DEMOGRAPHIC IMPACT OF HIV/AIDS ON THE POPULATION OF BOTSWANA 2001–2016

KHUMO CATHRINE MABILLE

**Submitted as part of fulfilment for the requirements of the Master of Social Science Degree in Population Studies
North West University-Mafikeng Campus
Faculty of Human and Social Sciences**

LIBRARY
MAFIKENG CAMPUS
CALL NO.:
2021 -02- 09
ACC.NO.:

SUPERVISOR: DR. M. E PALAMULENI

December 2012

DECLARATION

I, Khumo Cathrine Mabille, declare that this dissertation titled "Demographic Impacts of HIV/AIDS In Botswana 2001-2016" submitted for the degree of Master of Social Sciences (Population Studies), has not previously been submitted by me for the degree at this or any other university; that this is my own work in design and execution; and all the sources I have used or quoted have been duly acknowledged.

Khumo Cathrine Mabille

Date

ACKNOWLEDGEMENTS

My heartfelt thanks go to Dr. Martin Palamuleni, my supervisor, advisor and mentor, who guided me with intelligence and expertise which, with each meeting, shed more and more light on my dissertation path. With persistence and patience, he challenged me to learn, question, think, synthesize, and critically analyze which made me appreciate and illuminate my research study clearer.

I wish to acknowledge the support of the National Research Foundation (NRF) through their grants for students' research projects programme that enabled me to complete the research study. Special mention goes to Prof. Kalule-Sabiti, the Director of Research and Post Graduate Studies.

I also wish to acknowledge the support of my colleagues Mr. Philimon Selemela with whom we travelled the dissertation journey together. Without his encouragement, counsel and technical support, the journey would not have been fruitful.

Thanks to my family and friends for their understanding during this study time. Lastly, I would like to thank my beloved husband, Neo, for his enduring undivided support during this study. I am grateful.

Above all, thanks to Almighty.

DEDICATION

I dedicate this study to my late mother, **Kebonyetsala Motshelamadi,** who did not live long to witness this great achievement of her only daughter.

I also wish to dedicate this to all people who are either living or affected by the HIV/AIDS pandemic.

LIBRARY

ABSTRACT

This study examines the demographic impact of HIV/AIDS in Botswana, using data from the 2001 population census and the 2004 & 2006 Botswana AIDS Impact Surveys. The study prepares three sets of projections for the population of Botswana: slow, medium and fast decline of HIV/AIDS scenarios. The assumptions regarding mortality, fertility and migration are similar in all the three scenarios, except for HIV/AIDS assumptions. The fast variant represents the faster decline of HIV/AIDS prevalence rates, slow decline represents a slower decline rate of HIV/AIDS, and middle variant assumes that the trend that was observed between 2001 and 2004 will continue to be experienced. This study considers the medium variant to be the most likely scenario.

Based on the medium variant, the total population of Botswana is projected to grow from 1 669 190 in 2001 to 2 137 400 in 2016. Although the population is projected to grow, the growth rate of the country is projected to decline due to HIV/AIDS. In 2001, population growth was 2.5% and it is anticipated to decline to 0.6% in 2016.

The decline will also be experienced at district level. The most awful decline will be observed in Phikwe district with negative growth rate of -0.5% in 2016. Mortality has increased in the country from 2001 to 2013, and then improves to the year 2016. For example, life expectancy (e0) for both sexes will decline from 54.5 years in 2001 to 44.8 years in 2013, then rise to 45.5 years in 2016. Furthermore, the total fertility rate (TFR) will decline from 3.2 in 2001 to reach replacement level. Numbers of AIDS orphans and AIDS population will also increase. AIDS orphans will be 83 047 in 2016 and AIDS deaths will increase to 19 080 in the same year.

This study recommends that the government should intensify its efforts to prevent new infections because Botswana's long-term vision is to have no new HIV infections by 2016. This can only be achieved with an enormous and non-stop HIV prevention campaigns. In addition to that, Botswana has a potential to reap the benefits of demographic dividend, so in order for the country to realize that, right policies should be put in place. A broader measure would include infrastructure (health care systems,

schooling, roads, and transport) and a formal labour market with unions and laws protecting both employees and employers.

LIST OF ABBREVIATIONS

ACHAP	: African Comprehensive HIV/AIDS Partnerships
AIDS	: Acquired Immune Deficiency Syndrome
AIM	: AIDS Impact Model
ARV	: Anti Retro Viral
ART	: Anti Retro Viral Therapy
BAIS	: Botswana AIDS Impact Survey
BHRIMS	: Botswana HIV/AIDS Response Information Management Systems
BOCAIP	: Botswana Christian AIDS Intervention Programme
BOTUSA	: Botswana USA
CDC	: Centre for Disease Control
CSO	: Central Statistics Office
EPP	: Estimation and Projection Package
HIV	: Human Immunodeficiency Virus
HDI	: Human Development Index
IIASA	: International Institute for Applied System Analysis
IMR	: Infant Mortality Rate
LDC	: Less Developed Countries
NACA	: National Aids Coordinating Agency
OAU	: Organization of African Unity
PMTCT	: Prevention from Mother to Child Transmission
PRB	: Population Reference Bureau
PSI	: Population Services International
RUP	: Rural Urban Projections
TFR	: Total Fertility Rate
UN	: United Nations
UNAIDS	: United Nations Acquired Immune Deficiency Syndrome
UNDP	: United Nations Development Programme
UNHCR	: United Nations High Commission for Refugees
UNICEF	: United Nations Children's Fund
USA	: United States of America
VCT	: Voluntary Counselling and Testing
WHO	: World Health Organisation

GLOSSARY OF TERMS

Age-Dependency Ratio: The ratio of persons in the ages defined as dependent (less than 15 years and over 64 years) to persons in the ages defined as economically productive (15-64 years) in a population.

Age-Sex Structure: The composition of a population as determined by the number or proportion of males and females in each age-sex category. The age-sex structure of a population is the cumulative result of past trends in fertility, mortality and migration.

Census: A canvass of a given area, resulting in an enumeration of the entire population and often the compilation of other demographic, social, and economic information pertaining to that population at a specific time.

Demographic Dividend: is a rise in the rate of economic growth due to a rising share of working age people in a population.

Growth Rate: The number of people added to (or subtracted from) a population in a year due to natural increase and net migration expressed as a percentage of the population at the beginning of the time period.

HIV Prevalence: The proportion of a defined population with the infection of HIV/AIDS, at a given point or period of time.

Infant Mortality Rate: The number of deaths of infants (under age 1) per 1,000 live births in a given year.

Life Expectancy: The average number of additional years a person could expect to live if current mortality trends were to continue for the rest of that person's life. Most commonly cited as life expectancy at birth.

Median Age: The age that divides a population into two numerically equal groups; that is, half the people are younger than this age and half are older.

Migration: The movement of people across a specified boundary for the purpose of establishing a new or semi-permanent residence. Migration is divided into

international migration (migration between countries) and internal migration (migration within a country).

Mortality: Incidence of death in a population.

Orphan: In this study, an orphan is defined as a child under the age of 15 whose mother has died of AIDS. It is assumed that if the mother has AIDS, the father will have the fatal disease as well.

Population Density: Population per unit of land area; for example, people per square mile or people per square kilometre of arable land.

Population Distribution: The patterns of settlement and dispersal of a population.

Population Policy: Explicit or implicit measures instituted by a government to influence population size, growth, distribution, or composition.

Population Projection: Computation of future changes in population numbers, given certain assumptions about future trends in the rates of fertility, mortality, and migration. Demographers often issue low, medium, and high projections of the same population, based on different assumptions of how these rates will change in the future.

Population Pyramid: A bar chart, arranged vertically, that shows the distribution of a population by age and sex. By convention, the younger ages are at the bottom, with males on the left and females on the right.

Replacement–Level Fertility: The level of fertility at which a couple has only enough children to replace themselves, or about two children per couple (TFR = 2.1).

Sex Ratio: The number of males per 100 females in a population.

Total Fertility Rate (TFR): is the average number of children a woman would bear over the course of her lifetime if current age-specific fertility rates remained constant throughout her childbearing years (between the ages of 15 and 49).

Urban: Countries differ in the way they classify population as 'urban' or 'rural. In Botswana, urban settlement is defined by a minimum threshold population of 5000 residents with at least 75% of its economically active population engaged in non-agricultural activities.

NWU LIBRARY

Urbanization: Growth in the proportion of a population living in urban areas.

TABLE OF CONTENTS

DECLARATION ii
ACKNOWLEDGEMENTS iii
DEDICATION iv
ABSTRACT v

CHAPTER 1: INTRODUCTION 1
1.1 Background 1
1.2 Statement of the problem 1
1.3 Objectives of the study 4
1.3.1 Main objective 4
1.3.2 Specific objectives 4
1.4 Significance of the study 4
1.5 Organization of the study 5

CHAPTER 2: LITERATURE REVIEW 6
2.1 Introduction 6
2.2 Methods of population projections 6
2.2.1 National projections 6
2.2.2 Sub national projections 7
2.3 Uses of projections 9
2.4 Overview of existing population projections in Botswana 9
2.4.1 United Nations 9
2.4.2 World Bank 11
2.4.3 US Census Bureau 12
2.5 Components of population growth in Botswana 19
2.6 HIV/AIDS in Sub-Saharan Africa 25
2.6.1 HIV/AIDS epidemic in Botswana 25
2.6.2 Government interventions to curb HIV/AIDS in Botswana 27
2.6.3 Anti-Retroviral therapy (ART) 27
2.6.4 Voluntary testing and counselling 28
2.6.5 Prevention of mother to child transmission HIV 29
2.6.6 Improvement of blood safety 30
2.6.7 A free condom dispenser in Botswana 30
2.6.8 Male circumcision 31
2.7 Summary 31

CHAPTER 3: METHODOLOGY 32
3.1 Introduction 32
3.2 Background description of Botswana 32
3.2.1 Ethnic composition 32
3.2.2 Geographical aspect 32
3.2.3 Climate 33
3.2.4 Economy 33
3.3 Sources of data 34
3.3.1. Demographic data 34
3.3.2 HIV/AIDS data 34
3.4 Quality of data 35
3.5 Projection assumptions 35

3.5.1 Base population....35
3.5.2 Mortality assumptions....38
3.5.3 Fertility assumptions....40
3.5.4 Migration assumptions....41
3.5.5 HIV/AIDS assumptions....43
3.7 Software for data analysis....46
3.8 Limitations of the study....51
3.9 Summary....51

CHAPTER 4: ANALYSIS OF FAST DECLINE SCENARIO....52
4.1 Introduction....52
4.2 Results....52
4.2.1 Projected population of Botswana....52
4.2.3 Projected population growth rates....56
4.2.4 Age structure....57
4.4. 5 Vital rates....58
4.3 Summary....63

CHAPTER 5: ANALYSIS OF MEDIUM DECLINE SCENARIO....64
5.1 Introduction....64
5.2 Results....64
5.2.1 Projected population of Botswana....64
5.2.2 Percentage distribution....66
5.2.3 Projected population growth rates....68
5.2.5 Age structure....70
5.2.6 Median age....71
5.2.7 Vital rates....86
5.3 Summary....90

CHAPTER 6: ANALYSIS OF SLOW DECLINE SCENARIO....91
6.1 Introduction....91
6.2 Results....91
6.2.1 Projected population of Botswana....91
6.2.3 Projected population growth....93
6.2.4 Age structure....93
6.2.6 Vital rates....96
6.3 Summary....100

CHAPTER 7: CONCLUSION AND RECOMMENDATIONS....101
7.1 Introduction....101
7.2 Major findings....101
7.3 Conclusion....104
7.4 Recommendations....105

REFERENCES....106

LIST OF TABLES

Table 1: Base population of Botswana in thousands, 2001 (Males)....36
Table 2: Base population of Botswana in thousands, 2001 (females)....37
Table 3: Mortality assumptions for males, 2001-2016....38
Table 4: Mortality assumptions for females, 2001-2016....39
Table 5: Mortality assumption for both sexes, 2001-2016....39
Table 6: Fertility assumptions for districts in Botswana, 2001-2016....40
Table 7: Migration assumptions for males, 2001-2016....42
Table 8: Migration assumptions for females, 2001-2016....42
Table 9: Migration assumptions for both sexes, 2001-2016....43
Table 10: Slow decline HIV/AIDS assumptions....44
Table 11: Medium decline HIV/AIDS assumptions....45
Table 12: Fast decline HIV/AIDS assumptions....46
Table 13: Male ratio of HIV prevalence% at 20-29....48
Table 14: Female ratio of HIV prevalence% at 25-29....48
Table 15: Mothers receiving PMTCT....49
Table 16: Children born to HIV+ mothers by type of feeding (%)....49
Table 17: Probability of transmission of HIV from mother to child....50
Table 18: Number of adults receiving ART....50
Table 19: Children receiving ART and Cotrimoxazole....50
Table 20: Projected population for Botswana by districts, 2001-2016....53
Table 21: Projected percentage population distributions for Botswana, 2001-2016...55
Table 22: Annual population growth rates for Botswana, 2001-2016....56
Table 23: Projected age distribution by districts, 2016....57
Table 24: Projected median age by districts....58
Table 25: Projected infant mortality rates (IMR) by district, 2001-2016....59
Table 26: Projected life expectancy at birth for males by district, 2001-2016....60
Table 27: Projected life expectancy at birth for females by district, 2001-2016....60
Table 28: Projected life expectancy at birth for both sexes by district, 2001-2016.....61
Table 29: Projected AIDS deaths by district, 2001-2016....62
Table 30: Number of orphans in Botswana and districts, 2001-2016....63
Table 31: Projected population of Botswana by districts, 2001-2016....65
Table 32: Percentage distribution of population by districts....67
Table 33: Annual population growth rates for Botswana, 2001-2016....68
Table 34: Age distribution by broad age groups for Botswana & districts....70
Table 35: Projected median age by districts, 2001-2016....72
Table 36: Projected infant mortality rates by district, 2001-2016....86
Table 37: Projected life expectancy at birth for males by district, 2001-2016....87
Table 38: Projected life expectancy at birth for females by district, 2001-2016....87
Table 39: Projected life expectancy at birth for both sexes by district, 2001-2016.....88
Table 40: AIDS Deaths by district, 2001-2016....89
Table 41: Number of orphans by districts....90
Table 42: Projected population by district, 2001-2016....91
Table 43: Projected percentage distribution of population by districts....92
Table 44: Annual population growth rates, 2001-2016....93
Table 45: Projected age distribution by broad age groups for Botswana & districts 94
Table 46: Projected median age for Botswana and districts, 2001-2016....95

Table 47: Projected infant mortality by district, 2001-2016 96
Table 48: Projected life expectancy at birth for males by district, 2001-2016 97
Table 49: Projected life expectancy at birth for females by district, 2001-2016 97
Table 50: Projected life expectancy at birth for both sexes by district, 2001-2016 98
Table 51: Projected AIDS deaths by district, 2001-2016 98
Table 52: Number of AIDS orphans in Botswana and districts, 2001-2016 99
Table 53: Comparisons of different sets of projections, 2016 104

LIST OF FIGURES

Figure 1: Map of Botswana..33
Figure 2: Population of Botswana by districts 2001..54
Figure 3: Projected population of Botswana by district, 2016..54
Figure 4: Total population of Botswana, 2016 (in thousands)..65
Figure 5: Projected percentage population distributions for Botswana, 2001..66
Figure 6: Projected population percentage distributions by district, 2016..67
Figure 7: Projected population density for Botswana, 2016..69
Figure 8: Population pyramid for Botswana 2001..73
Figure 9: Population pyramid for Botswana 2016..73
Figure 10: Population pyramid for Central, 2001..74
Figure 11: Population pyramid for Central, 2016..74
Figure 12: Population pyramid for Gaborone, 2001..75
Figure 13; Population pyramid for Gaborone, 2016..75
Figure 14: Population pyramid for Francistown, 2001..76
Figure 15: Population pyramid for Francistown, 2016..76
Figure 16: Population pyramid for Ghanzi, 2001..77
Figure 17: Population pyramid for Ghanzi, 2016..77
Figure 18: Population pyramid for Kgalagadi, 2001..78
Figure 19: Population pyramid for Kgalagadi, 2016..78
Figure 20: Population pyramid for Kweneng, 2001..79
Figure 21: Population pyramid for Kweneng, 2016..79
Figure 22: Population pyramid for Lobatse, 2001..80
Figure 23: Population pyramid for Lobatse, 2016..80
Figure 24: Population pyramid for Ngami, 2001..81
Figure 25: Population pyramid for Ngami, 2016..81
Figure 26: Population pyramid for North East, 2001..82
Figure 27: Population pyramid for North East, 2016..82
Figure 28: Population pyramid for Phikwe, 2001..83
Figure 29: Population pyramid for Phikwe, 2016..83
Figure 30: Population pyramid for South East, 2001..84
Figure 31: Population pyramid for South East, 2016..84
Figure 32: Population pyramid for Southern, 2001..85
Figure 33: Population pyramid for Southern, 2016..85
Figure 34: Population of Botswana by districts, 2016..92

CHAPTER 1: INTRODUCTION

1.1 Background

Population projections can be defined as the calculation of the population's future size, structure and distribution based on the present age-sex structure and with the present rates of fertility, mortality, and migration (Shyrock & Siegel, 1976; Mayhew, 2011). The calculation of the future population size and structure is based on the past and expected trends in mortality, fertility and migration. The population projection is useful because of the need to plan for future population (Smith et al, 2001). Data collected from population censuses usually form a base for preparing population projections and estimation of initial growth rates and demographic indicators. Government policymakers and planners around the world use population projections to estimate future demand for food, water, energy, and services, and to anticipate future demographic characteristics (United Nations, 2000). Population projections can alert policy makers to major trends that may affect economic development and help policymakers craft policies that can be adapted for diverse projection scenarios (United Nations, 2000). In this study, the interest of the researcher is to demonstrate the impact of HIV/AIDS in the population of Botswana and its implications on population projections.

NWU
LIBRARY

1.2 Statement of the problem

A number of international organizations prepare population projection for the world, regions as well as individual countries (United Nations, 2000). In addition, the national governments prepare projections for their own countries. However, projections prepared by international organization such as United Nations (UN) and United States Census Bureau, only prepare projections for the world and individual countries. They do not go beyond sub-areas of those individual countries. Therefore, national governments prepare population projections at national level and its sub-regions. In the case of Botswana, the Central Statistics Office (CSO) in Botswana prepares population projections for the whole country and its districts. Hence, Botswana has population projections for its sub-areas (districts). CSO has produced population projections for Botswana and its districts basing on the census that the country has ever had. However, this study seeks to carry out population projections in

the face of the existing ones to correct the following unsatisfactory conditions with the current projections.

First, all the existing population projections use the ratio method to project districts (CSO, 2001). The ratio method projects the national population (using cohort-component method) and then estimates the population of the sub-national based on assumed proportion/percentage of the sub-national. In a way this can be regarded as "top-down" approach. This study suggests a dissimilar approach which is "bottom-up". In other words, projecting from smaller areas such as districts, to a larger area, an then the country. The advantage of bottom-up approach is that it is context-specific. This implies that since mortality, fertility is known to vary among socio-economic, racial or ethnic groups within the country; projections should start from the level where fertility and mortality are established to be homogenous in the population (Stats SA, 2005).

Second, most of the existing population projections are for a longer period. Therefore, this study projects from 2001 to 2016 because local-area projections tend to use shorter time horizons, typically less than 10 years, whereas national and global projections can extend decades into the future, and in some cases for more than a century (O'Neill et al, 2001; Smith, 2001). In addition to that, the longer the period of projections, the greater the errors will be in the assumptions and the lesser utilization of the population projections (Stover & Kirneryer, 1997).

Third, ante-natal data has since became the primary source of data on the spread of HIV/AIDS for the countries with generalized epidemics (UNAIDS, 2008; WHO, 2003). Ante-natal data is good because it provides ready and easy access to a cross-section of sexually active women from the general sexually active women from the general population who are not using contraception. In countries with low levels of HIV prevalence, strategically positioned sentinel sites are capable of providing an early warning for the start of the epidemic. However, despite the above mentioned advantages, ante-natal data has some weaknesses. It may not be representative of all pregnant women because many women may not attend ante-natal clinics or may attend private clinics (Yoder & Konate, 2002). In addition, the results are biased

estimates of the prevalence of all women aged 15-49 since only pregnant (and by definition sexually active) women are tested. At the younger ages (particularly below age 20) the HIV prevalence estimates can be expected to be much higher than the true prevalence in all women (many of whom would not yet be sexually active) (Colvin & Mullick, 1997). However, this study wishes to use Botswana AIDS Impact Survey (BAIS II & III) because it is assumed to be better data than the ante-natal data. It is better in the sense that it can provide representative estimates of HIV prevalence for the general population as well as for different sub-groups, such as urban and rural areas, women and men, age groups and region or district. The results from BAIS surveys can be used to adjust the estimates obtained from sentinel surveillance systems. Lastly, BAIS surveys provide an opportunity to link HIV status with social, behavioural and other biomedical information, thus enabling researchers to analyse the dynamics of the epidemic in more detail. This study acknowledges that, just like ante-natal data, BAIS may have weaknesses also, but it desires to see how the results will be, with alternative AIDS data. Moreover, the existing projections have used BAIS I and II. No study has used the BAIS III yet, which is the latest survey on (HIV/AIDS prevalence rates). So, this study will provide up to date population projections information of the HIV/AIDS pandemic in Botswana using the recent data (HIV/AIDS prevalence rates) from Botswana Aids Impact Survey III.

The fourth reason is that there are very few individuals who have prepared population projections for Botswana (See, for example, Udjo, 1995b; Dorrington et al, 2006). Thus, this study desires to provide alternative population projections by another individual.

Finally, the existing population projection by CSO (2001) assumes that immigration will decline until zero. For that reason, this study doubt that migration can come to zero because of globalization. Globalization acknowledges the greater movement of people, goods, capital and ideas due to increased economic integration which in turn is propelled by increased trade and investment. It is like moving towards living in a borderless world (World Bank, 2004). Therefore, this study takes migration into consideration and assumes that it remains constant.

1.3 Objectives of the study

1.3.1 Main objective

The main objective of this study is to project the likely future impact of the HIV/AIDS epidemic in Botswana, at district and national levels from the year 2001-2016.

1.3.2 Specific objectives

The specific objectives of this study are:

i. To determine the impact of AIDS on the population size and age structure;
ii. To determine the impact of HIV/AIDS population dynamics that is mortality and fertility;
iii. To estimate number of deaths attributed to AIDS;
iv. To estimate number of AIDS orphans by 2016; and
v. To suggest recommendations regarding the fight against HIV/AIDS.

1.4 Significance of the study

HIV/AIDS has a number of implications in society. It has an impact on population parameters (i.e. fertility, mortality and migration) and other aspects of development, for example, AIDS deaths increase mortality rates in Botswana. Life expectancy has decreased from 65.3 years in 1991 to 55.6 years in 2001 and infant mortality rate has increased from 48 to 56 deaths per 1000 over the same period (CSO, 1991 and 2001). Therefore, this study will project the population of Botswana in order to alert policy makers to major trends that may have an effect on economic improvement and assist policy makers to craft policies that can be adapted for a range of projection scenarios. For example, HIV/AIDS will be monitored to make informed decisions or to change the policy documents in order to advance the battle against the epidemic in Botswana. Alternative scenarios provide an indication of potential variation in future demographic trends, which facilitate planning for worst case outcomes. This will benefit the government of Botswana as they can rely on the results for policy decisions. In addition to that, many countries are decentralizing their government structures to better respond to local needs. This is the transfer of responsibility for planning, management, and resource-raising and allocation from the central government to subordinate units or levels of government (UNPF, 2000). In case of

Botswana, these subordinate units are districts. For that reason, districts need reliable detailed population estimates by age and sex structure for easy planning at that level.

1.5 Organization of the study

This study will be organized under seven chapters. Chapter 1 provides background information on population projections in Botswana, significance of this study and objectives of the study. Chapter 2 of this thesis will review existing literature on population projections of Botswana, method and assumptions. The study will further look into the measures taken by the country so far to curb the HIV/AIDS epidemic in the country. Chapter 3 provides methodology of the study as well as the assumptions. Chapter 4, 5 and 6 discuss the results of this study for fast, medium and slow decline scenarios respectively. Lastly, chapter 7 presents major findings of the study, conclusion and recommendations.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

This chapter will review previous studies on population projection focusing particularly in population projections for Botswana. This literature will cover methods and assumptions used in the projections. Because HIV/AIDS affect components of population, this chapter will further look into it and the interventions by Botswana government to fight the epidemic.

2.2 Methods of population projections

Population projection methodologies vary widely in terms of degree of sophistication, requirements and detail of results. Population projections can be classified into National and Sub-national methods.

2.2.1 National projections

Mathematical and Cohort Component methods are commonly used when preparing national projections (Shyrock & Siegel, 1976).

2.2.1.1 Mathematical methods

These methods extrapolate the population into the future according to either its past trends or an assumed future trend, usually fitting a mathematical formula. These mathematical methods include linear, geometric and exponential methods (Smith et al, 2001). Advantage of mathematical methods is that they are relatively simple to apply in most situations. On top of that smaller geographical areas are better projected by simplier methods such as ratio allocation or mathematical methods. The disadvantage is that mathematical extrapolation methods is the often unrealistic assumption that a particular rate of growth will continue over the entire projection period.

2.2.1.2 Cohort component method

In this method, the components of population change (fertility, mortality and net migration) are projected separately for each birth cohort, i.e. persons born in a given year (US Census Bureau, 2010). While this method may require extensively more

effort than other methods, due to the amount of data needed, it may result in a more accurate projection if the data is accurate (Smith et al, 2001). Most of the existing projections in Botswana have used cohort-component when projecting the national population. The advantage of this technique is a built in mechanism that augment accuracy by taking into consideration all factors influencing the population (Shyrock & Siegel, 1976).

The cohort component method is expressed as follows:

$P(_{x+k})^{t+k} = [(L_{x+k} / L_x] *(P_x)^t + (M_{x+k})^{t+k}$

Where x = age

K= number of years

$P(_{x+k})^{t+k}$ = number of survivors at age x+k at time t+k

$(M_{x+k})^{t+k}$ = net migration count at age x+k at time t+k

$(P_x)^t$= population at age x at time t

$(L_{x+k}) / L_x$ = survivorship rate

i.e. The probability of surviving from age x to age x+t.

2.2.2 Sub national projections

To project the population of sub-regions within the country, the same methods mentioned above can still be used (Mathematical and Cohort Component method). The only difference is that the selected method will be applied for each region or area in the country.

2.2.2.1 Ratio method

This method projects sub-national projections of a country using the total country projections obtained by other methods such as cohort component (top-down). This method allocates a specific area population as a proportion of a large area, or country, whose population is already projected. This method disregards the birth, death and migration processes in the locality of interest, and possible changes in the ratio itself (Smith et al, 2001).

2.2.2.2 Bottom up method

This approach means projecting population from smaller areas to get a larger population. In this case, smaller areas are districts of Botswana while the larger area is Botswana, as a country. Just like other methods, this approach applies cohort component method for each district and later average or sums the estimates to get the national ones. This study uses a bottom-up approach because most of the existing projections of Botswana have used the ratio method to obtain district projections. Arguments have been presented both in favour of and against this procedure (Stats SA, 2005). Arguments in favour of a control total (ratio) contend that information for the whole country is frequently of better quality than information for each region because vital events may be recorded by place of registration rather than by place of occurrence. Such misplacement of vital events may result in a distorted estimate of the components of growth of each region and hence events may not reflect the proper total for the country. The argument against control total is that, if vital registration is reliable, whatever happens in country will be the result of what happens in each of the regions (Stats SA, 2005).

However, this study prefers a bottom-up approach because it is based on the argument that components of population change (mortality, fertility and migration should be context-specific). This implies that since mortality, fertility are known to vary among socio-economic, racial or ethnic groups within the country, projections should start from the level where fertility and mortality are established to be homogenous in the population (Udjo, 1995b).

Future populations are derived from a base population through the projection of population change by its major demographic components; births, deaths, and migration. The projection of the demographic components of change is driven by the composition of the population by age, sex, districts of Botswana and the way these variables determine the tendency to bear children, die, and migrate to or from Botswana and within its districts. The projection of sub-areas (Botswana districts) will be used to come up with the total country population projections.

2.3 Uses of projections

There are many ways in which population projections are used. Government policymakers and planners around the world use population projections to estimate imminent demand for basic services such as food, water as well as other socio economic services such as health, education and employment (PRB, 2001). In addition to that, population projections can be used to anticipate future demographic characteristics. Population projections can alert policy makers to major trends that may affect economic development and help policymakers craft policies that can be adapted for diverse projection scenarios. Commercial organizations often use projections for marketing research. They usually want populations classified by socioeconomic categories such as income and consumption habits (in addition to age and sex) and by place of residence. Global change researchers often use projections as exogenous inputs to study topics such as energy consumption, food supply, and global warming. They may want to know what the potential effect of environmental feedbacks on growth might be (O Neill et al, 2001).

2.4 Overview of existing population projections in Botswana

Most national governments make population projections for their own countries. In addition, a few international organizations prepare population projections for the world, regions, and individual countries. International agencies which produce population projections for the entire world, its major regions and all the countries include United Nations, World Bank and United States Census Bureau (O Neill et al, 2001). Quite a few other agencies also produce international projections i.e. the Population Reference Bureau (PRB), International Institute for Applied systems Analysis, etc. These projections incorporate information from the most recent round of censuses in each country and use latest vital statistics and international migration (Lutz & Klingholz, 1995).

2.4.1 United Nations

The United Nations have prepared global population projections since the 1950s. The UN published its first comprehensive set of national, regional and global projections in 1958 and has since then published a new set every two years since 1978 (UN, 2004). United Nations provides information on the age and sex structure of the

population. The details of the projections have expanded over time with improvements in data and methods of analysis and with utilization of computer technology. The UN projections are the most widely used worldwide. For example, many national governments, international agencies, the media, researchers, and academic institutions rely on UN projections (UN, 2004). To project the population until 2100, the United Nations Population Division uses assumptions regarding future trends in fertility, mortality and international migration. Because future trends cannot be known with certainty, a number of projection variants are produced (UN, 2011).

The 2010 revision includes eight different projection variants (UN, 2011). Five of those variants differ among themselves only with respect to the level of fertility in each, that is, they share the assumptions made with respect to mortality and international migration (UN, 2011).

2.4.1.1 Fertility assumptions

The United Nations have five fertility variants, namely: High, medium, low, constant and instant replacement assumptions. Under the high variant, fertility is projected to remain 0.5 children above the fertility in the medium variant over most of the projection period. By 2020-2025, fertility in the high variant is therefore half a child higher than that of the medium variant. That is, countries reaching a total fertility of 2.1 children per woman in the medium variant have a total fertility of 2.6 children per woman in the high variant. Under the low variant, fertility is projected to remain 0.5 children below the fertility in the medium variant over most of the projection period. By 2020-2025, fertility in the low variant is therefore half a child lower than that of the medium variant. That is, countries reaching a total fertility of 2.1 children per woman in the medium variant have a total fertility of 1.6 children per woman in the low variant. According to Constant-fertility assumption, fertility remains constant at the level estimated for 2005-2010 each country. Lastly, the instant-replacement assumption for each country, fertility is set to the level necessary to ensure a net reproduction rate of one starting in 2010-2015. Fertility varies over the rest of the projection period in such a way that the net reproduction rate always remains equal to unity thus ensuring, over the long-run, the replacement of the population. United Nations projected total fertility rate of Botswana to be 2.62 in 2016 (UN, 2011).

2.4.1.2 Mortality projections

The UN projects mortality under 3 variants normal, constant as well as the model incorporating HIV/AIDS . Under normal mortality assumption, Mortality is projected on the basis of models of change of life expectancy produced by the United Nations Population Division (UN, 2011). These models produce smaller gains the higher the life expectancy already reached. The selection of a model for each country is based on recent trends in life expectancy by sex. For countries highly affected by the HIV/AIDS epidemic, the model incorporating a slow pace of mortality decline has generally been used to project a certain slowdown in the reduction of general mortality risks not related to HIV/AIDS. For constant mortality assumption, mortality over the projection period is maintained constant for each country at the level estimated for 2005-2010. To take HIV/AIDS into consideration, the model developed by the UNAIDS reference group on estimates, modelling and projections is used to fit past estimates of HIV prevalence provided by UNAIDS for each of the affected countries so as to derive the parameters determining the past dynamics of the epidemic in each of them. For most countries, the model is fitted assuming that the relevant parameters have remained constant in the past (UN, 2011).

2.4.1.3 International migration assumptions

Normal and zero are the two migrations underlying the 2010 revision. Under the normal migration assumption, the future path of international migration is set on the basis of past international migration estimates and consideration of the policy stance of each country with regard to future international migration flows. Projected levels of net migration are generally kept constant over the next decades and by the mid-century it is assumed afterwards to gradually decline to zero in 2100. For Zero-migration assumption each country, international migration is set to zero starting in 2010-2015 (UN, 2011).

2.4.2 World Bank

The World Bank began producing national, regional and global population projections in 1978. Some sets have included several alternative series, others only a single series. Until the mid-1990s, the projections were published in various issues of the world

development report. Since then, they have produced only for internal use (World Bank, 2000). World Bank projections generally are used for planning and for managing projects. World Bank mostly relies on assumptions formulated by United Nations.

2.4.3 US Census Bureau

US Bureau began producing national, regional and global projections in 1985 and publish update approximately every other year (US Census Bureau, 2000). The Census Bureau prepares national estimates and projections for all countries using census and survey data, vital statistics, administrative statistics from those countries, and information from multinational organizations that collect and publish data for these countries. Currently projections of the total population are available in 10 year intervals through 2050 and projections by age and sex are available for 2000 and 2025. The Census Bureau Population projections are based on cohort-component method (US Census Bureau, 2010).

2.4.3.1 Mortality assumptions

In order to project future mortality levels, the Census Bureau generally fits a logistic curve to one or more estimates of life expectancy at birth. The results of the logistic projection are carefully scrutinized, to ensure that they yield an acceptable projected level for the given individual country's circumstances (U.S. Census Bureau, 2009). More often than not, the Census Bureau uses a variant of the basic logistic to project e_0 that assumes the same slope for each country. This variant, developed at the Census Bureau in the late 1990s by fitting the logit transformation of e_0 for a number of countries and denoted as the fixed slope logistic, uses slope values of 0.0258 for males and 0.0271 for females (U.S. Census Bureau, 2009).

2.4.3.2 Fertility assumptions

As in the case for mortality, some assumptions about the fertility path are consistent across countries and regions. An expected increase in contraceptive prevalence is implicit in the assumptions about future fertility declines for many countries. For some countries, future fertility levels are projected to experience only minor change, either slight decreases or slight increases. While there is no single "right" way to make assumptions about the future, the Census Bureau relies heavily on extrapolation of

past trends in indicators, coupled with validation checks against published estimates of determinants and correlates in preparing assumptions about future fertility trends. Logistic functions are typically used to model the transition from relatively high fertility to relatively low fertility. In order to project future fertility levels, the US Census Bureau generally fits a logistic curve to one or more TFR estimates. If estimates of TFR are available for more than one date in the past and the TFR is not already below 1.7, a logistic function is fitted to these data (U.S. Census Bureau, 2009).

In some instances, no data on past trends in fertility are available for fitting a logistic curve. In that case, the past experience of neighbouring or similar countries serves as a guide for fitting the likely pace of future change. A logistic function is typically used to project TFRs to 2050 with lower and upper limits depending on the current level of fertility in a country (US Census Bureau, 2009). There are some commonalities among regions, however. Regions which tend to be transitioning from higher to lower fertility have high TFR limits of up to an average of 9 births per woman and a lower limit for 2050 of 2.19 The results of logistic projections are evaluated in light of recent socioeconomic trends, social policies, public health and program coverage, and the proximate determinants of fertility.

NWU
LIBRARY

2.4.3.3 Migration

If migration is known to have a negligible impact on a country's current growth rate, future migration is often assumed to be nil. If a country's migration is known to be significant, the estimated number of migrants during the past is frequently held constant in projecting to the near future.

2.4.3.4 HIV/AIDS

To make projections for countries seriously affected by HIV/AIDS, the Census Bureau models mortality levels and trends under the hypothetical scenario of no epidemic, then adds estimated AIDS-related mortality based on measured HIV prevalence, ensuring that the "with-AIDS" mortality levels are consistent with empirical, population-based estimates. The starting point for the procedure is the Census Bureau's HIV/AIDS Surveillance Data Base. This database is a compilation of aggregate data from HIV zero-prevalence and incidence studies in developing

countries. HIV prevalence points taken from this database are the basis for projecting HIV prevalence and estimating AIDS mortality in countries that have generalized HIV/AIDS epidemics (U.S. Census Bureau, 2009).

The U.S. Census Bureau explicitly models AIDS-related mortality for those countries where adult HIV prevalence is consistently above one percent in the general population and transmission is mainly through heterosexual sex (U.S. Census Bureau, 2009). The impact of AIDS mortality is currently modelled explicitly in the estimates and projections for selected countries located in Asia, Latin America and the Caribbean, Sub-Saharan Africa, and Europe. In 2004, a new application (RUPHIVAIDS) was developed at the Census Bureau to work with the Census Bureau's cohort component Rural-Urban Projection (RUP) program to model the impact of HIV/AIDS on the demography of a country. RUPHIVAIDS uses estimates of HIV prevalence from the Estimation and Projection Package (EPP), an epidemiologically realistic model developed and used by the WHO and the Joint United Nations Programme on AIDS (UNAIDS). The RUPHIVAIDS model estimates HIV incidence implied by the EPP estimates of HIV prevalence through 2010-2015, and then assumes a decline in HIV incidence of 50 percent by 2050.

In conjunction with these adult HIV prevalence estimates, RUPHIVAIDS applies assumptions from the UNAIDS Reference Group on Estimates, Modelling and Projections about the age and sex distribution of HIV incidence, sex ratios of new infections, and disease progression in both adults and children. This reference group provides the relevant technical basis for the UNAIDS/WHO global estimates and projections of HIV prevalence. The global estimates and projections represent the consensus reached at meetings held with representatives from the United Nations Population Division, U.S. Census Bureau, United Nations Children's Fund (UNICEF), WHO, and UNAIDS (U.S. Census Bureau, 2009).

2.4.4 International Institute for Applied System Analysis

The International Institute for Applied Systems Analysis (IIASA) also prepare population projections for the world. IIASA projections have been used primarily to assess various projection assumptions and methods.

2.4.4.1Fertility assumptions

IIASA fertility scenarios are based on current experience and the confidence that the demographic transition is almost assured to continue, it is assumed that fertility in less developed countries (LDC) will continue to decline. High scenario, which is based on the possibility that fertility transition is held back or delayed, fertility in the period 2030-35 is projected to be lower than it is today (O'Neill et al, 2001). One exception is China, where the high variant assumes that fertility rises from 2.0 to 3.0, based on the possibility that the country's one-child policy could be relaxed and fertility might rise as a result. The second exception is Latin America, where it is assumed that fertility stalls in the region as a whole at 3.0 since there is evidence that such a stall has occurred in particular countries due to mixed populations in which some parts are highly developed in the demographic transition while others have almost not started it (O'Neill et al, 2001).

Low-variant scenario assumes that fertility decline in LDCs, as has been the experience in more developed countries (MDCs), does not stop at a TFR of 2.1 but continues to decline, carrying countries into the range of sub-replacement fertility. The Central assumption is derived by averaging high and low variants and is assumed to represent the most likely case. It results in slightly above replacement-level fertility in 2030-2035 in most LDC regions and substantially so in sub-Saharan Africa (O'Neill et al, 2001).

High and low scenarios were assigned levels 0.5 above or below the central assumptions. Fertility in all regions is interpolated linearly between assumptions for 2030-35 and 2080-85, and held constant beyond 2080-85. It is also interpolated between the base period (1990-95) value and 2030-35.

2.4.4.2 Mortality assumptions

Unlike the UN, IIASA uses three diverse scenarios for mortality change. The low mortality scenario projects improvements in MDCs of three years per decade. The high scenario projects increases of one year per decade in developed country regions. The central scenario, as an average of the high and low, assumes a two-year per decade increase in life expectancy. An exception was made for European parts of the former Soviet Union, where the low and high scenarios were set to four and zero

years per decade increases; the latter assumes a continuation of difficult socio-economic conditions that have been associated with a recent decline in life expectancy.

In LDC regions, life expectancy is also assumed to increase at one, two or three years per decade in the high, central, and low mortality scenarios, with quite a lot of exceptions. For sub-Saharan Africa, the range was extended to improvements of four years per decade in the low mortality case to allow for the likelihood of a process of catching up with other regions of the world, and a decline of two years per decade in the high mortality case to take into account the possible impact of AIDS and potential food shortages (O'Neill et al, 2001). The central scenario therefore assumes slow improvements of one year per decade (Lutz & Klingholz, 1995). Since Botswana is part of Sub-Saharan Africa, it is good to assume an increase of two and three years per decade in life expectancy.

2.4.4 Central Statistics Office of Botswana

Apart from the international organizations mentioned above, most governments prepare population projections as part of analyzing census data. Since independence, Botswana has conducted five censuses in 1971, 1981, 1991, 2001 and 2011. The Central Statistics Office in Botswana has so far produced three sets of population projections (CSO, 1986, 1998, 2001). The results of the 2011 census are being analysed and another sets of projections is expected to be conducted thereafter.

2.4.4.1 1981-2011 Population projections

The first set of projections used 1981 population censuses of Botswana as the main source of data. Data used include population size by age and sex in the base year, age specific fertility, migration, mortality rates and the associated survival rates.

Fertility assumptions

Fertility has risen during the intercensal decade in spite of substantial gains in health, education, urbanisation and overall economic status of the people. Fertility rose between 1971 to 1981 in all ages except 40-44 years. However, because it was not known when and by how much will TFR in Botswana decline, the following three assumptions were adopted.

1. Fertility level and pattern will remain constant i.e. TFR of 7.07 throughout the projection period.
2. Fertility rate will decline exponentially by constant average of 1.2% per annum and its age pattern will gradually change to resemble the current urban fertility pattern by 2011.
3. Fertility rate will decline exponentially by a constant average of 2.0% per annum and pattern will change to resemble the current urban pattern by 2011.

In assumption (2) the TFR drops from its current level of 7.07 to 4.93 by 2011 whereas in assumption (3) it reaches 3.88 by the same year. Resulting projections are labelled high, medium and low respectively. Low owing to the difficulty of keeping a sustained and significant decline in fertility in a country where prevailing attitude and traditions are still favourable to high fertility. High presents impact of constant fertility on population size and structure. Medium is plausible because it takes into account moderate but continuous decline in fertility.

Mortality assumptions

The government of Botswana has long started its commitment to effective health and economic development policies that aimed at extending both preventive and curative measures to the people within its primary health care framework, as well as raising the standard of living. These improvements were expected to continue in the future so as to further reduce mortality rates for both sexes, though in view of the then male-female mortality differentials, the reduction was more significant among males than females. Improvements in male mortality were therefore assumed to be faster than females in such magnitude that the annual gain in life expectancy at birth would be 0.47 years per annum for males and 0.34 years per annum for females. The male mortality curve was assumed also to change gradually from the "West" pattern to the "North" pattern by the year 2011 as a result of those rapid improvements (CSO, 1986).

Migration assumptions

In the 80s people were more informed about economic opportunities elsewhere, thus net migration rate from 1981 (0.572 6%) was expected to rise in the next thirty years (CSO, 1986). For projection purpose it was kept constant deliberately to underestimate the magnitude of future population shifts. This was justified by the fact that Botswana was promoting rural development in order to improve rural living conditions and stem the tide of rural exodus. The number of net migrants for 2011 was derived by multiplying the projected (medium variant) aggregate population by the projected rate of migration, which yielded the sum of 14916 net in (or out) migrants in that year.

The derived number of annual net migrants in 2011 was distributed among males and females according to the sex ratio of migrants, observed during 1971-81 and among districts according to their % share in the total migrants in 1981.

2.4.4.2 1991-2021 Population projections

These population projections were projected under three scenarios: High, medium and low variants.

High variant scenario

Under the high variant scenario, fertility was assumed to be constant throughout the projection period (TFR 5.1). The underlying assumptions for mortality in the 1991 population projections were steady improvements in the life expectancy of both males and females and a continued improvement in infant mortality rates. Mortality was assumed with a gain of one year in life expectancy at birth every 5 years for both sexes throughout the projection period. Migration was assumed to be zero (Udjo, 1995).

Low variant scenario

The low variant assumed that mortality and migration were the same as in high variant population projections but modest decline in fertility was assumed to decline below replacement level, with TFR declining from 5.1 in 1991 to 4.5 in 1996, 4.0 in

2001 and 2 .0 in 2011. The medium variant was obtained by averaging both the high and the medium scenarios.

2.4.4.3 2001-2031 Population projections

The population projections are substantially different from those produced after the 1991 census because the greater attention was given to AIDS and also because fertility has fallen faster than previously expected.

2.5 Components of population growth in Botswana

As highlighted in the previous section, in order to prepare population projections assumptions regarding future trends in mortality, migration and fertility need to be established. In this section, trends and levels of mortality, fertility and migration are reviewed.

2.5.1 Mortality

Health and mortality conditions in the developing world have generally experienced very remarkable improvements since World War II (Lutz & Klingholz, 1995). Life expectancy in all developing countries has increased by more than 20 years since 1950-1955, when it was estimated to be around 40 years for both men and women (Lutz & Klingholz, 1995). As a result of this, Garenne & Gakusi, (2006) concluded in their survey of African mortality by stating that past trends in Africa have been induced by transfers of technology from the west, which affected almost all countries in a short period of time. Public health, nutrition, economic development and modern education were the key determinants of mortality decline (Hill et al, 1999). The impressive gains in life expectancy in the LDCs over the past several decades has in many countries been slowed or, in the most serious cases, even reversed due to the impact of AIDS. Sub-Saharan Africa has been most affected. For example, in Botswana life expectancy has dropped from about 63 years in the late 1980s to below 50 in the late 1990s, and Zimbabwe has seen life expectancy fall from 57 to 44 years over the same period (UN, 1999). By subjecting members of the most economically active and productive groups to a premature death, AIDS is imposing an enormous economic and social toll on the continent (Ainsworth et al 2000).

The level of infant mortality in any country has always been accepted as a good indicator of social development or as a more specific indicator of health status of a population (Hill, 1999). For Botswana, infant mortality rates at national level has dropped from 97.1 deaths per 1000 births in 1971 to 48.0 deaths per 1000 births in 1991 and increased to 56 deaths per 1000 births in 2001 (CSO, 2001; Majelantle, 2003). The rural and urban population experienced similar trends with rural populations showing higher levels of infant mortality compared to urban populations (CSO, 2001). The gains in chances of survival for infants experienced in the 1990's have been lost mainly due to the HIV/AIDS epidemic (Udjo, 1995a). The levels of infant mortality rates are now higher than the levels experienced in the mid-1980s. Furthermore, childhood mortality estimates show a similar pattern as infant mortality estimates. The probability that a one year old child will die before reaching age 5 has declined from 0.0358 in 1981 to 0.0160 in 1991 and increased to 0.019 in 2001. Life expectancy at birth has increased from 55.5 years in 1971 to 56.5 years in 1981 and 65.3 years in 1991. Regrettably, the gains in life expectancy could not be sustained mostly due to the spread HIV/AIDS (CSO, 2001). In addition HIV/AIDS has affected the age structure of population because the most severely infected age groups are those ranging from age 15 to 35, indicating that those in their most productive years will die. As a result, the age structure will become distorted as more young adults die, this will result in a shift away from the usual pattern of very old.

At district level, South East district has always enjoyed low mortality in Botswana compared to the other districts. Districts with high mortality include North East, Ngami and Central, with life expectancies of 40.1, 46.9 and 42.6 years respectively (CSO, 2001). These high mortality rates in the above mentioned districts implies that these districts will feel the major impact of HIV/AIDS such as an increase in AIDS orphans, slow population growth, changing age structure and so forth.

2.5.2 Fertility

The theory of demographic transition explains the transformation of countries from having high birth and death rates to low birth and death rates. In developed countries this transition began in the eighteenth century and continues today. Less developed countries began the transition later and are still in the midst of earlier stages of the model. Prior to the industrial revolution, countries in Western Europe had high crude

birth rates (CBR) and crude death rates CDR (Bongaarts & Bulatao, 1999). Births were high because more children meant more workers on the farm and with the high death rate; families needed more children to ensure survival of the family. Although most western countries experienced declining fertility rates, the total fertility rate remains high in Sub-Saharan Africa, with 25 countries showing a rate greater than 5.0 (CSO, 2001). Botswana is one of the first countries in Sub-Saharan African to experience fertility decline. Botswana experienced the greatest fertility decline in the region during 1971–2006, with the total fertility rate decreasing from 6.5 children per woman in the 1970s to 5.7 and 5.2 children per woman in 1988 and 1991 respectively, but further declined to 4.7 children per woman in 1994 and 3.3 in 2001 (Majelantle & Bainame, 1995; CSO, 2001).

In 2006, TFR was estimated to be 3.2. These estimates show that fertility levels dropped by 19% during the past decade. Several factors considered in the analysis of the fertility data from 1991 census account (directly, partly or jointly) to the sharp decline in fertility between 1981 and 1991 (CSO 1998). However, this fertility decline was also observed at district level. In 2001, Ngami had the highest TFR of 4.2 as compared to the other districts. It was followed by Ghanzi 3.9, Central 3.7 and North East with 3.2. The districts with the lowest TFR were Gaborone, Lobatse, South East and Phikwe with TFR of 2.3, 2.4, 2.4 and 2.6 respectively.

Profound changes in traditional nuptuality patterns and social and/or economic developments since the 1970s have been the principal causes of fertility decline (Gaisie, 1998). The expansion of mother and child health care and family planning services was timely and these programmes provided the highly motivated female population with access to modern contraceptive methods (Gaisie, 1998). In addition to that, female labour force participation and the high standard of living, result in most women deciding on having a smaller completed family size hence contributing to decline in fertility. More women are likely to delay childbearing and marriage in favour of furthering their education or career and this reduce their reproductive lifespan hence they will end up with fewer children (Thomas & Muvandi, 1994). It is also worth noting that more educated women have more control over their fertility

decisions (CSO, 2001). Due to the above mentioned factors, fertility is anticipated to decline further in future.

2.5.3 Migration

Migration refers to the permanent relocation of individual(s), from one administrative unit to another (Gwebu, 2003). There are two main types of migration: Internal migration and international migration. Internal migration refers to the movement of people from one administration unit to another within the same country whereas international migration is the movement from one country to another. Botswana is experiencing both types of migration.

2.5.3.1 Internal migration

Rural or urban migration is the most common form of migration in Botswana, hence the term urbanization. Over half of Botswana's population currently live in urban settlements. In Botswana urban settlement is defined by a minimum threshold population of 5,000 residents with at least 75% of its economically active population engaged in non-agricultural activities (Gwebu, 2002). People move from one administrative district to another for various reasons such as education and economic activities. Secondary education predisposes individuals to move, particularly to towns and probably urban villages, where most tertiary institutions are to be found and where the job market tends to be relatively more competitive.

2.5.3.2 International migration

International migration involves people leaving or entering the country. Prior to independence, Botswana was primarily a migrant sending country, with not many features to make it an appealing "destination" state in Southern Africa. It ranked among the world's 20 poorest countries, with real per-capita income measured at only about $300 in 1966, according to the United Nations Development Program (UNDP). With only one percent of Batswana living in urban areas before 1963, the overwhelmingly rural population survived mostly through subsistence farming and cattle herding, which fell under constant threat by years of drought. In addition to that Botswana faced a number of critical limits to economic growth, including severely underdeveloped infrastructure, a lack of start-up capital, a national population of less than one million people through the early 1980s (Lefko-Everette, 2004).

Given the intense poverty in the country, thousands of Batswana men became contract labourers in South Africa's gold and diamond mines as far back as the late 19th century, alongside workers from Angola, Lesotho, Mozambique, Swaziland, Zambia, and Zimbabwe. To combat unskilled workforce limitations, the government adopted an open approach to migration policy, allowing relatively unrestricted entry to visitors, tourists, and job seekers, soliciting foreign investment through incentives for multinationals such as De Beers, and courting foreign professional to work in Botswana (Lefko-Everett, 2004). However since gaining its independence from Britain in 1966, the glowing of the national economy has been the principal driver in the transition from migrant sending to migrant receiving. Retrenchments in South African mines, as well as the appeal of economic and political stability at home, brought steady numbers of expatriates back to Botswana, and the national census showed that the documented number of nationals living "abroad" fell from 45,735 in 1971, to 38,606 in 1991, and to 28,210 by 2001(CSO, 2001).

In the late 1990s, Botswana experienced a sudden new entry of refugees from neighbouring countries. Oppressive state regimes in Zimbabwe, Namibia, and South Africa, as well as the long and bloody civil war in Angola, produced huge numbers of refugees in the region during this period (Oucho et al, 2000). As a signatory to both the 1951 UN Convention relating to the status of refugees and the 1969 Organization for African Unity (OAU) convention governing the specific aspects of refugee Problems in Africa, Botswana was obligated to host many of these migrants (CSO, 2001). According to the United Nations High Commissioner for Refugees (UNHCR), prior to the independence of Zimbabwe in 1980 and Namibia in 1990, up to 45,000 migrants were housed at the Dukwi refugee camp outside Francistown. The Namibian government's attempts to squash the separatist movement in the Caprivi Strip pushed an estimated 2,400 secessionist sympathizers and San Bushmen across the Botswana border between 1998 and 1999. Most of these refugees were encamped at Dukwi (Oucho et al, 2000). During the same period, Angola saw a resurgence of violence following more than two decades of civil war, and an estimated 2,000 people sought refuge in Botswana. Combined numbers of Caprivians and Angolans, however, are still few in comparison to the tens of thousands of Zimbabweans who have arrived in

Botswana in the new millennium, driven by political uncertainty, growing repression, and economic "meltdown" in Zimbabwe (Lefko-Everett, 2004).

2.6 HIV/AIDS in Sub-Saharan Africa

As mentioned, population projections require prior understanding of the size, structure and distribution of human populations and its fertility, mortality and migration process (Shyrock & Siegel, 1976). Of late, HIV/AIDS has affected mortality in most parts of the world. HIV/AIDS is the leading cause of death in Sub-Saharan Africa and the biggest threat to the region's development (Cohen et al, 2005). According to UNAIDS, (2004), the sub-Saharan Africa is home to 10 percent of the world's population, yet it constitute two-thirds of all people living with HIV/AIDS. The region is characterized by variations in HIV prevalence, with some countries displaying disparities between urban and rural areas whilst others are showing stable HIV prevalence. Heterosexual transmission remains the main route of transmission. There is, however, terrific diversity across the region in levels and trends of HIV infection, with Southern Africa being the hardest hit. For example, in 2001, Swaziland is reported to have had the prevalence of 30 percent among pregnant women, whilst in Botswana the prevalence was 36 percent among pregnant women (Rollnick, 2002).

According to (UNAIDS, 2004), Sub-Saharan Africa has proportionately more women than men living with HIV. Hence feminization of the epidemic is more apparent in Sub-Saharan Africa where 57 percent of adults infected are women, and 75 percent of young people infected are women and girls. In addition, some parts of East and Central Africa show a decline in HIV infections. For example, Madagascar has an adult prevalence of 0.1percent (USAIDS 2010). Prevalence in West Africa has also remained relatively low with Sahel region experiencing HIV prevalence rate of 1 percent (UNAIDS, 2004).

NWU
LIBRARY

2.6.1 HIV/AIDS epidemic in Botswana

It has been 27 years since the first case of HIV/AIDS was diagnosed in 1985 in Botswana and ever since HIV prevalence has increased dramatically impacting on every aspect of the economy. HIV prevalence in Botswana remains among the highest in world (World Health Organisation, 2003). An estimated 37.4 percent HIV prevalence was reported in 2003 for pregnant women aged 15 years seeking ante-natal

care. The Botswana 2003 second generation HIV surveillance further reflects that HIV prevalence is higher in the Northern and Eastern part of the country than the Southern and Western parts (NACA, 2003).

In recognition of the devastating effects of HIV/AIDS on its population, the government of Botswana has put in place policies, infrastructure, programmes as well as resources, to control and diminish the impact of HIV/AIDS on its people. In particular, a national level structure and the national AIDS Council. HIV/AIDS has been mainstreamed into the National Development Plan 9 and vision 2016. The government has been able to form strategic partnership with different development partners, the civil society as well as the private sector to catalyze the scaling up of the national epidemic (NACA, 2003).

A national coordination structure, the National AIDS Coordinating Agency (NACA) has been set up as a department within the state president ministry to coordinate the national response efforts. A national monitoring and evaluation body has also been put in place as the Botswana HIV/AIDS Response Information Management System (BHRIMS). The BHRIMS monitors and evaluates the impact of interventions through systematic collection, storage, analysis and dissemination of HIV data and information (NACA, 2003).

2.6.1.1. HIV/AIDS and fertility

It is not clear how the total fertility rate might be affected by an HIV/AIDS epidemic. A number of studies have examined the fertility of HIV infected women to women who are not infected (Lewis et al, 2004). These studies generally show that fertility is lower in HIV-positive women than in HIV negative women. Gregson (1994) and Gregson, et al (1997) are among those who examined the question of the impact of HIV on fertility by examining potential changes in proximate determinants of fertility. They have found no clear evidence either way but concluded that the most likely result is that an HIV epidemic will slightly reduce fertility. Two studies in Uganda found that HIV infected women had lower fertility rates than HIV negative women. One of these, in rural Rakai district (Gray et al, 1997), found that age specific fertility rates for HIV infected women were 50 percent less than those for women who were

not infected. Another study among a rural population in Masaka (Carpenter et al, 1997) found that fertility rates were 20 to 30 percent lower among HIV infected women. Since most women did not know their sero–status, the reduced fertility rates were most likely due to biological rather than behavioural factors.

One may conclude that the reason for this low fertility in HIV positive women may be due the fact that HIV positive women may decide to stop childbearing upon learning that they are HIV positive in order to avoid leaving motherless children behind. AIDS could lead to a higher age at first intercourse as the dangers of unprotected sex become known. This trend would lead to lower fertility rates (Gregson, 1994). This is the case even though there is prevention from mother to child programmes.

2.6.1.2 HIV/ AIDS on migration

HIV/AIDS also have impact in migration. People living with AIDS commonly return to live with family members to obtain care. This might entail moving from urban areas to rural area or from one country to another (e.g. miners from South Africa to Botswana). Other people may migrate in order to provide care to family members living elsewhere. Loss of a household's income through death or debilitation of a former migrant encourages migration by other household members to seek income earning opportunities. As most migrations are currently male dominated, this could lead to an increase in female migration. Death or sickness of household members can lead to a decline in rural productivity and food security, thus contributing to pressure for remaining members to migrate (Clark et al, 2007).

2.6.2 Government interventions to curb HIV/AIDS in Botswana

In response to the effects of HIV/AIDS in Botswana, the government has put in place free Anti-Retro Viral therapy, voluntary testing and counselling, prevention of mother to child transmission, improvement of blood safety, free condoms and male circumcision (NACA, 2003).

2.6.3 Anti-Retroviral therapy (ART)

The provision of ART has been accredited with having a considerable positive outcome on the lives of people living with HIV/AIDS. Where it has been widely provided, it has been held responsible for emptying HIV/AIDS wards, for dramatic

falls in AIDS related mortality and morbidity and for people returning to their homes, families and jobs (Grubb et al. 2003). In high-income countries, where a combination of ART became widely available from 1996 onwards, AIDS related mortality declined markedly in the following two to three years, and has since been stable. Botswana became the first African country to supply free Anti-Retroviral drugs to all its needy citizens (NACA, 2003). The achievement of this treatment programme has made Botswana a model for other African nations to tag along. Yet, even with widespread treatment access, the country carries on suffering greatly from AIDS (United Nations, 2004). The provision of ARV program began in January 2002 and has been successfully extended to twenty nine sites countrywide, with about 32 500 patients enrolled 27 000 patients in the public health sector and 7 500 patients in the private sector. Access to ARV medication is reported to have prolonged the lives of those who are HIV infected and enable them to live healthier lives and consequently be able to take care of their families and contribute to the economy In addition there has been a remarkable change in the way people perceive the future as they are now more hopeful and live positive lives (NACA, 2003).

2.6.4 Voluntary testing and counselling

Other attainment made in the fight against HIV in the country includes the provision of voluntary counselling and testing services. Voluntary HIV counselling and testing (VCT) play a key part in HIV-related prevention and care (Akhiwu, 2012). It is particularly important as a starting point for accessing other HIV/AIDS related services (United Nations 2004). Since 2000, the Government of Botswana and the Centers for Disease Control (CDC) through Botswana USA (BOTUSA) have supported the Tebelopele network of VCT centres, which provide immediate and confidential VCT services for sexually active Batswana aged 18-49. By October 2005, the network had expanded to sixteen centres and eight satellites, and had provided free VCT services to over 230,000 visitors. Tebelopele became an independent non-governmental organisation in 2004. The Tebelopele centres have been supported by the "Know Your Status" and "Show You Care" campaigns, part of the VCT marketing strategy developed by the CDC in collaboration with Population Services International (PSI). These campaigns have been marketed through billboards, bus stops, banners, print advertisements and regular radio programmes throughout Botswana.

African Comprehensive HIV/AIDS Partnerships (ACHAP) in partnership with the Botswana Christian AIDS Intervention Programme (BOCAIP) has established eleven additional counselling centres. By September 2005, these centres had offered training to 447 counsellors and provided services to over 70,000 people (Dorrington, et al 2006). Since the beginning of 2004, HIV tests have been offered as a routine part of check-ups in public and private clinics in Botswana. The testing is part of the standard routine, but people who do not want to be tested can opt out. Currently, the adult HIV prevalence (15-49) is estimated to be 24.6 (NACA, 2010).

Botswana was the first country in Africa to have a national policy of routinely offering an HIV test at clinics (NACA, 2003). Health officials believe that routine testing is a good way to help prevention programmes and to lessen the burden on hospitals by helping people to access treatment at an earlier stage of disease. There is still a lot of stigma attached to sexually transmitted diseases. Officials believe this stigma can be reduced by treating the HIV test just like any other routine medical procedure. In the first six months of 2005, some 74,134 people were tested via the routine testing programme (Kaizer family foundation, 2005).

2.6.5 Prevention of mother to child transmission HIV

The 2002 survey of pregnant women attending ante-natal clinics in Botswana found an average HIV prevalence rate of 35.4%. In the absence of any interventions, around a third of babies born to HIV positive mothers will become infected during pregnancy and delivery or through breast feeding. This rate can be cut substantially through the use of anti-retroviral treatment and safer feeding practices (NACA, 2003). A prevention of mother-to-child transmission (PMTCT) programme was the first programme to distribute anti-retroviral drugs in Botswana, with the drug, Zidovudine (AZT), being provided free by the company GlaxoSmithKline (NACA, 2003). When early enrolment of women in PMTCT programmes was disappointingly low, the Government responded with training and recruitment programmes for PMTCT counsellors, and later with routine HIV testing of all pregnant women. HIV positive mothers who choose to avoid breastfeeding are given a year's free supply of infant formula.

Botswana's PMTCT programme is now one of the most successful in the developing world, serving over 95% of all women in need. Services have been established in all public facilities through the Maternal Child Health/Family Planning system, which serves over 90% of all pregnant women. Test results from between November 2006 and February 2007 indicate that less than 4% of babies born to HIV positive mothers were infected - a rate comparable with the USA and Western Europe (BAIS, 2004).

2.6.6 Improvement of blood safety

The Ministry of Health, the safe blood for Africa foundation, and other partners, have helped to improve the safety of blood transfusions in Botswana. The national supply of HIV-free blood doubled in size in the two years up to September 2005. Over the same period, the amount of HIV-infected blood given by donors fell by half, largely because of better screening of donors and counselling (NACA, 2003).

One of the projects contributing to the improvement in blood safety is called "Pledge 25". This project recruits young people to become blood donors and teaches them how to prevent HIV infection. The young people are encouraged to pledge to donate blood 25 times during their lifetime.

2.6.7 A free condom dispenser in Botswana

Successful social marketing and subsidization have substantially increased condom use in Botswana. Population Services International (PSI) has helped to promote the 'Lovers Plus' condom since 1993 and the 'Care' female condom since 2002. One of PSI's key strategies for marketing condoms has been peer education, which has been conducted in a variety of settings such as fairs and festivals, shopping malls, workplaces and bars. In 2003, the Government of Botswana, with funding and technical support from ACHAP, launched an extensive condom distribution and marketing campaign, providing for the installation of 10,500 condom dispensers in traditional and non-traditional outlets throughout the country. Millions of condoms have been secured for free distribution and are widely available for everyone (NACA, 2010).

2.6.8 Male circumcision

Male circumcision is the surgical removal of some or the entire foreskin from the penis. Male circumcision has been linked with a lower risk for HIV infection in international observational studies and in other randomized controlled clinical trials (Williams et al 2006). It is possible, but not yet adequately assessed, that male circumcision could reduce male to female transmission of HIV, although probably to a lesser extent than female to male transmission. Accordingly, male circumcision, together with other prevention interventions, could play a vital role in HIV prevention in settings similar to those of the clinical trials. Male circumcision reduces the risk that men will contract HIV through intercourse with infected women by about 70% according to studies reported in the Wall Street Journal (UNAIDS, 2008).

LIBRARY

2.7 Summary

This chapter has identified mathematical and cohort components as the main methods used for projecting the population. It further reviewed literature on components of population (mortality, fertility and migration). In addition, this chapter shed a light on current population projections by different organization such as UN, The World Bank, US census Bureau, IIASA and Central Statistics Office. The assumptions are also stated. Each of these international organizations uses slightly different methodologies, makes varying assumptions about future demographic trends, and begins with slightly different estimates of current population size. Nevertheless, their results fall within a relatively small band for the next 50 years.

CHAPTER 3: METHODOLOGY

3.1 Introduction

This chapter presents a background description of the situation in Botswana and describes the method of analysis used in this study. It also includes a discussion of the quality of demographic data and limitation of the study.

3.2 Background description of Botswana

This section of the study describes Botswana's background in terms of its ethnic composition, geographical aspect, climate and economy.

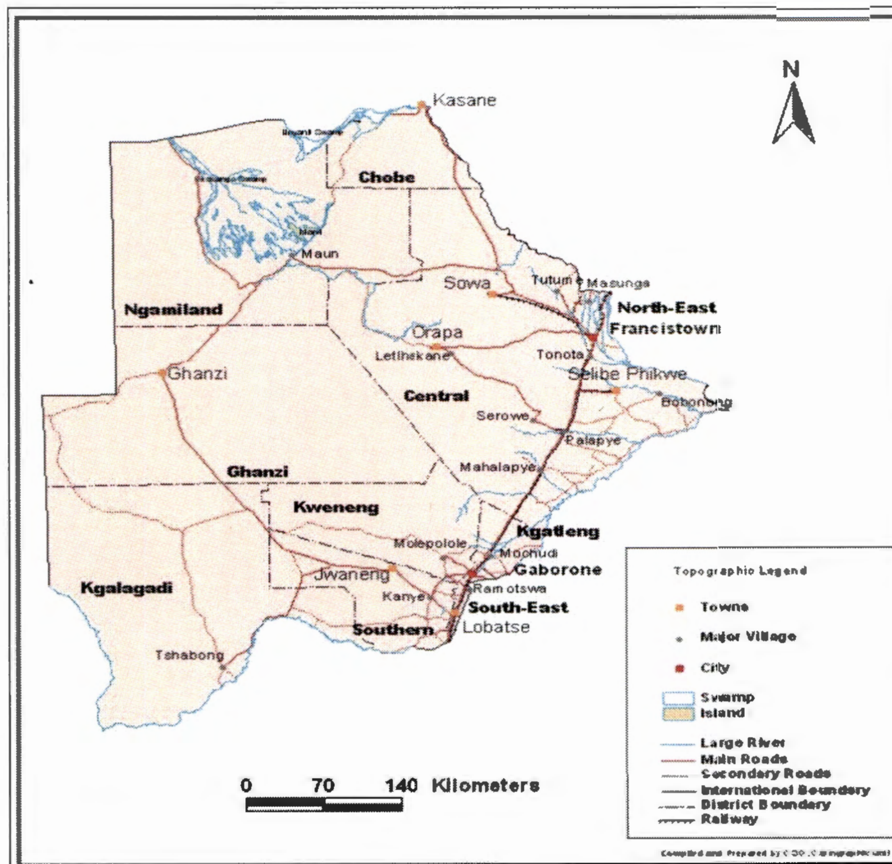
3.2.1 Ethnic composition

The population of Botswana comprises of several ethnic groups, who settled in the country before and shortly after the beginning of Christian era (Mompati & Prinsen, 2000). The San and the Khoi are believed to have been the early settlers in this country. Other ethnic groups in Botswana are Bangwaketse, Barolong, Bakgatla, Bakwena, Bakalanga, Bambukushu, Bangwato Batawana and Bakgalagadi.

3.2.2 Geographical aspect

Botswana is a landlocked country located in Southern Africa, and is bordered by South Africa to the South and South East, Namibia to the west, Zambia to the North and Zimbabwe to North-East. The country is divided into 13 districts which are further divided into 28 sub-districts (see figure 1). The country consists of sand filled undulating plateau with an average altitude of 1000 metres (3280 feet) while South of the plateau the terrain consists of hilly bush and grasslands. The Kalahari Desert which is a sandy tract covered with thorn bush and grass, lies to the west of the plateau and in the extreme North-West lies the Makgadikgadi salt pans as well as the Okavango swamps which are a great inland delta while forests and dense bush surround the swamps. Around 50% of the delta is perennial flooded and the rest is seasonally flooded. The principal river is the Okavango, which flows into and forms the Okavango swamps. The land area of the country is 582000 km^2 (CSO 2001).

Figure 1: Map of Botswana



3.2.3 Climate

Botswana has a sub-tropical climate, although the Northern regions of the country lie within the tropics. Winters are cool with frost common in the desert and the prevailing dry winds coming from the Atlantic Ocean while the winds also bring sand storms from the Kalahari. The summer season is from September to April with rain in the North and East falling almost totally between October to April. The country often suffers long periods of drought. Average annual precipitation in Francistown is 450 mm (18 inches) with average temperature ranging from 5 to 23 degrees Celsius (41 to 73 degrees Fahrenheit). In July the temperatures ranges from 18 to 31 degrees Celsius (64 to 88 degrees Fahrenheit) (Department of Meteorological services, 2004).

3.2.4 Economy

At the time of its independence from Britain in 1966, Botswana was one of the poorest countries in Africa. The country was overwhelmingly rural and depended

mainly on agriculture for livelihood. The economy relied strongly on beef production in terms of output and export earnings. However, significant changes in the economy have taken place since then. Discovery of diamonds in 1972 and sound economic management have led to rapid economic development as well as changes in the structure of the economy. Nevertheless, Botswana like other countries have been experiencing economic meltdown recently, diamond sales have gone down and most people have been retrenched from their jobs (Bank of Botswana, 2005). Botswana's Human development Index (HDI) value for 2011 is 0.633 in the medium human development category positioning the country at 118 out of 187 countries and territories (Human Development Report, 2011). The percentage urban population for Botswana has increased from 10 percent in 1971 to 55 percent in 2001. This means that more than 75 percent of its workforce is engaged in non-agricultural activities (UNDP, 2011).

3.3 Sources of data

The population projections that will be presented in this study for Botswana from 2001 to 2016 will be primarily based on the 2001 census data (demographic data) and 2004 and 2006 Botswana AIDS Impact Surveys (BAIS II and III).

3.3.1. Demographic data

Since independence, Botswana has conducted five census surveys: In 1971, 1981, 1991, 2001 and 2011. The demographic data used in this study were obtained from the 2001 population census as the data for 2011 were not available at the time of preparing this report.

3.3.2 HIV/AIDS data

The 2004 and 2006 Botswana AIDS Impact Surveys (BAIS II and III) are the two main sources of HIV prevalence rate at the national and district level for respective years. This kind of surveys are conducted to provide information to assess whether programmes on HIV/AIDS are operating as intended, assess performance of intervention programmes and whether people are changing their sexual behaviour. With BAIS III, unlike the previous surveys, blood samples were collected from willing respondents for the determination of HIV Prevalence and Incidence (CSO, 2008).

3.4 Quality of data

Census data on age distribution of population are found to have errors due to inaccurate reporting of ages and some of the errors may be due to under enumeration (Klosterman, 1990). In this study Carrier-Farrag, K-King Newton, Arriaga, United Nations and Strong smoothing techniques were carried out for age smoothing in 2001 census data by using Population Analysis Spread sheets (PAS). AGESMTH was applied to smooth the population for each district. The Arriaga technique was found to be satisfactory in levelling out the inconsistencies in the age structure because only ages 80 plus were not awarded smoothed values.

3.5 Projection assumptions

Three sets of population projections are prepared for each district. These sets of population projections are described as slow, medium and fast decline depending on the size of the projected population in 2016 (Hollmann et al, 2000).

For all the three scenarios, mortality improvement of two years is assumed, fertility is assumed to decline every year and migration is assumed to be constant throughout the projection period. The only difference between the three scenarios is the HIV/AIDS assumptions. The fast variant represents the faster decline of HIV/AIDS prevalence rates. Slow decline represents a slower decline rate of HIV/AIDS. Middle variant assumes that the trend that was observed between 2001 and 2004 will continue to be experienced. The detailed assumptions of mortality, fertility, migration and HIV/AIDS are outlined below.

3.5.1 Base population

The base population was obtained from the 2001 Botswana census See Table 1and 2. The same applies to mortality, fertility and migration. It is worth noting that all the 2001 estimates are those that were observed in the 2001 census, while the rest are assumed or projected.

Table 1: Base population of Botswana in thousands, 2001 (Males)

trict es	Central	Francistown	Gaborone	Ghanzi	Kgalagadi	Kgatleng	Kweneng	Lobatse	Ngami	North East	Phikwe	South East	Southern
	33 212	4 343	7 833	2 059	2 865	2 230	13 783	1 513	7 898	3 170	2 503	5 945	11 594
	35 948	4 137	7 297	2 011	2 745	3 590	14 558	1 417	8 193	3 660	2 357	6 395	12 816
14	37 307	4 007	7 172	1 950	2 613	4 686	14 990	1 353	8 294	3 954	2 265	6 790	13 505
19	31 773	4 263	9 098	1 820	2 417	4 464	13 710	1 457	7 426	3 276	2 445	6 900	11 525
24	20 367	5 130	13 960	1 659	2 230	3 390	11 398	1 808	5 909	1 748	3 035	7 257	7 248
29	15 553	4 780	13 300	1 481	1 910	2 760	9 442	1 682	4 791	1 212	2 825	6 423	5 592
34	12 828	3 897	10 015	1 316	1 473	2 112	7 213	1 323	3 648	1 023	2 181	4 824	4 816
39	10 792	3 093	7 795	1 074	1 187	1 758	5 817	1 068	2 852	858	1 849	3 856	4 184
44	9 560	2 124	5 404	749	934	1 570	4 777	804	2 138	771	1 647	3 015	3 847
49	7 990	1 506	3 806	561	746	1 320	3 783	606	1 682	659	1 303	2 355	3 283
54	6 078	960	2 396	404	577	1 022	2 675	419	1 319	522	868	1 719	2 536
59	5 092	640	1 524	316	463	858	2 155	291	1 101	458	562	1 351	2 144
64	4 547	423	852	263	378	769	1 965	176	975	434	237	1 124	1 839
69	3 893	278	478	227	302	631	1 605	114	835	386	113	886	1 711
74	3 253	173	240	202	232	483	1 223	74	700	333	63	661	1 661
79	2 627	108	140	188	168	327	818	56	570	277	87	449	1 689
al	**240 820**	**39 860**	**91 310**	**16 280**	**21 240**	**31 970**	**109 910**	**14 160**	**58 330**	**22 740**	**24 340**	**59 950**	**89 990**

Table 2: Base population of Botswana in thousands, 2001 (Females)

t	Central	Francistown	Gaborone	Ghanzi	Kgalagadi	Kgatleng	Kweneng	Lobatse	Ngami	North East	Phikwe	South East	Southern
	33 220	4 142	7 468	1 999	2 696	7 474	13 469	1 375	5 888	3 116	2 344	2 938	11 606
	34 900	4 538	8 162	1 991	2 624	6 086	14 531	1 525	7 333	3 464	2 666	3 202	12 404
	35 554	4 917	9 030	1 960	2 533	4 803	15 237	1 672	8 458	3 666	2 970	3 440	12 815
	31 086	5 203	10 770	1 810	2 348	4 047	14 163	1 798	7 983	3 134	3 190	3 550	11 295
	22 351	5 892	14 651	1 595	2 150	3 613	12 068	2 070	6 538	1 969	3 667	3 824	8 199
	18 219	5 228	13 499	1 385	1 840	3 058	10 192	1 870	5 443	1 531	3 233	3 406	6 741
	15 349	3 761	9 688	1 176	1 421	2 393	7 975	1 401	4 250	1 318	2 226	2 556	5 725
	13 461	2 879	7 372	944	1 159	2 038	6 595	1 099	3 390	1 202	1 704	2 044	5 055
	12 662	2 105	5 180	664	942	1 860	5 646	810	2 610	1 229	1 335	1 600	4 779
	10 698	1 485	3 530	496	768	1 560	4 494	600	2 040	1 081	945	1 240	4 061
	7 799	850	1 893	344	608	1 150	3 017	403	1 483	818	487	873	3 009
	6 501	550	1 098	286	492	980	2 423	287	1 247	713	273	688	2 491
	5 855	407	670	283	384	950	2 280	204	1 188	680	143	600	2 045
	5 185	293	410	267	326	810	1 950	146	1 082	610	98	490	2 015
	4 588	211	260	252	289	648	1 608	101	979	535	95	385	2 150
	4 063	159	220	238	271	462	1 252	69	881	455	135	285	2 450
	261 490	42 620	93 900	15 690	20 850	41 930	116 900	15 430	60 790	25 520	25 510	31 120	96 840

3.5.2 Mortality assumptions

This study formulates mortality assumption based on the United Nations working model for mortality improvement; quennial gains in life expectancy at birth according to the initial level of mortality (United Nations, 1999; Lutz, 1995) as Botswana is one of the hardest hit countries by HIV/AIDS. The study adopts the slow rate of mortality decline or scenario that is 2.0 years every 5 years for men and women of life expectancies below 65 years. The model postulates that the extent of mortality improvements decreases gradually as life expectancy at birth increases. For example, districts that have a life expectancy at birth of more than 67 years, the rate will decline from 2 years to 1.5 years. If it is more than 72.5 years like in South East the rate will be 0.5 years for men and 1.0 years for females. Detailed assumptions are portrayed in Tables 3 and 5 below. In addition to that, the study uses the Northern families of regional model life tables. Most of the Southern African countries follow that pattern (Mostert et al, 1998).

NWU
LIBRARY

Table 3: Mortality assumptions for males, 2001-2016

Year District	2001	2003	2005	2007	2009	2011	2013	2015	2016
Gaborone	63.9	64.7	65.5	66.3	67.1	67.9	68.7	69.5	69.9
Fransictown	56.6	57.4	58.2	59.0	59.8	60.6	61.4	62.2	62.6
Lobatse	54.9	55.7	56.5	57.3	58.1	58.9	59.7	60.5	60.9
Selebi-Phikwe	54.3	55.1	55.9	56.7	57.5	58.3	59.1	59.9	60.3
Central	42.6	43.4	44.2	45.0	45.8	46.6	47.4	48.2	48.6
Chobe	52.2	53.0	53.8	54.6	55.4	56.2	57.0	57.8	58.2
Ghanzi	58.5	59.3	60.1	60.9	61.7	62.5	63.3	64.1	64.5
Kgalagadi	51.1	51.9	52.7	53.5	54.3	55.1	55.9	56.7	57.1
Kgatleng	52.0	52.8	53.6	54.4	55.2	56.0	56.8	57.6	58.0
South East	73.9	74.7	75.5	74.8	75.6	74.9	75.7	76.5	75.4
Kweneng	51.5	52.3	53.1	53.9	54.7	55.5	56.3	57.1	57.5
North East	40.1	40.9	41.7	42.5	43.3	44.1	44.9	45.7	46.1
Ngamiland	46.9	47.7	48.5	49.3	50.1	50.9	51.7	52.5	52.9
Southern	46.4	47.2	48.0	48.8	49.6	50.4	51.2	52.0	52.4

Table 4: Mortality assumptions for females, 2001-2016

Year / District	2001	2003	2005	2007	2009	2011	2013	2015	2016
Gaborone	66.6	67.4	68.2	69.0	69.8	70.6	71.4	72.2	72.6
Fransictown	56.6	57.4	58.2	59.0	59.8	60.6	61.4	62.2	62.6
Lobatse	55.1	55.9	56.7	57.5	58.3	59.1	59.9	60.7	61.1
Selebi-Phikwe	57.2	58.0	58.8	59.6	60.4	61.2	62.0	62.8	63.2
Central	48.6	49.4	50.2	51.0	51.8	52.6	53.4	54.2	54.6
Chobe	59.7	60.5	61.3	62.1	62.9	63.7	64.5	65.3	65.7
Ghanzi	57.8	58.6	59.4	60.2	61.0	61.8	62.6	63.4	63.8
Kgalagadi	52.0	52.8	53.6	54.4	55.2	56.0	56.8	57.6	58.0
Kgatleng	57.5	58.3	59.1	59.9	60.7	61.5	62.3	63.1	63.5
South East	63.9	64.7	65.5	66.3	67.1	67.9	68.7	69.5	69.9
Kweneng	58.2	59.0	59.8	60.6	61.4	62.2	63.0	63.8	64.2
North East	49.2	50.0	50.8	51.6	52.4	53.2	54.0	54.8	55.2
Ngamiland	48.1	48.9	49.7	50.5	51.3	52.1	52.9	53.7	54.1
Southern	48.6	49.4	50.2	51.0	51.8	52.6	53.4	54.2	54.6

Table 5: Mortality assumption for both sexes, 2001-2016

Year / District	2001	2003	2005	2007	2009	2011	2013	2015	2016
Central	45.7	46.5	47.3	48.1	48.9	49.7	50.5	51.3	51.7
Francistown	56.6	57.4	58.2	59.0	59.8	60.6	61.4	62.2	62.6
Gaborone	65.3	66.1	66.9	67.7	68.5	69.3	70.1	70.9	71.3
Ghanzi	58.2	59.0	59.8	60.6	61.4	62.2	63.0	63.8	64.2
Kgalagadi	51.5	52.3	53.1	53.9	54.7	55.5	56.3	57.1	57.5
Kgatleng	55.1	55.9	56.7	57.5	58.3	59.1	59.9	60.7	61.1
Kweneng	55.0	55.8	56.6	57.4	58.2	59.0	59.8	60.6	61.0
Lobatse	55.0	55.8	56.6	57.4	58.2	59.0	59.8	60.6	61.0
Ngami	47.5	48.3	49.1	49.9	50.7	51.5	52.3	53.1	53.5
North East	44.9	45.7	46.5	47.3	48.1	48.9	49.7	50.5	50.9
Phikwe	55.8	56.6	57.4	58.2	59.0	59.8	60.6	61.4	61.8
South East	70.5	71.3	72.1	72.9	73.7	74.5	75.3	76.1	76.5
Southern	47.5	48.3	49.1	49.9	50.7	51.5	52.3	53.1	53.5

3.5.3 Fertility assumptions

The basic assumptions regarding future fertility in countries with above replacement fertility are (i) those countries will experience a fertility decline in the future, and (ii) that there is a relationship between the timing and speed of fertility decline and the socio-economic development and population programmes in these countries. In the medium variant population projections for countries above replacement level, it is assumed that fertility will decline and stabilize at replacement level (TFR of 2.1). The date on which the replacement level was expected to be reached is estimated by taking into consideration the population policy and programmes, adult literacy, school attendance and per capita income of relevant country. This scenario assumes fertility decline. This decline is in accordance with normal decline in the tenth five year plan that is 0.10 per year up to 2011 and then a slower decline of 0.02 per year (United Nation, 1999).

Table 6: Fertility assumptions for districts in Botswana, 2001-2016

Year / District	2001	2003	2007	2009	2011	2013	2015	2016
Gaborone	2.3	2.1	1.7	1.5	1.3	1.3	1.2	1.2
Francistown	2.9	2.7	2.3	2.1	1.9	1.9	1.8	1.8
Lobatse	2.4	2.2	1.8	1.6	1.4	1.4	1.3	1.3
S/Phikwe	2.6	2.4	2	1.8	1.6	1.6	1.5	1.5
Southern	3.4	3.2	2.8	2.6	2.4	2.4	2.3	2.3
South East	2.4	2.2	1.8	1.6	1.4	1.4	1.3	1.3
Kweneng	3.5	3.3	2.9	2.7	2.5	2.5	2.4	2.4
Kgatleng	2.8	2.6	2.2	2	1.8	1.8	1.7	1.7
Central	3.7	3.5	3.1	2.9	2.7	2.7	2.6	2.6
North East	3.5	3.3	2.9	2.7	2.5	2.5	2.4	2.4
Ngamiland	4.2	4	3.6	3.4	3.2	3.2	3.1	3.1
Ghantsi	3.9	3.7	3.3	3.1	2.9	2.9	2.8	2.8
Kgalagadi	3.4	3.2	2.8	2.6	2.4	2.4	2.3	2.3
Botswana	3.2	3.0	2.6	2.4	2.2	2.2	2.1	2.1

3.5.4 Migration assumptions

In most countries, net migration is relatively insignificant. As a result, for the majority of countries, no assumptions regarding migration are included in the population projections. The prediction of international migration is a risky undertaking because international migration may be influenced by unpredictable political, social and economic circumstances in the country of origin and destination. The assumption is that the net migration rates that were recorded in 2001 will remain constant throughout the year up to 2016. Table 7-9 states migration assumptions by sex and district, and the assumptions here include both internal and international migration. The assumptions indicate constant migration in all districts because it is anticipated that they will not loose people. The decentralisation system in Botswana makes people not to move from rural areas to urban areas because they have access to services in their own districts.

Table 7: Migration assumptions for males, 2001-2016

Year / District	2001	2003	2005	2007	2009	2011	2013	2015	2016
Central	3000	3000	3000	3000	3000	3000	3000	3000	3000
Francistown	400	400	400	400	400	400	400	400	400
Gaborone	2000	2000	2000	2000	2000	2000	2000	2000	2000
Ghanzi	75	75	75	75	75	75	75	75	75
Kgalagadi	150	150	150	150	150	150	150	150	150
Kgatleng	150	150	150	150	150	150	150	150	150
Kweneng	1000	1000	1000	1000	1000	1000	1000	1000	1000
Lobatse	150	150	150	150	150	150	150	150	150
Ngami	3000	3000	3000	3000	3000	3000	3000	3000	3000
North East	150	150	150	150	150	150	150	150	150
Phikwe	200	200	200	200	200	200	200	200	200
South East	300	300	300	300	300	300	300	300	300
Southern	700	700	700	700	700	700	700	700	700

Table 8: Migration assumptions for females, 2001-2016

Year / District	2001	2003	2005	2007	2009	2011	2013	2015	2016
Central	2000	2000	2000	2000	2000	2000	2000	2000	2000
Francistown	200	200	200	200	200	200	200	200	200
Gaborone	1500	1500	1500	1500	1500	1500	1500	1500	1500
Ghanzi	25	25	25	25	25	25	25	25	25
Kgalagadi	50	50	50	50	50	50	50	50	50
Kgatleng	50	50	50	50	50	50	50	50	50
Kweneng	500	500	500	500	500	500	500	500	500
Lobatse	50	50	50	50	50	50	50	50	50
Ngami	2000	2000	2000	2000	2000	2000	2000	2000	2000
North East	50	50	50	50	50	50	50	50	50
Phikwe	150	150	150	150	150	150	150	150	150
South East	200	200	200	200	200	200	200	200	200
Southern	300	300	300	300	300	300	300	300	300

Table 9: Migration assumptions for both sexes, 2001-2016

Year / District	2001	2003	2005	2007	2009	2011	2013	2015	2016
Central	5000	5000	5000	5000	5000	5000	5000	5000	5000
Francistown	600	600	600	600	600	600	600	600	600
Gaborone	3500	3500	3500	3500	3500	3500	3500	3500	3500
Ghanzi	100	100	100	100	100	100	100	100	100
Kgalagadi	200	200	200	200	200	200	200	200	200
Kgatleng	200	200	200	200	200	200	200	200	200
Kweneng	1500	1500	1500	1500	1500	1500	1500	1500	1500
Lobatse	200	200	200	200	200	200	200	200	200
Ngami	5000	5000	5000	5000	5000	5000	5000	5000	5000
North East	200	200	200	200	200	200	200	200	200
Phikwe	350	350	350	350	350	350	350	350	350
South East	500	500	500	500	500	500	500	500	500
Southern	1000	1000	1000	1000	1000	1000	1000	1000	1000

3.5.5 HIV/AIDS assumptions

In the preparation of the assumptions on HIV/AIDS, three variants of the population projections, namely, slow, medium and fast decline were compiled.

3.5.5.1 Slow decline scenario

HIV prevalence rates for 2001 and 2006 were used to predict future HIV/AIDS assumptions. The scenario assumes that HIV/AIDS prevalence rates will go down in all districts at a slower rate of 0.1 per year up to the projected year, 2016. A detailed assumption is demonstrated in Table 10.

Table 10: Slow decline HIV/AIDS assumptions

Year / District	2001	2003	2005	2007	2009	2011	2013	2015	2016
Francistown	24.6	24.2	23.8	23.5	23.3	23.1	22.9	22.7	22.6
Gaborone	18.3	17.9	17.5	17.2	17.0	16.8	16.6	16.4	16.3
Lobatse	17.8	17.4	17.0	16.7	16.5	16.3	16.1	15.9	15.8
North East	18.1	17.7	17.3	17.0	16.8	16.6	16.4	16.2	16.1
South East	14.2	13.8	13.4	13.1	12.9	12.7	12.5	12.3	12.2
Southern	12.4	12.8	13.1	13.2	13.0	12.8	12.6	12.4	12.3
Phikwe	23.3	24.6	25.9	26.4	26.2	26.0	25.8	25.6	25.5
Ngami	15.0	16.2	17.5	18.1	17.9	17.7	17.5	17.3	17.2
Kweneng	13.0	13.2	13.4	13.4	13.2	13.0	12.8	12.6	12.5
Kgatleng	14.7	15.1	15.6	15.7	15.5	15.3	15.1	14.9	14.8
Kgalagadi	13.5	13.0	14.0	15.4	15.2	15.0	14.8	14.6	14.5
Ghanzi	15.6	17.0	18.4	19.0	18.8	18.6	18.4	18.2	18.1
Central	17.6	17.2	16.8	16.5	16.3	16.1	15.9	15.7	15.6

3.5.5.2 Medium scenario

The scenario assumes that for each district the trend observed between 2001 and 2006 will continue. It was observed that Gaborone, Francistown, Lobatse, North East and South East experienced a decline in HIV/AIDS prevalence during the period under review. For these districts it was assumed that HIV/AIDS prevalence will continue to decline in future.

However, some districts such as Southern, Phikwe, Ngami, Kweneng, Kgatleng, Kgalagadi and Ghanzi showed an increase of HIV prevalence. For these districts the assumption is that HIV/AIDS prevalence will continue to increase. Detailed HIV/AIDS assumptions used in this variant are showed in Table 11.

Table 11: Medium decline HIV/AIDS assumptions

Year / District	2001	2003	2005	2007	2009	2011	2013	2015	2016
Francistown	24.6	22.4	20.2	18.0	15.8	13.6	11.4	9.2	8.1
Gaborone	18.3	17.8	17.3	16.9	16.4	15.9	15.4	14.9	14.7
Lobatse	17.8	17.2	16.6	16.0	15.4	14.8	14.2	13.6	13.3
North East	17.8	17.4	17.0	16.6	16.2	15.8	15.4	15.0	14.8
South East	14.3	13.7	13.0	12.4	11.7	11.1	10.5	9.8	9.5
Southern	12.4	12.8	13.1	13.5	13.8	14.2	14.6	14.9	15.1
Phikwe	23.3	24.6	25.9	27.1	28.4	29.7	31.0	32.3	32.9
Ngami	15.0	16.2	17.5	18.8	20.1	21.4	22.6	23.9	24.6
Kweneng	13.0	13.2	13.4	13.6	13.8	14.0	14.2	14.4	14.5
Kgatleng	14.7	15.1	15.6	16.0	16.5	16.9	17.3	17.8	18.0
Kgalagadi	13.5	14.3	15.1	15.8	16.6	17.4	18.2	19.0	19.4
Ghanzi	15.6	17.0	18.4	19.8	21.2	22.6	24.0	25.4	26.1
Central	17.6	17.2	16.8	16.4	16.0	15.6	15.2	14.8	14.6

3.5.5.3 Fast decline scenario

HIV prevalence rates for 2001 and 2006 were used to come up with future HIV/AIDS assumptions. The scenario assumes that HIV/AIDS prevalence rates will go down in all districts at a faster rate of 0.4 per year. For districts such as Phikwe, Ngami, Kweneng, Kgatleng, Kgalagadi and Ghanzi which experienced an increase of HIV prevalence between the year 2001 and 2006, will continue to experience an increase up to the year 2011 and thereafter the prevalence rates will come down at a rate of 0.4 per year up to the projected year, 2016. All other districts that experienced a decline in HIV prevalence will continue to experience that decline but at a faster pace of 0.6. A detailed assumption is demonstrated in Table 12.

Table 12: Fast decline HIV/AIDS assumptions

Year / District	2001	2003	2005	2007	2009	2011	2013	2015	2016
Central	17.6	17.2	16.8	16.0	14.8	13.6	12.4	11.2	10.6
Francistown	24.6	22.4	20.2	17.6	14.6	11.6	8.6	5.6	4.1
Gaborone	18.3	17.8	17.3	16.5	15.2	13.9	12.6	11.3	10.7
Ghanzi	15.6	17.0	18.4	19.8	21.2	21.6	21.0	20.4	20.1
Kgalagadi	13.5	14.3	15.1	15.8	16.6	16.7	16.1	15.5	15.2
Kgatleng	14.7	15.1	15.6	16.0	16.5	16.4	15.8	15.2	14.9
Kweneng	13.0	13.2	13.4	13.6	13.8	13.6	13.0	12.4	12.1
Lobatse	17.8	17.2	16.6	15.6	14.2	12.8	11.4	10.0	9.3
Ngami	15.0	16.2	17.5	18.8	20.1	20.4	19.8	19.2	18.9
North East	17.8	17.4	17.0	16.2	15.0	13.8	12.6	11.4	10.8
Phikwe	23.3	24.6	25.9	27.1	28.4	28.8	28.2	27.6	27.3
South East	14.3	13.7	13.0	12.0	10.5	9.1	7.7	6.2	5.5
Southern	12.4	12.8	13.1	13.5	13.8	13.7	13.1	12.5	12.2

3.6 Sex ratio at birth

The sex ratio at birth is estimated to be 103 male births per female birth (UNECA 1968). This is assumed to be constant throughout the period of the projection.

3.7 Software for data analysis

The cohort-component method and SPECTRUM were used to prepare population projections for each district in Botswana. Spectrum is software for preparing population projections developed by Futures Group International (Stover, 2009). The software is a window based system designed to assist policy makers in deciding policy questions related to population dynamics. The system consists of various components such as family planning, AIM, RAPID, goals, and so forth. For the purpose of this study DEMPROJ and AIM modules have been used. DEMOPROJ prepares population projections on the basis of the base population and fertility, mortality and migration assumptions using cohort component projection model. AIM is the module that incorporates HIV/AIDS assumptions and projects the consequences of HIV/AIDS. In order to incorporate HIV/AIDS, AIM requires some additional assumptions. Since the population projections are carried from district level to national level, some of the data

required by AIM was not available at district level. Thus, this study assumed that the national estimates will also apply at district level because they are in percentages.

The following are additional assumptions SPECTRUM requires in order to incorporate HIV/AIDS in preparing population projections: HIV progression, HIV age distribution, percent of HIV+ mothers receiving prophylaxis to prevent mother-to-child transmission, children born to HIV+ mothers by type of feeding probability of transmission of HIV from mother to child; number of adults receiving ART and number of children receiving ART and Co-trimoxazole. It suffices to note that the above mentioned assumptions are only available at national level. In order to incorporate them at district level, the national estimates were assumed to apply at district levels. In cases where the estimates are in numbers, such as number of adults and children receiving ART and Cotroxazole, the numbers were converted to percentages and assumed in all districts. This means progression from infection to need for ART. In this study normal pattern in Spectrum was used. This describes a progression with a median time from infection to need for ART of 7.5 years for adult men, 8.5 years for adult women, and 2 years for children as well as progression from need for treatment to AIDS death without ART (adults). Normal patterns in Spectrum which describe a progression with a median time are 3 years. HIV age distribution can be described as HIV by five age groups. The study assumed a generalized epidemic pattern. Detailed HIV age distribution by sex is portrayed in Tables 13 and 14. The other remaining additional assumptions are given in Tables 15 to 19.

Table 13: Male ratio of HIV prevalence% to prevalence% at 20-29

Year / Age	2001	2003	2005	2007	2009	2011	2013	2015	2016
0-4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5-9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10-14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15-19	0.5	0.4	0.4	0.3	0.3	0.3	0.3	0.2	0.2
20-24	0.5	0.5	0.5	0.5	0.4	0.4	0.4	0.4	0.4
25-29	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
30-34	1.6	1.7	1.7	1.7	1.8	1.9	1.9	2.0	2.0
35-39	0.8	0.9	0.9	1.0	1.0	1.1	1.1	1.2	1.3
40-44	0.8	0.8	0.8	0.9	1.0	1.0	1.1	1.3	1.3
45-49	0.8	0.8	0.9	0.9	0.9	1.0	1.1	1.2	1.2
50-54	0.3	0.3	0.3	0.4	0.4	0.5	0.5	0.6	0.6
55-59	0.3	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.5
60-64	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
65-69	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
70+	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 14: Female ratio of HIV prevalence% to prevalence% at 25-29

Year / Age	2001	2003	2005	2007	2009	2011	2013	2015	2016
0-4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5-9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10-14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15-19	0.5	0.5	0.4	0.4	0.3	0.3	0.3	0.3	0.3
20-24	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.6
25-29	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
30-34	0.9	0.9	0.9	0.9	1.0	1.0	1.0	1.0	1.0
35-39	0.6	0.7	0.7	0.8	0.8	0.8	0.9	0.9	1.0
40-44	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.5	0.5
45-49	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3
50-54	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3
55-59	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2
60-64	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
65-69	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
70+	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 15: Mothers receiving PMTCT

Year	None	SD NVP	Dual ART	Triple ART	Total
2001	80.2	19.8	0	0	100
2002	73.6	26.4	0	0	100
2003	67.0	33.0	0	0	100
2004	52.1	24.8	20.8	2.2	100
2005	37.2	16.7	41.4	4.5	100
2006	22.4	8.6	62.2	6.8	100
2007	7.6	0.4	83.0	9.0	100

NWU LIBRARY

Table 16: Children born to HIV+ mothers by type of feeding (%)

Year	Mixed	Exclusive Breastfeeding	Replacement Feeding	Total
2001	81	1	18	100
2002	74	2	24	100
2003	67	3	30	100
2004	52	3	45	100
2005	36	4	60	100
2006	21	4	75	100
2007	5	5	90	100

Table 17: Probability of transmission of HIV from mother to child

Prophylaxis	Mixed feeding	Exclusive breastfeeding	Replacement feeding
None	34	24	27
SD NVP	23	13	16
Dual ART	13	2.8	6
Triple ART	5	1.9	3

Table 18: Number of adults receiving ART

Year	First line ART	Second line ART	Total
2000	932	0	932
2001	1865	0	1865
2002	2797	14	2811
2003	10,264	82	10,346
2004	30,600	849	31,449
2005	50,044	1617	51,661
2006	79,490	2384	81,874
2007	91,780	2753	94,533

Table 19: Children receiving ART and Cotrimoxazole

Year	ART	Cotrimoxazole
2004	2142	5474
2005	3503	8115
2006	5564	8830
2007	6251	9858

The above mentioned assumptions are only available at national level. In order to incorporate them at district level, the same estimates were assumed at district levels. In cases where the estimates are in numbers such as number of adults and children receiving ART and Cotrimoxazole, the numbers were converted to percentages and assumed in all districts.

3.8 Limitations of the study

To use Demoproj and AIM to study fertility is difficult because in some instances input fertility data may be the same as output or results. This is the case with this study. Reasons for this are based on the assumptions that have been made. Some countries are experiencing stalled fertility rates over periods which people would think TFR will change. However, Botswana is not one of the countries that are experiencing stalled fertility in Sub Saharan Africa, so the explanation for this possibly will be that TFR may be less sensitive to changes in one input depending on the strength of other inputs. The other limitation incurred in this study is that, projection on AIDS deaths and number of orphans does not match with the base year (2001). This is because progression from infection to HIV deaths takes quite some time. In other words, if a person is infected in 2001, he/she cannot die within the same year. The deaths may occur after 3 or more years if the person is not on treatment. The same is expected of orphan estimates. There will be orphans after the HIV/AIDS deaths by parents have occurred.

3.9 Summary

This chapter mainly focused on methodology of the study. This includes sources of data and its quality, projection assumptions that is mortality, fertility, migration and HIV AIDS assumptions. In addition to that, software for data analysis and limitations of the study are discussed.

CHAPTER 4: ANALYSIS OF FAST DECLINE SCENARIO

4.1 Introduction

This chapter presents the districts and national population projection results for Botswana population based on the fast declining scenario. This scenario is based on assumptions of slow decline of mortality, slow decline of fertility and constant migration. In terms of HIV/AIDS, this scenario assumes that HIV/AIDS prevalence rates will go down in all districts at a faster rate of 0.4 percent per year. To get the total number of the projected population of Botswana, district populations are summarized. To obtain other rates such as life expectancy, IMR, and so forth, district results are averaged.

4.2 Results

4.2.1 Projected population of Botswana

Table 20 presents the results of population projections assuming a fast decline scenario. Based on the assumptions used in this variant, the population of Botswana will increase from 1 669 190 in 2001 to 2 144 930 in 2016. All districts show an increase in their population from the year 2001 to 2016. Phikwe is the only district that shows a decline after the year 2013. Phikwe's population will decline from 57 335 in 2013 to 57 008 in 2016.

Table 20: Projected population for Botswana by districts, 2001-2016

Year / District	2001	2003	2005	2007	2009	2011	2013	2015	2016
Central	502 011	522 345	542 768	561 676	577 901	591 702	605 453	619 342	626 937
Francistown	82 482	87 589	92 132	95 698	98 000	99 194	99 928	100 430	100 729
Gaborone	185 211	201 284	216 183	228 953	239 092	246 947	253 285	258 898	261 599
Ghanzi	31 970	33 509	34 983	36 300	37 373	38 210	38 970	39 688	40 072
Kgalagadi	42 091	43 649	45 143	46 463	47 520	48 313	49 025	49 681	50 038
Kgatleng	73 902	75 765	77 479	78 852	79 751	80 228	80 663	81 113	81 441
Kweneng	226 812	239 153	251 167	262 187	271 727	279 867	287 683	295 247	299 209
Lobatse	29 591	31 014	32 242	33 160	33 705	33 926	34 024	34 054	34 084
Ngami	119 124	134 333	149 566	164 404	178 373	191 406	204 145	216 674	223 065
North East	48 262	49 269	50 322	51 266	51 991	52 515	53 047	53 597	53 930
Phikwe	49 851	52 350	54 573	56 235	57 149	57 393	57 335	57 104	57 008
South East	91 071	94 001	96 643	98 679	99 958	100 559	100 870	101 078	101 220
Southern	186 830	191 738	196 611	201 055	204 721	207 723	210 767	213 851	215 601
Botswana	1 669 190	1 755 990	1 839 800	1 914 930	1 977 250	2 027 990	2 075 200	2 120 750	2 144 930

Figure 2: Population of Botswana by districts, 2001

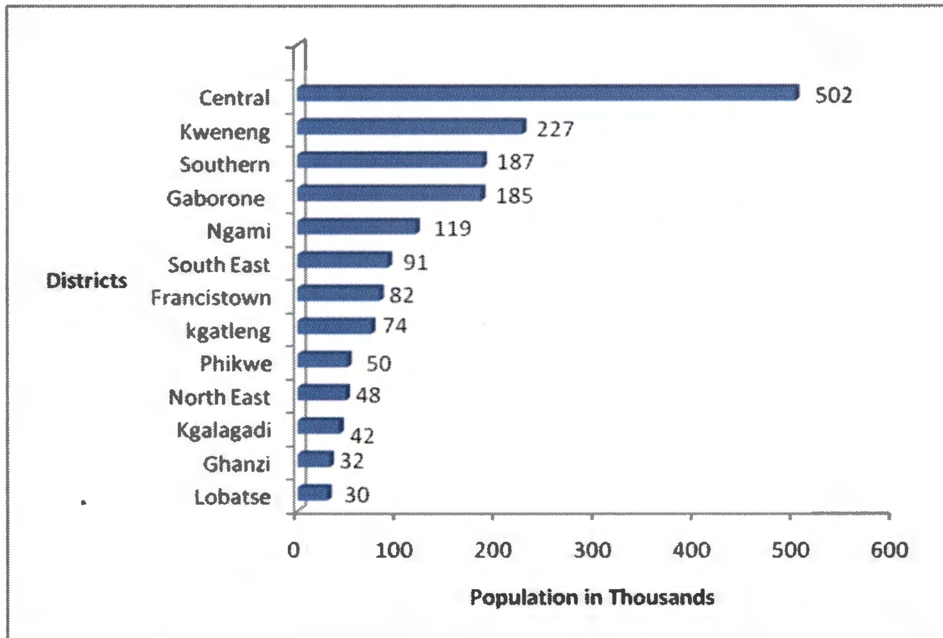


Figure 3: Projected population of Botswana by district, 2016

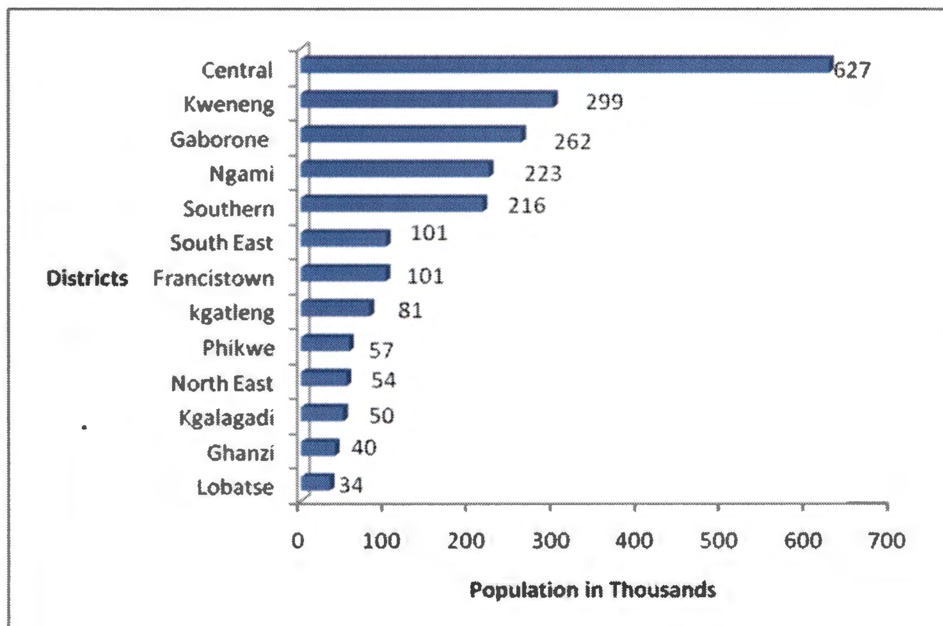


Figure 2 and 3 show the base and the projected population of Botswana by districts in 2001 and 2016 respectively. In 2001, Southern district was in the third position in terms of higher

population, but that is projected to change in 2016 as Gaborone is projected to be in the third position, followed by Ngami. Southern district will find itself in the fourth place.

Table 21: Projected percentage population distributions for Botswana, 2001-2016

Year / District	2001	2003	2005	2007	2009	2011	2013	2015	2016
Central	30.1	29.7	29.5	29.3	29.2	29.2	29.2	29.2	29.2
Francistown	4.9	5.0	5.0	5.0	5.0	4.9	4.8	4.7	4.7
Gaborone	11.1	11.5	11.8	12.0	12.1	12.2	12.2	12.2	12.2
Ghanzi	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9
Kgalagadi	2.5	2.5	2.5	2.4	2.4	2.4	2.4	2.3	2.3
Kgatleng	4.4	4.3	4.2	4.1	4.0	4.0	3.9	3.8	3.8
Kweneng	13.6	13.6	13.7	13.7	13.7	13.8	13.9	13.9	13.9
Lobatse	1.8	1.8	1.8	1.7	1.7	1.7	1.6	1.6	1.6
Ngami	7.1	7.6	8.1	8.6	9.0	9.4	9.8	10.2	10.4
North East	2.9	2.8	2.7	2.7	2.6	2.6	2.6	2.5	2.5
Phikwe	3.0	3.0	3.0	2.9	2.9	2.8	2.8	2.7	2.7
South East	5.5	5.4	5.3	5.2	5.1	5.0	4.9	4.8	4.7
Southern	11.2	10.9	10.7	10.5	10.4	10.2	10.2	10.1	10.1
Botswana	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Table 21 above indicates projected percentage distribution of Botswana's population by districts. In 2016, the Central district will still be the district with the largest share of the population of Botswana (29.2%). This has declined from 30.1% in 2001. Still in 2016, Kweneng is projected to follow Central with 13.9 percent. The district with the lowest proportion will be Lobatse with 1.6%. Most districts show a decline in percentage distribution since 2001. For example, Francistown declined from 4.9 to 4.7 percents, Kgalagadi from 2.5% to 2.3%. Other districts that show a decrease include Kgatleng, Lobatse, North East, Phikwe, South East and Southern district. Districts which show an increase are Gaborone 11.1% to 12.2%, Kweneng 13.6% to 13.9% and Ngami 7.1% to 10.4%.

NWU
LIBRARY

4.2.3 Projected population growth rates

The projected population growth rates were calculated and the results are presented in Table 22. The population growth rates are expected to decline in all districts. Central will decline from 2.0% per annum in 2001 to 1.25% per annum in 2016. Lobatse will decline from 2.5% per annum to 0.1% per annum during these years. Gaborone, Francistown, Ngami, South East growth rates will remain constant in 2015 to 2016. Phikwe will experience a negative growth of -0.2% per annum in 2016. At national level, a decline in growth rates will also be observed.

Table 22: Annual population growth rates for Botswana, 2001-2016

Year / District	2001	2003	2005	2007	2009	2011	2013	2015	2016
Central	2.0	1.9	1.8	1.6	1.3	1.1	1.1	1.1	1.2
Francistown	3.2	2.8	2.3	1.7	1.0	0.5	0.3	0.3	0.3
Gaborone	4.4	3.9	3.3	2.6	2.0	1.5	1.2	1.0	1.0
Ghanzi	2.4	2.3	2.1	1.7	1.4	1.0	1.0	0.9	1.0
Kgalagadi	1.9	1.8	1.6	1.4	1.0	0.8	0.7	0.7	0.7
kgatleng	1.3	1.2	1.1	0.8	0.5	0.2	0.3	0.3	0.4
Kweneng	2.7	2.6	2.3	2.0	1.7	1.4	1.4	1.3	1.3
Lobatse	2.5	2.2	1.8	1.2	0.7	0.2	0.1	0.0	0.1
Ngami	6.1	5.5	5.0	4.4	3.8	3.3	3.1	2.8	2.8
North East	1.0	1.1	1.0	0.9	0.6	0.5	0.5	0.6	0.6
Phikwe	2.6	2.3	1.9	1.3	0.6	0.1	-0.1	-0.2	-0.2
South East	1.7	1.5	1.3	0.9	0.5	0.2	0.1	0.1	0.1
Southern	1.3	1.3	1.2	1.1	0.9	0.7	0.7	0.8	0.8
Botswana	2.5	2.3	2.1	1.7	1.2	0.9	0.8	0.7	0.8

4.2.4 Age structure

The projected population age structure was calculated and the results are portrayed in Table 23.

Table 23: Projected age distribution by districts, 2016

	Age Groups					Age Groups				
	2001					2016				
Districts	<15	15-64	65 +	Total	Dependency Ratio	<15	15-64	65+	Total	Dependency Ratio
Gaborone	25	74	1	100	36	26	70	3	100	42
Francistown	32	67	1	100	49	30	67	3	100	50
Lobatse	30	68	2	100	47	24	72	4	100	39
Phikwe	30	69	1	100	46	27	70	3	100	43
South East	32	65	3	100	54	17	77	6	100	30
Kgatlèng	39	56	5	100	77	25	70	5	100	43
North East	44	51	5	100	96	29	67	5	100	50
Ghanzi	37	58	4	100	72	33	63	4	100	59
Kweneng	38	58	4	100	72	33	63	4	100	58
Kgalagadi	38	58	4	100	72	28	67	4	100	49
Ngami	39	57	4	100	75	35	61	3	100	63
Central	42	53	5	100	87	31	65	4	100	53
Southern	40	54	6	100	86	28	67	5	100	49
Botswana	36	61	3	100	67	28	68	4	100	48

In this scenario, Ngami is anticipated to have the largest percentage of the population under 15 years (35%), followed by Ghanzi and Kweneng with 33% each. The district that will have the lowest proportion aged below 15 years is South East with 17 %. As for the economically active group, age group 15-64 years, urban districts are expected to have the larger percentage of the population as compared with rural districts. South East is leading with 77%, followed by Lobatse with 72%, then Gaborone, Phikwe and Kgatleng with 70% each. South East is expected to have a higher percentage for the age group 65+, with 6.0%. For Botswana, 28% with less than 16, 68% will be the percentage population aged 16-64, and for the population aged 65+, it will be 4%. Age dependency ratio in 2016 was the highest in Ngami (63%) and lowest in South East (30%).

4.2.5 Median age

Median age is an index that is often used when describing whether a population is young or old, and whether it is becoming younger or older. Populations with medians under 20 are described as being young and those with medians of 30 and above as being old. Those with median ages between 20 and 29 are referred to as populations of intermediate age (Shryock & Siegel, 1976). Table 24 presents the projected median age for the population of Botswana and its districts.

For the country as a whole, median age is projected to increase from 21 years in 2001 to 26 years in 2016, indicating that the population will change from being described as young to intermediate. In 2001, the districts of Central, Ngami, North East and Southern could be described as young, whereas the remaining districts were intermediate. In 2016, all the districts were intermediate with the exception of Gaborone and South East which are projected to be old.

Table 24: Projected median age by districts

Year / District	2001	2003	2005	2007	2009	2011	2013	2015	2016
Central	18	19	20	21	22	22	23	23	24
Francistown	23	23	24	25	25	25	26	26	26
Gaborone	25	25	26	27	28	29	29	30	30
Ghanzi	21	21	22	22	22	23	23	23	23
Kgalagadi	20	21	22	22	23	24	24	25	25
Kgatleng	20	21	22	23	23	24	25	26	26
Kweneng	20	20	21	22	22	23	23	24	24
Lobatse	23	24	25	26	27	28	28	29	29
Ngami	19	20	21	21	22	22	22	22	23
North East	17	18	19	20	21	22	23	24	24
Phikwe	23	24	25	26	26	27	27	28	28
South East	23	24	25	27	28	29	30	31	31
Southern	19	20	21	22	22	23	24	25	25
Botswana	21	22	23	23	24	25	25	26	26

4.4. 5 Vital rates

This section presents rates of the components fertility and mortality. They indicate the nature and possible change in the population.

Table 25: Projected infant mortality rates (IMR) by district, 2001-2016

Year District	2001	2003	2005	2007	2009	2011	2013	2015	2016
Central	130	138	130	121	122	117	113	109	107
Francistown	79	92	83	73	77	73	69	66	64
Gaborone	47	55	52	48	50	46	43	39	33
Ghanzi	73	82	75	67	69	66	62	59	57
Kgalagadi	101	106	100	93	94	90	86	82	80
Kgatleng	88	95	88	80	81	77	73	70	68
Kweneng	87	89	83	78	76	73	69	66	64
Lobatse	86	94	86	79	80	76	72	68	67
Ngami	119	126	119	111	113	109	105	101	99
North East	137	144	136	127	128	124	119	114	112
Phikwe	83	94	87	88	95	91	86	83	81
South East	35	47	39	34	37	35	32	29	29
Southern	120	124	118	111	110	106	102	98	96
Botswana	91	99	92	85	87	83	79	76	73

Districts such as Kgalagadi, Southern, North East, Central and Ngami experienced very high infant mortality rates in 2001, i.e., more than 100 infant deaths per 1000 live births. Districts which experienced very low infant mortality rates is South East and Gaborone with 35 infant deaths per 1000 live births and 47 infant deaths per 1000 live births, respectively. However, under this scenario, the IMR is projected to decline throughout all the districts as well as at country level. Detailed analyses of results are outlined in Table 25.

Table 26: Projected life expectancy at birth for males by district, 2001-2016

Year / District	2001	2003	2005	2007	2009	2011	2013	2015	2016
Central	42.6	42.6	41.0	37.8	35.1	34.4	35.0	36.6	37.6
Francistown	56.6	55.8	52.6	46.6	41.8	40.1	40.6	42.6	43.8
Gaborone	63.9	63.2	60.4	55.0	50.2	48.5	49.4	52.1	53.9
Ghanzi	58.5	58.1	56.1	51.8	47.5	45.7	45.9	47.6	48.8
Kgalagadi	51.1	51.3	50.1	47.3	44.4	43.3	43.8	45.3	46.4
Kgatleng	52.0	51.8	50.1	46.6	43.3	42.1	42.6	44.3	45.5
Kweneng	51.5	51.8	49.9	45.8	42.0	40.2	40.1	41.4	42.3
Lobatse	54.9	54.7	52.6	48.2	44.5	43.2	44.1	46.4	47.8
Ngami	46.9	46.8	45.3	42.0	38.9	37.8	38.2	39.9	40.9
North East	40.1	40.2	38.6	35.3	32.7	31.8	32.4	33.9	34.8
Phikwe	54.3	53.8	50.7	44.6	39.7	37.9	38.0	39.4	40.3
South East	73.9	73.4	71.5	66.0	62.1	59.6	60.7	63.3	63.8
Southern	46.4	46.6	45.4	42.7	40.2	39.5	40.1	41.9	42.9
Botswana	53.3	53.1	51.1	46.9	43.3	41.9	42.4	44.2	45.3

Table 27: Projected life expectancy at birth for females by district, 2001-2016

Year / District	2001	2003	2005	2007	2009	2011	2013	2015	2016
Central	48.6	48.7	48.6	47.4	45.1	43.6	43.0	43.3	43.6
Francistown	56.6	55.9	55.5	53.2	49.4	46.7	45.4	45.2	45.4
Gaborone	66.6	66.0	65.4	63.1	59.5	57.0	55.9	56.0	56.6
Ghanzi	57.8	57.5	57.3	55.5	51.9	49.3	47.9	47.7	47.9
Kgalagadi	52.0	52.3	52.2	51.2	49.0	47.2	46.4	46.4	46.7
Kgatleng	57.5	57.6	57.4	55.9	53.1	51.1	50.3	50.5	50.9
Kweneng	58.2	58.5	58.9	58.6	57.9	57.7	58.2	59.2	59.8
Lobatse	55.1	54.9	54.8	53.4	50.9	49.2	48.5	48.8	49.1
Ngami	48.1	48.0	48.1	47.1	44.8	43.0	42.0	42.0	42.2
North East	49.2	49.3	49.1	47.8	45.3	43.6	43.0	43.3	43.6
Phikwe	57.2	56.7	56.0	53.0	48.6	45.6	44.0	43.6	43.7
South East	63.9	63.5	62.9	60.4	56.4	53.7	52.6	52.9	53.5
Southern	48.6	48.9	49.0	48.2	46.5	45.3	45.0	45.5	45.9
Botswana	55.3	55.2	55.0	53.4	50.6	48.7	47.9	48.0	48.4

Table 28: Projected life expectancy at birth for both sexes by district, 2001-2016

Year / District	2001	2003	2005	2007	2009	2011	2013	2015	2016
Central	45.7	45.7	44.9	42.7	40.3	39.1	39.1	40.0	40.7
Francistown	56.6	55.8	54.1	50.0	45.7	43.5	43.1	43.9	44.6
Gaborone	65.3	64.6	62.9	59.1	54.9	52.8	52.7	54.1	55.3
Ghanzi	58.2	57.8	56.7	53.6	49.7	47.4	46.9	47.6	48.3
Kgalagadi	51.5	51.8	51.1	49.2	46.7	45.2	45.0	45.9	46.5
Kgatleng	55.1	55.1	54.2	51.8	48.8	47.1	46.9	47.8	48.5
Kweneng	55.0	55.3	54.5	52.3	50.2	49.2	49.5	50.6	51.4
Lobatse	55.0	54.8	53.7	50.9	47.7	46.2	46.3	47.6	48.5
Ngami	47.5	47.4	46.7	44.5	41.8	40.3	40.1	40.9	41.5
North East	44.9	45.0	44.1	41.9	39.3	38.0	37.9	38.8	39.4
Phikwe	55.8	55.2	53.4	48.9	44.3	41.9	41.1	41.6	42.1
South East	70.5	69.9	68.5	64.1	60.0	57.5	57.8	59.6	60.1
Southern	47.5	47.8	47.3	45.5	43.4	42.4	42.6	43.7	44.4
Botswana	54.5	54.3	53.2	50.3	47.1	45.4	45.3	46.3	47.0

Life expectancies at birth in districts were projected for males, females and both sexes. The results are shown in Tables 26-28 above. At national level, mortality is expected to increase with life expectancy declining from 54.5 years to 47.0 years in 2001 and 2016, respectively. The same trend was observed across all the districts.

Table 29: Projected AIDS deaths by district, 2001-2016

Year / District	2003	2005	2007	2009	2011	2013	2015	2016
Central	257	791	1942	3447	4501	4919	4829	4676
Francistown	70	225	562	985	1272	1360	1300	1242
Gaborone	106	430	1115	1946	2519	2690	2539	2390
Ghanzi	19	54	131	238	318	354	353	343
Kgalagadi	16	51	128	235	319	358	356	346
Kgatleng	27	96	246	438	578	634	621	599
Kweneng	62	265	725	1292	1705	1857	1787	1701
Lobatse	15	55	143	250	322	341	319	300
Ngami	75	224	562	1075	1499	1735	1786	1765
North East	23	72	176	311	407	445	438	425
Phikwe	33	132	358	631	823	900	882	852
South East	32	127	334	587	759	805	751	705
Southern	64	207	515	937	1224	1339	1302	1248
Botswana	799	2729	6937	12372	16246	17737	17263	16592

AIDS deaths are expected to increase across districts - at least up to the year 2015. Thereafter the deaths will decline. For example, in Francistown AIDS deaths will increase from 70 in 2003, to 1300 in 2015. Thereafter the deaths are projected to decline to 1242 in 2016. The deaths in Lobatse will increase from 15 to 319 in 2015, then come down to 300 in 2016. As for the country, AIDS deaths are also expected to increase from 799 in 2001 to 17 263 in 2015 then decrease to 16 592.

NWU LIBRARY

Table 30: Number of orphans in Botswana and districts, 2001-2016

Year District	2006	2008	2010	2012	2014	2015	2016
Central	1 742	4 487	9 640	15 109	19 483	21 097	22 298
Francistown	526	1 409	2 833	4 178	5 083	5 373	5 586
Gaborone	828	2358	4 865	7 504	9 550	10 257	11 567
Ghanzi	129	365	781	1 240	1 627	1 775	1 893
Kgalagadi	106	286	635	1 030	1 374	1 505	1 604
Kgatleng	189	530	1 118	1 757	2 283	2 470	2 601
Kweneng	804	2 333	4 998	8 001	10 649	11 696	12 514
Lobatse	116	308	634	955	1 181	1 250	1 292
Ngami	543	1483	3 359	5536	7 500	8 330	9 044
North East	147	382	808	1257	1 609	1738	1 830
Phikwe	238	611	1 254	1897	2 369	2 529	2 646
South East	169	518	1083	1697	2 195	2 366	2 476
Southern	443	978	2 462	3 914	5 114	5 562	5 892
Botswana	5 980	16 048	34 470	54 075	70 017	75 948	81 243

Table 30 depicts detailed figures of projected number of orphans. Each district is projected to have increase in the number of AIDS orphans. At national level, number of AIDS orphans is projected to increase at an alarming rate, from 5980 in 2001 to 81 243 in 2016. As for the districts, Central will be leading with 22 298 AIDS orphans. Lobatse is projected to have the least number of HIV/AIDS orphans (1292).

4.3 Summary

This part of the study has presented results based on the fast decline scenario of HIV/AIDS in Botswana. Under this scenario, the population of Botswana is projected to increase to 2 144 930 in 2016. Annual population growths will decline from 2.5 to 0.8 in 2016. Median age will increase from 21 years to 26years. IMR will decline from 91infant deaths per 1000 live births to 73 infant deaths per 1000 live births. Life expectancy for both sexes will decline from 55 years to 48 years. AIDS deaths are estimated to reach 16 592 in 2016. There will be 81 243 AIDS orphans in Botswana.

CHAPTER 5: ANALYSIS OF MEDIUM DECLINE SCENARIO

5.1 Introduction

This chapter presents the districts and national population projection results for Botswana's population based on the medium, variant scenario. This scenario is based on assumptions of slow decline of mortality, slow decline of fertility and constant migration. In terms of HIV/AIDS, this scenario assumes that the trend that was observed during the period 2001-2006 will continue in future. The projections are carried out separately for each district. The projections for Botswana as a whole are obtained by averaging the results for the districts.

5.2 Results

5.2.1 Projected population of Botswana

Table 31 presents the results of population projections, assuming the medium decline scenario. Based on the assumptions used in this variant, the population of Botswana will increase from 1 669 190 in 2001 to 2 137 400 in 2016. All districts show an increase in their population from the year 2001 to 2016. Phikwe is the only district that shows decline of 831 between 2011 and 2016.

Table 31: Projected population of Botswana by districts, 2001-2016

Year / District	2001	2003	2005	2007	2009	2011	2013	2015	2016
Central	502 011	522 345	542 768	561 675	577 872	591 555	604 958	618 092	625 110
Francistown	82 482	87 595	92 160	95 781	98 211	99 623	100 678	101 636	102 229
Gaborone	185 211	201 285	216 186	228 962	239 103	246 944	253 216	258 621	261 145
Ghanzi	31 970	33 509	34 983	36 300	37 366	38 178	38 864	39 423	39 687
Kgalagadi	42 091	43 646	45 132	46 433	47 452	48 191	48 811	49 308	49 548
Kgatleng	73 902	75 765	77 479	78 851	79 745	80 192	80 533	80 779	80 951
Kweneng	226 812	239 153	251 167	262 187	271 713	279 771	287 316	294 291	297 804
Lobatse	29 591	31 014	32 243	33 163	33 712	33 938	34 036	34 054	34 071
Ngami	119 124	134 333	149 566	164 402	178 342	191 250	203 620	215 340	221 104
North East	48 262	49 269	50 324	51 273	52 006	52 533	53 051	53 552	53 844
Phikwe	49 851	52 350	54 573	56 234	57 135	57 333	57 154	56 673	56 392
South East	91 071	94 002	96 645	98 683	99 970	100 579	100 890	101 061	101 163
Southern	186 830	191 738	196 611	201 055	204 697	207 620	210 429	213 004	214 364
Botswana	**1 669 190**	**1 755 990**	**1 839 830**	**1 914 970**	**1 977 320**	**2 027 700**	**2073 560**	**2115 820**	**2137 400**

Figure 4: Total population of Botswana, 2016 (in thousands)

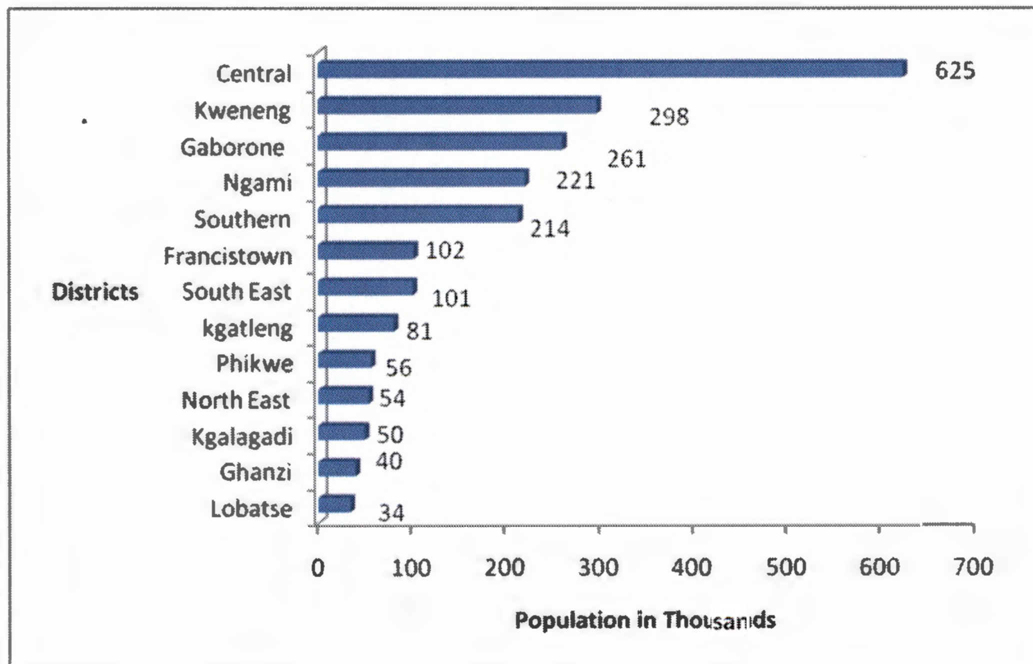


Figure 4 shows the projected population in 2016. All districts indicate an increase in their populations. Central district is leading in terms of total population, while Lobatse is the least. In 2001, the Southern district had a higher population counting than Gaborone, but in 2016 Gaborone was the higher than the Southern district. This shows that Gaborone, as the capital city, is growing faster than other districts.

5.2.2 Percentage distribution

Figure 5: Projected percentage population distributions for Botswana, 2001

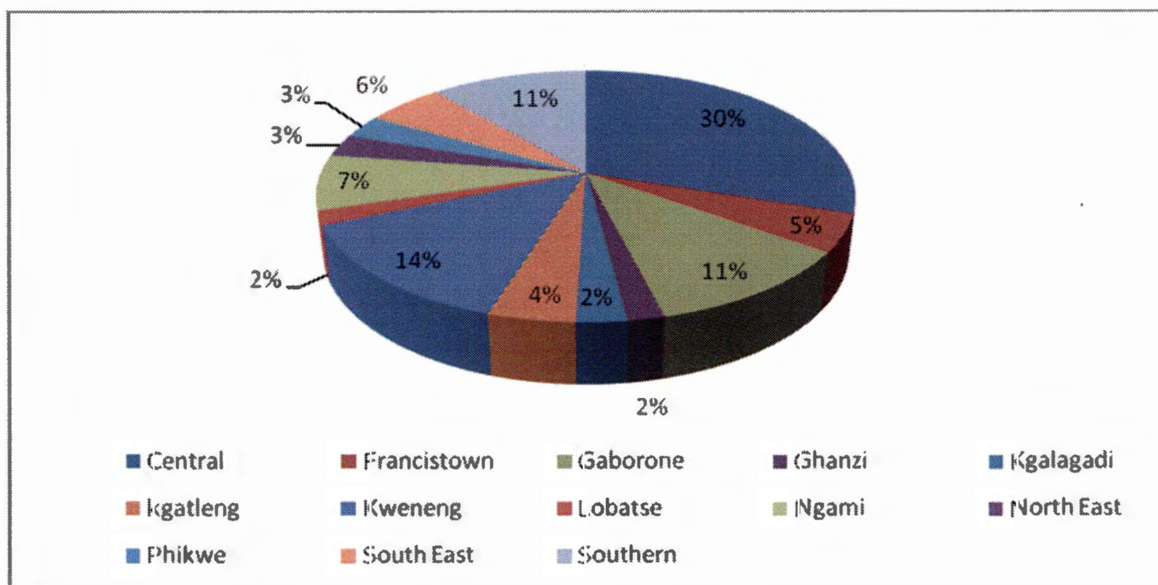


Figure 6: Projected population percentage distributions by district, 2016

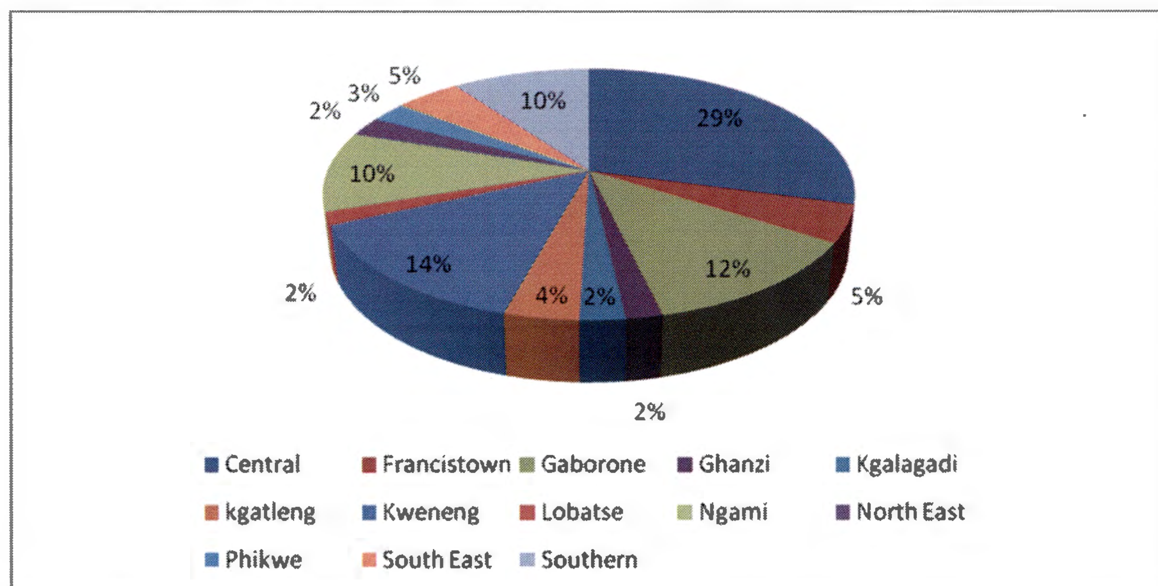


Table 32: Percentage distribution of population by districts

Year / District	2001	2003	2005	2007	2009	2011	2013	2015	2016
Central	30.1	29.7	29.5	29.3	29.2	29.2	29.2	29.2	29.2
Francistown	4.9	5.0	5.0	5.0	5.0	4.9	4.9	4.8	4.8
Gaborone	11.1	11.5	11.8	12.0	12.1	12.2	12.2	12.2	12.2
Ghanzi	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9
Kgalagadi	2.5	2.5	2.5	2.4	2.4	2.4	2.4	2.3	2.3
Kgatleng	4.4	4.3	4.2	4.1	4.0	4.0	3.9	3.8	3.8
Kweneng	13.6	13.6	13.7	13.7	13.7	13.8	13.9	13.9	13.9
Lobatse	1.8	1.8	1.8	1.7	1.7	1.7	1.6	1.6	1.6
Ngami	7.1	7.6	8.1	8.6	9.0	9.4	9.8	10.2	10.3
North East	2.9	2.8	2.7	2.7	2.6	2.6	2.6	2.5	2.5
Phikwe	3.0	3.0	3.0	2.9	2.9	2.8	2.8	2.7	2.6
South East	5.5	5.4	5.3	5.2	5.1	5.0	4.9	4.8	4.7
Southern	11.2	10.9	10.7	10.5	10.4	10.2	10.1	10.1	10.0
Botswana	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Table 32 shows percentage distribution of Botswana's population. In 2001, Central districts had the largest share of the country's population (30.1%), followed by Kweneng (13.6%), Southern District (11.2 %) and Gaborone (11.1%). The districts with the smallest share were Lobatse, Ghanzi and Kgalagadi. However, in 2016, the percentage share of Central district is projected to decline to 29.2 %. Gaborone will increase from 11.1% to 12.2%. Percentage distribution of Ghanzi is projected to remain constant at 1.9% throughout the projection period.

5.2.3 Projected population growth rates

The projected population growth rates were calculated and the results are presented in Table 32.

Table 33: Annual population growth rates for Botswana, 2001-2016

Year / District	2001	2003	2005	2007	2009	2011	2013	2015	2016
Central	2.0	1.9	1.8	1.6	1.3	1.1	1.1	1.1	1.1
Francistown	3.2	2.8	2.4	1.7	1.1	0.6	0.5	0.5	0.6
Gaborone	4.4	3.9	3.3	2.6	2.0	1.5	1.2	1.0	0.9
Ghanzi	2.4	2.3	2.1	1.7	1.3	1.0	0.9	0.7	0.7
Kgalagadi	1.9	1.8	1.6	1.3	1.0	0.7	0.6	0.5	0.5
Kgatleng	1.3	1.2	1.1	0.8	0.5	0.2	0.2	0.2	0.2
Kweneng	2.7	2.6	2.3	2.0	1.7	1.4	1.3	1.2	1.2
Lobatse	2.5	2.2	1.8	1.2	0.7	0.2	0.1	0.0	0.0
Ngami	6.1	5.5	5.0	4.4	3.8	3.2	2.9	2.6	2.5
North East	1.0	1.1	1.0	0.9	0.7	0.5	0.5	0.5	0.5
Phikwe	2.6	2.3	1.9	1.3	0.6	0.0	-0.2	-0.5	-0.5
South East	1.7	1.5	1.3	0.9	0.5	0.2	0.1	0.1	0.1
Southern	1.3	1.3	1.2	1.1	0.9	0.7	0.7	0.6	0.6
Botswana	2.5	2.3	2.1	1.7	1.2	0.9	0.8	0.7	0.6

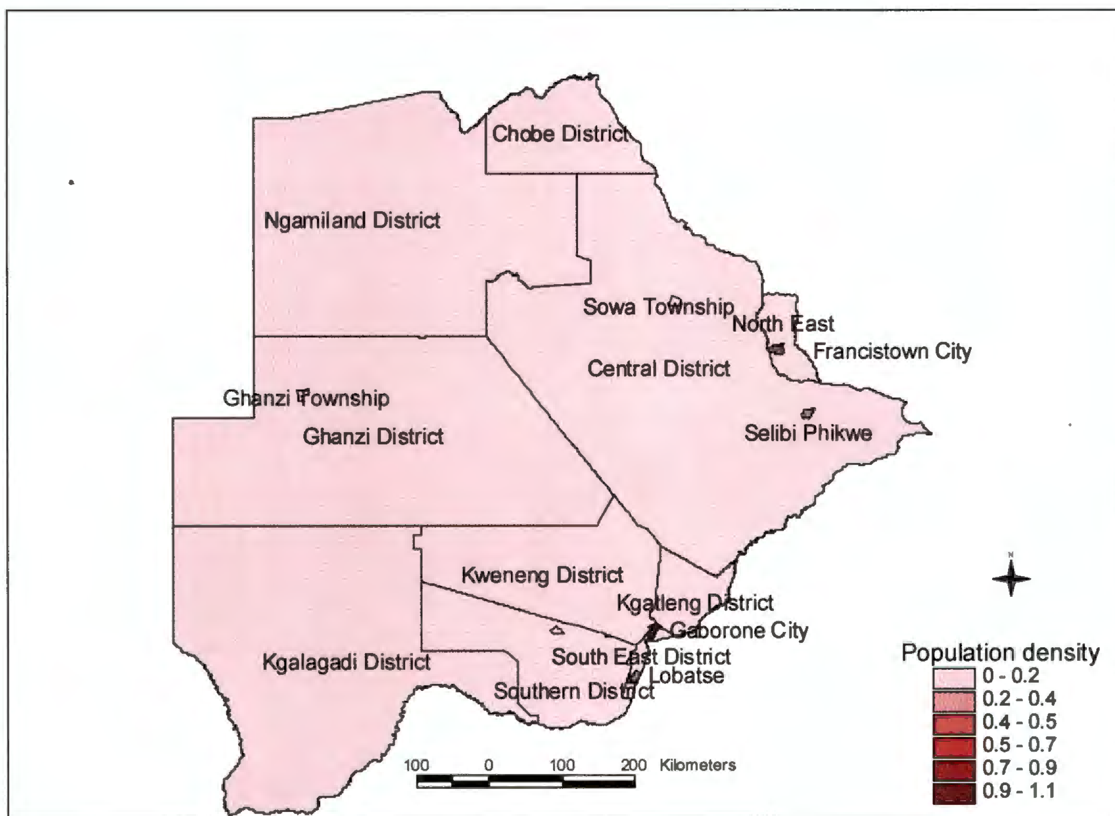
The population growth rates for all districts shows a declining trend between 2001 and 2016. The decline was faster in districts such as Gaborone, Francistown and Ngami. However, some districts such as Central and Southern showed a slower rate of decline. Annual population growth rate for the country as a whole will decline from 2.5% per annum to 0.6% per annum. Gaborone will decline from 4.4% per annum in 2001 to 0.9% per annum in 2016. Districts such as Kweneng, Kgatleng, North East, Lobatse and Francistown will experience constant population

growth towards the end of projection period. Lobatse will experience 0% growth per annum while Phikwe will experience -0.5% per annum.

5.2.4 Projected population density

Population density refers to the number of people in a defined jurisdiction, in relation to the size of the area that they occupy, i.e., the number of people per square kilometre. Figure 7 below shows the projected population density of Botswana.

Figure 7: Projected population density for Botswana, 2016



Under this scenario, all urban districts have a higher population density, while rural districts have a less population density. It is obvious for the population density to be higher in urban areas than in rural communities because urban districts attract a lot of people as they offer employment

opportunities, best education and health facilities. This projected density does not differ with that of the base population. The same picture was observed in 2001. Population density was higher in Gaborone, followed by Francistown, Selibe-Phikwe and South East district. The rest of the districts had a less population density of 0-0.2 per km^2.

5.2.5 Age structure

The projected population age structure was calculated and the results are presented in Table 33.

Table 34: Age distribution by broad age groups for Botswana and districts, 2001 and 2016

	Age Groups					Age Groups				
	2001					2016				
Districts	<15	16-64	65+	Total	Dependency Ratio	<15	16-64	65+	Total	Dependency Ratio
Gaborone	25	74	1	100	36	26	70	3	100	42
Francistown	32	67	1	100	49	30	67	3	100	49
Lobatse	30	68	2	100	47	24	72	4	100	39
Phikwe	30	69	1	100	46	27	70	4	100	43
South East	32	65	3	100	54	17	77	6	100	30
Kgatleng	39	56	5	100	77	25	70	5	100	43
North East	44	51	5	100	96	29	67	5	100	50
Ghanzi	37	58	4	100	72	33	63	4	100	60
Kweneng	38	58	4	100	72	33	63	4	100	58
Kgalagadi	38	58	4	100	72	29	67	4	100	49
Ngami	39	57	4	100	75	35	61	3	100	63
Central	42	53	5	100	87	31	65	4	100	53
Southern	40	54	6	100	86	28	67	5	100	49
Botswana	36	61	3	100	67	28	68	4	100	48

Botswana

Tables 32 depict the estimated and projected age distributions in broad age groups. Population below 15 in Botswana is projected to decline from 36.6 % in 2001 to 28% in 2016. An increase will be observed in population aged 65+ from 3% to 4% in 2016. On the other hand, at national level, the population 15-64 years is projected to increase from 61% in 2001 to 68% in 2016. Between 2001 and 2016, the population 65+ will increase by 1%. That is from 3% in 2001 to 4% in 2016.

Districts

In 2001, North East had the highest population aged less than 15 years (44%), followed by Southern (40%). Gaborone had the lowest percentage (25%). However, this is projected to change in 2016. The projected age-sex distributions suggest that Ngami will have the highest percentage of persons aged 0-15 years (35%) while South-East has the lowest (17%). In addition, South-East is projected to have the largest percentage (77%) of persons in the working age group (persons aged 16-64 years) while Ngami has the lowest proportionately (61%) The projections further suggest that Phikwe has the highest proportion of the elderly population (65+) at 6% while Francistown, Gaborone and Ngami have the lowest (4% each). Age dependency ratio in 2001 was the highest in the North-East (96) and the lowest in Gaborone (36). In 2016, it was high in Phikwe (63) and low in the South-East district (30).

Districts such as Francistown, Gaborone, Lobatse and South-East will experience an increase in aging population from 1% in 2001 to 3% in 2016, 1% to 3%, 2% to 4% and 3% to 6%, respectively. While the rest of the remaining districts will experience a decline in aging population. Districts that experience an increase in aging population are mostly urban areas.

5.2.6 Median age

One common measure of population aging is the increase in the median age of its members (Gavrilov & Heuveline, 2003). The median age, the age at which exactly half the population is

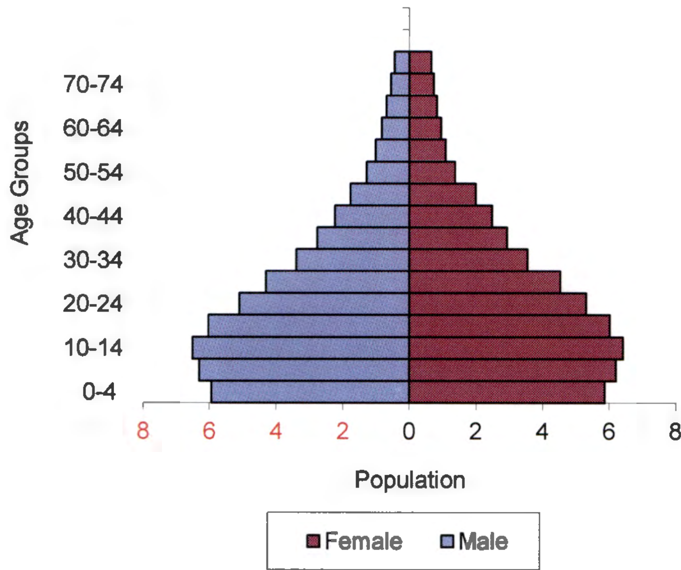
older and another half is younger, is the other most widely used indicator. Table 33 shows projected median age by districts.

Table 35: Projected median age by districts, 2001-2016

Year District	2001	2003	2005	2007	2009	2011	2013	2015	2016
Central	18	19	20	21	22	22	23	23	24
Francistown	23	23	24	25	25	25	26	26	26
Gaborone	25	25	26	27	28	29	29	30	30
Ghanzi	21	21	22	22	22	23	23	23	23
Kgalagadi	20	21	22	22	23	24	24	25	25
Kgatleng	20	21	22	23	23	24	25	26	26
Kweneng	20	20	21	22	22	23	23	24	24
Lobatse	23	24	25	26	27	28	28	29	29
Ngami	19	20	21	21	22	22	22	22	22
North East	17	18	19	20	21	22	23	24	24
Phikwe	23	24	25	26	26	27	27	27	28
South East	23	24	25	27	28	29	30	31	31
Southern	19	20	21	22	22	23	24	25	25
Botswana	21	22	23	23	24	25	25	26	26

The projected median age in Botswana under this scenario is the same as the previous one (fast decline). It is projected to increase from 21 years to 26 years.

Figure 8: Population pyramid for Botswana 2001



NWU LIBRARY

Figure 9: Population pyramid for Botswana 2016

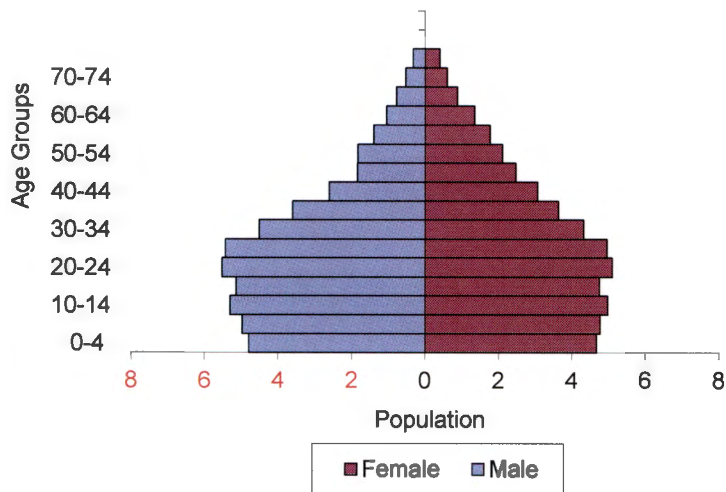


Figure 10: Population pyramid for Central, 2001

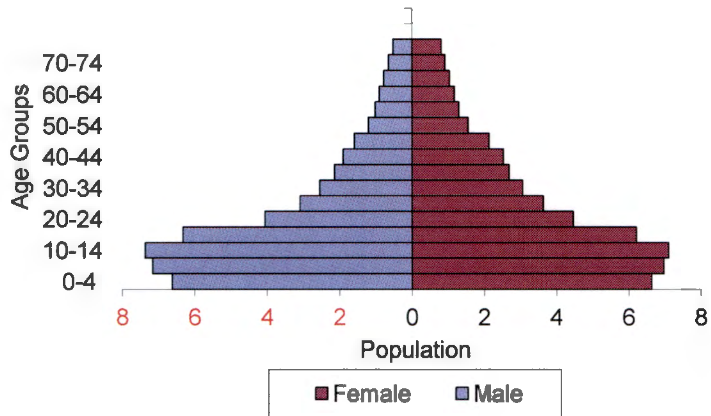


Figure 11: Population pyramid for Central, 2016

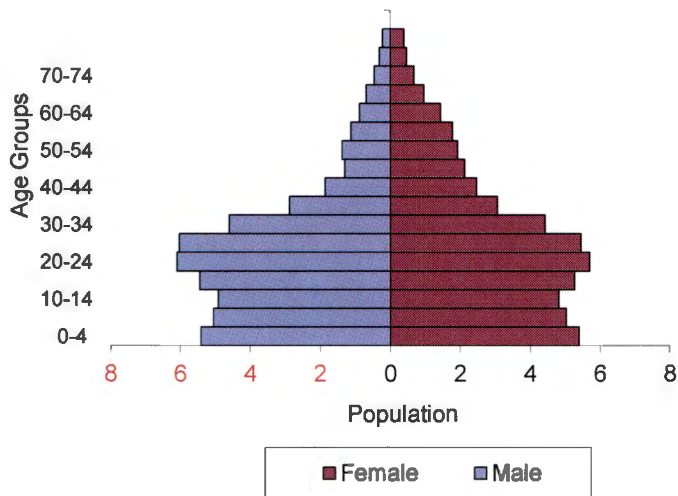


Figure 12: Population pyramid for Gaborone, 2001

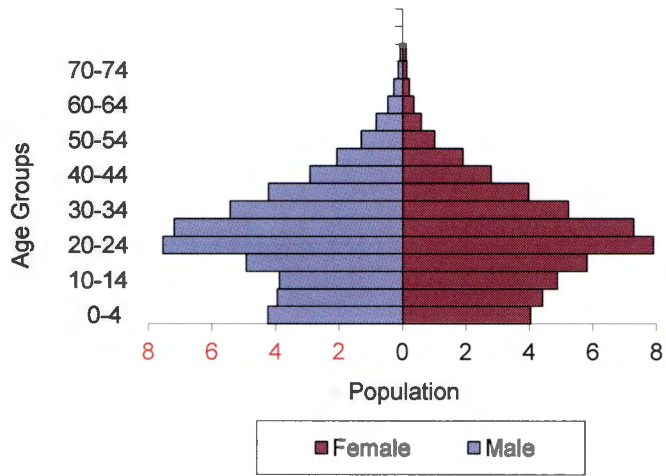


Figure 13; Population pyramid for Gaborone, 2016

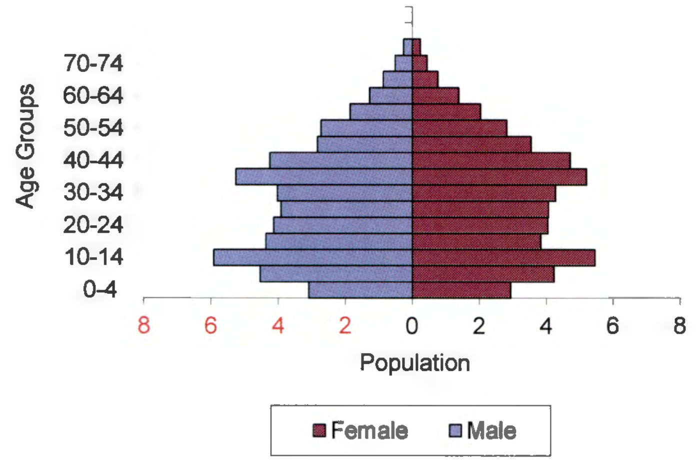


Figure 14: Population pyramid for Francistown, 2001

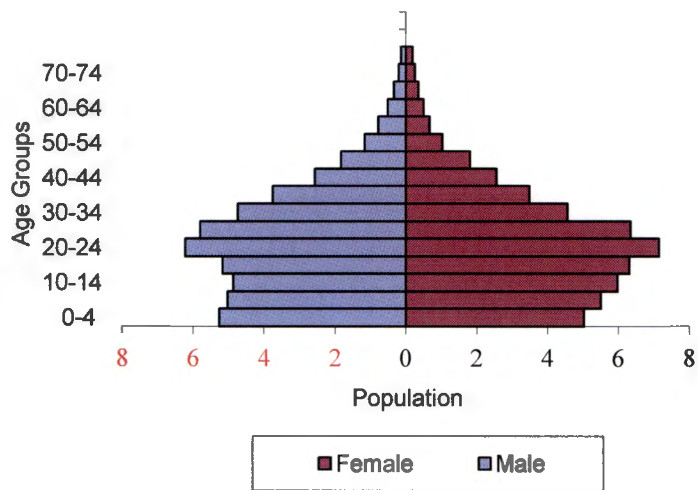


Figure 15: Population pyramid for Francistown, 2016

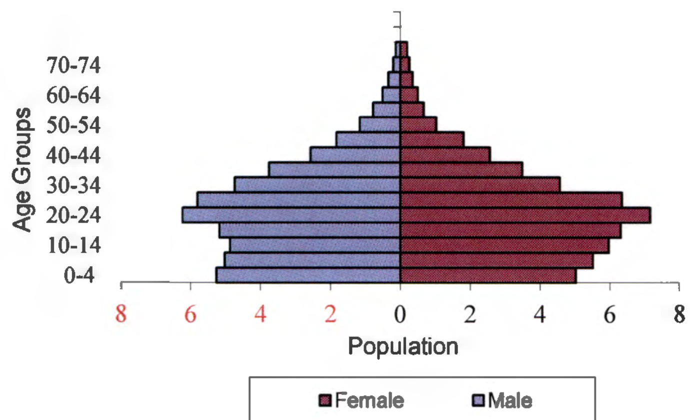


Figure 16: Population pyramid for Ghanzi, 2001

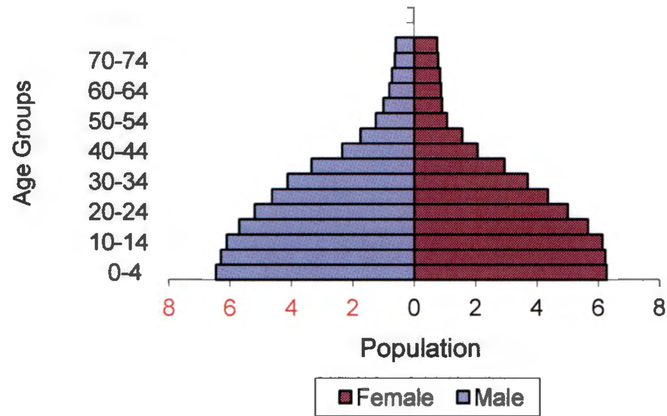


Figure 17: Population pyramid for Ghanzi, 2016

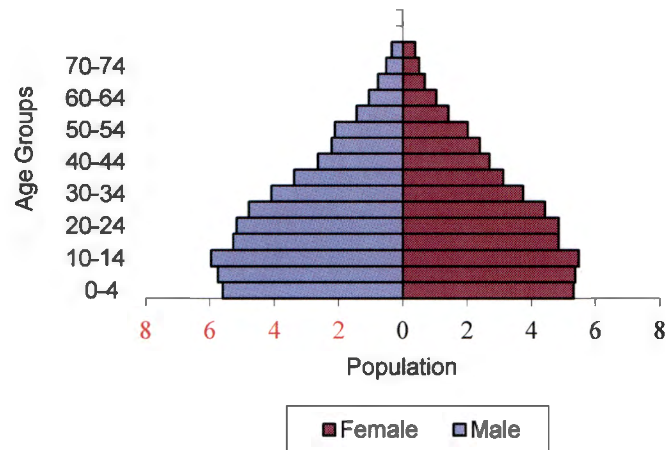


Figure 18: Population pyramid for Kgalagadi, 2001

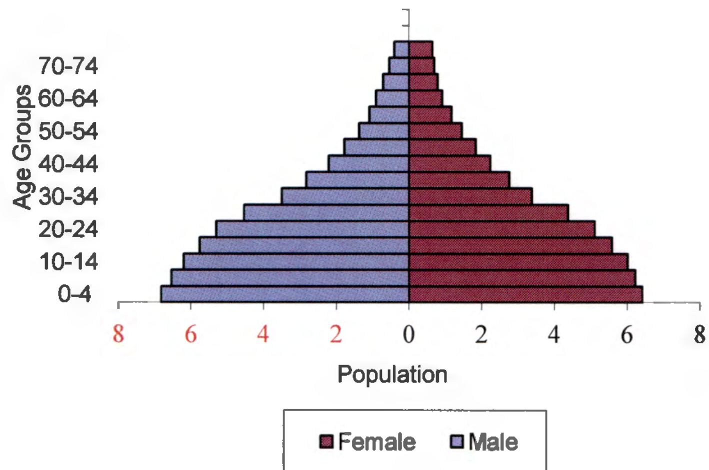


Figure 19: Population pyramid for Kgalagadi, 2016

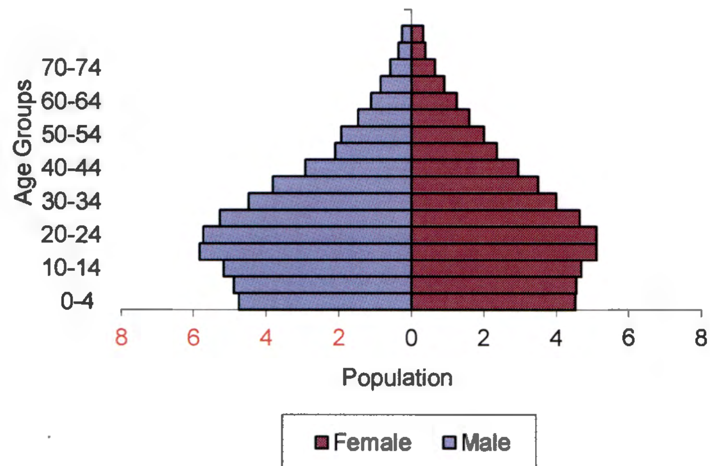


Figure 20: Population pyramid for Kweneng, 2001

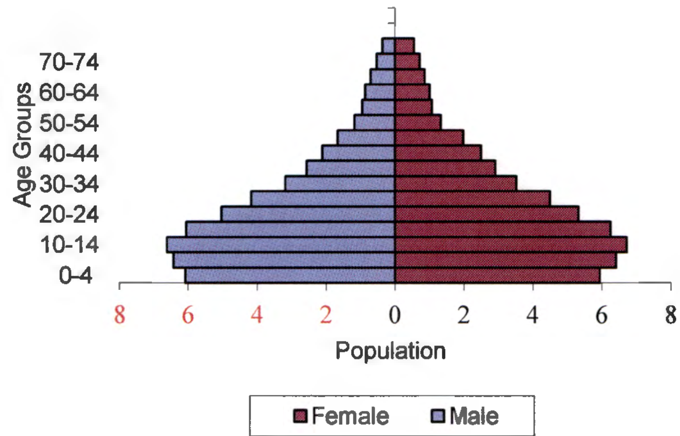


Figure 21: Population pyramid for Kweneng, 2016

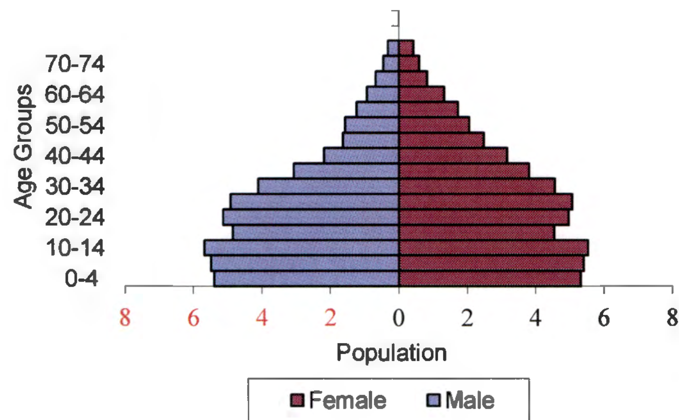


Figure 22: Population pyramid for Lobatse, 2001

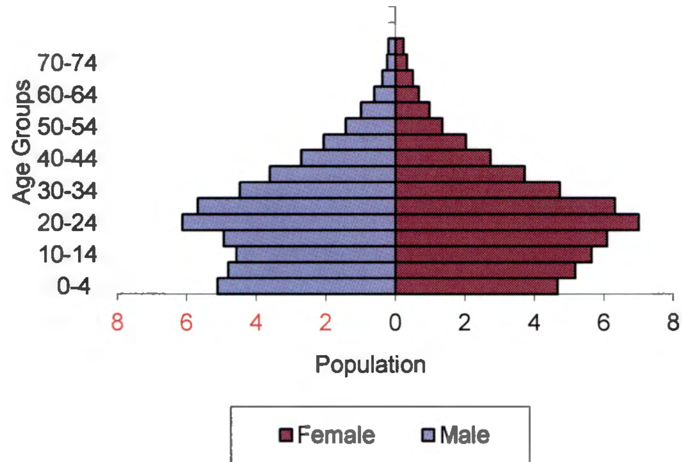


Figure 23: Population pyramid for Lobatse, 2016

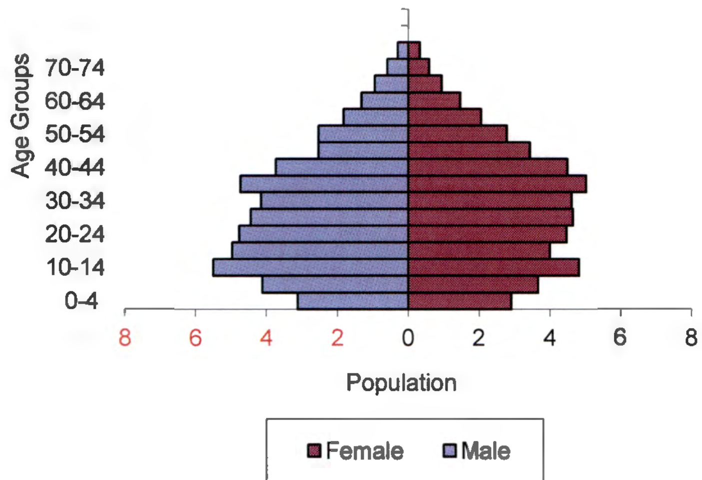


Figure 24: Population pyramid for Ngami, 2001

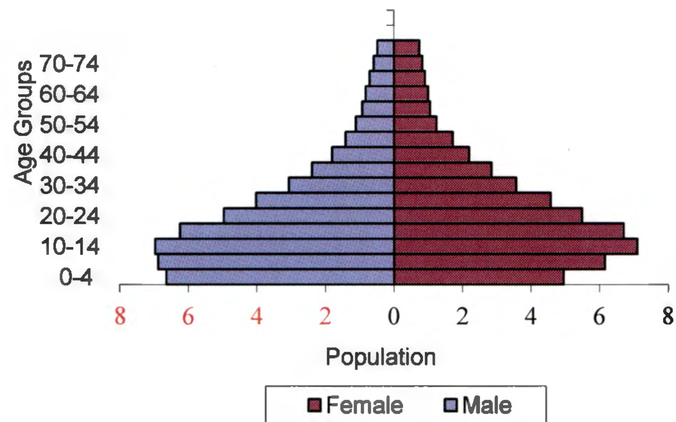


Figure 25: Population pyramid for Ngami, 2016

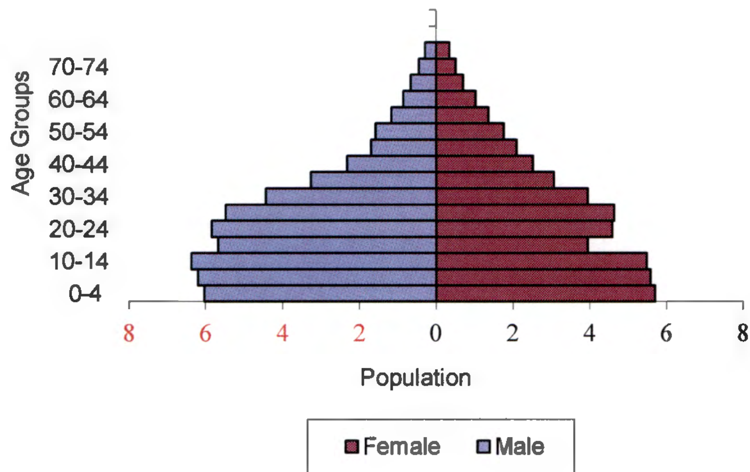


Figure 26: Population pyramid for North East, 2001

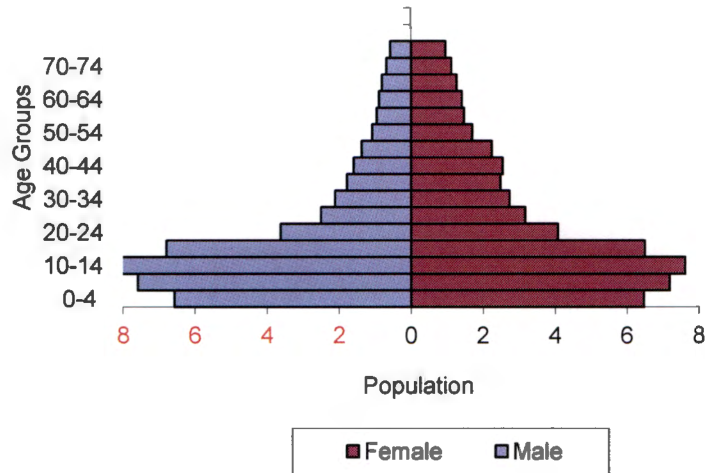


Figure 27: Population pyramid for North East, 2016

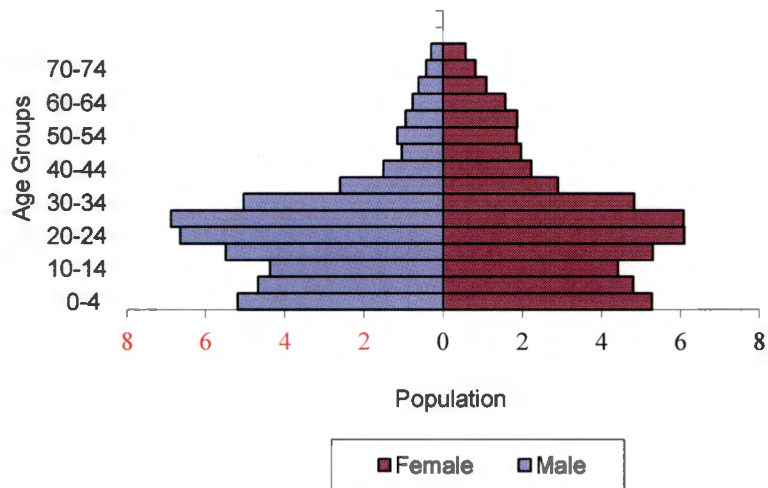


Figure 28: Population pyramid for Phikwe, 2001

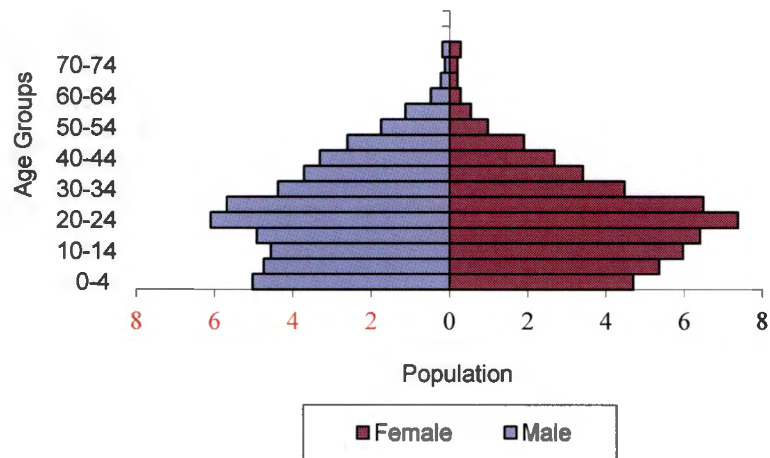


Figure 29: Population pyramid for Phikwe, 2016

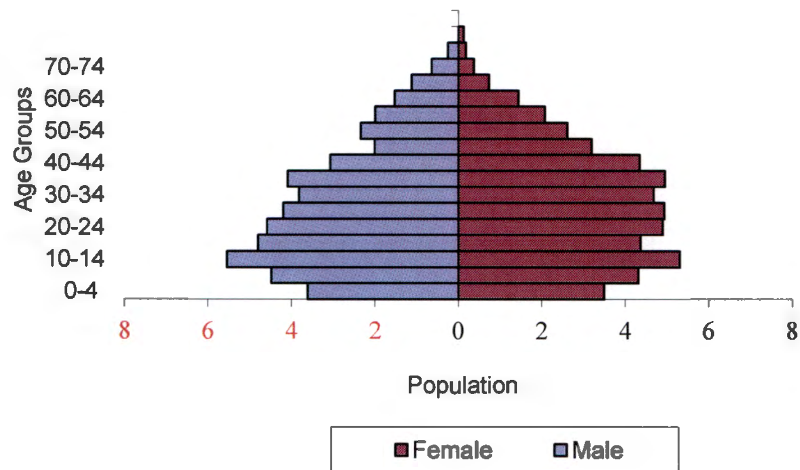


Figure 30: Population pyramid for South East, 2001

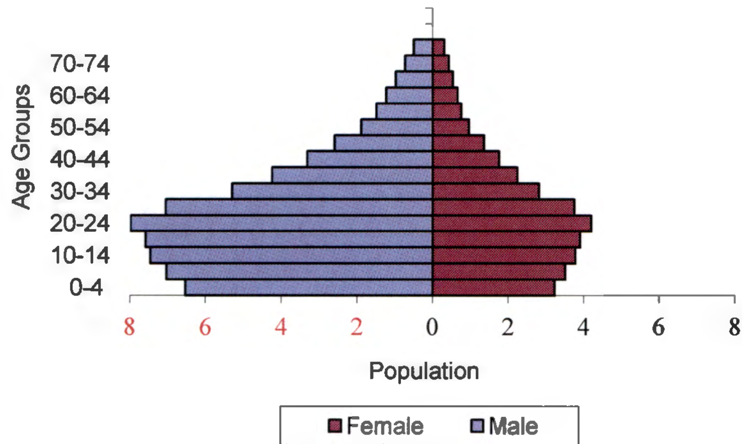


Figure 31: Population pyramid for South East, 2016

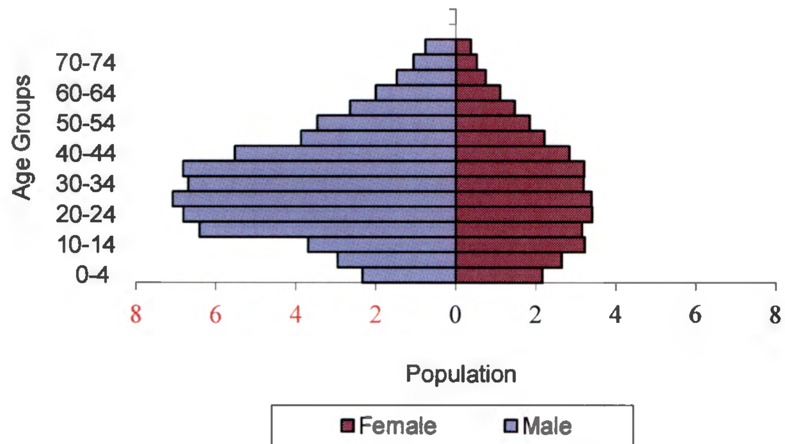
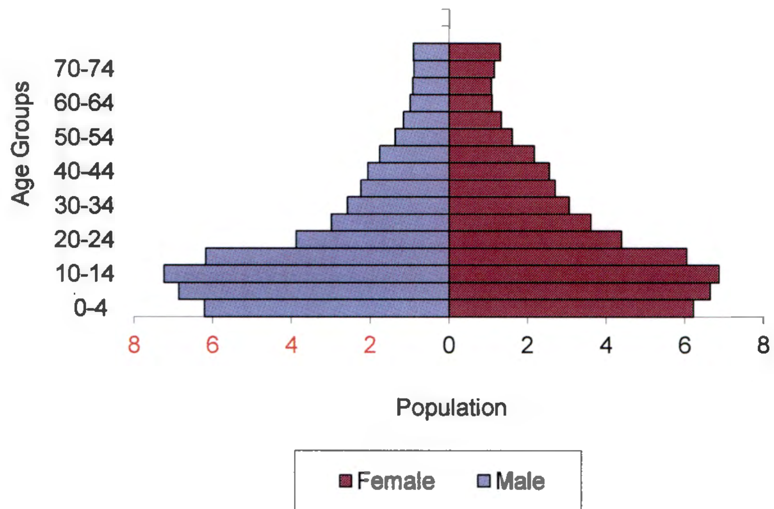
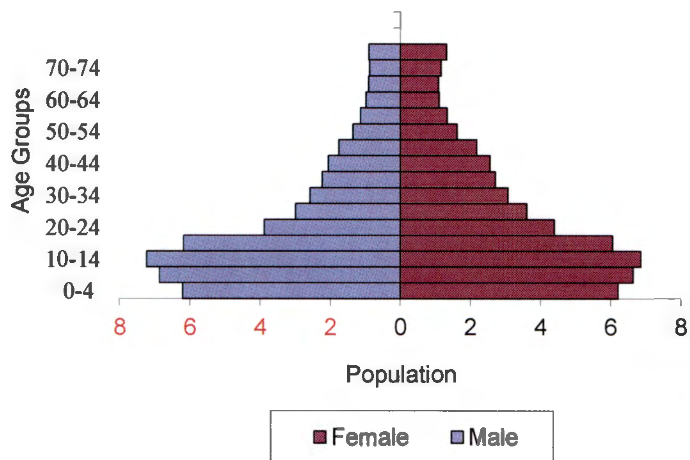


Figure 32: Population pyramid for Southern, 2001



NWU
LIBRARY

Figure 33: Population pyramid for Southern, 2016



Population pyramids were constructed for each district. Although it is called pyramid, it is not always pyramid in shape. Figure 9 shows the age structure of Botswana in 2016. It shows a more stable population except in ages 45+. At district level, North East, South East, Lobatse and Central indicate a classic shape of shrinking population in 2016.The figures show that pre-reproductive age groups (0-14 years) have smaller populations than the reproductive age groups (15-44 years). On the other hand, South-East shows more male than female population. For the same year Phikwe and Kweneng (except 25 and 45 plus) show a stable population. In 2016, Ghanzi shows unmistakable pyramid shape caused by high fertility rates.

5.2.7 Vital rates

This section presents rates of those components, such as fertility and mortality. They indicate the nature and possible change in the population.

Table 36: Projected infant mortality rates by district, 2001-2016

Year District	2001	2003	2005	2007	2009	2011	2013	2015	2016
Central	130	138	130	121	123	118	115	111	109
Francistown	79	91	81	72	73	69	65	61	59
Gaborone	47	55	52	48	51	48	45	43	35
Ghanzi	73	82	75	67	72	70	67	66	65
Kgalagadi	101	107	100	93	96	93	90	87	86
kgatleng	88	95	88	81	83	80	76	73	72
Kweneng	87	89	83	78	77	74	70	67	66
Lobatse	86	93	86	79	80	76	73	69	68
Ngami	119	126	119	112	115	112	110	107	106
North East	137	144	136	127	129	124	120	116	114
Phikwe	83	94	87	89	99	98	96	96	96
South East	35	47	39	34	37	36	33	31	31
Southern	120	124	118	111	112	108	105	102	100
Botswana	91	99	92	86	88	85	82	79	77

Infant Mortality Rates are projected to be high in North East district with 114 infant deaths per 1000 live births in 2016, followed by Central with 109 infant deaths per 1000 live births. Districts which experienced very low Infant Mortality rates are South-East and Gaborone with

35 infant deaths per 1000 live births and 47 infant deaths per 1000 live births, respectively. However, the IMR is projected to decline throughout all the districts except south district which will incur constant IMR as well as at the country level. Detailed analyses of results are outlined in Table 35.

Table 37: Projected life expectancy at birth for males by district, 2001-2016

Year / District	2001	2003	2005	2007	2009	2011	2013	2015	2016
Central	42.6	42.6	41.0	37.8	35.1	34.2	34.6	36	36.8
Francistown	56.6	55.9	52.9	47.1	42.4	40.8	41.5	44.1	45.8
Gaborone	63.9	63.2	60.4	55.0	50.2	48.5	49.2	51.4	53.1
Ghanzi	58.5	58.1	56.1	51.8	47.4	45.1	44.4	44.8	45.1
Kgalagadi	51.1	51.2	49.9	46.7	43.7	42.4	42.4	43.2	43.6
Kgatleng	52.0	51.8	50.1	46.6	43.2	41.7	41.7	42.6	43.2
Kweneng	51.5	51.8	49.9	45.8	41.9	39.8	39.2	39.4	39.7
Lobatse	54.9	54.7	52.6	48.2	44.5	43.2	44.0	46.1	47.3
Ngami	46.9	46.8	45.3	42.0	38.8	37.3	37.2	37.8	38.2
North East	40.1	40.2	38.6	35.4	32.8	31.9	32.2	33.5	34.3
Phikwe	54.3	53.8	50.7	44.5	39.5	37.3	36.7	37.1	37.4
South East	73.9	73.4	71.5	66.1	62.0	59.6	60.5	62.9	63.2
Southern	46.4	46.6	45.4	42.7	40.1	39.2	39.3	40.3	41
Botswana	53.3	53.1	51.1	46.9	43.2	41.6	41.8	43.0	43.7

Table 38: Projected life expectancy at birth for females by district, 2001-2016

Year / District	2001	2003	2005	2007	2009	2011	2013	2015	2016
Central	48.6	48.7	48.6	47.4	45.0	43.4	42.6	42.4	42.6
Francistown	56.6	56.0	55.7	53.7	50.6	48.8	48.4	49.3	50.1
Gaborone	66.6	66.0	65.4	63.2	59.5	56.9	55.5	55.0	55.4
Ghanzi	57.8	57.5	57.3	55.4	51.7	48.6	46.3	44.6	43.9
Kgalagadi	52.0	52.2	52.1	51.0	48.5	46.5	45.1	44.1	43.7
Kgatleng	57.5	57.6	57.4	55.9	53.0	50.7	49.3	48.5	48.3
Kweneng	58.2	58.5	58.9	58.6	57.9	57.6	57.8	58.4	58.8
Lobatse	55.1	54.9	54.9	53.5	51.0	49.2	48.5	48.4	48.6
Ngami	48.1	48.0	48.1	47.1	44.6	42.5	40.9	39.7	39.1
North East	49.2	49.3	49.2	47.8	45.4	43.6	42.8	42.7	42.8
Phikwe	57.2	56.7	56.0	53.0	48.4	44.9	42.6	41.0	40.4
South East	63.9	63.5	62.9	60.5	56.5	53.8	52.6	52.4	52.6
Southern	48.6	48.9	49.0	48.2	46.4	45.1	44.2	43.8	43.7
Botswana	55.3	55.2	55.0	53.5	50.7	48.6	47.4	46.9	46.9

Table 39: Projected life expectancy at birth for both sexes by district, 2001-2016

Year / District	2001	2003	2005	2007	2009	2011	2013	2015	2016
Central	45.7	45.7	44.9	42.7	40.2	39.0	38.7	39.3	39.7
Francistown	56.6	55.9	54.3	50.5	46.6	44.8	45.0	46.8	48.0
Gaborone	65.3	64.6	62.9	59.1	54.9	52.7	52.3	53.2	54.3
Ghanzi	58.2	57.8	56.7	53.6	49.5	46.8	45.3	44.7	44.5
Kgalagadi	51.5	51.7	51.0	48.8	46.1	44.4	43.7	43.6	43.7
kgatleng	55.1	55.1	54.2	51.8	48.7	46.8	45.9	45.9	46.1
Kweneng	55.0	55.3	54.5	52.3	50.1	49.0	48.8	49.3	49.7
Lobatse	55.0	54.8	53.8	50.9	47.8	46.3	46.3	47.3	48.0
Ngami	47.5	47.4	46.7	44.5	41.6	39.8	39.0	38.7	38.7
North East	44.9	45.0	44.2	41.9	39.4	38.0	37.8	38.3	38.7
Phikwe	55.8	55.2	53.4	48.9	44.1	41.2	39.7	39.1	38.9
South East	70.5	70.0	68.5	64.1	60.1	57.5	57.7	59.2	59.4
Southern	47.5	47.8	47.3	45.5	43.3	42.2	41.8	42.1	42.3
Botswana	54.5	54.3	53.3	50.4	47.1	45.3	44.8	45.2	45.5

Table 36 to 38 show projected life expectancy at birth for districts and Botswana as a whole. Life expectancy for both sexes in Botswana is expected to decline from 54.5 years to 45.5 years in 2016. This is the same for districts. Life expectancy will fall across all districts at least up to 2013 and thereafter there will be slight improvements in life expectancies. For example, life expectancy in Gaborone was 65.3 years in 2001; 52.3 years in 2013 and it went up to 54.3 years in 2016. The same pattern is observed in all districts. However, it is noticed that although mortality in these districts is projected to decline, the rate of decline is different. Gaborone, Francistown, Lobatse, and South-East will experience faster decline while the rest of the districts will experience slower decline. Faster decline in the districts mentioned above, is due to the fact that those districts urbanized. Phikwe is urbanized, but it will experience slower decline of mortality. The only reason for this is that the area is the hardest hit when it comes to HIV/AIDS Ghanzi is the only district that shows a continued increase of mortality until the year 2016. It shows that life expectancy will decrease from 58.2 years in 2001 to 44.5 years in 2016 this may be due to lack of developments in Ghanzi.

AIDS deaths

Numbers of AIDS deaths are projected to increase in every district. In 2016, Central will have the most deaths (5220), followed by Gaborone with 2560 deaths. The district with the least number of deaths is Lobatse 310. Table 39 shows detailed AIDS deaths.

Table 40: AIDS Deaths by district, 2001-2016

Year / District	2003	2005	2007	2009	2011	2013	2015	2016
Central	260	790	1940	3470	4580	5130	5250	5220
Francistown	70	210	530	910	1160	1200	1070	970
Gaborone	110	430	1110	1950	2530	2730	2660	2560
Ghanzi	20	50	130	240	330	400	440	460
Kgalagadi	20	60	140	260	350	410	440	460
Kgatleng	30	100	250	440	600	690	740	750
Kweneng	60	260	730	1300	1760	2020	2120	2140
Lobatse	10	50	140	250	320	340	330	310
Ngami	70	220	560	1100	1580	1960	2240	2360
North East	20	70	170	310	410	460	470	460
Phikwe	30	130	360	640	850	970	1020	1030
South East	30	130	330	580	750	810	780	740
Southern	60	210	520	950	1280	1480	1590	1620
Botswana	790	2710	6910	12400	16500	18600	19150	19080

Orphans

Orphans, due to AIDS deaths, were projected and presented in Table 40. In 2006, most AIDS orphans were in Central with 1742 orphans, followed by Gaborone and Kweneng with 827 and 804 respectively. In addition, Gaborone and Kweneng are still expected to lead in terms of number of orphans in 2016 with 11 545 and 13 116, respectively. The district with the least number of AIDS orphans is Lobatse (1281). At national level, 83 047 of Botswana's population are projected to be AIDS orphans.

Table 41: Number of orphans by districts

Year District	2006	2008	2010	2012	2014	2015	2016
Central	1742	4475	9599	15056	19487	21185	22521
Francistown	511	1365	2761	4105	5042	5341	5541
Gaborone	827	2345	4822	7418	9428	10130	11545
Ghanzi	129	362	775	1240	1657	1832	1987
Kgalagadi	117	312	680	1092	1456	1604	1729
kgatleng	189	527	1109	1752	2305	2519	2691
Kweneng	804	2326	4984	8026	10845	12060	13116
Lobatse	115	306	628	945	1168	1237	1281
Ngami	543	1473	3331	5528	7624	8592	9505
North East	145	375	793	1234	1588	1722	1824
Phikwe	238	609	1250	1900	2398	2579	2722
South East	169	515	1072	1677	2172	2347	2467
Southern	443	973	2442	3900	5162	5681	6118
Botswana	5972	15963	34246	53873	70332	76829	83047

5.3 Summary

This chapter has projected the population of Botswana by districts. The main assumption of this variant is that the HIV/AIDS trend that were observed in 2001 and 2006 among all districts will continue in future. The findings show that the population of Botswana will increase from 1 669 190 in 2001 to 2 137 400 in 2016. Life expectancy at birth will decline from 51.9 years to 45.5 years in 2016. Total fertility rate will decline from 3.2 children to reach replacement level in 2016. Annual population growth is projected to decline from 1.3% in 2001 to 0.6% in 2016.

CHAPTER 6: ANALYSIS OF SLOW DECLINE SCENARIO

6.1 Introduction

This chapter presents the results of the slow decline scenario. This scenario is based on slow decline of mortality, fertility as well as constant migration. For HIV/AIDS, it is assumed that HIV/AIDS prevalence rates will go down in all districts at a slower rate of 0.1% per year.

6.2 Results

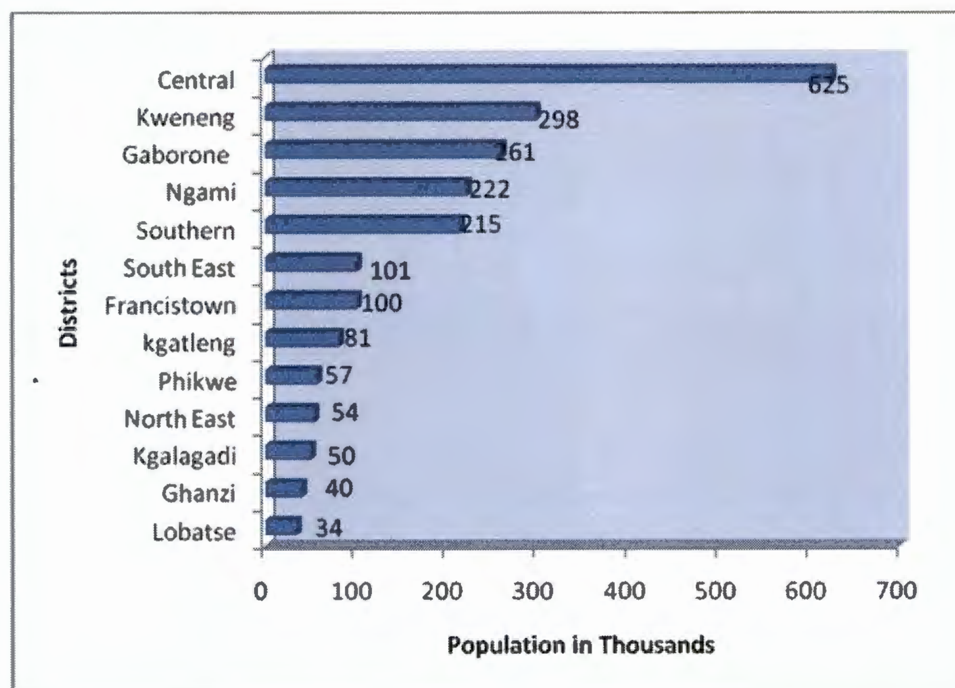
6.2.1 Projected population of Botswana

Table 41 represents the results of population projections assuming slower variants. Based on the assumptions used in this variant, the population of Botswana will increase from 1 669 190 in 2001, to 2 137 310 in 2016. All districts, except Phikwe and Lobatse, show an increase in their population. Phikwe will experience population decline from 57 370 in 2011 to 56 760 in 2016. Lobatse will experience it from the year 2013 with 34 000 to 33 970 in 2016.

Table 42: Projected population by district, 2001-2016

Year District	2001	2003	2005	2007	2009	2011	2013	2015	2016
Central	502010	522340	542770	561670	577870	591520	604830	617780	624650
Francistown	82480	87590	92130	95700	98000	99170	99850	100200	100390
Gaborone	185210	201280	216180	228950	239070	246870	253070	258320	260740
Ghanzi	31970	33510	34980	36300	37370	38200	38930	39590	39920
Kgalagadi	42090	43650	45140	46460	47520	48300	48980	49550	49850
Kgatleng	73900	75770	77480	78850	79750	80210	80580	80910	81140
Kweneng	226810	239150	251170	262190	271720	279800	287420	294560	298200
Lobatse	29590	31010	32240	33160	33700	33920	34000	33980	33970
Ngami	119120	134330	149570	164400	178360	191340	203930	216140	222280
North East	48260	49270	50320	51270	51990	52500	52990	53460	53730
Phikwe	49850	52350	54570	56230	57140	57370	57260	56930	56760
South East	91070	94000	96640	98680	99950	100540	100790	100850	100870
Southern	186830	191740	196610	201050	204710	207660	210550	213310	214810
Botswana	1 669 190	1 755990	1839800	1914910	1977150	2027400	2073180	2 115580	2137310

Figure 34: Population of Botswana by districts, 2016



6.2.2 Percentage distribution

Percentage share of district population were projected and detailed analysis are shown in Table 42.

Table 43: Projected percentage distribution of population by districts

Year District	2001	2003	2005	2007	2009	2011	2013	2015	2016
Central	30.1	29.7	29.5	29.3	29.2	29.2	29.2	29.2	29.2
Francistown	4.9	5.0	5.0	5.0	5.0	4.9	4.8	4.7	4.7
Gaborone	11.1	11.5	11.8	12.0	12.1	12.2	12.2	12.2	12.2
Ghanzi	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9
Kgalagadi	2.5	2.5	2.5	2.4	2.4	2.4	2.4	2.3	2.3
kgatleng	4.4	4.3	4.2	4.1	4.0	4.0	3.9	3.8	3.8
Kweneng	13.6	13.6	13.7	13.7	13.7	13.8	13.9	13.9	14.0
Lobatse	1.8	1.8	1.8	1.7	1.7	1.7	1.6	1.6	1.6
Ngami	7.1	7.6	8.1	8.6	9.0	9.4	9.8	10.2	10.4
North East	2.9	2.8	2.7	2.7	2.6	2.6	2.6	2.5	2.5
Phikwe	3.0	3.0	3.0	2.9	2.9	2.8	2.8	2.7	2.7
South East	5.5	5.4	5.3	5.2	5.1	5.0	4.9	4.8	4.7
Southern	11.2	10.9	10.7	10.5	10.4	10.2	10.2	10.1	10.1
Botswana	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Table 42 shows a detailed percentage distribution of population of Botswana. Central district (29.2) persists to hold a larger share of population in 2016 as also indicated in previous scenarios. This will be followed by Kweneng (14.0%), Southern District (10.2 %) and Gaborone (12.2%). Lobatse, Ghanzi and Kgalagadi will still remain the districts with the smallest share with 1.6, 1.9 and 2.3, respectively.

6.2.3 Projected population growth

Table 44: Annual population growth rates, 2001-2016

Year District	2001	2003	2005	2007	2009	2011	2013	2015	2016
Central	2.0	1.9	1.8	1.6	1.3	1.1	1.1	1.1	1.1
Francistown	3.2	2.8	2.3	1.7	1.0	0.5	0.3	0.2	0.2
Gaborone	4.4	3.9	3.3	2.6	1.9	1.5	1.1	1.0	0.9
Ghanzi	2.4	2.3	2.1	1.7	1.3	1.0	0.9	0.8	0.8
Kgalagadi	1.9	1.8	1.6	1.4	1.0	0.7	0.7	0.6	0.6
kgatleng	1.3	1.2	1.1	0.8	0.5	0.2	0.2	0.2	0.3
Kweneng	2.7	2.6	2.3	2.0	1.7	1.4	1.3	1.2	1.2
Lobatse	2.5	2.2	1.8	1.2	0.7	0.2	0.1	0.0	0.0
Ngami	6.1	5.5	5.0	4.4	3.8	3.3	3.0	2.8	2.7
North East	1.0	1.1	1.0	0.9	0.6	0.4	0.5	0.5	0.5
Phikwe	2.6	2.3	1.9	1.3	0.6	0.1	-0.2	-0.3	-0.3
South East	1.7	1.5	1.3	0.9	0.5	0.2	0.1	0.0	0.0
Southern	1.3	1.3	1.2	1.1	0.9	0.7	0.7	0.7	0.7
Botswana	2.5	2.3	2.1	1.7	1.2	0.9	0.8	0.7	0.7

Projected annual population growth rates are projected to decline throughout all districts. Francistown, Gaborone and Ngami will decline rapidly from 2.0 % in 2001-0.2, 4.4% to 0.9 and 6.1% to 2.7 respectively. At national level, the growth rate will drop from 2.5 to 0.7% in 2016.

6.2.4 Age structure

The projected population age structure was calculated and the findings are illustrated in Table 43. The estimated and projected age distributions are in broad age groups.

Table 45: Projected age distribution by broad age groups for Botswana and districts, 2001 and 2016

	Age Groups 2001					Age Groups 2016				
Districts	<15	15-64	65+	Total	Dependency Ratio	< 15	15-64	65+	Total	Dependency Ratio
Gaborone	25	74	1	100	36	26	70	3	100	45
Francistown	32	67	1	100	49	30	67	3	100	67
Lobatse	30	68	2	100	47	24	72	4	100	39
Phikwe	30	69	1	100	46	27	70	3	100	43
South East	32	65	3	100	54	17	77	6	100	30
Kgatleng	39	56	5	100	77	25	70	5	100	43
North East	44	51	5	100	96	29	67	5	100	50
Ghanzi	37	58	4	100	72	33	63	4	100	59
Kweneng	38	58	4	100	72	33	63	4	100	58
Kgalagadi	38	58	4	100	72	28	67	4	100	49
Ngami	39	57	4	100	75	35	61	3	100	63
Central	42	53	5	100	87	31	65	4	100	29
Southern	40	54	6	100	86	28	67	5	100	49
Botswana	36	61	3	100	67	28	68	4	100	45

At national level, the population below 15 is projected to decline from 36.6 % in 2001 to 28% in 2016. An increase will be observed in the population aged 65+ from 3% to 4% in 2016. The population 15-64 years is projected to increase from 61% in 2001 to 68% in 2016.

In 2001, North-East had the highest population aged less than 15 years (44%), followed by Central (42%) and Southern 40%. Gaborone had the lowest percentage (25%). In 2016, the projected age sex distributions imply that Ngami will have the highest percentage of persons aged 0-15 years (35%), while South-East has the lowest (17%). The projections further depict that South-East has the highest proportion of the elderly population (6%) while Francistown, Gaborone and Ngami have the lowest (3% each). Age dependency ratio in 2001 was the highest in North-East (96) and lowest in Gaborone (36). In 2016 it was high in Francistown (67) and low in Central (29).

6.2.5 Median age

Table 46: Projected median age for Botswana and districts, 2001-2016

Year District	2001	2003	2005	2007	2009	2011	2013	2015	2016
Central	18	19	20	21	22	22	23	23	24
Francistown	23	23	24	25	25	25	26	26	26
Gaborone	25	25	26	27	28	29	29	29	30
Ghanzi	21	21	22	22	22	23	23	23	23
Kgalagadi	20	21	22	22	23	24	24	25	25
kgatleng	20	21	22	23	23	24	25	26	26
Kweneng	20	20	21	22	22	23	23	24	24
Lobatse	23	24	25	26	27	28	28	29	29
Ngami	19	20	21	21	22	22	22	22	22
North East	17	18	19	20	21	22	23	24	24
Phikwe	23	24	25	26	26	27	27	28	28
South East	23	24	25	27	28	29	30	31	31
Southern	19	20	21	22	22	23	24	25	25
Botswana	21	22	23	23	24	25	25	26	26

The median age of Botswana is projected to rise from 21 years in 2001 to 26 years in 2016. The median age will increase by 3 to 8 years within all districts from 2001-2016. Detailed analysis of median aging is outlined in Table 45.

6.2.6 Vital rates

This section presents rates of those components, such as fertility and mortality. They indicate the nature and possible change in the population.

Table 47: Projected infant mortality by district, 2001-2016

Year / District	2001	2003	2005	2007	2009	2011	2013	2015	2016
Central	130	138	130	121	123	119	115	111	109
Francistown	79	92	83	74	78	74	71	68	66
Gaborone	47	55	52	49	52	49	47	44	36
Ghanzi	73	82	75	67	70	67	64	61	60
Kgalagadi	101	106	100	93	95	91	88	84	83
kgatleng	88	95	88	81	82	79	75	72	70
Kweneng	87	89	83	78	77	73	70	67	65
Lobatse	86	94	86	79	81	77	74	71	69
Ngami	119	126	119	111	114	110	107	103	101
North East	137	144	136	127	129	125	121	117	115
Phikwe	83	94	87	89	97	93	90	88	87
South East	35	47	39	34	38	37	35	33	33
Southern	120	124	118	111	111	108	104	100	98
Botswana	91	99	92	86	88	85	81	78	76

Table 46 shows the projected infant mortality rates in Botswana and its districts. IMR is projected to increase between 2001 and 2003 then a decline is indicated thereafter. For instance, Botswana's IMR is projected to increase from 91 infant deaths per 1000 live births in 2001, to 99 infant deaths per1000 live births in 2002 and a decline is indicated thereafter reaching 76 per 1000 in 2016. There are variations in the level and trends in IMR by districts. North-East is projected to have the highest IMR in 2016 (115). It will be followed by Central and Ngami with 109 and 101 respectively. South-East is projected to have the lowest IMR of 33 infant deaths per 1000 live births.

Table 48: Projected life expectancy at birth for males by district, 2001-2016

Year / District	2001	2003	2005	2007	2009	2011	2013	2015	2016
Central	42.6	42.6	41.0	37.8	35.1	34.2	34.6	35.8	36.6
Francistown	56.6	55.8	52.6	46.6	41.7	40.0	40.3	41.9	42.7
Gaborone	63.9	63.2	60.4	54.9	50.1	48.4	49.0	51.0	52.6
Ghanzi	58.5	58.1	56.1	51.8	47.5	45.5	45.3	46.5	47.3
Kgalagadi	51.1	51.3	50.1	47.3	44.4	43.1	43.2	44.3	45.0
Kgatleng	52.0	51.8	50.1	46.6	43.2	41.9	42.1	43.3	44.1
Kweneng	51.5	51.8	49.9	45.8	42.0	39.9	39.5	40.0	40.4
Lobatse	54.9	54.7	52.6	48.2	44.4	43.1	43.7	45.6	46.6
Ngami	46.9	46.8	45.3	42.0	38.9	37.6	37.8	39.0	39.8
North East	40.1	40.2	38.6	35.3	32.6	31.7	32.0	33.2	33.9
Phikwe	54.3	53.8	50.7	44.6	39.6	37.6	37.4	38.4	39.1
South East	73.9	73.4	71.5	66.0	62.0	59.5	60.2	62.2	62.2
Southern	46.4	46.6	45.4	42.7	40.2	39.3	39.6	40.9	41.7
Botswana	53.3	53.1	51.1	46.9	43.2	41.7	41.9	43.2	44.0

NWU LIBRARY

Table 49: Projected life expectancy at birth for females by district, 2001-2016

Year / District	2001	2003	2005	2007	2009	2011	2013	2015	2016
Central	48.6	48.7	48.6	47.4	45.0	43.4	42.5	42.2	42.3
Francistown	56.6	55.9	55.5	53.2	49.3	46.5	44.9	44.2	44.1
Gaborone	66.6	66.0	65.4	63.1	59.4	56.7	55.1	54.4	54.7
Ghanzi	57.8	57.5	57.3	55.4	51.8	49.0	47.3	46.4	46.3
Kgalagadi	52.0	52.3	52.2	51.2	48.9	47.0	45.8	45.3	45.2
Kgatleng	57.5	57.6	57.4	55.9	53.0	50.9	49.7	49.3	49.3
Kweneng	58.2	58.5	58.9	58.6	57.9	57.6	57.9	58.7	59.1
Lobatse	55.1	54.9	54.8	53.4	50.8	48.9	48.0	47.6	47.6
Ngami	48.1	48.0	48.1	47.1	44.7	42.8	41.6	41.0	40.9
North East	49.2	49.3	49.1	47.8	45.3	43.4	42.5	42.3	42.3
Phikwe	57.2	56.7	56.0	53.0	48.5	45.3	43.4	42.5	42.3
South East	63.9	63.5	62.9	60.4	56.3	53.3	51.7	51.0	50.8
Southern	48.6	48.9	49.0	48.2	46.4	45.2	44.5	44.4	44.5
Botswana	55.3	55.2	55.0	53.4	50.6	48.5	47.3	46.9	46.9

Table 50: Projected life expectancy at birth for both sexes by district, 2001-2016

Year District	2001	2003	2005	2007	2009	2011	2013	2015	2016
Central	45.7	45.7	44.9	42.7	40.2	38.9	38.6	39.1	39.5
Francistown	56.6	55.8	54.1	50.0	45.6	43.3	42.7	43.1	43.4
Gaborone	65.3	64.6	62.9	59.0	54.8	52.5	52.0	52.7	53.7
Ghanzi	58.2	57.8	56.7	53.6	49.6	47.2	46.3	46.5	46.8
Kgalagadi	51.5	51.8	51.1	49.2	46.6	45.0	44.5	44.8	45.1
Kgatleng	55.1	55.1	54.2	51.8	48.7	46.9	46.3	46.6	47.0
Kweneng	55.0	55.3	54.5	52.3	50.1	49.0	49.0	49.7	50.2
Lobatse	55.0	54.8	53.7	50.9	47.7	46.1	45.9	46.6	47.1
Ngami	47.5	47.4	46.7	44.5	41.7	40.1	39.6	40.0	40.4
North East	44.9	45.0	44.1	41.9	39.3	37.8	37.5	37.9	38.3
Phikwe	55.8	55.2	53.4	48.9	44.2	41.6	40.5	40.5	40.8
South East	70.5	69.9	68.5	64.1	59.9	57.3	57.1	58.1	58.1
Southern	47.5	47.8	47.3	45.5	43.4	42.3	42.1	42.6	43.1
Botswana	54.5	54.3	53.2	50.3	47.1	45.2	44.8	45.2	45.7

Life expectancies per district were projected for males, females and both sexes and the results are shown in Table 47 to 49 above. At national level, mortality is expected to increase with the life expectancy declining from 54.5 years to 45.7 years in 2001 and 2016 respectively. The same trend was observed for all districts.

Table 51: Projected AIDS deaths by district, 2001-2016

Year District	2003	2005	2007	2009	2011	2013	2015	2016
Central	257	791	1944	3471	4598	5180	5354	5362
Francistown	70	225	562	989	1283	1397	1382	1352
Gaborone	106	430	1117	1959	2551	2778	2747	2669
Ghanzi	19	54	131	239	324	371	386	386
Kgalagadi	16	51	128	237	327	379	399	401
Kgatleng	27	96	246	441	590	668	691	691
Kweneng	62	265	725	1299	1745	1975	2026	2014
Lobatse	15	55	143	251	325	352	346	337
Ngami	75	224	562	1083	1531	1823	1967	2003
North East	23	72	176	314	415	468	485	485
Phikwe	33	132	358	634	835	929	938	925
South East	32	127	334	589	769	842	838	824
Southern	64	207	516	946	1257	1429	1484	1487
Botswana	799	2729	6942	12452	16550	18591	19043	18936

AIDS deaths are expected to increase across districts at least up to the year 2015, thereafter the deaths will decline. For example, in Francistown AIDS deaths will increase from 70 in 2003 to 1382 in 2015. Thereafter, the deaths are projected to decline to 1352 in 2016. The deaths in Lobatse will increase from 15 to 346 in 2015, then come down to 337. Districts such as Ghanzi, Kgatleng and North-East will show constant AIDS deaths from the year 2015 to 2016. Surprisingly, Kgalagadi and Central show a different pattern. The AIDS deaths are projected to increase up to the year 2016. As for the country, AIDS deaths are also expected to increase from 799 in 2001 to 19 043 in 2015 then decrease to 18 936.

Table 52: Number of AIDS orphans in Botswana and districts, 2001-2016

Year District	2006	2008	2010	2012	2014	2015	2016
Central	1742	4472	9589	15045	19496	21217	22588
Francistown	526	1406	2822	4160	5064	5360	5587
Gaborone	828	2346	4821	7415	9431	10145	11605
Ghanzi	129	364	778	1238	1634	1791	1923
Kgalagadi	106	285	632	1028	1384	1525	1641
kgatleng	189	528	1112	1753	2294	2498	2653
Kweneng	804	2328	4988	8018	10787	11954	12942
Lobatse	116	307	630	948	1174	1246	1294
Ngami	543	1479	3345	5523	7528	8405	9192
North East	147	381	804	1251	1610	1747	1853
Phikwe	238	610	1252	1896	2376	2544	2670
South East	169	516	1077	1694	2212	2404	2545
Southern	443	975	2449	3903	5139	5631	6028
Botswana	5980	15997	34299	53872	70129	76467	82521

Table 51 provides detailed figures of projected number of orphans. Each district is projected to have an increase in the number of AIDS orphans. At national level, number of AIDS orphans is projected to increase at an alarming rate, from 5980 in 2001 to 82 521 in 2016. As for the districts, Central will be leading with 22 588 AIDS orphans. Lobatse is projected to have the lowest number of HIV/AIDS orphans (1294).

6.3 Summary

This section of the study has presented results based on the slow decline scenario of HIV/AIDS in Botswana. This scenario projects the population of Botswana to be 2 137 310. Annual population growth will decline from 2.5 to 0.7 in 2016. Median age will increase from 21 to 26 years. IMR will decline from 91infant deaths per 1000 births to 76 deaths. Life expectancy will decline from 47.5 years to 42.1 in 2013 then improve to 42.6 years.

CHAPTER 7: CONCLUSION AND RECOMMENDATIONS

7.1 Introduction

This chapter presents the main findings, conclusion and recommendations of the study. As mentioned, this study consisted of three sets of projections, slow, medium and fast decline scenarios. Therefore, findings discussed below are based on medium decline scenario as they are likely to provide more probabilistic results.

7.2 Major findings

The main features of the projected demographic situation of Botswana, taking into account the impact of AIDS, may be summarised as follows. The study has discovered, that despite the country being hit hard by HIV/AIDS, population of Botswana will continue to increase. This is confirmed by the three scenarios. Slow decline projects the population of Botswana to grow from 1 669 190 to 2 137 310, while the medium and the fast decline projects it to reach 2 137 400 and 2 144 930 respectively, in 2016. This increase is also expected at district level. Although the population is projected to increase in numbers, this is not the case with the annual growth rates. At national level, the slow decline projects the growth rate to decline from 2.5% in 2001 to 0.7% in 2016. Medium decline projects it to decline to 0.6%, while fast decline projects it to decline to 0.8%. The same is to be observed at district level. All the districts, except Central and Ngami, are expected to have natural decrease below 1%. Phikwe will decrease by -0.5% per annum. This negative or zero natural population growth means that these districts have more deaths than births or an even number of deaths and births. These figures clearly demonstrate the impact of HIV/AIDS in those districts. Above all, the decline in population growth is attributed to increased access to family planning and female labour force participation. It has been found that HIV infected women have a lower fertility rate than HIV negative women (Gray, et al, 1997).

HIV/AIDS has proven to be the leading cause of mortality in Botswana (CSO, 2001). However, Infant Mortality Rate is projected to go down from 91 deaths per 1000 live births in 2001 to 76, 77, and 73 deaths per 1000 live births in 2016 under slow, medium and fast decline respectively. This indicates that Botswana will achieve one

of the millennium's development goals to reduce child mortality. As for life expectancy at birth, it is projected to decline under all the three scenarios. For slow decline it will drop from 54.5 years in 2001 to 45.7 years in 2016. Under medium scenario it will decline to 45.5 years and 47.0 years under fast decline scenario. AIDS deaths further illustrate the impact of AIDS on mortality. All the three scenarios estimate AIDS deaths to reach more than 19 000 in 2016. Lastly, the study has found that AIDS has an impact in the number of orphans in Botswana. As AIDS deaths occur, orphans are left behind and this becomes a burden for the government. In 2016, number of orphans are projected to be 83 047 for medium scenario, 82 521 for slow and 81 243 for the fast decline scenario. At district level, Central will lead with 22 521 followed by Gaborone with 11 545 orphans. The least number of orphans is observed in Lobatse with 1281 orphans.

As the countries move through demographic transition from high fertility and high mortality to a low fertility and low mortality equilibrium, the size of the working age population mechanically increases. At national level, dependency ratio is projected to decline from 67 in 2001 to 48 in 2016 under both the medium and the fast decline scenarios. The slow decline scenario is projected to be 45. At district level, Gaborone is the only district that shows an increase (36 in 2001 to 42 in 2016). As for Francistown, a constant dependency ratio of 49 will be observed between 2001 and 2016. The rest of the districts show a decline in the dependency ratio. Lower dependency ratio indicates that the country has the potential to reap the benefits of the demographic dividend (Bloom & Canning, 2003). Many countries, especially those from Asia and Latin America have already enjoyed these benefits (Ross, 2004). The Republic of Korea serves as an example. Its birth rate fell in the mid-1960s, elementary school enrolments declined and funds previously allocated for elementary education were used to improve the quality of education at higher levels (Bloom & Williamson, 1998). For a country to benefit from the demographic dividend, solid institutional settings will be vital for its realization. These include rule of law, efficiency of the bureaucracy, corruption political freedom infrastructure (health care systems, schooling, roads, transport and formal labour laws protecting both employees and employers (Lee & Mason, 2006).

HIV/AIDS seems to have an impact on aging. Median age, an index that is often used to describe whether a population is young or old, indicates that Botswana is changing from being described as young to intermediate. The median age is projected to increase from 21 years in 2001 to 26 years in 2016. Gaborone and South-East will be described as the old population as they have the median age of 30 and 31 years respectively. The rest of the districts will be intermediate. The projected population aging in South-East and Gaborone may pose profound challenges to public institutions that must adapt to a changing age structure. The first challenge is that population aging creates social and political pressures on social support systems. For example, the social security system may face a profound crisis if no radical modifications are enacted. These may include cuts in benefits, tax increases, massive borrowing, lower cost-of-living adjustments and later retirement ages. Population aging is also a great challenge for the health care systems. As nations age, the prevalence of disability, frailty, and chronic diseases (Alzheimer's disease, cancer, cardiovascular and cerebrovascular diseases, etc.) are expected to increase dramatically (Ebenstadt, 1997).

NWU LIBRARY

The results of the population projections presented in this study compared favourably with population projections prepared by other organisations as shown in Table 52. According to Table 52, our projections based on medium decline scenario are higher than the CSO projections, and fall between those prepared by the United Nations and US Census Bureau. As for IMR and e_0, they are very much far from the rest of those of other organisations. For example, IMR for the rest organisations are within the rate of thirties. The same is observed with life expectancies at birth. All the other organisations project it to range from 53.6 and 55.6 years. But this study projects it to be 45.2 years. Thus, these differences are mainly due to the method used in this study, a bottom–up approach. UN and US bureau never projected beyond the country's sub-regions. Therefore, they might have under-estimated the impact of HIV/AIDS. Although CSO projects at district level, they use the ratio approach or top-down hence the difference. The good thing about a bottom–up approach is that it is context specific. One need to be cautious, however, in comparing results from different projections as there is no accepted standard for judging the accuracy of other projections, and this can only be assessed afterwards (Preston et al. 2001).

Table 53: Comparisons of different sets of projections, 2016

Organisation	Total Pop	TFR	e_0	IMR	Net Migration
United Nations	2135000	2.62	53.6	31.5	1.5
US Bureau	2209000	2.3	54.5	31.5	4
CSO	1947806	2.6	55.6	30.8	0.7
Current study	2137400	2.1	45.2	77.0	0.8

7.3 Conclusion

Although a bottom-up approach is tedious, it is good as it gives population results that are reliable and context specific (Udjo, 2008). The district projections will assist very well in the decentralization issue in Botswana. The findings of the study indicates that population of Botswana will grow, but with the rate of growth going down from 2.5% per annum in 2001 to 2.6% per annum in 2016. This signifies that HIV/AIDS is contributing to this decline. A decline in life expectancy at birth shows that people are still expected to die because of this pandemic, at least up to 2015, thereafter the country will experience a mortality decline. On the other hand, the mortality rate of parents means orphans. As for IMR, there is hope that Botswana will realize millennium development goal number four which talks of reducing child mortality. A decline in TFR and population below age 15 are signs of falling birth rates. Apart from increased women education and women participation in labour force, HIV/AIDS is also a contributing factor in this decline. Economically, the active population group (15-64) is anticipated to increase. With the increasing size of the labour market due to growth, unemployment rates might be exacerbated if job creation is unable to keep up with the pace. The increasing number of population aged 65+ and orphans are also a challenge because they have implications for pension schemes and provision of special welfare services for the elderly and the orphaned.

7.4 Recommendations

As alluded to, population projections can serve as policy-making guidelines as they illustrate the likely consequences of decisions (or failure to take action). Findings of this study have socio-economic implications for the country may pose challenges for development, some of which include; provision of food, health, education, housing and job creation, among others. Based on the above findings, this study recommends the following that will address problems regarding HIV/AIDS.

- Firstly, given that adult mortality is projected to increase, and this is obviously due to HIV/AIDS, this study suggests that the government should assist to prevent new infections because Botswana's long-term vision is to have no new HIV infections by 2016, and this can only be achieved with an enormous and nonstop HIV prevention campaigns.

- Lastly, given that this study has projected that the population aged 15-64 will increase, Botswana has the potential to reap the benefits of the demographic dividend. There is therefore need to enact appropriate policies and ensure solid institutional setting that should enable Botswana to benefit from the increase in the working population.

- Botswana has the potential to reap the benefits of the demographic dividend, but solid institutional settings will be imperative for its realization (Lee & Mason, 2006; Bloom & Canning, 2003). Such institutions include rule of law, efficiency of the bureaucracy, corruption, political freedom and expropriation risk, openness (political system, trade barriers, and black market premium), freedom of political representation and freedom of speech. Even with this list of measures, a broader measure would include infrastructure (health care systems, schooling, roads, transport), and a formal labour market with unions and laws protecting both employees and employers.

REFERENCES

Ainsworth, M and Semali, I. 2000.*The Impact of Adult Deaths on Children's Health in Northwestern Tanzania.* World Bank Paper, Washington, DC.

Akhiwu P.2012. *Factors Affecting the Utilisation of Voluntary Counselling and Testing (VCT) Services for HIV/AIDS in Sowa, Botswana.* Institutional Repository Environment on Displace.

Bank of Botswana. 2005. *Annual Report*. Gaborone.

Bloom, D. E and Canning, D. 2003. *The Demographic Dividend: A New Perspective on the Economic Consequences of Population Change*. Wordsworth Cambridge University Press.

Bloom, D, E and Williamson J.G. (1998). Demographic Transitions and Economic Miracles in Emerging Asia, *World Bank Economic Review 12 (3): 419-55.*

Bongaarts, J and Bulatao, R.A. 1999. *Completing the Demographic Transition. Population and development review 25(3)* National Research Council, United States of America.

Central Statistics Office (CSO). 1986. *The 1981 Population & Housing Census: Population Projections 1981-2011.* Gaborone; Demographic Unit, Central Statistics Office.

Central Statistics Office (CSO). 1998. *The 1991 Population & Housing Census: Population Projections 1991-2021.* Gaborone; Demographic Unit, Central Statistics Office.

Central Statistics Office (CSO). 2001. *The 2001 Population & Housing Census: Population Projections 2001-2031.* Gaborone; Demographic Unit, Central Statistics Office.

Botswana Central Statistics Office (CSO). 2002. *Botswana Aids Impact Survey.* Gaborone: Demography Unit, Central Statistics Office.

Botswana Central Statistics Office (CSO). 2008. *Botswana Aids Impact Survey III.* Gaborone: Demography Unit, Central Statistics Office.

Botswana Government.1997. Vision 2016: *Long term vision for Botswana.* Gaborone Government printers.

Carpenter L.M, Nakiyindi J.S and Malamba S. L. 1997. *Estimates of the Impact of HIV-1 Infection on Fertility in Rural Ugandan Cohort,* Presented at the Socio-Demographic Impact of AIDS in Africa Conference, Sponsored by the International Union for the Scientific Study of Population and the University of Natal-Durban.

Clark, S.J, Collinson, M.A, Kahn, K, Drullinger, K and Tollman, S.M. 2007. Returning Home to Die: Circular Labour Migration and Mortality in South Africa. *Scandinavian Journal of Public Health,* 35 (S69): 35-44.

Cleary, S and Mdntyre, K. 2003. *Cost effectiveness of Antiretroviral Treatment for HIV-Positive Adults in a South African Township,* Health Economics Unit, Infectious Diseases Epidemiology Unit, School of Public Health and family medicine, University of Cape town Cape town.

Cohen J, Schleifer R, Tate T.2005. AIDS IN Uganda; the Human Rights Dimension. *Lancet*, 365, 2075-7076

Colvin, M and Mullick, S. 1997. *Draft Outline of a National STD/HIV/AIDS Surveillance Strategy,* Durban, South Africa, Medical Research.

Council, Lewis J, Ronsmans C, Ezeh A, and Gregson S. 2004. *The population Impact of HIV on Fertility in Sub-Saharan Africa.* National Research Council, Washington, D.C.

Department of Infrastructure, Planning and Natural Resources. 2004. *Method for Population Projections for Statistical Local Areas in NSW,* Transport and Population Data Centre.

Department of Meteorological Services. 2004. *Botswana Technological Needs Assessment on Climate Change,* Ministry of Environment, Wildlife and Tourism, Government of Botswana.

Dorrington, R.E, Moultrie, T.A and Daniel T. 2006. *The Demographic Impact of HIV/AIDS in Botswana.* Gaborone: UNDP and NACA, Botswana.

Ebenstsdt, N. 1997. World Population Implosion. *Public Interest*, 129:3-22

Gaisie, Samuel K. (1998). Fertility Transition in Botswana. *Journal of Contemporary African Studies*. Volume 16 #2. July. pp. 277-296.

Garenne, M and Gakusi, E. 2006. *Health Transitions in Sub-Saharan Africa: Overview of Mortality Trends in Children under 5 years old (1950-2000),* Bull World Health Organisation. USA.

Gavrilov, L and Heuveline P. 2003. *Aging of Population. Macmillan Reference*, USA.

Gray, R.H, Wawer M.J and Serwadda D. 1997. Reduced Fertility in Women with HIV Infection: A population –Based Study in Uganda. Presented at the Socio-Demographic Impact of AIDS in Africa Conference, Sponsored by the International Union for the Scientific Study of Population and the University of Natal-Durban.

Gregson, S. 1994. *Will HIV Become a Major Determinant for Fertility in Sub-Saharan Africa?* Department of Economic and Social Affairs, United Nations Secretariat.

Gregson, S, Zhuwau, T and Anders R. 1997. *HIV and Fertility Change in Rural Zimbabwe,* Blair Research Institute, Harare.

Grubb, I. Perriens, J and Schwartlander B. 2003. *Public Health Approach to Anti-Retroviral Treatment; Overcoming Constraints,* World Health Organisation, Geneva.

Gwebu T.D. 2002. *Migration, Settlement and Sustainable Rural and Urban Development in Africa: Implications for the Twentieth Century,* Department of Environmental Science. University of Botswana.

Gwebu T.D. 2003. *Evolving Population Trends in Botswana and their Policy Implications for National Development,* Department of Environmental Science. University of Botswana.

Hill, K, Pande, R, Mahy M and Jones J. 1999. *Trends in Child Mortality in the Developing World, 1960-1996.* New York, UNICEF.

Hollmann, F.W, Tammany J and Jeffrey E. 2000. *Methodology and Assumptions for the Projections of the United States: 1999-2100,* Population Division, Washington DC.

Kaizer Family Foundation. 2005. *HIV/AIDS Policy Fact Sheet.* Washington DC.

Klosterman, R. E. 1990. *Community and Analysis Planning Techniques*, Rowmand and Littlefield Publishers, Maryland.

Lee, R and Mason, A. 2006. *What is demographic dividend?* International Monetary Fund, Finance & Development, Washington, D.C.

Lefko-Everett K. 2004. *Botswana's changing migration patterns*, South African Migration Projects, migration policy institute, Washington DC.

Lewis, J, Ronsmans, C, Ezeh A and Gregson S. 2004. The Impact of HIV on Fertility in Sub-Saharan Africa. *AIDS,* vol 18. Pp S35-S43 Aurum Institute for Health Research, Johannesburg.

Lutz, W and Klingholz R. 1995. *The Future Population of the World, What Can We Assume today.* Earthscan Publications LTD. London.

Majelantle, R G. and Bainame K. 1995. *Regional Variations in the Levels of Mortality and Fertility in Botswana.* Central Statistics Gaborone. Office,

Majelantle R.G. 2003. *Infant and childhood Mortality Patterns in Botswana.* Central Statistics Office, 2001 Population and Housing Census Dissemination Seminar. Gaborone, Department of Printing and Publishing Services.

Mayhew S. 2011. *A Dictionary of Geography*, Oxford University Press, United Kingdom.

Mompati T and Princen G. 2000. Ethnicity and Participatory Development Methods in Botswana: Development in Practice, Volume 10. Taylor & Francis LTD.

Mostert W, Hofmeyr B, Oosthuizen J and Van zyl J. 1998. *Demography; Textbook for Southern Student.* Human Sciences Research Council, Pretoria.

National AIDS Coordinating Agency (NACA). 2003. *Botswana National Strategic Framework for HIV/AIDS*, National AIDS Coordinating Agency, Republic of Botswana.

National AIDS Coordinating Agency (NACA) in collaboration with CSC and other Development Partners. 2005. *Botswana AIDS Impact Survey II*: Technical Report.

Newell, C. 1988. *Methods and Models in Demography*, John Wiley & Sons Ltd, Baffins Lane, West Sussex PO19 1UD, England.

O'Neill, B.C, Balk, D, Brickman, M and Ezra M. 2001. *A Guide to Global Population Projection,* Max-Planck-Gesellschaft, Germany.

Oucho, J, Campbell, E, and Mukamaambo, E. 2000. *Botswana; Migration Perspectives and Prospects,* Southern African Migration Project.

Population Reference Bureau. 2001. *Understanding and Using Population Projections*. Measure Communication, Washington DC.

Preston, S.H, Heuveline, P and Guillot, M. 2001. *Demography: Measuring and Modelling Population Processes.* Oxford: Blackwell Publishers.

Rollnick, R. 2002. Botswana's high stakes assault on AIDS; An African Test Case for Wide Distribution of Life Prolonging Medicines. *Africa Recovery*, Vol 16 #2-3 p 2

Ross J. 2004._*Understanding the Demographic Dividend*, Policy Project. Washington DC.

Shyrock H.S, Siegel J.S and Associate. 1976. *Studies in Population; The Methods and Materials of Demography.* Academic Press, INC: New York.

Smith, S.K. Tayman, J. and Swanson D.A. 2001. *State and Local Population Projections: Methodology and Analysis,* New York: Kluwer Academic/Plenum Publishers.

Statistics South Africa. 2005. *Mid-year Population_Estimates*, South Africa. Pretoria: Statistics South Africa.

Stover, J. and Kirneryer, S. 1997. Demproj Version 4, *A Computer Program for Making Population Projections Spectrum System of Policy Models*, The Futures Group International and Research Triangle Institute.

Stover, J. 2009. *A Computer Programme for Making HIV/AIDS Projections and Examining the Demographic and Social Impacts of AIDS*. USAID.

Thomas D and Muvandi I. 1994. The Demographic Transition in Southern Africa: Another Look at the Evidence From Botswana and Zimbabwe. *Demography*. Vol 31 #2. May. pp. 185-200.

Udjo, E.O. 1995a. *Childhood and adulthood mortality patterns*, Directorate of Analysis, Statistics SA, Pretoria.

Udjo, E. O. 1995b. Fertility and Mortality Trends and Implications for Social Demands in Botswana. *Southern African Journal of Demography*. Volume 5(1):1-10.

United Nations AIDS (UNAIDS). 2008. *Annual Report on the Global AIDS Epidemic*, Geneva, Switzerland.

United Nations Development Programme. 2000. *Botswana Human Development Report*. Petadco Printing House, Gaborone West Industrial, Botswana.

United Nations Development Programme. 2011. *Botswana Human Development Report; Sustainability and Equity: A better Future for All.* Petadco Printing House, Gaborone West Industrial, Botswana.

United Nations Economic Commission for Africa (UNECA). 1968. *Report of the Seminar on the Organization and Conduct of Censuses of Population and Housing*, Vol II, Part II. Addis Ababa: UNECA.

United Nations Population Fund (UNPF). 2000. *What is Decentralization*? New York.

United Nations. 1999. *World Population Prospects*: The 1998 Revision. Vol. II, Sex and Age. New York.

United Nations. *World Population Prospects*: The 2000 Revision Highlights. New York: UN, 2000. United Nations, Department of Economic and Social Affairs, Population Division, New York.

United Nations. 2004. *World Population Prospects*: The 2004 Revision Highlights: UN, Department of Economic and Social Affairs, Population Division, New York.

United Nations AIDS (UNAIDS). 2008. *World Population Prospects*. Population Division of the Department of Economic and Social Affairs Population Division, New York.

United Nations. *World Population Prospects*: 2011. UN, Department of Economic and Social Affairs, Population Division, New York.

U.S Census Bureau. 2000. *National Population Projections.* Government Printing Office, Washington DC.

U.S. Census Bureau, Population Division. 2009. *International Programmes Center, Population* Studies Branch.

U.S. Census Bureau. 2010. *US Population Projections*. Population Division.

Yoder P and Konate M. 2002. *Obtaining Informed Consent for HIV testing: the DHS experience in Mali.* Calverton, MD, ORC Macro International.

Williams BG, Lloyd-Smith JO, Gouws E, Hankins C, Getz WM, Hargrove J, de Zoysa I, Dye C, Auvert B. 2006. The potential impact of male circumcision on HIV in Sub-Saharan Africa. *PLoS Med.* 3(7):e262.

World Bank. 2000. *World Development Indicators,* Washington DC.

World Bank. 2004. *Addressing the challenges of globalization.* World Bank OED, Washington DC.

World Health Organisation (WHO). 2003. Laboratory Bio-Safety Manual, (2nd edition), revised. Interim guidelines. Geneva.