by Source, 1981 - 2003

Year	Coal	LPG	AvGas	Jet A	Petrol	Paraffin	Diesel	Fuel Oil	Lubes	Electri -city	Wood	Solar	Other RE	Total
1981	16.0	0.3	0.2	0.2	6.6	0.5	10.4	0.1	0.4	6.9	58.3	-	-	100
1982	15.1	0.3	0.2	0.2	7.2	0.5	10.1	0.1	0.4	7.4	58.3	-	-	100
1983	14.6	0.4	0.2	0.2	7.9	0.5	10.0	0.1	0.4	7.7	58.1	-	-	100
1984	15.5	0.4	0.2	0.2	8.4	0.5	9.6	-	0.4	7.4	57.3	-	-	100
1985	15.9	0.5	0.2	0.3	8.9	0.5	9.4	-	0.4	7.2	56.8	0.1	-	100
1986	15.1	0.5	0.2	0.3	9.6	0.7	10.3	-	0.4	7.1	55.7	-	-	100
1987	14.9	0.6	0.3	0.4	11.3	0.7	10.2	-	0.4	7.3	53.8	-	-	100
1988	14.0	0.8	0.2	0.9	10.9	0.9	9.8	0.1	0.4	7.1	55.1	-	-	100
1989	12.6	1.2	0.2	0.8	11.9	1.0	11.3	0.4	0.5	6.8	53.3	-	-	100
1990	11.8	1.3	0.2	1.3	14.6	1.2	14.2	0.5	0.6	7.6	46.6	0.1	-	100
1991														
1992	9.6	1.2	0.2	0.7	15.8	1.0	13.7	5.2	0.5	7.8	44.2	0.1	-	100
1993	9.4	1.2	0.1	0.4	16.8	1.1	12.5	4.5	0.5	8.1	45.3	0.1	-	100
1994	9.7	1.3	0.1	0.4	17.2	1.1	11.9	0.1	0.5	9.7	47.7	0.1	-	100
1995	7.3	1.2	0.2	0.6	18.7	1.1	13.4	0.2	0.5	10.0	46.6	-	-	100
1996	10.0	1.2	0.2	0.5	18.2	1.0	13.1	0.2	0.6	10.7	44.1	-	-	100
1997	8.8	1.1	0.2	0.5	18.6	1.0	14.5	0.3	0.5	10.9	43.5	-	-	100
1998	18.1	1.4	0.1	0.5	16.9	0.8	13.6	0.1	0.6	9.2	38.6	-	-	100
1999	12.0	1.0	0.3	0.6	18.6	0.9	16.0	0.3	0.6	10.1	39.7	-	-	100
2000	12.3	0.9	0.2	0.4	18.5	0.8	17.0	0.3	0.4	11.6	37.5	-	-	100
2001	13.7	1.7	0.3	0.4	19.6	1.4	16.9	0.2	0.3	10.6	34.8	-	-	100
2002	14.5	1.7	0.3	0.5	19.9	1.4	17.2	0.2	0.3	10.8	33.1	-	-	100
2003	9.2	1.8	0.3	0.5	21.8	1.6	18.6	0.2	0.4	11.8	33.7	-	-	100

Source: Energy Affairs Division, Ministry of Minerals, Energy and Water Affairs Energy Balances

Table 9.16 Final Energy Demand by Sector (TJ) 1981 – 2003

Year	Households					Agriculture				Industry					
	LPG & PFN	Wood	Other	Sub Total		Diesel	Other	Sub-Total		Coal	Diesel	Electri-city	Others		Sub Total
1981	156	15,216	109	15,481		286	2	288		4,217	674	1,522	176		6,590
1982	167	15,760	122	16,049		289	2	291		4,114	604	1,708	181		6,607
1983	183	16,304	136	16,623		264	2	266		4,138	523	1,828	165		6,654
1984	199	16,880	155	17,234		340	3	343		4,589	481	1,812	154		7,036
1985	225	17,472	219	17,916		336	3	338		4,874	654	1,809	181		7,518
1986	307	18,080	219	18,606		424	3	426		4,874	722	1,906	183		7,685
1987	352	17,600	219	18,171		349	3	352		4,874	811	1,863	209		7,757
1988	500	20,416	275	21,191		365	3	367		5,150	893	2,037	197		8,276
1989	762	20,960	313	22,035		450	38	488		4,889	1,014	2,033	308		8,244
1990	831	17,408	346	18,584		450	38	488		4,323	1,147	2,159	1,005		8,633
1991															
1992	877	19,680	466	21,023		475	53	528		4,289	1,323	2,279	2,627		10,518
1993	928	20,288	517	21,733		475	53	528		4,128	1,253	2,218	2,342		9,941
1994	982	20,944	608	22,534		475	53	528		4,080	1,305	2,592	253		8,229
1995	951	20,527	648	22,126		475	46	521		3,111	1,380	2,657	304		7,451
1996	985	21,039	694	22,719		475	46	521		4,466	1,582	2,819	379		9,246
1997	1,019	21,456	755	23,231		475	46	521		4,153	2,001	3,003	431		9,587
1998	1,278	22,720	717	24,715		475	46	521		8,472	2,106	2,927	337		13,842
1999	1,019	22,720	751	24,490		475	46	521		6,816	2,656	3,146	503		13,121
2000	1,019	22,720	809	24,548		475	46	521		6,312	3,122	3,539	472		13,445
2001	1,076	22,720	1,220	25,016		862	300	1,162		7,639	2,239	4,433	1,613		15,925
2002	1,130	22,256	1,339	24,725		897	99	995		7,589	4,090	4,802	1,750		18,231
2003	1,187	21,808	1,503	24,497		943	103	1,046		5,498	4,3790	4,943	1,775		16,596

Table 9.16 Final Energy Demand by Sector 1981 – 2003 (TJ, Continued)

	Trade & Hotels					Transport				
Year	Electricty	Wood	Other	Sub-Total		AG & JA	Petrol	Diesel	Others	Sub-Total
1981	47	224	60	331		111	1,676	1,681	49	3,517
1982	50	224	57	331		112	1,905	1,770	53	3,840
1983	54	224	55	333		111	2,169	1,916	58	4,255
1984	59	208	54	320		133	2,440	1,901	61	4,535
1985	63	208	52	323		151	2,666	1,818	65	4,700
1986	63	208	55	327		187	3,064	2,118	68	5,437
1987	63	208	57	329		207	3,646	2,080	88	6,021
1988	63	208	42	313		388	3,986	2,267	96	6,737
1989	63	208	88	359		381	4,151	2,681	154	7,367
1990	63	208	88	359		565	4,330	3,448	156	8,499
1991	..	..	..	..		..	..	..	..	..
1992	608	240	119	967		430	6,512	4,063	155	11,160
1993	792	240	95	1,127		236	6,867	3,401	179	10,683
1994	929	..	53	982		258	6,871	3,054	146	10,329
1995	950	488	6	1,444		363	7,908	3,924	182	12,376
1996	1,264	..	100	1,364		325	8,082	3,881	184	12,472
1997	1,278	..	4	1,282		345	8,571	4,360	133	13,409
1998	904	..	1,731	2,635		373	8,527	4,640	204	13,744
1999	965	..	131	1,096		498	8,842	5,126	206	14,672
2000	1,044	..	964	2,008		345	9,569	5,777	131	15,822
2001	408	..	1,131	1,539		453	9,460	6,001	290	16,204
2002	428	..	1,134	1,562		453	9,870	4,573	1,026	15,923
2003	450	..	448	898		476	10,289	5,180	304	16,249

Table 9.16 Final Energy Demand by Sector 1981 – 2003 (TJ Continued)

	Social & Private Services				Government							
Year	Electricity	Other	Sub Total		Coal	Petrol	Diesel		Electricity	Others	Sub Total		Total
1981	34	..	34		19	..	103		116	1	240		26,481
1982	37	..	37		19	..	103		125	1	249		27,405
1983	41	..	41		22	..	132		135	1	290		28,463
1984	45	..	45		22	..	125		145	2	293		29,807
1985	50	..	50		22	..	115		157	2	295		31,142
1986	50	2	53		22	..	129		157	2	309		32,842
1987	50	..	50		22	..	132		281	2	437		33,116
1988	50	8	58		22	..	154		304	27	506		37,449
1989	50	8	58		48	456	328		304	63	1,199		39,752
1990	50	8	58		48	456	328		304	63	1,199		37,823
1991	..	..	..		..	..	..		..	..	..		..
1992	50	170	221		48	605	446		263	358	1,719		46,137
1993	47	170	217		120	756	647		256	332	2,110		46,340
1994	47	170	217		216	739	534		270	354	2,113		44,932
1995	47	161	208		163	456	328		311	17	1,275		45,402
1996	..	..	..		175	456	328		384	17	1,361		47,682
1997	..	..	..		120	456	328		403	17	1,324		49,354
1998	..	..	..		360	1,289	793		972	19	3,432		58,889
1999	..	..	..		0	1,469	901		972	52	3,394		57,295
2000	..	..	..		120	1,455	935		1,728	19	4,257		60,601
2001	..	..	..		360	2,538	1,900		530	81	5,409		65,254
2002	..	..	..		439	2,748	1,995		558	90	5,829		67,267
2003	..	..	..		194	3,021	1,512		587	94	5,409		64,696

Source: Energy Affairs Division, Ministry of Minerals, Energy and Water Affairs, Energy Balance Balance

10.0 MINING

10.1 Introduction

Mining is the extraction of valuable minerals or other geological materials from the earth, usually (but not always) from an ore body, vein, or (coal) seam. Materials commonly recovered by mining include bauxite, coal, copper, diamonds, iron, gold, lead, manganese, magnesium, nickel, phosphate, platinum, salt, silver, tin, titanium, uranium, and zinc. Other highly useful materials that are mined include clay, sand, cinder, gravel, granite, and limestone. Any material that cannot be grown from agricultural processes must be mined. Mining in a wider sense can also include extraction of petroleum and natural gas.

The extraction of different minerals in Botswana started in earnest in the 1970's after diamonds were discovered in 1967, copper nickel in 1970 and later coal. Mining techniques can be divided into two basic excavation types being *surface and sub-surface mining.*

Surface mining is used to extract deposits of mineral resources that are close to the surface. *Open-pit surface mining* is used at all the four **diamond** mines that are found in Botswana. Three of these mines are located in the Central District at Orapa, Letlhakane and Damtshaa whereas the other one is in the Southern District at Jwaneng. This mining method usually leaves large devastated areas called spoil banks, unless the land is recovered.

Coal is mined at Morupule using open pit form of mining. Morupule Thermal Power Station, as well as the mining operations at Selibe Phikwe and Sua Pan soda ash plants uses the coal. Even though suitable for use as power station fuel, the coal produced by Morupule is of lower quality, with relatively high levels of ash and sulphur, which make it unsuitable for other purposes without washing and cleaning.

There is a **copper/nickel** mine at Selibe Phikwe which has a smelter. The company has three mining areas at Phikwe, Selebi and Selebi North. The typical mining method used is the vertical hoisting shafts, using a certain number of men cage for transportation of personnel and heavy 6-to-12 tonne skips for ore and waste hoisting. The mining method varies from one mine to the next depending on the depth and thickness of the ore body and ground conditions. But generally the methods employed are the cut-and-fill, open stopping with rib pillars and hand jackhammers.

The other minerals that are mined, is **soda ash** and **salt** at Sowa Town and **gold** mining in the Francistown area. The importance of mining in Botswana has been immeasurable as some of these minerals are exported abroad and bring in the much-needed foreign capital.

10.2 Mining Inventory

Mining inventory is a section that looks at the quantities of reserves, production and location of minerals that are found in a country. Active mines and mine-related facility inventory provides a comprehensive tabulation of information concerning sites within Botswana where natural

resources were or are being mined or processed. This information is of great value to planners and the public at large as it can help in deciding on the measures that can be taken to mitigate any negative environmental impacts.
Sources for the information include reports and databases of the Department of Mines and state agencies that share responsibility for monitoring and regulating mining and processing activities, and publications of private sector institutions, organizations and associations that monitor the scientific, business and environmental aspects of this activity. Production and reserves data, in particular, for diamonds is considered confidential and is rarely made public.

The Government of Botswana is engaged in joint ventures with mining companies for the extraction of the different minerals found in the country. The Government usually leases the area of the land used for mining purposes and this generates some income through payment of royalties by the mining companies.

10.2.1 Location and Land Area Of Mining Sites

The area of the land used for mining gives an estimate of the land that will need to be rehabilitated after the mining operations have ended. This is of great importance to environmentalists and land planners as this enables them to come up with remedial measures that will be taken during the land rehabilitation.

Table 10.1 Location and Land Area of Mining Sites

Mining Sites	Mineral	Mining Licence Issue Date	Date of Expiry of Mining Licence	Length of Period of Mining Licence	Area of Land Allocated for Mining (Hectares)
Orapa	Diamonds	1992	2017	25	2,236.9
Letlhakane	Diamonds	1992	2017	25	16,767.0
Jwaneng	Diamonds	1979	2004	25	2,990.6
Damtshaa	Diamonds	2000	2025	25	2,400.0
Selibe Phikwe	Copper/ Nickel	1997	2022	25	26,145.6
Tati	Copper/ Nickel	1988	2013	25	3,230.0
Morupule	Coal	2001	2026	25	3,432.4
Sowa	Soda Ash/ Salt	1995	2020	25	76,868.3
Francistown	Gold	2001	2008	7	576.5
Francistown	Gold	1998	2003	5	2,373.0
Francistown	Gold/ Silver	2003	2013	10	1,165.6
Francistown	Gold/ Silver	1996	2003	7	320.0
Francistown	Gold/ Silver	1987	2012	25	5,240.0
TOTAL					**143,745.8**

Source: Department of Mines Annual Report

Table 10.1 shows that most of the mining in Botswana takes place in the Central and Northern parts of the country. Most of the Gold is mined, in and around the Francistown District. It can also be deduced from Table 10.1 that mining licenses for Diamonds, Copper/ Nickel, Coal and Soda Ash are for a twenty-five year period. For Gold and Silver,. these licences can be renewed if there are still some reserves that need to be mined after the expiry of the lease.

Table 10.2: Proportions of Total Mining Area Allocated to different Minerals

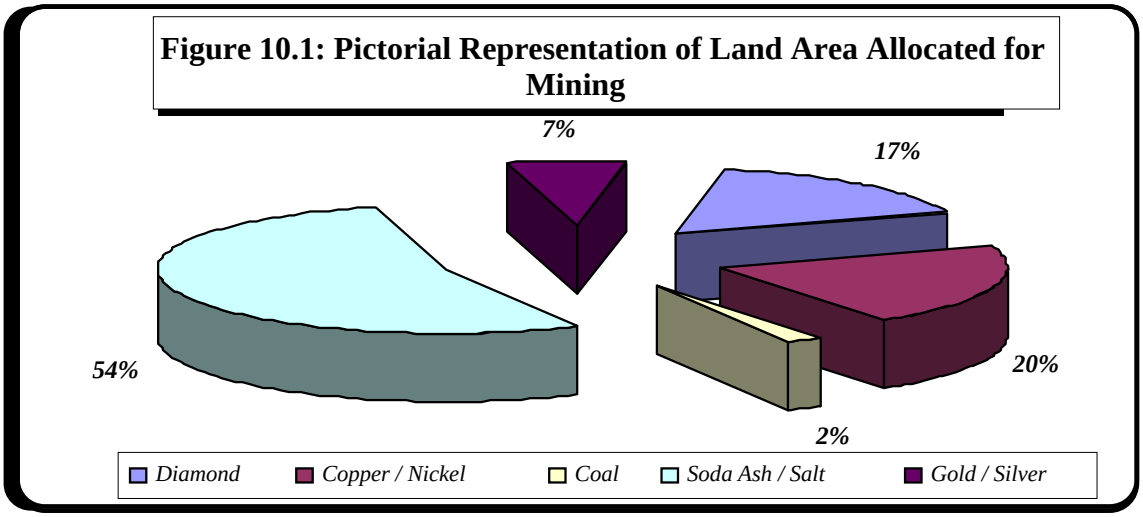
Mineral	Area of Land Allocated for Mining (Hectares)	Proportion of Total
Diamond	24,394.5	17.0
Copper / Nickel	29,375.6	20.4
Coal	3,432.4	2.4
Soda Ash / Salt	76,868.3	53.5
Gold / Silver	9,675.0	6.7
TOTAL	**143,745.8**	**100.0**

Total Area of Land Allocated for Mining does not include the area of land allocated for quarries and other mining activities.

Source: Department of Mines Annual Reports

Table 10.2 shows that Soda Ash mining accounts for almost fifty-four percent of the designated mining areas. On the other hand, the mining of Diamonds, which is the most important economic activity in the mining sector, covers only seventeen percent of the total mining area in the country. This is well represented by Figure 10.1.

Figure 10.1: Pictorial Representation of Land Area Allocated for Mining



Derived from table 10.2

Although some companies have been issued licences for these other activities like for clay mining, gravel and sand mining, these companies are not well monitored by the authorities except those with explosive licences.

The discovery and mining of different minerals has contributed in many ways to the economic and social development of the country. The Government has then been able to undertake investment in both human and physical infrastructure development. Road networks, which were hitherto undeveloped, were improved significantly throughout the country, and a number of schools and health facilities were built to improve access to social services and the standard of living for Batswana. Mining also created employment opportunities for the residents.

10.2.2 Production

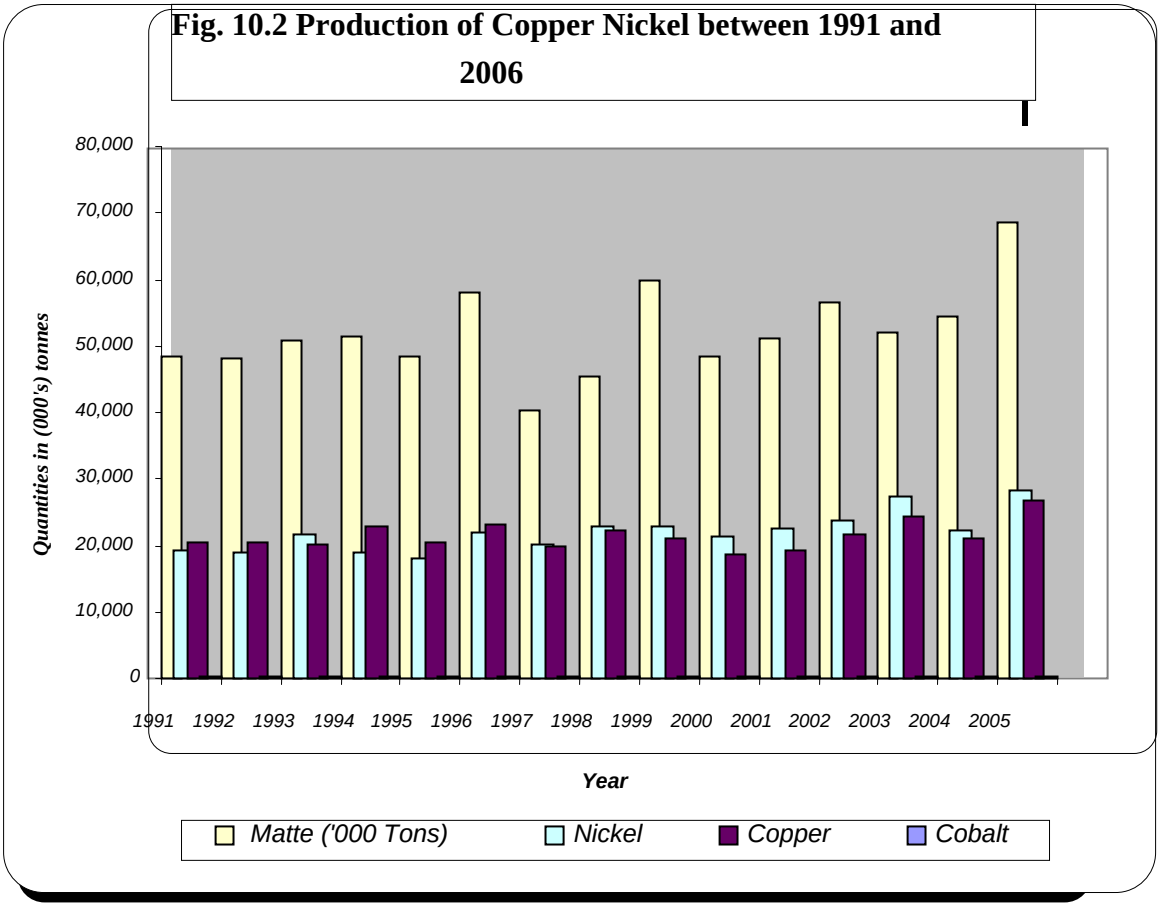
a) Copper/nickel

Copper and Nickel mining, is a joint venture of the Botswana Government and the Anglo American Corporation. After prospecting activities that commenced in the late 1950's, the ore deposits were discovered
in 1962 and the mine started operation at Selibe Phikwe in 1973. The mining company operates three underground mines. The extracted ore is fed to the on-site concentrator, then dried and smelted. The matte produced is of high-grade quality and it is exported for separation and refining.

The major destination for copper-nickel has been Norway, and recently Zimbabwe. About 51 percent of total production was exported to Norway, and remaining 49 percent was exported to Zimbabwe in 2001.

Figure 10.2: Copper Nickel Production

Fig. 10.2 Production of Copper Nickel between 1991 and 2006



Source: Annual Publications, Department of Mines

Derived from Table 10.3

Table 10.3 Production of Copper / Nickel between 1991 and 2006

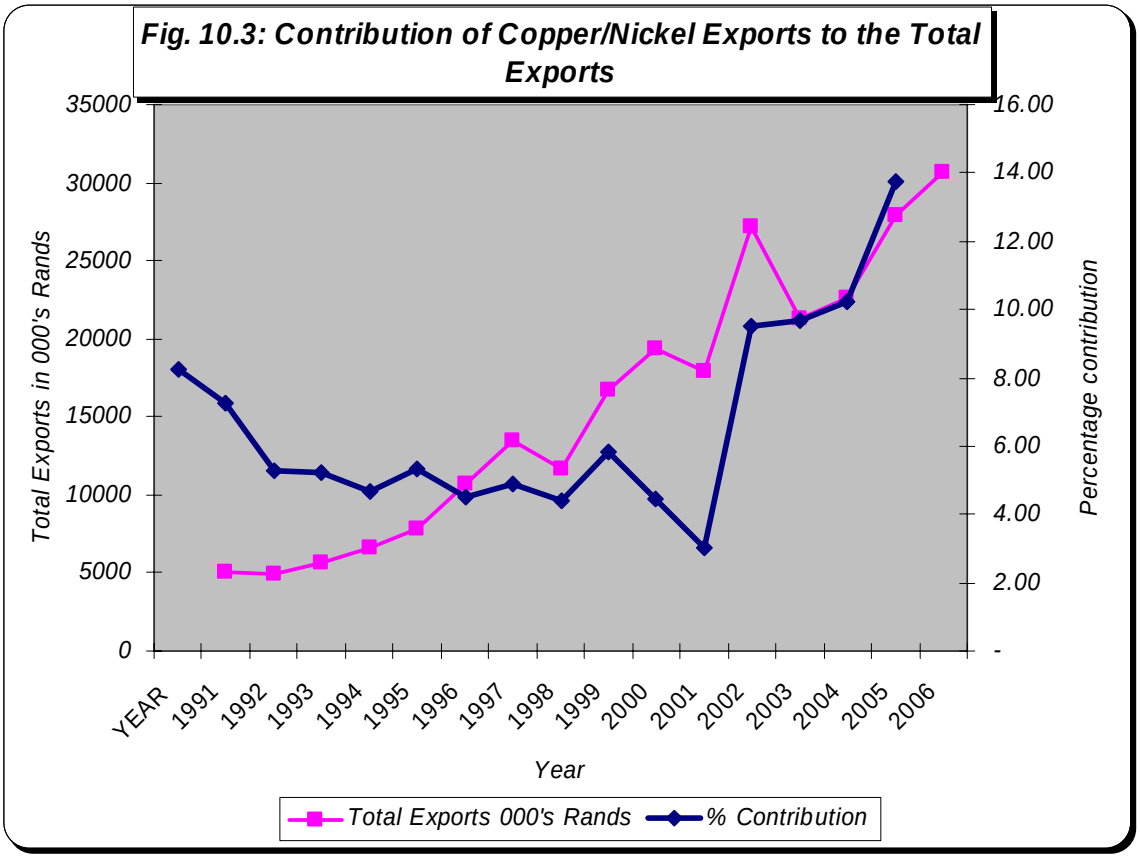
YEAR	Matte Matte ('000 Tons)	Contained Metals			% of Matte Content			Copper & Nickel Exports	Total Exports 000's Rands	% Contribution
		Nickel	Copper	Cobalt	Nickel	Copper	Cobalt			
1991	48,319	19,294	20,576	208	39.9	42.6	1.08	422.6	5,108.8	8.27
1992	48,071	18,873	20,413	208	39.3	42.5	1.10	355.3	4,910.8	7.24
1993	50,783	21,621	20,132	205	42.6	39.6	0.95	296.9	5,644.6	5.26
1994	51,488	19,041	22,780	225	37.0	44.2	1.18	341.7	6,561.4	5.21
1995	48,456	18,088	20,461	271	37.3	42.2	1.50	362.4	7,771.4	4.66
1996	57,948	22,095	23,299	406	38.1	40.2	1.84	575.0	10,739.6	5.35
1997	40,312	20,157	19,820	334	50.0	49.2	1.66	606.6	13,471.7	4.50
1998	45,310	22,851	22,124	335	50.4	48.8	1.47	569.7	11,665.3	4.88
1999	59,877	22,898	20,960	332	38.2	35.0	1.45	738.6	16,692.3	4.42
2000	48,420	21,446	18,722	308	44.3	38.7	1.44	1,129.8	19,409.1	5.82
2001	50,999	22,454	19,209	325	44.0	37.7	1.45	801.6	17,925.3	4.47
2002	56,626	23,896	21,590	269	42.2	38.1	1.13	816.0	27,140.7	3.01
2003	51,983	27,400	24,289	294	52.7	46.7	1.07	2,028.0	21,292.3	9.52
2004	54,448	22,292	21,195	223	40.9	38.9	1.00	2,194.8	22,659.8	9.69
2005	68,637	28,212	26,704	326	41.1	38.9	1.16	2,856.5	27,873.0	10.25
2006	64,368	26,762	24,255	303	41.6	37.7	1.13	4,220.3	30,720.9	13.74

It is worth noting that higher matte quantity does not imply that the quantities of copper and nickel will also be high. This is explained by the figures for 1999 in which Matte production was high at 68,637,000 tonnes containing 28,212,000 tonnes of Nickel and 26,704,000 tonnes of Copper. The highest quantities for both Copper and Nickel were recorded in the year 2005 and the Matte produced during that year was the highest.

Production of matte has been on the increase and the highest quantity that has been mined so far is 68 637 in 2005 59, 877, 000 tonnes in 1999. The least quantity of matte produced between the years 1991 and 2006 was 40,312 Tonnes in 1997.

Nickel mattes, nickel oxide and other intermediate products exported to Zimbabwe and Norway for separation and refining has been of great importance to the country's much needed foreign exchange. Figure 10.3 shows the trend since 1991 up to 2006 inclusive.

Figure 10.3 Contribution of Copper/Nickel Exportation to the Total Exports



Source: External Trade Statistics Publications, 1990 – 1998 Central Statistics Office

Derived from Table 10.3

The percentage contribution of copper/ nickel to total exports from 1991 to 1999 has been on the downward trend since the highest contribution of 8.3 percent was recorded in 1991 as shown by Figure 10.3 above. The percentage contribution picked up again in 2003 and

continued to increase until 2006. The international market prices for copper/ nickel has been depressed between the period 1991 and 2004, and this has led to the Government of Botswana having to give BCL Mine grants and loans from international financial institutions to keep the mining town of Selibe Phikwe going.

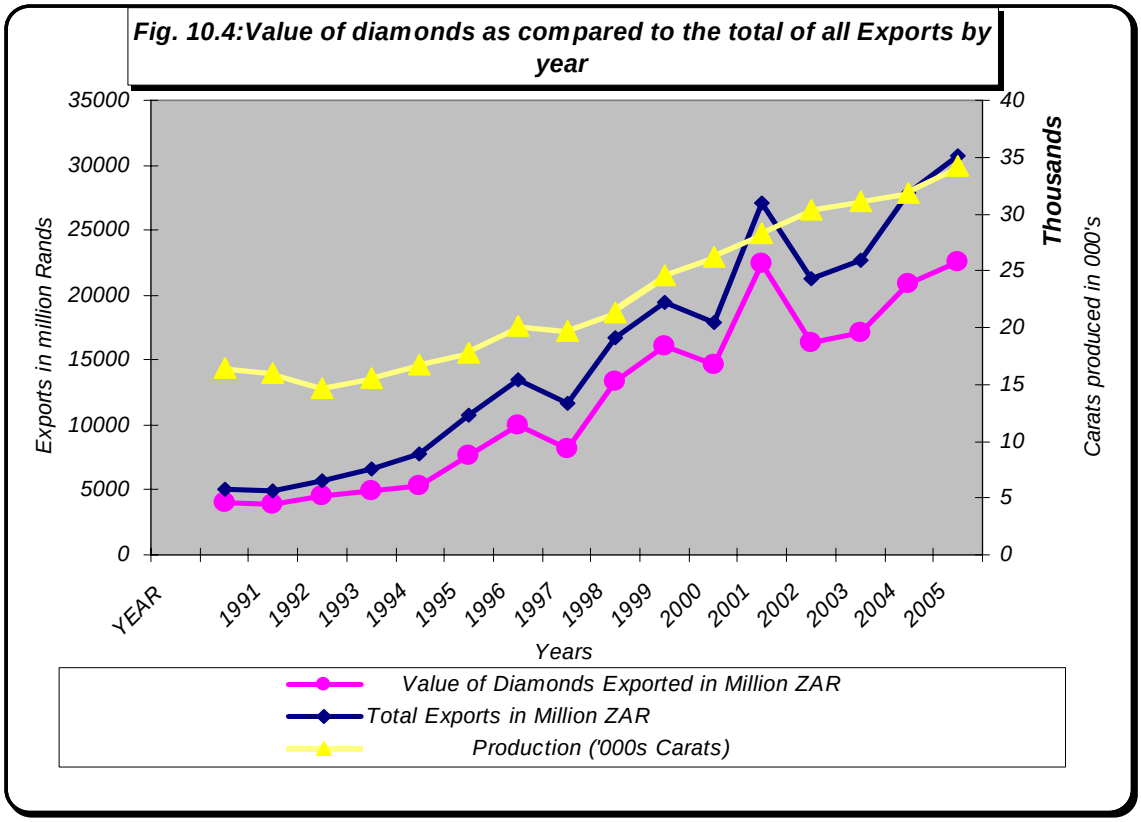
b) Diamonds

Debswana, a joint venture between Botswana Government and the De Beers Mining Company in a 50/50 market share is the sole diamond miner in the country. Botswana's competitive edge in diamonds is as sharp as ever. While its rapid rate of growth in the past cannot be projected to continue into the future, diamonds will remain a major contributor to both the Gross Domestic Product and Government revenues.

The diamonds as mentioned in the introduction are then sorted at the different diamond mines and then valued by Botswana Diamond Valuing Company before they are sold through the Central Selling Organisation, a United Kingdom based company.

In the past few years diamond cutting and polishing factories have been established in an effort to diversify within the diamond industry and create additional employment opportunities. Teemane Diamond Manufacturing was opened at Serowe and Molepolole to undertake this job of cutting and polishing of diamonds before they can be exported.

Figure 10.4 Productions from the Diamond Mines and Value of Diamond Exports

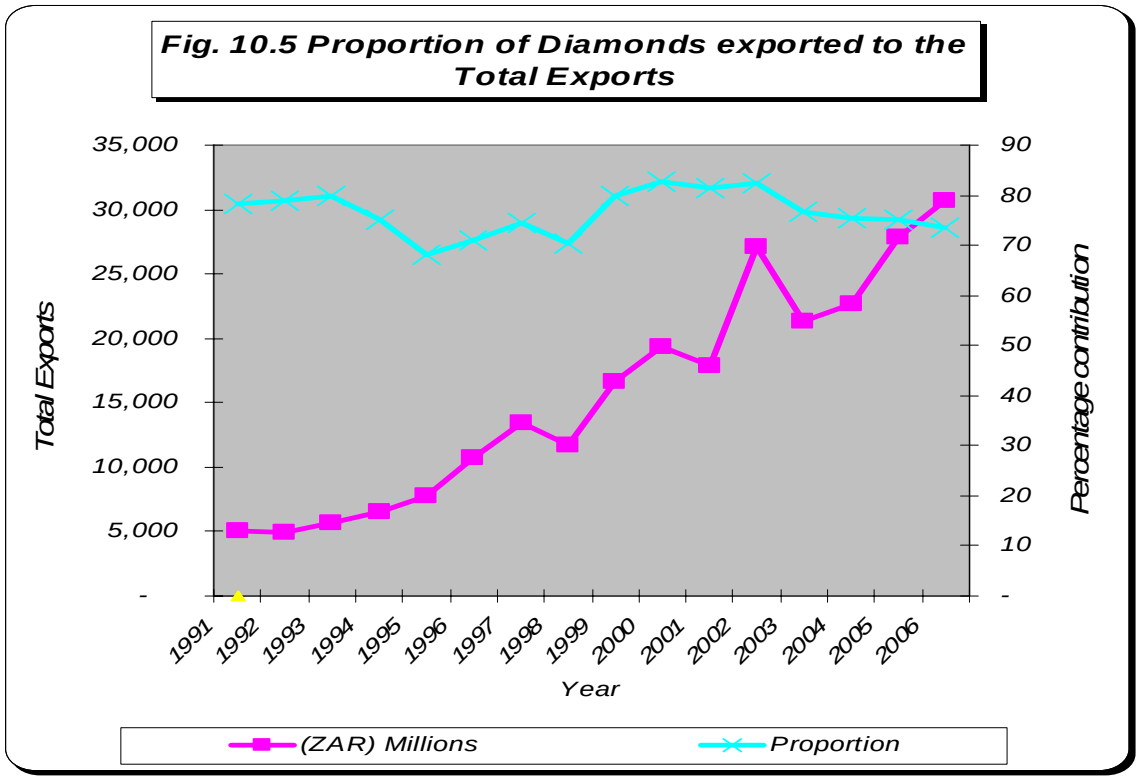


Source: Department of Mines Annual Publications, 1991 to 2006 External Trade Statistics Publications, 1991 to 1997. Central Statistics Office

Production of diamonds has been on the increase in the early 1990's.The highest quantity ever produced was in 2006 when it stood at 34,293 million carats. The lowest quantity ever produced between 1991 and 2006, was 14,730 million carats in 1993.

Diamonds contribution to the total exports has been on the increase as well; with the highest contribution between the period 1991 and 2006 standing at 84.10 percent in 2001.The lowest contribution was realised in 1995 and it stood at 68.05 percent. A pictorial diagram of Figure 10.5 shows some of the changes highlighted herein.

Figure 10.5 Proportion of Diamonds Exported to the Total Exports



It should be noted that diamond production is not at all proportional to the value of diamonds exported. Some of the diamonds produced is stockpiled if the producers feel that prices in the international market are low.

Figure 10.5 shows comparison of the value of diamonds exported and total exports amount from 1991 to 2006. A trend that is increasing for both quantities can be realised between the years 1998 and 2003 inclusive. In 1998, diamond's contribution to the total exports went down and there was a subsequent increase thereafter.

Table 10.4: Production of Diamonds from 1991 to 2006 and the associated contributions to the Total Exports

YEAR	Value of Diamonds Exported in Million ZAR	Total Exports in Million ZAR	Production ('000s Carats)
1991	4,002	5,109	16,506
1992	3,874	4,911	15,946
1993	4,512	5,645	14,730
1994	4,926	6,561	15,550
1995	5,288	7,771	16,802
1996	7,622	10,740	17,707
1997	10,038	13,472	20,111
1998	8,197	11,665	19,639
1999	13,356	16,692	21,263
2000	16,023	19,409	24,635
2001	14,621	17,925	26,190
2002	22,392	27,141	28,368
2003	16,338	21,292	30,412
2004	17,073	22,660	31,125
2005	20,923	27,873	31,890
2006	22,564	30,721	34,293

Source: Department of Mines Annual Reports

c) Soda Ash

Total annual world consumption of this alkaline chemical basic to everyday life total some 30 million tons, a figure expected to increase to more than 40 million tons by the turn of the century. Approximately two-thirds of the world demand for soda ash is one produced chemically, using salt and lime as raw materials. In Southern Africa approximately 35 percent of soda ash is used in glass manufacture, 30 percent in metallurgical applications, 13 percent in the detergent industry and the balance in general chemical manufacture.

The soda ash plant at Sua Pan is currently operating below capacity, mainly due to weak market conditions for its products. Soda Ash Botswana's facility uses the natural carbonate resources of Botswana and has installed capacity to make the sub-continent virtually independent of imported materials. This plant also has the capacity to produce 650,000 tons of salt per year, the quality of the product making it ideally suited as a raw material in the production of certain chemicals

The stages in the production of salt are harvesting, washing and screening, and fine salt drying and milling. Coarse salt is exported to South Africa for use in the production of chlorine and caustic soda. Both fine and coarse salt is supplied for domestic consumption throughout Southern and Central Africa.

The production and exportation of Soda and Salt is shown in Table 10.5.The table shows that the highest production levels reached for both soda ash and salt were 283,197 and 315,259 tonnes respectively in 2002. However, as indicated above, the plant is operating below capacity with the amounts that are shown in the table. The contribution of Soda and Salt to the national foreign exchange coffers is relatively non-existent when compared to Diamonds. Since the mining of this mineral started in 1991, Soda and Salt prices have not been favourable due to the low demand of this mineral in the international market. Variation in the production of Soda and Salt is as shown in Figure 10.6.

Figure 10.6: Variation of Salt and Soda Production between 1995 and 2006

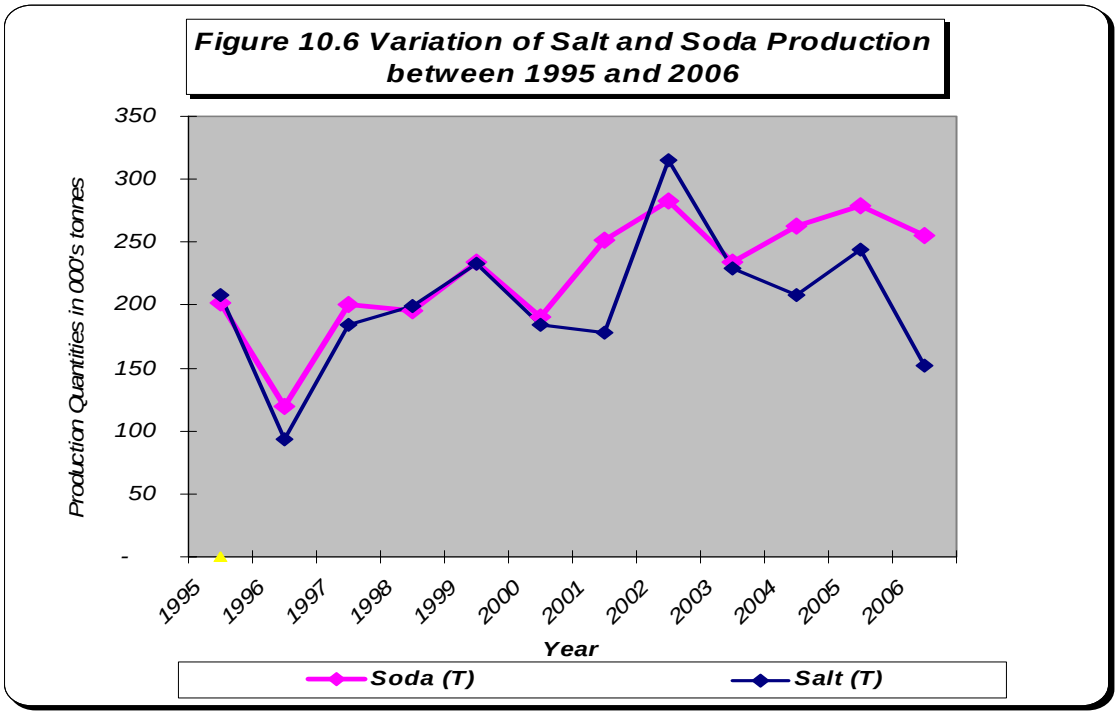


Table 10.5 Production and Exportation of Soda Ash and Salt

YEAR	Production		Export Values in million ZAR		Total Exports in Million ZAR	% Contribution to Total Exports
	Soda (T)	Salt (T)	Soda	Salt		
1995	201,657	208,126	24.67	27.552	7,771	0.67
1996	119,137	93,886	89.16	22.179	10,740	1.04
1997	199,990	184,533	138.52	18.364	13,472	1.16
1998	195,500	199,300	128.71	38.944	11,665	1.44
1999	233,643	233,069	141.61	63.869	16,692	1.23
2000	191,000	184,800	134.15	50.334	19,409	0.95
2001	251,231	178,646	174.89	57.664	17,925	1.30
2002	283,197	315,259	46.78	25.799	27,141	0.27
2003	234,520	229,432	128.99	57.694	21,292	0.88
2004	263,358	208,319	146.44	78.778	22,660	0.99
2005	279,085	243,945	139.58	105.151	27,873	0.88
2006	255,677	151,595	133.58	16.899	30,721	0.49

Source: Department of Mines Annual Reports
Trade Statistics, Central Statistics Office

d) Production of Coal

Coal resources suitable for power station use have been identified in eastern Botswana, and Morupule Colliery, the country's only coalmine, is situated some 10 km outside the town of Palapye. The colliery has been in operation since 1973.

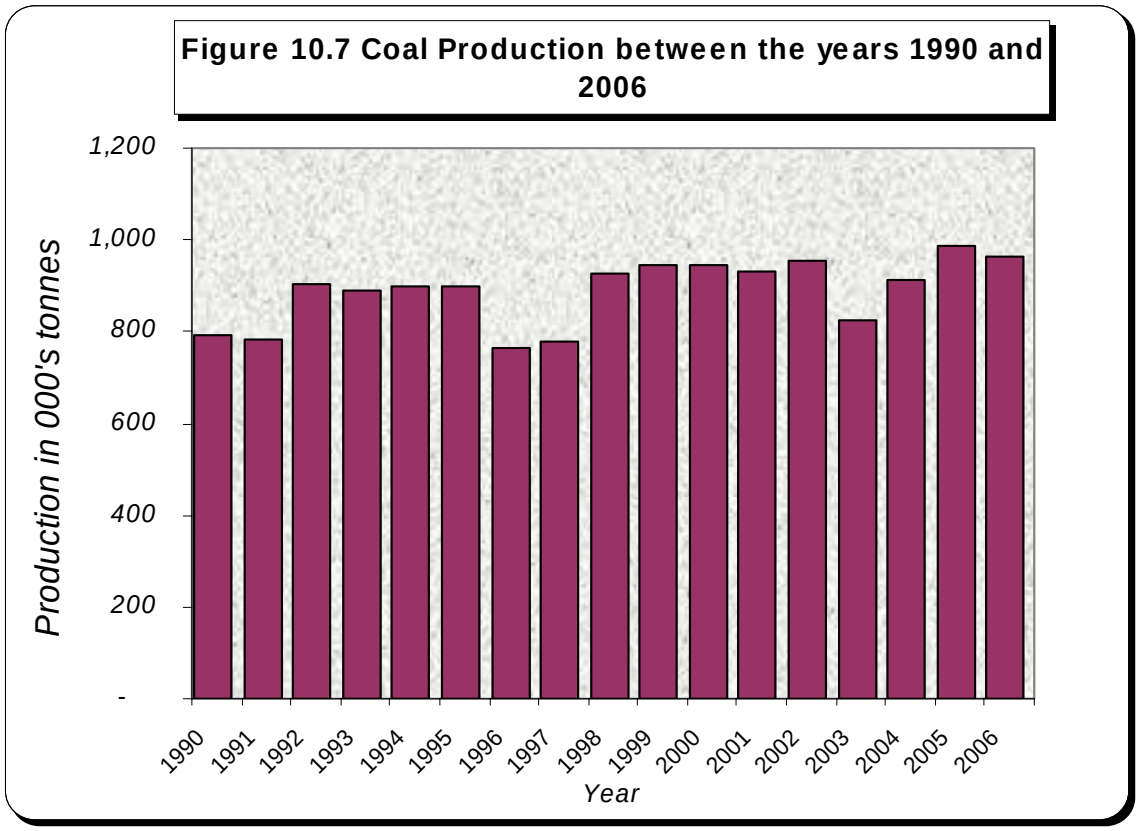
While Botswana is renowned for its diamonds, it should also be recognised for its coal deposits, which are not insignificant either. For example, the Mmamabula area contains large deposits and could conveniently supply Gaborone's industrial needs.

The Kgaswe resource could see Morupule Colliery Limited (MCL) expanding its annual output by a factor of 20 to reach mega-mine status. Most of the coal produced at Morupule, (approximately 60 percent) is used for electricity production by Botswana Power Corporation. Bamangwato Concession Limited and Sowa Mine use thirty-seven percent of the coal production for their mining operations. The remaining three- percent is sold to local factories and the retail market.

Table 10.6 Coal Production since 1990

YEAR	COAL (T)
1990	794,041
1991	783,873
1992	901,452
1993	890,000
1994	900,298
1995	898,383
1996	763,240
1997	776,917
1998	928,100
1999	945,316
2000	946,900
2001	930,374
2002	953,081
2003	822,780
2004	913,087
2005	984,876
2006	962,427

Source: Department of Mines Report



Source: Derived from Table 10.6

Production has been on the increase since 1973 when coal was first mined although declines were observed in a number of years. Production in the 1990's has just been a little below the One million tons/year mark.

e) Precious Metals

Gold was one of the earliest minerals to be exploited in the country. A number of mines are operating today and most of them salvage from tailings left by older, less efficient methods of extraction. Monarch Gold Mine has been re-opened with more advanced technologies for small-scale operations, Jacamar Manganese re-opened the manganese mine at Kgakgwe Hill in the southern district, and production is under way at the Lobatse Clayworks. Crushed stone and sand as well as limestone are quarried for use in road building and the construction sector. Table 10.8 shows the production of Gold and its contribution to the total exports in monetary values.

Table 10.8 Gold Production and Value Exported

Year	Production in Kg	Value of Gold in million ZAR	Total Exports in million ZAR	% Contribution to the Total Exports
1991	20	3.356	5,109	0.00066
1992	165	44.502	4,911	0.00906
1993	192	4.198	5,645	0.00074
1994	234	-	6,561	-
1995	86	1.366	7,771	0.00018
1996	5	0.148	10,740	0.00001
1997	28	1.717	13,472	0.00013
1998	1	0.770	11,665	0.00007
1999	8	0.403	16,692	0.00002
2000	4	4.094	19,409	0.00021
2001	2	5.317	17,925	0.00030
2002	8	4.168	27,141	0.00015
2003	9	0.071	21,292	0.00000
2004	162.15	12.592	22,660	0.00056
2005	2,708.80	12.592	27,873	0.00045
2006	3,020	12.592	30,721	0.00041

Source: Department of Mines Annual Reports
Trade Statistics Unit, CSO
'-" information not available from Trade Statistics Unit, CSO

f) Other Minerals

There are a lot of other minerals found in Botswana and the list comprises of the following: Agates, Fluorite, Kyanite, Silver, Antimony, Glass Sand, Graphite, Limestone, Talc, Gypsum, Lead, altered Serpentinite, Asbestos Manganese, Uranium, Chromite, Iron, Platinum, Zinc, Feldspar Kaolin and Gold.

Commercial exploitation of some of the mentioned minerals has been constrained by a number of factors, such as insufficient reserves, unfavourable metallurgical properties and having the reserves in remote locations where there is no infrastructure to support the mining of such

reserves. Developments are in some cases constrained by the weak and often volatile markets for some of these minerals. For example, asbestos, talc, kainite and manganese have been exploited in the past, but are no longer in commercial production because mining them is no longer feasible.

10.3 Employment in the Mining Industry

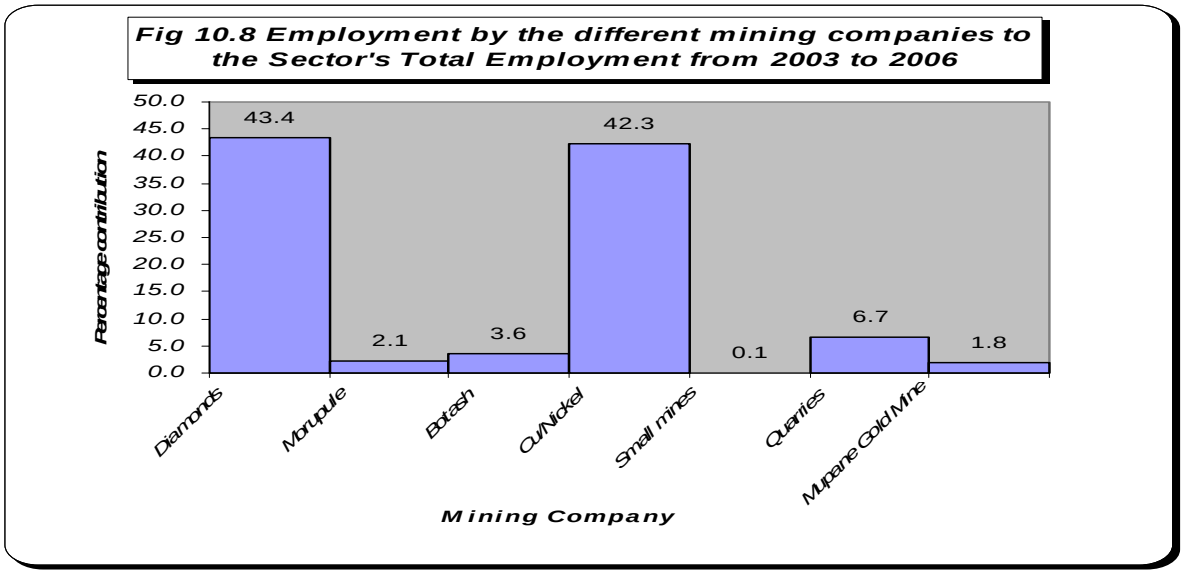
The mining industry generates many employment opportunities within and outside this industry through forward and backward linkages. It also provides training opportunities for the citizens both within and outside the industry itself:; thus contributing to the human development of the economy. Table 10.9 shows the employment trend from the different mines. It reveals that most of the mining workforce is in the diamond mining followed by the copper/nickel mining.

Table 10.9 Employment in the Mining Industry

Mineral Mining Company	Year				Total	Percentage Contribution
	2003	2004	2005	2006		
Diamonds	5,927	6,689	5,703	6,449	**24,768**	**43.39**
Morupule	339	344	246	249	**1,178**	**2.06**
Botash	646	493	467	445	**2,051**	**3.59**
Cu/Nickel	5,188	5,765	7,063	6,151	**24,167**	**42.34**
Small mines	6	7	7	28	**48**	**0.08**
Quarries	1,130	966	876	858	**3,830**	**6.71**
Mupane Gold Mine	-	304	345	394	**1,043**	**1.83**
Total Employment	**13,236**	**14,568**	**14,707**	**14,574**	**57,085**	**100.00**

Source: Department of Mines, 2006 Annual Report

(Information sourced from monthly returns submitted by mines and quarries)



11.0 NON-GOVERNMENTAL ORGANISATIONS (NGOs) AND COMMUNITY BASED ORGANIZATIONS (CBOs)

In response to the state of the environment and natural resources as highlighted in this publication, communities have come together to form organizations in a bid to address the situation. The organizations have a full bearing on the environment, their primary activities are directed towards environmental conservation and natural resources management while others have indirect bearing on it, refer to table 11.1 below.

Table 11.1 Non-Governmental Organizations with Full Bearing on the Environment

Non-Governmental Organizations	Programme
Kalahadi Conservation Society	- Promote knowledge of Botswana's rich wildlife and its environment through education and publicity. - Encourage, and in some cases, Finance research into issues affecting these resources and their conservation - Promote and support policies of Conservation wildlife and its habitat.
Forestry Association of Botswana	- Work in partnership with disadvantaged individuals and communities to improve their living standards through forestry and other environmental activities. - Advance public awareness of education on the importance of tree planting, with emphasis on indigenous species. - Promote ecologically sound indigenous forest management practices through research and extension work. - Encourage among communities sustainable utilization of natural woodlands and maintenance of biological diversity. - Actively assist and cooperate with government, private sector and non-governmental organizations involve in forestry and environmental

	management and lobby as the need arises. - Act as a focal point for all non-governmentalforestry activities in Botswana.
Conservation International (CI) Okavango Programme	- Conserve the Okavango Delta's biodiversity and to demonstrate that human societies are able to live there.
Khama Rhino Sanctuary Trust	- Protect the environment within the sanctuary and to protect and nurture endangered rhinoceros and all other fauna and flora. - Establish, Maintain and pressure the bio-diversity within the sanctuary. - Generate revenue for the local community from tourism and other uses of the sanctuary's renewable resources. - Provide environmental education to Botswana and to the general public.
Kuru Family of Organization/Letloa Trust	- Empower the most vulnerable group of indigenous in Southern Africa namely the San' to take over their own destines through a holistic process approach to development.
Environmental Heritage Foundation	- Promote the generation and value management of funds for empowering communities that implement environmental conservation project activities.
Permaculture Trust of Botswana (PTB)	- To use available natural resources by developing local expertise. - Income generation through the Sustainable use of natural resources to alleviate poverty. - Equip the rural communities in order to diversify their means of

	Survival through self-help programs in gender sensitivity. - Educate people on the importance of conservation of nature so that optimum results can be obtained there from.
Somarelang Tikologo (ST)	- Increase the recycling of materials dumped into the environment e.g cans, glass, paper and plastic, and to encourage reuse where appropriate. - Encourage greater environmental awareness and the need for each individual to protect Botswana's environment by conserving resources, recycling refraining from littering. - Identify, monitor and discourage pollution-generating activities, which threaten environment. - Promote alternatives to environmentally damaging activities. - Promote the more efficient use of natural resources by individuals, institutions, industry and others. - Provide information and advice on pollution, waste disposal, resource conservation and recycling. - Encourage the adoption and effective implementation of legislation and policies, which promote environmentally sound technologies, processes and waste disposal practices. - Liaise with relevant government and non-government organizations involved in activities related to environmental protection and resource conservation.
Thusano Lefatsheng Trust (TL's)	- Create partnership with poor rural communities to identify natural

	resources, add value and market the products. -Develop Human Resource development plan. - Generate income to finance critical Operations. - Maximize benefits of TL's activities on target groups. - Ensure sustainable use of natural Resources. - Uphold principle of good governance. - Diversify resource mobilization. - Apply the state of the Monitoring and evaluation methods.
Veld Products Research (VPR)	- Research on veld products so as to foster sustainable utilization of the products. - Develop sustainable agro-forestry systems.
Birdlife Botswana	- Promote and make recommendations, advice the appropriate institutions on the formulation and enforcement ofany legislation relating to the conservation of birds and their habitats. - Encourage and promote an interest in Knowledge of birds and bird watching.
Tshole Trust	- Provide information and advice on waste oil recovery, disposal and recycling. - Identify, monitor and discourage waste oil-generating activities which threaten the well being of the environment. - Encourage the adoption and effective Implementation of legislation and policies, which promote waste oil management, processes, resource utilization, and waste of disposal practices.

12.0 ENVIRONMENT RELATED LEGISLATION

Given the impact on the environment due to development activities, individuals, societies and public authorities have to come up with measures to control and prevent the negative impacts, and reinforce positive ones. One of the measures is to come up with Legislation as an instrument to regulate use of natural resources. This chapter therefore looks at various pieces of Legislation in Botswana which have the intention of guarding against environmental deterioration and promote environmental conservation.

12.1 Introduction

At the moment, there is no overarching Legislation on the environment. The Environment Management Act which is envisaged to be encompassing is still at draft form yet to be considered by Parliament. As such, there are various pieces of Legislation housed in different departments and ministries that have a bearing on the environment.

The environment sector is located in the Ministry of Environment, Wildlife and Tourism and it is here that most pieces of environment related Legislation are found. Other ministries which have such Acts are the Ministry of Minerals, Energy and Water Resources, Ministry of Agriculture, Ministry of Lands and Housing, and the Ministry of Health.

This chapter gives a list of these various Acts and their objectives. Some of the Acts are already under review since most of them were formulated a long time back and are somewhat out of date.

12.2 List of Acts with a bearing on the environment

The following table gives a list of Acts in Botswana which have a bearing on the environment.

Table 12.1 Botswana Environment related Legislation

Name of Act	Objectives of the Act	Administering Department	Ministry
Waste Management Act of 1998	To make provision for the planning, facilitation and implementation of advanced systems for regulating the management of controlled waste in order to prevent harm to human, animal and plant life; to minimize pollution of the environment, to conserve natural resources; to cause provisions of the Basel Convention to apply in regulating the trans-boundary movement of hazardous wastes and their disposal		
Agricultural Resources Conservation Act of 1972	Conserves the (a) soils of Botswana; (b) waters of Botswana (c) plant life and vegetation of Botswana, and the vegetable products of the soil; (d) animal life and fauna of Botswana including animals, birds, reptiles, fish and insects	Department of Forestry and Range resources	
Herbage Preservation (Prevention) of Fires) of 1978	• Prohibition of burning of vegetation • Duty to extinguish fires • Notice to be given before burning vegetation		
Forest Act of 1968	Provides for the better regulation and protection of forests and forest produce in Botswana and to provide for matters incidental thereto		
Wildlife Conservation and National Parks Act of 1992	Provision for the conservation and management of the wildlife of Botswana, giving effect to CITES and any other international convention for the protection of fauna and flora to which Botswana is, from time to time, a party, to provide for the establishment, control and management of national parks and game reserves	Department of Wildlife and National Parks	
Fish Protection Act of 2004	Provide for the effectual regulation, control, protection and improvement of fish and fishing in Botswana		

Environmental Impact Assessment Act of 2007	Provide for environmental impact assessment to be used to assess the potential impacts of planned developmental activities; To determine and to provide mitigation measures for effects of such activities as may have such significant adverse impact on the environment; to put in place a monitoring process and evaluation of the environmental impacts of implemented activities	Department of Environmental Affairs	
Tourism act of 1993	Regulating the tourist industry with a view to promoting its development and well being	Department of Tourism	
Botswana Tourism Board Act of 2004	To market and promote Botswana's tourist attractions, and to encourage and facilitate travel, by local and foreign tourists, to the said attractions. (a) Plan, develop and implement tourism marketing and promotion strategies aimed at creating and sustaining a positive image of Botswana as a tourist and investor destination (b) Plan, formulate and implement strategies for promoting sustainable tourism development in collaboration with the private sector in the tourism industry, local authorities, local communities and non governmental organisations	Botswana Tourism Board	
Petroleum (Exploration and Production) Act of 1983	(i) Provides for the granting, renewal and termination of petroleum exploration and development licences (ii) Empowers Minister to prevent and order the ceasing of wasteful production or processing practices		
Mines, Quarries, Works and Machinery Act of 1978	Provides for safety, health and welfare of those engaged in prospecting, mining and quarrying operations	Department of Mines	
Explosives Act of 1962	Provides for the control of the manufacture, importation, sale transport, storage, use and disposal of explosives		
Boreholes Act of 1966	(i) Regulates the sinking and deepening of boreholes beyond stated thresholds (ii) Empowers Geological Surveys to, inter alia, inspect, pump-test boreholes and access records for boreholes	Department of Geological Surveys	

Water Act of 1962	Provides for the grant of water rights and servitudes and makes provisions incidental thereto	Department of Water Affairs	
Water Works Act of 1962	(i) Provides for the creation of water authorities for water works areas and of water works areas (ii) Empowers authorities to inspect waterworks (iii) Criminalises and punishes injury, diversion, pollution, misuse and waste of water		
Aquatic Weeds (Control) Act of 1971	(i) Provides for the control of aquatic weeds listed (harmful weeds) and matters incidental thereto (ii) Prescribes that certain aquatic weeds shall not be imported into Botswana or be moved from one place to another (in Botswana) (iii) Provides that persons wishing to import boats and other water vessels must have an import permit and that the importation must be through gazetted ports of entry to enable inspection and other things		
Plant Diseases and Pests Act of 1959	Provide for the prevention of the introduction into and spread within Botswana of plant diseases and plant pests	Department of Crop Production	Ministry of Agriculture
Agrochemical Act of 1999	Provide for the registration and licensing of agrochemicals; to control or regulate their importation, manufacture, distribution, use and disposal		
Noxious Weed Act of 1916	Provide for the eradication and destruction of noxious weeds, every owner or occupier of land within any area to which this Act applies shall eradicate and destroy any burweed (Xanthium spinosum) growing or being upon the land owned or occupied by him, this shall apply to any noxious weed other than burweed		
Importation of Bees Act of 1910	To prevent the introduction of the disease amongst bees known as “foul brood”		
Locust Act of 1923	Provide for the destruction of locusts		
Livestock and Meat Industries Act of 1962	Provide for the control of the operation of abattoirs, slaughter houses, cold storages, canning plants, slaughter poles, bone meal factories, livestock produce store, tanneries and meat processing plant, for the control of dealings in and marketing, pricing, grading and inspection of livestock	Department of Animal Health and Production	

	produce and the produce of tanneries and for matters incidental thereto		
Diseases of Animals Act of 1977	Provide for the prevention and control of diseases of animals; to regulate the import, export and movement of animals; to provide for the quarantine of animals in certain circumstances and to provide for matters incidental to and connected with the foregoing		
Land Control Act of 1975	Provides for the control of transactions in agricultural land, i.e land apportioned for agricultural use whether it is freehold or tribal land. It prohibits the sale/transfer/lease of such land without consent from the relevant government authority	Department of Lands	Ministry of Lands and Housing
The Tribal Land Act of 1970	Provides for the establishment of tribal land boards in which are vested powers and duties of managing tribal land with the aim of ensuring the fair distribution of land resources among citizens and different uses (which are mainly agricultural and residential)	Department of Land Boards Services	
Town and Country Planning Act of 1980	Primarily concerned with an orderly and progressive development of land in both urban and rural areas, the preservation and improvements of amenities thereof. It also aims at controlling the planning and use of such land so as to ensure the safety of public property and health as well as the amenities thereof.	Department of Town and Regional Planning	
The Sate Land Act of 1966	Defines the state of land of Botswana and provides for the proper usage of public land held in trust by the state so as to ensure the benefit of all the citizens of the country	Department of Town and Regional Planning	

Public Health Act of 1981	Designed to maintain a good environment for the protection of human health. It makes the notification of certain diseases compulsory and provides for the control of such diseases subject to international health regulations. The Act further provides for the prevention of the introduction of diseases into Botswana, the regulation of sanitation and housing, and the protection of foodstuffs and water supplies among other things. For instance, it forbids the pollution of water sources that are used or likely to be used for domestic purposes, by, for example, the indiscriminate dumping of chemicals in the water which may compromise human health	Department of Public Health	
Control of Smoking Act of 1993	To control smoking of tobacco and tobacco products	Department of Public Health	
Sleeping Sickness Act of 1939	Makes it compulsory for persons infected or suspected to be infected with sleeping sickness to submit themselves for medical examinations, and those who are infected to submit themselves for treatment. The Act makes it mandatory for employers to grant facilities for the examination and treatment of their employees and the owners and occupiers of land in sleeping sickness areas to take measures to prevent the outbreak or spread of the disease. It authorizes the President to declare sleeping sickness areas and some part thereof as restricted entry areas on account of the difficulty of protecting the persons therein. The Act gives powers to relevant government departments to control the breeding of the tsetse fly by spraying infested areas and through public education campaigns	Department of Public Health	