UNIVERSITY OF SOUTHAMPTON

FACULTY OF SOCIAL AND HUMAN SCIENCES

DEPARTMENT OF SOCIAL STATISTICS AND DEMOGRAPHY

THE DEMOGRAPHY OF ARMED CONFLICT AND VIOLENCE: ASSESSING THE EXTENT OF POPULATION LOSS ASSOCIATED WITH THE 1998 – 2004 D. R. CONGO ARMED CONFLICT

By

Richard Tshingamb KAPEND

Thesis submitted for the degree of Doctor of Philosophy

April, 2014

Abstract

In an effort to document and monitor the scale and scope of recent conflicts (1998–2004) in Democratic Republic of Congo (DRC), the International Rescue Committee (IRC), in conjunction with some of the world's leading epidemiologists, conducted a series of five surveys in the country over a seven years' period (2000–2007). Estimates of conflict-related mortality generated from the IRC's surveys range from 3.3 million between years 1998 and 2002, to 5.4 million excess deaths for the period between 1998 and 2007. Reflecting on the IRC's work, the current study combines four different data sources – 1984 DRC Population Census, 1995 and 2001 DRC Multiple Indicator Cluster Survey (MICS) and the 2007 DRC Demographic and Health Survey (DHS) – to derive demographic estimates and assess the extent of population loss associated with the conflict period between 1995 and 2007. Both statistical and demographic techniques are relied upon for this purpose. Findings from this study do not warrant estimates produced by the IRC. The IRC approach may have overestimated the scale of excess deaths associated with the 1998 – 2007 armed conflict period. Because the approach used in the current study is mainly based on selected assumptions, a level of uncertainty is expected to be associated with the derived estimates. For this reason, sensitivity analyses have been conducted to define a range of plausible estimates representing the excess population loss.

This doctoral thesis is dedicated to victims of armed conflicts in the Democratic Republic of Congo

Table of contents

List of tables

List of figures

DECLARATION OF AUTHORSHIP

I, Richard Tshingamb Kapend, declare that the thesis entitled:

"The demography of armed conflict and violence: Assessing the extent of population loss associated with the 1998 – 2004 D. R. Congo armed conflict" and the work presented in the thesis are both my own and have been generated by me as the result of my own original research. I confirm that:

- this work was done wholly or mainly while in candidature for a research degree at this University;
- where any part of this thesis has previously been submitted for a degree or any other qualification at this University or any other institution, this has been clearly stated;
- where I have consulted the published work of others, this is always clearly attributed;
- where I have quoted from the work of others, the source is always given. With the exception of such quotations, this thesis is entirely my own work;
- I have acknowledged all main sources of help;
- where the thesis is based on work done by myself jointly with others, I have made clear exactly what was done by others and what I have contributed myself;
- none of this work has been published before submission, or [delete as appropriate] parts of this work have been published as: [please list references]

Signed: ………………………………………………………………………………..

Date: …………………………………………………………………………………..

Acknowledgements

Wanting to study to this level would not have been possible without the love and care from my mother Catherine Kaj Matemb and my late father André Tshasmar Kapend. My mother has been instrumental in my education. My mother only made it to year three of primary education but was committed and sacrificed more than one can ever imagine ensuring I get better education. I equally extend my appreciation to my late father who lived long but not long enough to share this achievement with me. His commitments to hard work and resilience have taught me to endure even in the most difficult circumstances.

I would also like to thank my wife Sarah Atule Mambuku, she has been there all the time cheering and supporting me through the good and difficult times. My appreciation also go to our four boys, Dodi Kapend, Christopher kapend, Daniel Kapend and Nathan Kapend without whom I wouldn’t have had the same drive and determination to undertake and finish this research project. It has always been very refreshing and a blessing to return home after a long day and see them race through the front door to welcome me.

Special thanks to all my brothers and sisters: My older sister Esther Kapemb, my older brother David Kapend, my older brother Christophe Mbay, my late older brother Moïse Ntambwe, my older sister Georgette Kapend, my older sister Lucienne Kapend, my older brother Michel Kapend and my sister Dr Yollande Kapend and my younger sister Carine Kapend for their support and encouraging me with their best wishes and the value they placed in my studies. The same goes to all my nieces and nephews.

Finally, completing this thesis would not have been possible without the invaluable assistance and support I received from numerous individuals and institutions throughout my PhD. I am particularly grateful to my supervisory team including Dr. Andrew Hinde, Dr. Jakub Bijak and Dr. Andrew Chanon. They have been the driving force in giving me the opportunity to develop my research proposal, their interest in the topic, their support and guidance in the formulation, execution and writing of the current doctoral thesis. I consider myself to be privileged to have worked with them and benefited from their professionalism, their knowledge of demographic research and most importantly their exceptional qualities as caring human beings.

List of abbreviations and acronyms

AFDL	Alliance des Forces Démocratiques pour la Libération du Congo Alliance of Democratic Forces for the Liberation of Congo
APR	Armée Patriotique Rwandaise Rwandan Patriotic Army
CEI	Commission Electorale Indépendante Independent Electoral Commission
CNDP	Congrès National pour la Défense du Peuple National Congress for the Defence of the People
DHS	The Demographic and Health Surveys
DRC	Democratic Republic of Congo
ECCAS	Economic Community of Central African States
EIC	Etat Independent du Congo Congo Free State
FARDC	Forces Armées de la République démocratique du Congo Armed Forces of the Democratic Republic of Congo
FAZ	Forces Armées Zaïroises Zaïrean Armed Forces
FDLR	Forces démocratiques de libération du Rwanda Democratic Forces for the liberation of rwanda
HNTS	Health and Nutrition Tracking Service
IAC	International Armed Conflict
ICGLR	The International Conference on the Great Lakes Region
ICRC	The International Committee of the Red Cross
ICTY	International Criminal Tribunal for the former Yugoslavia
IDP	Internally Displaced Person
IHL	International Humanitarian Law
IRC	International Rescue Committee
IRIN	Integrated Regional Information Networks
LLT	Lambert & Lohlé-Tart

LRA	Lord's Resistance Army
MICS	Multiple Indicator Cluster Survey
MLC	Movement for the Liberation of Congo
MONUC	Mission d'Organisation des Nations Unies au Congo UN Mission in the Democratic Republic of Congo which changed to become MONUSCO following a UN resolution
MONUSCO	Mission de l'Organisation des Nations Unies pour la stabilisation en République démocratique du Congo The United Nations Organisation Stabilisation Mission in the Democratic Republic of the Congo. Which used to be MONUC
NGO	Nongovernmental Organisation.
NIAC	Non-International Armed Conflict
RCD-Goma	Rassemblement Congolais pour la Démocratie
RCD-Kisangani	Congolese Rally for Democracy Goma was backed by rwanda and Kisangani was backed by Uganda
RCD-KML	Rassemblement Congolais pour la Démocratie-Mouvement de Libération Congolese Rally for Democracy-Liberation Movement
RCD-N	Rassemblement Congolais pour la Démocratie-National Congolese Rally for Democracy-National
RPF	Rwandan Patriotic Front
SADC	Southern African Development Community
UN	United Nations.
UNITA	The Union for the Total Independence of Angola
UPDF	Ugandan People's Defence Force
WW I	World War I
WWII	World War II

Chapter 1 Introduction

In 1994, a context of political instability and generalised crises in the Great Lakes region[1] led to the development of armed conflict in the Democratic Republic of Congo (DRC) (The National Geographic Education, 2012). The assassination of the then Rwandan President, Juvenal Habyarimana on 6th April 1994, prompted the massacre of people from the ethnic minority Tutsi and moderate members of the Hutu majority, by Rwandan extremists. This situation led to the 1994 Rwandan genocide (UN Security Council, 1994). In its aftermath, Tutsi rebels from the *Front Patriotique Rwandais* FPR (Rwandan Patriotic Front) captured Kigali, the capital city of Rwanda on 4 July 1994. An estimated two million Rwandan refugees, mainly Hutu, fled their country to seek refuge in the neighbouring countries. Most of the refugees fled to Kivu a Province in eastern Democratic Republic of Congo known as Zaïre at that time (Organisation of African Unity, 1995).

Refugees who fled violence in Rwanda entered the DRC and into refugee camps with most of their military equipment, important sums of money as well as part of the Rwandan state apparatus. The presence of the Rwandan refugees who were thought to be the authors of the 1994 genocide in refugees' camps inside DRC constituted a threat to the newly installed Rwandan regime led by Paul Kagame. The presence of masses of 'unsupervised' Rwandan Hutu refugees accused of having perpetrated the 1994 genocide at the border between the DRC and Rwanda became

1 The term 'Great Lakes' means system of lakes in and around the Great Rift Valley: Lake Albert, Lake Edward, Lake Kivu, Lake Malawi, Lake Tanganyika, Lake Turkana, and Lake Victoria. The region comprises the following countries, Burundi, Democratic Republic of Congo, Rwanda, southern Sudan, and Uganda.

a catalyst for growing tensions in the whole Great Lakes region and more specifically between the two countries (Turner, 2007).

In May 1997, the rebellion and its allies saw their successful military campaign overthrow the regime led by Mobutu Sese Seko, the former president of the DRC. The DRC was known as Zaïre[2] for almost thirty two years – from 1965 to 1997 – during which Mobutu and his regime had total control of the country, imposing one of the most brutal dictatorships in Africa.

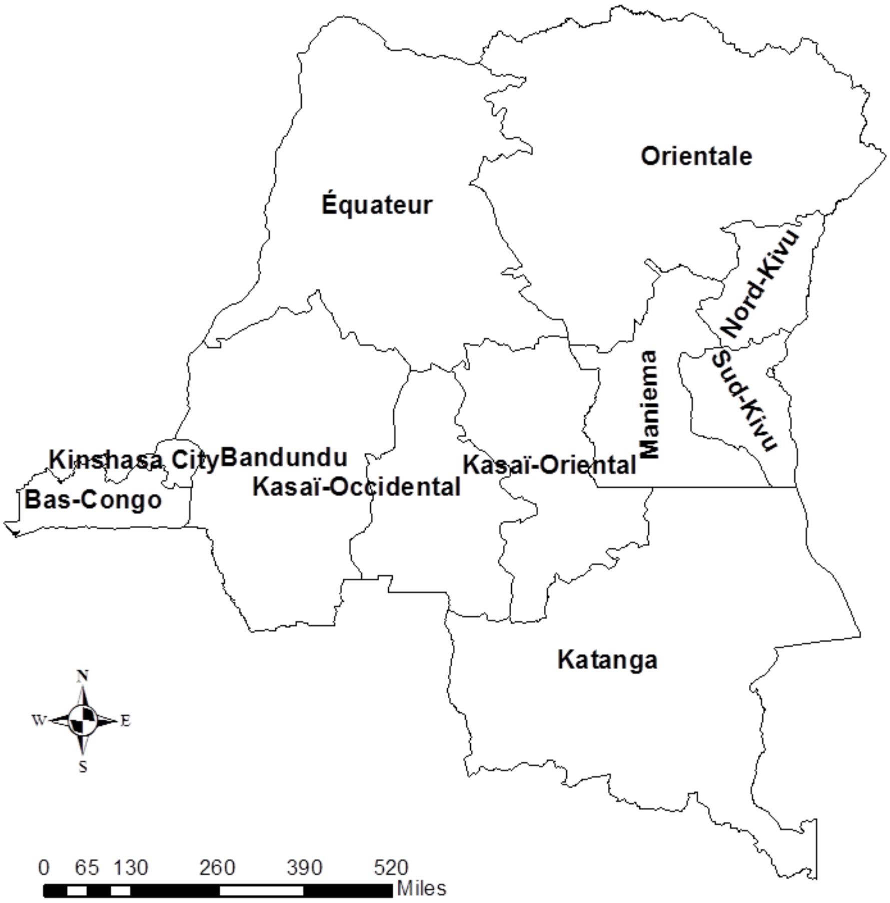
On the 13th of October 1996 in Uvira, a city located in the Province of Sud-Kivu, Congolese of Tutsi descent backed by the regimes of Rwanda, Uganda and Burundi started a rebel movement. The rebel movement enlisted fighters coming mainly from remnant armed groups hostile to the Mobutu regime. One such armed group was the People's Revolutionary Party (PRP)[3] led by Laurent Désiré Kabila who has been in rebellion since the early 1960s, following Mobutu’s coup and the subsequent wave of brutal assassinations of opposition figures.

---

[2] From 1908 to 1960 the country was known as Belgian Congo; from 1960 to 1971 the country adopted the name republic of Congo; from 1971 to 1997 the country was called Zaïre and from 1997 to now, the country is called the Democratic Republic of the Congo.

[3] In 1967 Laurent Désiré Kabila founded the People's Revolutionary Party (PRP). With the support of the People's Republic of China the PRP created a secessionist Marxist state in South Kivu province, west of Lake Tanganyika

Figure 1.1 Political map of the DRC divided into administrative provinces



Source: Own work based on GIS data from GADM database of Global Administrative Areas[4]

The map in Figure 1.1 shows the different administrative provinces of the DRC designed following the country's 2006 constitution (Republique Democratique du Congo, 2006). It has to be noted that the 2006 constitution has made provisions to further divide the current eleven provinces shown in the above map into twenty five including the capital city of Kinshasa. This is meant to be implemented when the

[4] GADM is an online source for spatial database of the location of the world's administrative areas (or administrative boundaries) for use in geographic information system (GIS).

DRC parliament votes and adopts appropriate legislation accompanying the implementation of the new administrative entities. The legislation on the implementation of the new provinces is very much dependent on the political will, the logistics and the level of development of the concerned entities. At the time of writing this study, there were still eleven provinces in the DRC A province is the first level of administration just below the national one. Provinces are headed by elected governors who have provincial governments and are accountable to elected provincial parliaments. Provinces are divided into decentralised territorial administrations including cities, counties, sectors and "*chefferies*[5]" depending on the size of the population and the level of urbanisation. Economically, provinces are entitled to a share worth 40% of the national income collected by the central government on their territory. However, this clause has not been implemented, to date, due to various political reasons (Republique Democratique du Congo, 2006).

A group of provinces located in the central east part of the country constitute the old Kivu provinces but these have since been divided into three different provinces including the Maniema with its capital city Kindu; Sud-Kivu with capital city Bukavu and Nord-Kivu with capital city Goma. These provinces share the border with Rwanda, Burundi and Uganda on their eastern flank and as we know, these three countries have experienced a prolonged period of instability and ethnic violence during the past few decades. In this regard, one could expect a degree of correlation between ethnic conflicts in these countries and instability in the Kivu province. These provinces have been the epicentre of the on-going conflict. The old Kivu province

[5] Known as "Chiefdom" in English, which is the lowest level of administrative entities in rural areas of the DRC.

was divided into three provinces in 1988 with the aim of bringing administrators closer to the local population in order to prevent ethnic violence and reduce tension in the province. Ten years later with the onset of the on-going armed conflict, it can be said that dividing the Kivu province into three provinces seems to have not adequately addressed the risk of armed conflict in the area.

At the peak of the 1998–2004 conflict around the year 2000, the DRC was divided into two main parts. On the one hand the west part of the country, mostly, starting from the Kasai provinces to Bas-Congo, was controlled by the central government and its allies; and on the other hand mostly the eastern part of the country was controlled by at least five rebel groups and their allies. Although the antagonism and the frontline between rebel groups and the government were stable and easy to demark, alliances and frontlines between rebel groups were dynamic and unpredictable. Most of the rebel groups were backed by countries located at the eastern flank of the DRC. Not only did neighbouring countries support rebel groups but the chain of command for certain rebel groups culminated all the way up to the level of government institutions in one of the above mentioned neighbouring countries; as shown by various UN's Group of Expert reports (UN Security Council, 2013).

In August 1998, the alliance that overthrew the Mobutu regime collapsed amid acrimonious disagreements. The disagreement was deep to the point of leading the Rwandan and Ugandan armies into a war for the control of mining areas inside the DRC: specifically the Province Orientale in the north east part of the country. The fallout between former AFDL allies was followed by intense and generalised fighting plunging almost 80% of the national territory – mainly its eastern part including the provinces of Nord-Kivu, Sud-Kivu, Maniema, Oriental, and the north-east part of the province of Katanga – into a prolonged armed conflict with devastating consequences. This conflict displaced many people and claimed many lives, both directly and indirectly (BBC NEWS, 1999; Coghlan, et al., 2006; Turner, 2007; Lambert & Lohlé-Tart, 2008 and the UN Office of the High Commissioner for Human Rights, 2010).

Up to the present time (July 2013), heavy fighting is still taking place between remnant and newly formed armed groups and the DRC national army (FARDC) backed by the United Nations peace keeping force. So far the Congolese army is struggling to restore peace and the rule of law and order in certain areas of the eastern DRC, most specifically in the territory of Rutshuru and Masisi province of Nord-Kivu (UN News Centre, 2012; UNHCR, 2012). Armed confrontations continue to happen despite the fact that many peace agreements have already been signed over the past few years between various stakeholders and parties to the conflict, and despite the fact also that the DRC is often referred to as a post-conflict[6] country (UNHCR, 2012; Genocide Watch, 2012).

Despite the extensive news coverage, the intensity of fighting and the persistent nature of this conflict, there has only been very limited academic interest in empirically assessing or corroborating the actual extent of its human cost. Some of the reports on the actual human cost are put together by both the United Nations'

[6] Certain literature started to refer to the DRC as a post-conflict country just after the 2004 peace agreement which was followed by the adoption of a new constitution in 2005 and general elections, hailed as credible and fair, in 2006.

agencies and independent sources then published in the media without a rigorous assessment of the methods through which they were analysed. Adding to this is the fact that there is a lack of a Congolese own perspective at both the institutional and academic levels to systematically investigate the actual demographic consequence of the above mentioned armed conflict.

In brief it can be said that whilst most areas of the DRC – almost eight provinces out of the existing eleven – seem relatively stable and calm, as of June 2013, the security situation remains volatile in the east and especially in the province of Nord Kivu, where violent clashes between armed groups and the FARDC continue. The armed conflict contributes to the emergence of new armed groups and further armed confrontations in a sort of vicious circle that leaves many dead, forcing many others away from their lands, social environments and into displaced camps. To this must be added numerous cases of indiscriminate human rights violations including the use of rape or mass rape as a weapon of war. Most of the cases of human rights abuses are conducted by members of both elements of the Congolese national army and armed groups of rebels on vulnerable civilians especially women and children living in conflict-affected areas (UN News Centre, 2012; Security Council, 2012).

The account of the armed conflict given here is simply a snapshot of a complex and fast moving situation hence the fact that some of the most recent developments may not be included. However, the account given here is illustrative of how the currently studied armed conflict in the DRC has started and developed over the years. This account is also intended to set out the context in which the current study is assessing the extent of population loss associated with the armed conflict in the DRC.

1.1 Statement of the problem

The current study aims to assess and document the extent to which the 1998–2004 armed conflict in the DRC has impacted on demographic components of population change and in particular on population losses. Before stating the problem, it is important to determine the period during which the current study assesses the extent of excess population loss linked to the DRC conflict.

The recent armed conflict in the DRC, which is also the one studied in the current doctoral thesis, saw its onset from late 1995 on the back of a generalised crisis that ensued following the spill-over of the Rwandan early 1990s conflict which culminated into the 1994 genocide. In late 1994, many refugees who fled the Rwandan conflict crossed the border into the DRC with their weapons leading to a subsequent armed crisis in the DRC; and this conflict is still on-going to this day (as of June 2013). Defining the time starting from 1998 to 2007 as the period to be studied in the current work is justified by the following main reasons:

First, stating the period 1998–2007 as the conflict period allows estimates derived from the current study to be comparable with estimates derived from existing studies (Coghlan, et al., 2009; Lambert & Lohlé-Tart, 2008) since the studies mentioned above used the same period, 1998–2007, as the basis for their analyses.

Second, it has been documented that between 1995 and 1998, instability following the spill-over of the 1994 Rwandan conflict into the DRC did not show an onslaught of violent armed clashes between belligerents and high numbers of casualties amongst civilians. This is mainly because rebel groups, which started their activities by mid-1996 with the dual aims of dealing with the threat posed by Rwandan extremists accused of the 1994 genocide and of overthrowing the regime in Kinshasa – marching the whole length and breadth of the DRC, going from the east to the west and ending up by overthrowing the Mobutu regime in May 1997 – did not encounter major resistance (IRIN, 1996). The lack of resistance is said to come from the fact that the already-demoralised Mobutu army also wanted to see regime change in the country and thus did not oppose any significant fighting, or stand in the way of the rebels. Not confronting the rebels averted the exposure of more people to the consequences of war; hence there is no indication of significant war-related casualties during the period 1996–1998. However, it is at the beginning of August 1998, when the alliance (AFDL) grouping various rebel movements and their allied countries broke, that significant armed confrontations started (IRIN, 1997).

The year 2007 is used as the end of the assessment period for the current study due to the fact that not only does the year coincide with the end of the period chosen by existing studies, as mentioned above, but also because 2007 is the year when the latest completed Demographic Health Survey (DHS) results were published for the DRC. Having 2007 as the end of the assessment period is important as the 2007 DHS data offers the last benchmarking point for analyses conducted in the current study. Therefore, besides the prospect of being able to compare findings from the current study with those from existing studies, the year 2007 offers an opportunity to firm up the derived estimates by correcting population projections conducted throughout the assessment period with more recent data.

Coming back to the statement of the problem, it is worth noting that from 2000 to April 2007, the International Rescue Committee (IRC), in collaboration with some of its partners, conducted a series of five retrospective mortality surveys in the DRC, to assess the extent and scope of excess mortality associated with the armed conflict. The IRC's first survey covered the period between April and May 2000; the second survey was conducted in March 2001; the third survey in the period between September and November 2002; the fourth survey in the period between April and July 2004 and the final survey was conducted in the period between May and July 2007.

Concerns have been raised regarding the IRC methodology and consequently its findings. There are problems linked to the IRC with the way in which the IRC generalised to the national level results obtained from cluster samples or, with the fact that the IRC chose the average Sub-Saharan crude death rate as the baseline mortality to compare against mortality rate found in the DRC during the war. In this respect, Lambert and Lohlé-Tart (2008) conducted another study with the same objective – assessing the extent and scope of excess population loss associated with the armed conflict in the DRC – but ended up deriving a number of excess mortality more than ten times smaller than what is suggested by the IRC. A close examination of both the IRC and Lambert and Lohlé-Tart findings present confirms the fact that there are significant methodological issues with both studies; these are explored in more detail later in the relevant chapter and sections.

At this stage it can be said that one of the United Nations' main missions is the maintenance of international peace and security. In this respect, it can be submitted that demographic estimates such as excess deaths linked to violent conflict have the potential to significantly influence policies at both the national and international levels hence the need for alternative assessments. For this reason, Section 1.3 and 1.4 on rationale behind the current study shows the link between the IRC estimates of excess deaths in the DRC and resolutions adopted by the UN Security Council in relation with the concerned armed conflict between 1999 and 2014. A complete list of UN Security Council resolutions on the DRC can be found in Appendix 5.

Reflecting on problems related to both the IRC and the Lambert and Lohlé-Tart methods, the current study suggests a different approach to assessing the same armed conflict for the same period (1998–2007). Before detailing the approach suggested by the current study, the next section lists the objectives and research questions.

1.2 Objectives and research questions

The main aim of this study is to assess and document the extent of excess population losses associated with the 1998–2007 armed conflict in the DRC. Such an assessment will be able to look at the effect of armed conflict on components of population change. To do so, the current study derives missing demographic estimates through the application of both the direct and indirect techniques and developing a population projection framework. The current study also evaluates figures of excess population loss from existing studies and hence contributes critically to the body of knowledge looking into the demographic consequences of armed conflict. Besides its other advantages, the process undertaken in this study broadly requires a review of the definition of armed conflict, defining the assessment period and narrowing down the wide range of uncertainty associated with the numbers of excess population loss, provided by existing studies. In other words, this study endeavours to achieve the following:

a. Review the literature on the classification or typology of armed conflicts whilst reflecting on the DRC crisis for the period explored in this study.
b. Use both the direct and indirect demographic techniques of estimation to assess the extent to which components of population change have been affected by the armed conflict.
c. Evaluate the effect each of the components of population change has on the derived number of excess population loss throughout the 1998–2007, armed conflict period.
d. Derive a range of plausible estimates of excess population, given the data and methods suggested in the current study.
e. Contribute to the body of knowledge dedicated to assessing the actual human cost of armed conflicts; for the purpose of distributive justice, assessing victimisation and post-conflict truth and reconciliation processes.

To meet the above mentioned objectives, the following five research questions are explored throughout the current study:

1. What can be said about the recent conflict (1998–2004) in the DRC and its potential to affect population change?
2. How to derive missing demographic estimates for the DRC given the absence of census since 1984, the recent armed conflict and the lack of credible and traceable vital registration data?

3. What are the steps needed to derive missing estimates and reconstruct plausible model life table which reflects the DRC demographic situation?
4. What set of assumptions is needed to derive a range of plausible estimates rather than a single estimate representing the number of excess population loss associated with the 1998–2004 DRC armed conflict?
5. How can the current study contribute to reducing the gap between existing estimates of excess population loss from existing studies by the IRC, and Lambert and Lohlé-Tart (Coghlan, et al., 2009; Lambert & Lohlé-Tart, 2008)?

Answers to the above research questions will be addressed in the chapters and sections presented below. However, in the concluding remarks, each of the questions will be further discussed based on findings generated throughout the thesis. Before exploring in more detail the topic introduced so far, the next section looks at the rationale behind the need for the current study. More importantly, the last part of the following section deals with the link between demographic estimates or excess deaths in the DRC and peacekeeping presence in the country and hence highlighting the added value of the current study.

1.3 Rationale behind the current study

Many reasons justify the importance of the current study and what motivates its occurrence:

First, for the past few years, the DRC and the death toll associated with the on-going armed conflict have been in the limelight of both the worldwide media and various discussions within the international community. It is surprising to see that in most cases reports on the DRC's armed conflict and the ensuing death toll do not necessarily rely on empirical demographic studies. Just as no credible policy can afford to ignore the importance of empirical studies, we believe the current study is able to demonstrate the importance of demographic assessments in seeking to understand patterns of the actual human cost associated with the conflict in the DRC.

Second this study can contribute to inform policy related to the DRC population change as a result of the 1998–2004 armed conflict. Although it may seem difficult to confirm the causation of the change in policy related to the war in the DRC by the international community, there seems to be an association between the IRC's reports and the presence of the UN peacekeeping force in the DRC. Since the publication of the first IRC reports on excess mortality in the DRC, there has been an increase in the size of the UN peacekeeping force. Due to the importance of the link between demographic estimates and policy related to the extent of UN resources in a conflict affected country, the second justification is further discussed in the following section.Third, the geopolitical importance of the DRC both in the central African region and indeed in the world constitutes another significant justification of the importance of studies such as the one suggested in the current thesis. An understanding of demographic changes in the DRC in relation to the armed conflict has significant implications for the understanding of many other demographic and socio-economic dynamics elsewhere in the region and far beyond.

Fourth and finally, researching the demographic impact of conflict in the DRC is also a quest for the truth. The armed conflict in the DRC, its direct consequences on the population, the deteriorating economic situation and its ramifications on the components of population change have lasting consequences on the future of country. Until we are able to look into the details of such changes objectively, we will not be able to understand the reality behind these changes. In the same way, it can be anticipated that failing to put in place objective assessment frameworks that will enable the generation of credible estimates can have an impact on people's perception of victimhood and sense of justice. This is also true due to the politicisation of statistics; situations in which statistical data are skewed and used to serve specific political agendas. In such instances, it is to be feared that inaccurate statistics linked to armed conflicts such as the one in the DRC can constitute a source for future conflicts.

As introduced earlier, there are many reasons justifying the need for the current study; but for clarity, only selected ones have been presented here. It has to be noted that the lack of empirical studies on demographic consequences of the armed conflict in the DRC renders making and implementing population-related policies more complicated. From what has been said above, it can be submitted that the current study suggests a non-stakeholder or independent approach whilst striving for objectivity in order to accommodate the justifications presented above.

1.4 Demographic estimates of violent conflict and peacekeeping

Introduction

In his report dated 22 November 2013, the UN Secretary-General recommended the establishment of a UN-wide mechanism to record civilian casualties as part of an effort to improve human rights monitoring in areas affected by armed conflict (UN

Security Council, 2013). Jennifer Cooke[7]; cited in (Axe, 2010), expressed that reports claiming a high excess death toll can be a politically powerful tool. Cooke also said that accuracy and specifying the extent of competing causes of death are equally crucial in influencing policy related to armed conflicts. Recent research undertaken in response to request on the protection of civilians reveal that casualty recording is gaining increased recognition by states, UN experts and civil society organisation worldwide as a practice that can help save lives. However, casualty recording is not currently a widespread practice within the UN system (Beswick & Minor, 2014). In the case of the DRC the debate over existing figure of excess population loss is linked to the IRC's assumptions regarding baseline mortality rate and the sampling method used in the retrospective surveys. Despite that, the UN Security Council seems to have drawn heavily on the IRC finding to inform its policy on the DRC conflict. For this reason, advancement of casualty-recording practice by the UN in conflict-affected countries should be pursued, as this would have clear benefits to the work of a range of UN entities, and so to the people that they serve.

Between 1999 and January 2014 the UN presence in the DRC increased by almost 220% going from 90 military observers to 22,016 uniformed personnel. This includes 19,522 military personnel, 502 military observers; 1,193 police, 979 international civilian personnel, 2,967 local civilian staff and 560 United Nations with an annual budget of $1.5 billion US Dollars. Much of this increase in personnel and resources has been justified by the deterioration in human rights conditions as well as the overall excess human cost resulting from the armed conflict.

[7] Africa analyst and director at the Center for Strategic and International Studies

If the deterioration in human rights conditions has been assessed over time by various UN's multidisciplinary panels of experts, the overall excess human cost or the number of people dying in excess as a result of the armed conflict has mainly been provided by the IRC which conducted a series of retrospective mortality surveys to cover the period between 1998 and 2007. On this basis, it can be submitted that the IRC figures on excess deaths have played an important role in informing the UN Security Council's policy on the DRC armed conflict. As mentioned earlier, figures on DRC excess deaths from the IRC have attracted considerable critics. Some of the critics focused on weaknesses related to the IRC's choice of baseline mortality and the sampling methods used for the retrospective mortality surveys. For this reason, the current study suggests that alternative approaches to assess excess deaths linked to the DRC armed conflict is the best way to ensure that more objectivity and inclusiveness are allowed to inform UN policy related to the DRC armed conflict.

1.4.1 UN Resolutions and conflict dynamic

Even though the DRC armed conflict was triggered by the 1994 Rwandan genocide and that, from 1998 armies from more than six African nations were involved in this conflict, it was not until 1999 that the UN Security Council adopted a resolution related to the above mentioned conflict. From 1999 to 2014 the United Nations Security Council adopted 64 resolutions on the DRC and the ongoing armed conflict. Out of the 64 resolutions, around 60% or 38 were adopted in the period between 2003 and 2008.

UN Security Council’s resolutions are formal expressions of the opinion or will of United Nations organs. They generally consist of two clearly defined sections: a preamble and an operative part. The preamble generally presents the considerations on the basis of which action is taken, an opinion expressed or a directive given. The operative part states the opinion of the organ or the action to be taken (UN Security Council, 2014). It is worth noting that most of the resolutions on the DRC constituted the preamble part where the Security Council expressed a number of concerns on various issues related to human rights violations. However, the operative parts of these resolutions are the ones determining decisions related to peacekeeping missions, size and mandates are defined and managed. More specifically it is through the operative part of UN resolutions that the number of peacekeeping force is decided according to the extent of human cost or human rights conditions on the ground.

In August 1999, through resolution S/RES/1258 (1999), the United Nations Security Council recognised that the situation in the DRC demanded an urgent response by all parties to the conflict with the support of the international community (UN Security Council, 1999). In this respect the Security Council authorised the deployment of up to 90 United Nations military liaison personnel, together with the necessary civilian, political, humanitarian and administrative staff to the capital States involved in the conflict and the rear military headquarters of the main belligerents. This initial mission was possible following the signing of the Lusaka Ceasefire Agreement between the DRC and five regional States (Angola, Namibia, Rwanda, Uganda and Zimbabwe). One of the main mandates of this deployment was to secure from the parties guarantees of cooperation and assurances of security for possible deployment in-country of military observers, to plan for the observation of the ceasefire and disengagement of forces and maintain liaison with all parties to the Ceasefire Agreement (UN Security Council, 1999, pp, 2-3).

For this initial mission up to 90 United Nations military liaison personnel, together with the necessary civilian, political, humanitarian and administrative staff were deployed to the capitals of the States signatories to the Ceasefire Agreement and the provisional headquarters of the Joint Military Commission (JMC). Security conditions permitting, the mission was also to deploy to the rear military headquarters of the main belligerents.

If early motivations in deploying a peacekeeping force in the DRC were linked to the maintenance of international peace and security by assisting the implementation of the Agreement signed by all parties, later motivations expanded in response to shifting patterns of the conflict in order to best address threats to peace and security. Over the years and as the conflict evolved, the Security Council, through its technical team assessed various factors related to security conditions in all areas of its operation, with emphasis on local conditions affecting future decisions on the introduction of United Nations personnel. Among these factors featured the assessment of the consequences of the conflict for the security and well-being of the civilian population as well as its adverse impact on the human rights and international humanitarian law situation. The technical team was composed by UN's multidisciplinary staff in the fields of human rights, humanitarian affairs, public information, medical support, child protection, political affairs and administrative support.

1.4.2 Excess deaths and review of UN mandate

Based on excess deaths and the extent of incidents affecting human rights conditions, the Security Council increased of its military presence in the DRC. In this respect, the UN's military presence in the DRC moved from 90 military observers in August 1999 to 5,537 military personnel including up to 500 observers by February 2000. This increase in UN personnel has been justified by the fact that the UN determined that the situation in the DRC constituted a threat to international peace and security in the region based on reported cases of violations and abuses of human rights and international humanitarian law, limited access of humanitarian workers to refugees and internally displaced persons in some areas.

In relation to the need for empirical demographic studies on the consequences of armed conflicts on population change as highlighted in the current thesis the following argument is worth noting. Although human rights violations reported by the Security Council have the potential to lead to excess population loss, the Security Council failed to rely upon demographic expertise to empirically assess the extent to which the reported incidents could have affected population change. Maintaining international peace without an empirical assessment of the demographic consequences of the conflict is less likely to lead to meaningful policies.

Between 2000 and 2003 the UN military strength in the country increased from 5,537 to 10,800 personnel. It can be submitted that, despite the UN's own assessments on human rights conditions, external pressures by various rights groups and NGOs played a key role in influencing this increase. An example of this pressure is the case of the OXFAM report titled "The war in the Democratic republic of Congo is at a critical juncture" (Oxfam, 2002). The report was submitted at the UN Security Council in April 2002. The report quoted, for instance, that the humanitarian situation in the country has deteriorated over the past 12 months, that the conflict in the country was a human tragedy likely to have cost over two million lives and that the real implications for health, mortality, internal displacements and poverty were enormous. In the same way, recommendations from the third UN Panel of Experts on the DRC report published in August 2002 quoted conclusion from the IRC survey mentioning that 2.5 million more people died since the beginning of the war, or the period from August 1998 to April 2001, than would have died had the war not occurred (U N Security Council, 2002; Roberts, et al., 2003).

Between 2004 and 2007 MONUC military strength was again increased going from 10,800 to up to 17,030 personnel. Similar to 2002, the UN mapping report mentions that millions of Congolese were reported dead between 1998 and 2007 and used findings from the IRC surveys to support the claim (UN Office of the High Commissioner for Human Rights, 2010). It is known that, in conducting the series of retrospective mortality surveys one of the IRC's main objectives is to document rates and trends in mortality and provide recommendations for political and humanitarian interventions. For this reason, the UN Security Council has again relied upon the IRC findings to decide further increase of its military presence and resources in the country.

Based on more recent developments and the accumulation of proofs demonstrating outside meddling and support to rebel movements in eastern DRC, the UN Security Council has adopted an unprecedented resolution establishing an Intervention

Brigade within MONUSCO. According to the UN Security Council Resolution 2098 adopted on 28 March 2013, the Intervention Brigade consists of and inter alia of three battalions, one artillery and one special force and reconnaissance company under the direct command of MONUSCO Force commander. The Intervention Brigade has a mission to neutralise armed groups and the protection of civilians hence reduce threats they pose to state authority and civilian security. This mandate is unprecedented because it authorises, for the first time in history, UN peacekeeping force to carry out offensive operations through the Intervention Brigade either unilaterally or jointly with the FARDC, in a robust, highly mobile and versatile manner and in strict compliance with international law. **[Implication of this to be seen in conclusion Chapter]**

Summary of demographic estimates and peacekeeping

Given the fact that the UN Security Council reflected extensively on the above mentioned reports to inform its policy on the DRC, one can see the importance of alternative assessments on the demographic consequences of the armed conflict in this country. Alternative demographic assessments as suggested in the current study would have provided the UN Security Council with a needed second or third opinion to either empirically corroborate or challenge existing narratives on excess population loss. This has the potential to lead to much more concerted and informed policies when it comes to the deployment of UN peacekeeping force or the allocation of various resources to help stabilise the war affected country.

1.5 Thesis outline

The current thesis is divided into nine chapters including this introductory one, where the statement of the problem, the study's main objectives, research questions and rationale are highlighted.

Chapter 2 critically reviews selected literature on the typology of armed conflicts in light with the International Humanitarian Law (IHL). Further to reviewing the typology of armed conflicts, chapter three also looks into selected literatures on measuring the human cost as a consequence of armed conflict. Chapter 3 ends by reviewing specific case studies, selected based on their relevance and their ability to inform the approach adopted in the current study.

Chapter 3 gives a background to the 1998–2004 DRC armed conflict. The chapter looks into the country's key historical events, giving a chronological account of how the studied armed conflict started and developed over the years. Chapter 2 also provides an overview on key dates, actors, and places of the armed conflict alongside their potential to affect population change.

Chapter 4 details the methodology suggested in the current study. The chapter explains how the current study derives missing demographic estimates by applying both direct and indirect techniques of estimation using data sources identified in the current study.

In **Chapter 5,** demographic estimates derived in Chapter 4 are used as input for population projections, where the latest census in the DRC constitutes the baseline. The projections process developed in Chapter 5 is then benchmarked at specific points in time with demographic estimates from surveys conducted between 1984 and 2007 in the DRC including the 1995 Multiple Indicator Cluster Survey[8] (MICS 1); the 2001 MICS2 and the 2007 DHS.

Chapter 6 explores the projection framework developed in Chapters 4 and 5 by defining two main scenarios that allow calculating the number of excess population loss for a closed population. These scenarios include a factual and a counterfactual situation. For the factual scenario, the estimates on population recorded in different surveys are deemed to reflect the actual demographic situation of the DRC at the time they were recorded. For the counterfactual scenario it is assumed the war did not happen hence the study determines, based on comprehensive criteria, alternative demographic trends for the projection period. The difference between the factual and the counterfactual scenarios, as calculated in Chapter 6, enables the calculation of the extent of excess population loss for a closed population.

Chapter 7 takes further population projections developed in Chapter 6 in order to apply the scenarios developed there to an open population. This is done by incorporating age and gender-specific migration data to the population data then conduct projection based on the two scenarios mentioned above. From Chapter 7 it is possible to assess the effect of non-zero migration on the overall population projection and in particular on excess population loss as derived from Chapter 6.

---

[8]MICS or Multiple Indicator Cluster Survey is an international survey initiative by the UNICEF to assist countries in collecting and analysing data in order to fill data gaps for monitoring the situation of children and women, covering health, education, child protection and HIV/AIDS; it includes vaccination, contraceptive use and symptoms like diarrhoea cough and fever. MICS1 is the first of this kind conducted in DRC in 1995 and MICS2 is the second of its kind conducted in 2001.

Chapter 8 assesses all assumptions used to project the population up to Chapter 7 in order to identify realistic ones, which enable us to derive a range of plausible estimates of excess population loss. Based on plausible estimates retained in Chapter 8, it has been possible for the current study to determine age and gender-specific population loss.

The final **Chapter 9** summarises and evaluates selected aspects of the current study. The final chapter discusses key points related to this study's research rationale, its objectives and outlines some of the implications arising from the questions raised and findings generated in the current work.

Chapter 2 Review of selected literature on armed conflict

Introduction to Chapter 2

This review aims at providing a critical assessment of existing literature related to the quantification of population change as a consequence of armed conflict. The review is also intended to illustrate the dynamics of armed conflict in the case studies presented here and their potential to influence all three components of population change; distinguishing between their short and long term as well as direct and indirect consequences. Furthermore, the current review constitutes a conceptual framework upon which the background on the armed conflict in the DRC is reflected upon in order to set out the expected impacts of the studied conflict on each of the three components of population change.

Some studies tend to equate armed conflicts with mass killings and widespread human rights abuses and international humanitarian law violations. Although such approach constitutes a valuable aspect of conflict analysis, it however tends to overlook the broader demographic context, which often entails an intertwinement of all three components of population change; especially in the longer term. More often literature is silent on the broader demographic context, although conflict-related excess deaths have the potential to provide a comprehensive measure for ranking the intensity of an armed conflict. In this respect, World War One and World War Two, for instance, are known as the greatest in the last century Europe. In the same way, some of the modern conflicts highlighted in media accounts are ‘small’ by historical standards and based on their estimated number of excess deaths. Excess death or mortality, however, is only one aspect of the demography of armed conflict and violence. As explained earlier, armed conflicts have the potential to affect all three components of population change. Fertility can be affected through the reduction of births and marriages. The forced migrations they often give rise to can both increase and reduce the death toll. Armed conflicts affect mortality in different ways; they tend to be more area-specific and they are more likely to target differently males and females. Moreover, armed conflicts have demographic causes as well as consequences; and the consequences may be long-term as well as short-term and concerning mortality, armed conflicts can have both direct and indirect impacts. By direct impacts it is meant, for instance, fatalities resulting directly from fighting or from collateral damages and by indirect impact it is meant fatalities or population losses resulting from hardship and severe strain imposed on living conditions by the armed conflict.

Studies have assessed the political, military, economic or the broader development costs of various armed conflicts. Despite the fact that the human cost seems to be the most significant consequence of any armed conflict, it can be submitted that not many studies have relied on demographic methods to empirically assess such cost. Distinguishing between earlier and the more recent studies, the following can be said: for earlier studies, the difficulty maybe linked to both the precariousness of analysis techniques and the data existing at that time and, for more recent studies the difficulty can be linked, mainly, to the lack of reliable data and clear cut classification of various types of armed conflicts. The difficulties mentioned here are not mutually exclusive since they can overlap and reinforce one another be it for earlier studies or for more recent ones.

While using demographic methods to assess the impact of conflict and violence on components of population change has recently experienced a growing interest in the academia (Brunborg & Tabeau, 2005; Brunborg, et al., 2006), there does not seem to be a clear cut definition or a precise enough set of criteria to determine the concept of armed conflicts. Where this concept has been defined, there is still legal debates on whether the current dichotomy – under which armed conflicts are classified, either as international or internal – is enough to define new factual scenarios where a conflict can be both international and internal or neither of the two; based on the existing typology. For this reason, the current study reviews the literature related to the typology of armed conflicts in order to set out the meaning of armed conflict in the context of this study.

The current review is divided into two parts. The first part looks at the literature related to the typology of armed conflicts; this is to provide a context to the definition of armed conflict as applied in the current study. The second part offers a critical review of selected case studies in which quantitative methods have been applied to assess demographic consequences of armed conflicts. Reflecting on the dynamics of armed conflicts the two parts of this review are structured in a way to offer a discussion of the relationship between conflict and demography.

2.1 Typology of armed conflicts

Literature shows a distinction between two main types of conflicts within the International Humanitarian Law, the branch of international law which governs armed conflict. Armed conflicts have often been classified as either international armed conflict or non-international armed conflict, which is also known as civil war.

Therefore, legally speaking, no other type of armed conflict exists (ICRC, 1949). To these two main types of conflict, cases of genocide, ethnic cleansing and crimes against humanity have been added through additional protocols to the 1949 Geneva conventions, although they are seen as special cases of violent deaths, but not always related to, as armed conflicts (ICRC, 1949, p. 26; ICRC Opinion Paper, 2008).

Determining the type of armed conflict and subsequently the level of IHL to apply is not always clear cut. This is mainly due to the fact that the nature of armed conflicts is not static over time. An armed conflict can be dynamic starting as an international conflict involving two or more different countries but then change into a non-international armed conflict when outside countries pull out of the conflict leaving factions from the same country to continue with the hostilities; or this can happen the other way round. Even when the classification of an armed conflict is conducted over time, the question of determining when and what level of armed conflict applies or who is entitled to classify an armed conflict remains problematic.

Although it is known that the ICRC is the main repository of the IHL and the Geneva conventions, some have expressed that this institution lacks the needed authority to enforce any provision of the laws to individual states (Kallenberg, 2009). According to Kallenberg (2009), leaving individual states to determine what level of protection they want to afford their enemy and then labelling the armed conflict to fit that distinction led to inconsistency in the classification of armed conflicts. Although the passage of additional protocols allowed several other categories of conflicts to be recognised as international in nature, determining a non-international armed conflict remained a problem. Because of these difficulties it seems there is no clear cut divide in the dichotomy offered by the 1949 Geneva Conventions on the classification of armed conflicts.

Bartels (2009) noted that conflicts such as the ones involving Israel and Hezbollah, the incursions by Turkish armed forces into northern Iraqi territory to raid Kurdish strongholds, to name but a few, have been defined as being at the same time international as well as non-international. This is because there were non-state entities operating beyond the borders of a single state involved. Similarly, the Supreme Court of the United States ruled that the fight against Al Qaeda, which is not limited to Afghanistan or Iraq and conducted outside the United States, was covered by Common Article 3 that applies to non-international armed conflicts (Vité, 2009). In the same way, most war crimes, crime of genocide and other crimes against humanity do not feature under either international or non-international armed conflicts but they are included in the International Committee of the Red Cross study of customary international humanitarian law and in the Rome Statute of the International Criminal Court (ICRC, 1949). It can be said that the difficulty of having a comprehensive classification of armed conflicts can be linked to the problem posed by varying perceptions of given conflicts by different parties involved as well as the changing nature of armed conflicts.

According to Reeves and Thurnher, (2013), the contemporary law of armed conflict is based on the existence of a balance betweenthe traditionally recognised principles of military necessity and humanity. Finding a balance between competing principles in order to avoid either concept gaining primacy over the other is often delicate. For Reeves and Thurnher (2013), historical over-emphasis on military necessity has led to horrendous atrocities; conversely, when humanitarian concerns are dominant, state military actions are hampered by heavy regulations and thus compromise compliance. Ensuring that these principles are balanced is therefore important to regulate warfare. More recent studies have found that there has been a shift in emphasis toward humanitarian considerations over the past decades and external influences have begun hindering the ability of states to preserve the appropriate balance.

Given the changing nature of conflict in the DRC, it can be submitted that regardless of IHL classification, the impact of the DRC armed conflict on demographic components of population change includes significant human losses, forced migration, unsettlement of reproductive behaviour and worsening of living conditions. This observation can be supported by the fact that the jurisprudence of the international tribunals and courts also seems to lessen the need for a distinction between the two types of armed conflict. Zegveld (2002, p.33) observed that international practice demonstrates a trend to diminish the relevance of the distinction between the law applicable to international and to non-international armed conflicts. Therefore, regardless of how a conflict is classified, it remains nonetheless important to measure demographically armed conflict-related death toll on population change. This is more relevant with the DRC, where the conflict can have far reaching consequences at the national and international level both directly and indirectly. A demographic assessment will enable not only accounting for the number of excess deaths over a defined period but also inform policy at all levels.

The next section reviews selected case studies of armed conflicts. This is to offer an illustrative rather than an exhaustive understanding of both the advantages and challenges encountered when measuring demographic consequences associated with a given armed conflict over a defined period.

2.2 Conflict-related human cost

This section looks at selected cases of armed conflict and violence where demographic methods have been relied upon to assess their consequences on components of population change. The selection of case studies reviewed here is based on the fact that they relate to this study's main topic in terms that show a balance between the theoretical, methodological and practical aspects. The selection targeted early empirical studies on the demographic consequence of armed conflicts and more recent case studies in order to identify and summarise any progress which may have happened between early and more recent studies. In this respect, the age of the study was one of the criteria used in the selection. Adding to that were the similarities in terms of both the nature of the conflict studied and the context in which they happened. Similarities in the nature and context of the conflict were important selection criteria since they helped draw parallels on more than one level between the current study and the reviewed ones. Because this study's main aim is to assess excess population loss linked to the DRC conflict and not a systematic process analysing, evaluating and summarising all scholarly materials on armed conflict, the review of studies presented here is aimed to be more illustrative and comprehensive than exhaustive.

This section is divided in four sub-sections including a review of literature on early studies, recent studies, specific case studies and existing demographic studies on the DRC armed conflict.

2.2.1 Early developments

One of the earliest studies to look at the impact of conflict on demography was conducted by Günther Franz's work on the German involvement in the Thirty Years' War[9], *Der Dreißigjährige Krieg und das deutsche Volk*; cited in (Theibault, 1997). In his analysis of Franz's work and subsequent studies on the Thirty Years' War, Theibault (1997, p. 2) noted that the most widely cited authority on the demographic impact of conflict and violence continued to be Günther Franz's work. Given that Franz's work was published more than sixty years ago, even most recent studies on the Thirty Years War have relied on his work to provide a general picture of its demographic impact. Despite providing broad answers to the question of just how many people died during the Thirty Years' War, some researchers have expressed that deriving a single best figure of the actual population loss associated with that war is not possible Theibault (1997, p. 4).

To show, for instance, the extent of depopulation occasioned by the Thirty Years War, Franz made a comparison between pre-war and post-war numbers of households in 10 towns out of 24 towns recorded in a 1639 survey. Franz's figures suggested that 74.9% of households were lost in towns and that 85.7% of households were lost in villages. However, from Franz's own interpretation of the

[9] The Thirty Years War from 1618 to 1948 is one of the longest-lasting and, geographically, one of the most widespread conflicts to have had extreme demographic consequences in Europe hence it has generated greater interest among historical demographers (Theibault, 1997, p. 2).

data, the same territories lost 30% and 50% of their respective population during the war (Theibault, 1997, p. 10).

Discrepancies between the reported loss of households within villages and towns and the reported loss of population in towns and villages led critics of Franz's work to argue that the magnitude of the number of households have only partial connections to the actual population size. This makes it difficult to derive the overall number of population loss since the recorded households did not have detailed information about their composition (Theibault, 1997). In other words, it is important to have disaggregated figures of households' composition to be able to derive the actual number of population loss for a given geographic area.

Limitations related to deriving the size of population loss based on information of households for a given geographical area as conducted by Franz's study of the Thirty Years War, can be paralleled to the case of the DRC. Starting with the DRC colonial period which is a period closer to when the Thirty Years War took place, the colonial power collected data on the indigenous population with the aim to implement the colonisation agenda. Such information was mainly designed to help the colonial administration to get an idea of the labour force, plan for the future or deal with potential population related issues that could arise at that time (Hochschild, 1998). The data collected were rough estimates often conducted at household or chiefdom levels rather than an enumeration of individuals by age and gender, then grouped at households or chiefdom level. Similar to Franz's reliance on data at household level, such data are of limited use when it comes to deriving estimates related to odd events such as slavery campaigns, colonial violence or armed conflicts which have the potential to significantly affect population change both in the short as well as in the long terms.

2.2.2 Recent studies

In recent times, it can be seen that despite the progress seen in demographic techniques, successive governments in the DRC have not collected and explored demographic data regularly. Collecting demographic data regularly would have helped form a reliable statistical basis upon which various demographic analyses could be framed in order to assess excess population loss linked to conflicts made easier (Siegel & Swanson, 2008). Except for the 1984 census, recent demographic surveys (Unicef, 1995; Unicef, 2001; Ministère du Plan & Ministère de la Santé, 2008) in the country did a good job in accommodating specific studies on the condition of children and women. The lack of census and regular population studies in DRC has prevented the establishment of reliable benchmarks upon which various studies of the population could be conducted including the assessment of conflict related impact on components of population change.

Michael Cranna (1994) compiled selected studies on the human cost occasioned by armed conflicts. In his analysis, he examined seven conflicts including the Gulf War; the Indonesia invasion of East Timor; the Mozambique civil war; the Sudan civil war; the guerrilla in Peru; the Kashmir struggle for independence; and the war in former Yugoslavia. Cranna developed and applied a multidisciplinary approach to assess the various costs of the above mentioned conflicts both in terms of short and long term population losses. However, most of the studies compiled by Cranna did not provide a comprehensive method outlining how various demographic estimates related to the human cost of these conflicts were derived (Cranna, 1994).

Unlike early studies, in which demographic assessments of the impact of conflict and violence were either scarce or archaic and sometimes both, there have been in recent years increasing interest for topics related to the impact of armed conflicts on demography (Brunborg, Tabeau, & Urdal, 2006). The lack of comprehensive demographic assessments of the impact of armed conflict in the DRC is one of the motivations behind this study. Shortcomings in previous studies on conflict situations inform this research on how to set out the demographic assessments.

Under the auspices of the International Union for the Scientific Study of Population (IUSSP) a seminar on the demography of armed conflict and violence was organised in Oslo in 2003. The seminar aimed at providing a well-informed overview of current researches on the demographic aspects of wars and conflict. The seminar outlined a number of research questions on demography of armed conflicts that helped classify existing and future research, into the following four main areas (Lambert & Lohlé-Tart, 2008b):

1. Demographic factors as causes of conflict
2. Demographic consequences of conflict
3. Data and methods to measure the population impact of conflict and violence
4. Special cases of violence and conflict and their demographic and determinants.

On the first point, the seminar focussed on studies related to the impact of population composition, cultural characteristics and how the interaction between demographic factors and economic, political and environmental conditions can be affected by the risk of armed conflict. Although not directly related to the main topic of the current study, similar to the classification of armed conflicts, demographic causes of armed conflicts may be hard to determine. This is mainly due to the fact that parties involved would want to define the causes of the conflict so that it fits their own subjective perceptions. Conversely, when listing conditions that he believed would continue to make the world a place vulnerable to armed conflict and violence, Patrick Hughes expressed that the existence of youth bulges was first on his list (Hugues, 1997). Henrik (2004, p. 2) looked at the role of youth in political violence. In his study, Henrik cited Jack A. Goldstone (2001) who claimed that:

> *“Youth have played a prominent role in political violence throughout recorded history: and the existence of a ‘youth bulge’ (an unusually high proportion of youths 15–25 relative to the total population) has historically been associated with times of political crisis” (Goldstone, 2001)*.

This is an indicator that demography combined with other factors can be a cause of armed conflict but to be entirely sure of this, a more representative study is needed before one can generalise such assumption.

On the second point of the Oslo seminar, studies focused on the consequences of conflict on factors such as morbidity, mortality and disability. In the same way, the impact of conflict was assessed through its psychosocial effects on fertility, reproductive health, nuptial arrangements and household composition. This point also looked at the consequences of conflict in terms of forced internal and international migration. Studies looking at the demographic consequences of armed conflicts were found crucially relevant and very important to this study since they have the potential to inform the methodological background from which this study's methods are drawn. It is said in some of these studies that demographic reconstructions are hindered by the reliability of measurement of each population component. In the same way, some of the studies mentioned the lack of data as being a source of uncertainty. The studies mentioned some of these limitations without going as far as to suggest ways of assessing them in order to design alternative solutions. This study will aim to identify such difficulties and look at plausible ways to suggest alternative solutions.

The third point covered issues related to the selection and collection of data where conditions to do so are difficult. This gives an overview on the development of demographic methods based on incomplete or deficient data. This explored the use of estimates of war casualties to prosecute war crimes. This was possible due to the fact that such estimates can inform truth and reconciliation commissions, as well as playing a key role for forensic demography (Brunborg, Tabeau, & Urdal, 2006).

The last point looked at the extent to which demographic factors, such as age composition or ethnic heterogeneity, can impact on the risk of terrorism. In the same way, research related to the definition of the term genocide through the analysis of long-term demographic and other consequences on the population that have experienced genocide was also presented (idem).

The Oslo seminar on the demography of conflict saw the presentation of various studies related to the issues of conflict and mortality, counting victims of conflict, demographic consequences of conflict and, post conflict demographic responses.

Studies presented here are important for this paper in many respects. This is to do with the fact that the Oslo seminar was the first of its kind to assemble the most recent studies on the demography of armed conflict and led to the publication of the presented studies in one comprehensive document (Brunborg, Tabeau, & Urdal, 2006).

2.3 Case studies

In the section above, an overview on recent perspectives in researching the demography of conflicts and violence was presented. The current section looks at selected case studies on measuring demographic consequences of armed conflict. As mentioned earlier, the cases studied here are intended to be illustrative rather than exhaustive but the relevance of their structure and method remains important to inform the current study's overall approach.

2.3.1 Cambodia 1970 – 1979

Patrick Heuveline used Cambodian electoral lists from 1992, registered by the United Nations, to estimate the size of population loss during the Khmer Rouge regime in the 1970s. Heuveline's study was not only able to map out the extent of potential excess mortality; it also assessed the impact of violence-related deaths on population composition and structure during the same period (Heuveline, 1998).

It has been argued that estimates of excess deaths attributed to the Khmer Rouge period in Cambodia – April 1975 to January 1979 – may be extreme and probably more reflexive of a propaganda than scientific results (Vickery, 1984, 1988; as cited in Heuveline, 1998, p. 49). Kiernan (1997) noted that the major problem with some of his analyses was the lack of evidence. Despite his contribution to the knowledge of the Khmer Rouge period, some have expressed the opinion that Vickery's work did not consult peasant sources seriously. It was discovered that only one out of ninety eyewitness interviewees was actually a peasant. Because his work was based on eyewitness accounts rather than quantitative estimation his findings were therefore not representative of the actual account of deaths known by peasants during that period (Kiernan, 1997, p. 298).

Heuveline (1998) identified two main approaches to quantifying the exceptional mortality of the Khmer Rouge era. The first approach used a retrospective count of deaths in a sample comprised of grave excavations and survivors' accounts, and then extrapolated it to the population of Cambodia. The second approach involved demographic accounting; here, instead of estimating population through the balancing of total number of births, deaths and net migration, a cohort component method of projection was used to determine changes in population size.

Heuveline (1998) noted weaknesses in the two approaches. For the first approach, the quality of estimates cannot be realistically assessed and it was impossible to verify the dates of death. For the second approach, it was noted that using demographic methods to reconstruct the size of population was hindered by the uncertainties of measurement in each component which are compounded in the estimate of the residual component (Heuveline, 1998, p. 50).

According to Heuveline, his study was an attempt to contribute to the reconstruction of the demographic history of Cambodia in the following three ways (Heuveline, 1998, p. 50):

- Reassessing the population of Cambodia after the 1970s through the use of unpublished electoral lists rather than using 1980 census data which some thought followed a political agenda.
- Assigning a range of plausible values to each parameter of the reconstruction and ensuring these are consistent with current demographic evidence.
- Distinguishing between different causes of excess death; e.g. direct, indirect, violence related etc., by analysing the age and gender structure of excess mortality.

Heuveline's results combined a set of estimates (minimum, medium and maximum) to derive a set of projections yielding the number of excess deaths in the period 1970–79 (Khmer Rouge era). The resulting numbers ranged from a minimum of 1.17 million to a maximum of 3.42 million deaths. The medium estimate gave 2.52 million deaths and seemed more plausible. However, Heuveline noted that migration remained the main component of uncertainty as it may account for an incorrect attribution of excess mortality estimates of at least 650,000 persons. The lack of good data on migration did not help to make reliable migration assumptions.

It has to be noted that Heuveline's study went a step further in investigating the extent to which specific components of population change were affected by the conflict hence contributing to the overall change in population size.

Heuveline's work on Cambodia is very important to this study since it provides the basis upon which the current study modelled the main components of its approach to assessing excess population loss linked to the armed conflict in the DRC. However, due to the lack of a more recent census with which to conduct a backward population projection to correct the forward population projection, the current study uses four benchmark points to correct the forward population projection. More on this study's approach is explored in the method and data chapter. Further to that, Heuveline's work shows that migration was the main component that provided uncertainty when accounting for excess mortality estimates. In this respect, it can be anticipated, for this study, that migration is one of the components to be cautious of with when conducting the assessment.

2.3.2 Rwandan genocide of 1994

Marijke Verpoorten (2005) focussed on the Gikongoro Prefecture of Rwanda to evaluate the number and the profile of genocide victims as a way of contributing to the debate on the 1994 Rwandan genocide's death toll. The study described the geographical patterns of the 1994 killings basing its assessment on records from the local population's registers and census data.

Comparing the 1991 census with 1990's administrative records of population in one Prefecture, Gikongoro, Verpoorteen was able to establish that the number of Tutsi living in the Gikongoro Prefecture was under-reported in censuses. The reliability of population data from local administration was due to the fact that, prior to the genocide, Rwanda had one of the few African countries to have a well organised administrative structure. This administrative structure was called "nyumbakumi" or ten-house agglomerations, and one of the tasks devoted to this structure was to file reports on population four times a year.

For each report, a personal file recording key demographic events on individuals aged 17 and above was kept at the Commune[10]. Nyumbakumi leaders reported these events to leaders of cells, who reported to leaders of sectors, who reported to the leaders of the Communes and all the way up to the central government via Prefectures. This made it possible for every individual to be recorded in the years before the 1990s, prior to the genocide (Verpoorten, 2005, p. 336).

Doubts concerning the reliability of population censuses were also sustained by the fact that census interviewers sent by the central government were not allowed to physically check the respondent's identity. The use of ID cards or birth certificates – where the information of ethnicity used to be mentioned – could have helped confirm the ethnicity as reported by respondents during census interview. Unlike vital registration, where ethnicity could be verified and cross checked by different officials, the 1991 census had restrictions on crosschecking respondents' "true" ethnicity. This led some individuals to misreport their actual ethnicity (Verpoorten, 2005).

Verpoorten's use of the term "ethnicity" is open to debate. This is because the notion of ethnicity can be perceived as a social construct which can be defined in different ways. Therefore, people can identify themselves according to their perception of their ethnic identity hence not necessarily thinking they have, intentionally, misreported their ethnicity. Even if it is agreed that ethnicity can be intentionally manipulated and hence change, thus affecting the official statistics recording ethnicity, it also remains true that genuine ethnic misreporting can also influence official statistics.

[10] A township (or municipality); in the context of this paper it is a settlement which has the status and powers of a unit of local government.

In a slightly different context, John Blacker (2007) examined the allegation that up to 300,000 Kikuyu and others died as a result of the Mau Mau Emergency in Kenya back in the 1950s. In studies upon which those allegations were made, it was demonstrated that figures representing deaths of Kikuyu and other ethnic groups were based on comparative numbers from the 1948 and 1962 Kenyan censuses. According to Blacker (2007), this assessment failed to take into account the change made in tribal classification between the two censuses and their differences in coverage.

Similar to the case of Rwanda where ethnicity can cause a fault in official statistics, the Mau Mau study by Blacker shows that many cases of inaccurate representations of demographic facts can still be found in reports about conflict and violence. Such findings are important since they serve as a precedent in preventing reports on conflicts such as the DRC's to be based on inaccurate baselines or misclassified variables. As said earlier, the need to thoroughly investigate the nature of data sources to be used in this study is crucial since it will help avoid mistakes such as the ones unveiled by Blacker (2007).

Verpoorten (2005) found that prior to the genocide the size of the Tutsi population was under-reported by about 40% at the national level. This meant there were about 837,100 Tutsi in Rwanda in 1991 instead of 596,400, as reported by the 1991 census. Assuming a non-genocide scenario, this number (837,100) would have increased to 913,600 Tutsi at the end of July 1994. The death toll was obtained by subtracting the estimated 150,000[11] Tutsi survivors from the Tutsi population as

[11] Local population data were used to estimate the average survival chance of Tutsi based on killing patterns in prefectures.

estimated in July 1994, 763,600 or (913,600 – 150,000). An additional issue here is that the number of survivors is also an estimate that bears errors. Due to the sensitive nature of the topic, there do not seem to be many critics or studies providing a different figure than the one obtained by Verpoorten.

Verpoorten supported her claim that, prior to 1994, the Tutsi population in Rwanda was underestimated, by comparing data from the 1991 census and records from the 1990 vital registration. Two hypotheses have been put forward to explain this finding. On the one hand, the paper found that, because of the ethnic quota policy[12] , the Hutu-led Rwandan government at that time had a motive to underreport the proportion of Tutsi in the population in order to increase the chances for the majority Hutu to access public services or offices. On the other hand, it is believed that some Tutsis registered as Hutu in order to avoid discrimination hence inflating the number of recorded Hutu to the detriment of the Tutsi (Verpoorten, 2005).

From Verpoorten's paper it can be implied that, combining and comparing between population registers at and census data, it is possible to depict useful details of potential differentials in the way specific components of demographic change can be affected by conflict. However, it has to be noted that Verpoorten's paper did not investigate issues related to potential limitations of both vital registrations and census data. It would have been insightful if Verpoorten's paper presented an assessment of the extent to which limitations related to issues such as recall events could have affected the data sources used in the estimation of Tutsi underreporting.

[12] A system where access to public services or responsibilities is regulated proportionally to the size of the ethnic group.

Verpoorten's work is important to this study since it has focussed on a country located geographically next to the eastern part of the DRC and the fact that some of the underlying causes of the conflict in Rwanda can also be paralleled to the DRC's case. This is mainly because the two conflicts seem to share some of the underlying causes with regards to ethnic tensions and the ties to the lands in that region.

2.3.3 Iraq

Burnham et al (2004), studied mortality before and after the 2003 invasion of Iraq. The study analysed the first of the two Lancet surveys on the effect of the 2003 invasion of Iraq and subsequent occupation, on the Iraqi mortality rate. The study divided Iraq into 33 regions or clusters, attempting to sample 30 households for each cluster. This resulted in 988 households selected with 7868 residents. The aim was to compare mortality during the period of 14.6 months preceding the invasion and 17.8 months after the invasion. The survey collected information related to household composition, the number of births and deaths since January 2002. In households reporting deaths, additional questions related to the date, cause, and circumstances of violent deaths were also recorded. Such questions allowed the study to assess relative risks of death associated to the 2003 invasion and occupation of Iraq.

Estimates gave the risk of death after the 2003 invasion to be 2.5 times higher with a confidence interval CI (1.6, 4.2) at a 95% significance level, when compared to the period before the invasion (Burnham et al. 2004, p. 1860). When data from the Fallujah cluster was excluded, the risk of death was only 1.5 times higher after the invasion with a CI (1.1, 2.3), in other words, estimates from the study show that there were 98,000 excess deaths after the invasion outside Fallujah, and even higher when data from the outlier Fallujah cluster was included in the model. According to the authors excluding the Falluja cluster was due to the fact that it was an extreme statistical outlier and interpreting results will be complicated when such outliers are included.

The Burnham et al. (2004) study selected a random main street within each cluster, then choose a random cross orthogonal street to this main street, before selecting a random household on the cross orthogonal street to start the interviewing process. Johnson et al. (2008), commenting on the Burnham et al paper, expressed the concern that cluster sampling methodology, as conducted in the case of Iraq, can introduce an unexpected, yet substantial, bias into the resulting estimates. This is because selected streets are a natural habitat for military or combatants' patrols, convoys, police stations, roadblocks, cafes, and street-markets. This bias comes about because residents from households on cross-streets to the main streets are more likely to be exposed to violence than those living further away. The Burnham et al. study also raised concerns related to the adequacy of the process used to obtain informed consent as well as doubts about formulation and translation of survey questions. This is important because not conforming to the ethic will be a breach to fundamental standards of science and undermine the credibility of the study. To this, one can add the argument about the non-random nature of the Iraq conflict (Kane, 2007).

The study on Iraq is evidence that the demography of conflicts and violence is coming to the fore and that complex and physically dangerous situations do not, always, prevent the collect and the analysis of demographic data. However, it is worth noting that whilst collecting such data is possible, there are still risks related to over or under recording certain entries as well as misreporting details of certain events. This is because, for instance, respondents had to remember whether the deceased person had lived in the household for more than two months before to be considered a household or simply due to various pressure or intimidation (Burnham, et al., 2004, p. 1859).

The study by Burnham et al. (2004) is useful to this research since some of the issues it raises can also be paralleled to the case of the DRC. For instance, in relation to the lack of data in Iraq during the conflict, the same can be said with the DRC conflict where despite the scarcity of data during the conflict period, it is possible to derive demographic estimates through indirect methods. However, as can be seen in the method chapter, deriving demographic estimates is not risk free since there are difficulties inherent to data quality as well as the lack of flexibility of certain methods.

2.3.4 Bosnia and Herzegovina

Tabeau & Bijak (2006) provides a critique of previous estimates of war-related deaths occurred during the 1992-1995 armed conflicts in Bosnia and Herzegovina for the purpose of war-crimes prosecution. Their assessment focussed on civilian victims whose death can be associated directly to the armed conflict. Unlike most of the assessment cases seen so far and to avoid mistakes made by previous estimations, Tabeau and Bijak method consisted of carefully analysing selected sources for individual records that allow to identify victims. Through this method, individual records were verified, duplicates eliminated and those overlapping between more than one source excluded.

Tabeau and Bijak final estimate of war-related deaths in Bosnia and Herzegovina is 102,622 victims including 55,261 civilians. This estimate is deemed credible but minimum since each individual casualty is counted only once regardless of the number of sources where they are mentioned. It can be said that this study leaves little room to innacuracy in its estimates however, due to the fact that any uncertain entry from any source has been systematically excluded, estimates presented in Tabeau and Bijak (2006) are either an undersestimation or an incomplete work. For this reason, further work focussing on matching new data sources or validating excluded entries will help improve estimate obtained so far.

2.4 Measuring demographic consequences of the DRC conflict

The current section looks at the only studies to have so far measured the demographic consequences of the recent conflict in the DRC.

A series of five surveys was conducted by the International Rescue Committee (IRC) from April 2000 to July 2007, to document rates and trends in mortality and provide recommendations for political and humanitarian interventions in relation to DRC conflict (Coghlan, et al., 2006). Surveys were conducted for 14,000 households, on average, in 35 Zone de Santé[13] across all eleven provinces of the DRC. Households

[13] The DRC Ministry of Public Health is structured into three levels: First central level, second intermediary level and third provincial or peripheral level. The health zones are located at the third level. The DRC has theoretically 515 health zones with 393 General hospitals and 8504 areas of primary health care. The third level is responsible of implementing primary health care strategies under the supervision of the intermediary level. Depending on the geographical size of the province, there are on average 47 Zone de Santé or Health Zones per province where the province with less health zones has 18 and the province with the most has 83 health zones (Ministère de la Santé Publique, 2010).

were selected according to their geographical distribution and the size of the Zone de Santé. Although the IRC survey's sampling and questionnaire methods changed over time, the basic method in all five surveys consisted of estimating the crude death rate (CDR).

The IRC divided the DRC territory into two strata following the military frontline in the year 2000. One stratum surveyed territory formerly held by rebel groups, hence covering big parts of Eastern DRC, and the other stratum surveyed the territory held by government forces, hence covering big parts of Western DRC. The IRC surveyed each stratum using three-stage household-based cluster sampling technique. The sample size was designed to detect differences in mortality between East and West strata since populations in the two strata were exposed to different security and health conditions (Coghlan, et al., 2009, pp. 2-3).

To estimate CDR, the IRC respondents were asked about the size and composition of their household, and whether there had been any deaths in the household, during a specified survey's recall period, which was equal to sixteen months for most surveys. The estimated CDR was then compared to the average CDR for Sub-Saharan Africa, which was 1.5 deaths per 1,000 population per month between 1998 and 2004 – used by the IRC as the baseline – and the difference assumed to constitute excess deaths associated with the 1998 – 2007 armed conflict (Coghlan, et al., 2009).

The IRC's mortality rates were expressed as deaths per 1,000 population per month. Assuming that the total number of children being born was equal to the number of children turning 5 years of age during the recall period, the IRC estimated a nationwide mortality rate at 5.00 under-five year old deaths per 1,000 population per month or 60 under-five year old deaths per 1,000 per year for the period 2006-2007. For the total population, the IRC found a national crude mortality rate of 2.1 deaths per 1,000 population per month (95% CI 1.6 – 2.6) or 25.1 per 1,000 per year (Coghlan, et al., 2009). According to the IRC, this mortality rate was greater by almost 40% than the average Sub-Saharan Africa regional level of 1.5 deaths per 1,000 population per month in 2004. This rate corresponded to 600,000 more deaths than would be expected during the 16 months recall period, or 38,000 excess deaths per month (Coghlan, et al., 2006, p. 46). Based on results generated by the five surveys, the IRC estimated that between August 1998 – considered as the start of the war – and April 2007, when the last survey was conducted, the cumulative death toll reached 5.4 million excess deaths (Coghlan, et al., 2009).

Although the IRC claims that the cumulative death toll reached 5.4 million, they did not explain how they extrapolated the recall period to the whole surveyed period. A different baseline crude mortality would have produced a different figure for excess deaths. Because the DRC's situation had been deteriorating rapidly since the late 1980s, it can be assumed that when living conditions are decreasing rapidly through general crisis mortality would have been increasing and that the sub-Saharan rate of 1.5 deaths per 1,000 per month would not have been an appropriate reference. This is because having a higher mortality baseline would have produced a lower excess mortality. For this reason, this study's approach is to have the DRC's own mortality rates as baseline and benchmarks rather than taking the average estimate of Sub-Saharan Africa as the reference.

The IRC's 5.4 million excess deaths are distributed as follow for the five surveys between 2000 and 2007:

Table 2.1 The IRC surveys for the period 1998 - 2007 in the DRC

Cumulative period	Recall period for survey	Conflict-related deaths in 1,000s	Cumulative Deaths in 1,000s
Aug 1998-Apr 2000	Jan 1999 to Median survey date	1,700	1,700
Aug 1998-Mar 2001	Christmas 1999 to March 2001	800	2,500
Aug 1998-Dec 2002	Jan 2002 to Median day of survey 2002	800	3,300
Aug 1998-Apr 2004	January 2003 to April 2004	600	3,900
Aug 1998-Apr 2007	January 2006 to April 2007	1,500	5,400
Total		**5,400**	

Source: Mortality from the conflict in the DRC 1998 - 2006 (Pedersen, 2009, p. 2)

In **Error! Reference source not found.** the first two surveys are relatively small independent but carried out in different locations in the east of the DRC and produced around 2.5 million excess deaths for the period 1998 - 2002. The remaining three surveys were nationwide and produced around 2.9 million excess deaths for the period 2002 – 2007.

The IRC's work on excess death has been the most, if not the only, prominent empirical study assessing demographic consequences associated with the armed conflict in the DRC. In this respect, the study has informed policy related to the DRC's recent armed conflict at many levels (UN Monusco, 2010). Despite the fact that the study has almost been adopted by many and its unwavering efforts to document such a complex issue, selected aspects of the IRC study are open to debate, hence offering an opportunity for further research.

In a report titled, "*The Shrinking Cost of War",* by the Simon Fraser University, the methods and subsequent results from the IRC work have been criticised. The report by the Simon Fraser University challenged, in particular, the use of retrospective surveys to determine wartime mortality rates as applied by the IRC to assess excess death in associated with the 1998 – 2004 armed conflict in the DRC (Human Security Report, 2011).

The Human Security Report claimed that even if some of the missteps found in the IRC work were ignored, other methodological errors led to large and unwarranted increases in the excess death estimates. Researchers from the Human Security Report Project corrected for a series of erroneous assumptions in one of the IRC's calculations, for the period covered by the first survey, the excess death toll declined by almost 60% going from 1.6 million to 678,600. The report highlighted, for instance, using a different pre-war mortality rate led the excess deaths estimate of some 2.5 million shrinks to less than 900,000 (Human Security Report, 2011).

Commenting on IRC's results, Andrew Mack, director of the Human Security Report Project, explained that he and his colleagues initially accepted IRC's results but slowly changed their minds. In a letter to the IRC and the Burnet Institute, which co-led and authored the final two surveys he said:

> *"Retrospective mortality surveys appeared to provide a logical answer to the [war-related deaths] measurement problem--we wrote admiringly about the IRC's work in the Congo in our 2005 report. But the more we looked the more insuperable the challenges appeared" (Science Insider, 2010).*

A joint response by the IRC and the Burnet Institute to the Human Security Report's critique, they maintained that the criticised limitations have already been acknowledged and widely discussed in the process of scientific peer review and at academic conferences with broad agreement that they do not invalidate findings.

It is worth noting that despite being critical of the IRC work, the Human Security Report Project did not provide its own estimate of what would have been the most accurate estimate of excess death in the DRC. In their report, they simply expressed the following:

> *"Our revision of the IRC's estimates reduces the excess death toll dramatically, but the revised data still show a large number of excess deaths (direct as well as indirect), which, given the deadliness of the conflict measured in terms of battle deaths, is not surprising… The accuracy of our revised estimate, which still relies on the IRC's survey data for overall mortality rates, is, however, impossible to determine." (Human Security Report, 2011, p. 131).*

In a similar effort to the IRC study, a team of Belgian demographers André Lambert and Louis Lohlé-Tart challenged the IRC's overall methods and findings (Lambert & Lohlé-Tart, 2008c).

Lambert and Lohlé-Tart (2008) challenged the IRC's report by pointing to the fact that the survey had focussed on the use of the average crude death rate (CDR) for Sub-Saharan Africa as a baseline to assess the excess death yet the DRC is not an average Sub-Saharan country. They substantiated their claim with the fact that their study assumed mortality rates in DRC to be uniformly high before, during, and after, the war. However, intermediate surveys (MICS and DHS) show that mortality level in the DRC has been changing between 1998 and 2007.

Lambert and Lohlé-Tart (2008) projected the 1984 DRC population, as recorded in the census, to year 2006 and matched it with the adult population as featuring on the voters' registration for the 2006 elections. The representativeness of the voter registers could be called into question, but since being on the voter register gave access to an ID card, this played as an incentive to have more people registering in a country where police harassment around identity is frequent. The matching process consisted of comparing the size, gender and age distribution between the projected adult population for the period of 1998–2005 and the voters' registration of 2006. They estimated the number of excess deaths to be 405,759 deaths. However, when they considered the fact that mortality during this period could not be distributed in the same way in the all parts of the country, the estimated number was revised to 222,762 deaths.

In the same way, looking at the evolution of life expectancy at birth in provinces not directly affected by war, Lambert and Lohlé-Tart found that there has been a decline in life expectancy at birth in all provinces. According to them this decline in life expectancy at birth was confirmed after comparing the projected population and the voters' registration at sub-national level (Lambert & Lohlé-Tart, 2008).

Lambert and Lohlé-Tart based most of their calculations and estimates on the 2005-2006 voters' registration data. However, one major problem with Lambert and Lohlé-Tart study is that they were unable to make this data source available so that others can assess their findings using the same dataset. Lambert and Lohlé-Tart have stated that they could not provide the dataset because the use is restricted because the Congolese electoral commission vetoed the publication of the electoral dataset.

Critics have noted that, while not disclosing the source of information can be justified on ethical or political grounds, but this was not acceptable on scientific grounds since no one can assess the genuineness and authenticate the source of such datasets (Checchi, 2009).

The other issue with the estimate is the fact that voters' registers only had data for persons aged 18 and above. In other words, the dataset only covers about half of the population and misses out children, who experienced considerably higher mortality rates than adults. Amongst many other weaknesses, it has to be noted that Lambert and Lohlé-Tart study provides no quantitative evidence to show that population coverage for the 2005-2006 voters' registers was high (Lambert & Lohlé-Tart, 2008a). In this respect, the voters' registration may not be a reliable dataset upon which to derive meaningful estimates related to particular components of population change. However, this cannot alter the validity of the study to the same extent as the availability of the data source.

The current study also looks at selected aspects of the IRC study related to the choice of the baseline mortality rate, the way the under-five mortality rate was derived, and the overall methodology to suggest another approach to be explored in the method chapter.

Firstly, in relation to the baseline mortality rate, the IRC used the sub-Saharan African average of 1.5 deaths per 1,000 per month between 1998 and 2004 as its baseline mortality rate. For the IRC, this Sub-Saharan mortality rate was conservative, since the DRC government's own mortality rate was estimated at 1.3 per 1000 per month by the 1984 census and that UNICEF estimated the same mortality rate, for the same period, to be rate at 1.2 per 1,000 per month rate for the same period (Coghlan, et al., 2009, p. 2). The current study argues that the DRC is not an average Sub-Saharan African country. For this reason, the current study intends to derive DRC's own demographic estimates though direct and indirect techniques to set baseline population as well as benchmark points where population projections will be corrected.

Secondly, concerning child mortality, the IRC based its calculation of child mortality on a nationwide child mortality rate of 5 under-five deaths per 1,000 per month. However, other sources, for instance, the 2007 Demographic and Health Survey (DHS) estimated this, over a five year span, at 2.46 deaths per 1,000 per month, which is almost half the IRC's estimate of 5 deaths per 1000 per month (Ministère du Plan & Ministère de la Santé, 2008). Although it can be said that the DHS estimate is not a gold standard, due to the big difference between the two rates, one would want to find out more why this difference and if it is possible to pick only the best one or reconcile the two. The current study intends to overcome this problem by benchmarking its projections using various data sources and allowing a range of plausible estimates including age specific mortality, fertility schedules and migration for the considered period; more on the methods.

Thirdly, for the methodology, two out of the five surveys conducted by the IRC only covered war-affected parts of the DRC then extrapolating findings from these areas to the rest of the country. The three subsequent surveys were nation-wide (Coghlan, et al., 2009, p. 2). This complicates the comparison of demographic estimates from war affected areas over time, since it is known that the conflict did not have the same intensity in all parts of the country (Turner, 2007).

Existing studies listed above inform the current research to a great extent. This is the case, for instance, with the IRC study which sets the path through which the presented research on the DRC conflict follows. In the same way, Lambert and Lohlé-Tart study sets out an interesting approach, despite its lack of available evidence. In this respect, these two studies offer an opportunity to take further the assessment of the impact recent armed conflict in DRC may have had on population change in the DRC.

Summary of Chapter 2

From the literature reviewed in the current chapter three main methods of investigating demographic of armed conflicts have come to light. These methods include retrospective mortality surveys (Burnham, Roberts, Lafta, Garfield, & Khudhairi, 2004), population projection (Heuveline, 1998) and matching death records from various sources (Tabeau & Bijak, 2006). As seen in this chapter, each of the above mentioned methods has its strengths as well as weaknesses.

Looking at retrospective mortality survey, Chapter 2 has shown that the main strength of retrospective mortality surveys is linked to the fact that they seem to be the only viable alternative when other demographic data needed to benchmark population projections are not available. In the same way, in situations where there is a lack of regular data points needed to benchmark population projections or constitute a source upon which to match death records, retrospective mortality survey offers the best alternative since it can reconstitute mortality patterns based on answers provided by respondents. However, retrospective mortality survey has weaknesses when it comes to assessing the impact of armed conflict on other components of population change. Retrospective mortality survey does not account for impact on fertility or migration. In this respect, this method only offer an answer to one instead of three components of population change. Sampling is another weakness that has the potential to complicate the assessment of war-related excess death. This is because, armed conflict do not necessarily affect the whole country or area of the country in the same way and over the whole period of the conflict. Based on the fact that the three components of population change are interlinked due to the fact that changes in one component can have consequences in the other two components, it will be incomplete to limit the assessment of demographic consequences of armed conflict to mortality alone.

The method consisting of matching records of war-related deaths to various sources has proven very useful in cases where it constituted expert contribution to the prosecution. One of the strength of this method is that it can provide evidence of war-related excess deaths beyond any doubt and this is vital for cases brought to tribunals. However, it has to be noted that in countries such as the DRC where the culture of keeping demographic data is not well implemented or indeed any country affected by armed conflicts and that certain demographic data are either destroyed or intentionally manipulated, it can be difficult to find enough sources needed to constitute a strong evidence basis. Another major weakness with the matching method is linked to the cost and time needed to identify, acquire and then analyse the various sources. In this respect, such method is expensive, time consuming and exposed to the risk of not constituting a strong enough basis upon which to rest a prosecution case.

Population projections are a viable alternative to the above two methods. This is because the method is flexible and may in some cases need only two data points in time upon which to conduct a forward and backward population projection and assess the difference between the two. This method has therefore, the advantage of being not expensive and when the analytic framework is ready it is possible to assess not only war-related mortality or excess deaths. The method allows assessing war-related consequences on all three components of population change. Furthermore, the assessment can be disaggregated by sex, age and area. There are weaknesses linked to population projections. This is the case, for instance, of cases when data points are scarce hence complicating the framing of counterfactual assumptions. In the same way, as seen in the selected studies presented above, the definition of certain variables may change over time and when benchmarking two data points it is possible to miss out certain aspect of the data or variables due to a change in the definition over time. in other words, it is possible to not compare like for like when conducting a population projection over two points in time that are not close enough.

Chapter 2 shows that at the same time as defining armed conflict seems to be a problem under existing laws and conventions, there is a further problem about measuring the actual extent and scope of population loss associated with violence and armed conflict. Such problem can be linked to the various methods. Therefore, it can be submitted that demography can contribute to the effort of setting a comprehensive framework upon which both the definition of armed conflicts and the enumeration of conflict related impact on population change can be assessed.

Reflecting from the discussion developed in Chapter 2, the current study is able to contribute to the debate on how to generate most reliable methods needed to assess the impact of armed conflict on all three components of population change based on the dynamics of a given conflict. The impacts would be significant on a variety of factors including: excess mortality as both a direct and indirect consequence of fighting, fertility decline as a consequence of migration and separation, increase in female-headed households as a consequence of male going to battle or not returning, forced migration, a rise in internally displaced persons, to name but a few. However, the choice on a suitable method would mainly depend on its cost, the time and data needed for the assessment. On the balance of the strengths and weaknesses of each of the methods seen in the cases presented above, the current study suggests the use of population projection as the main methods. More justifications for this choice are provided in Chapter 4 where more details on the methodology are provided. Before then, the following Chapter 3 gives the evolution and chronology of the DRC armed conflict. Reflecting from the background, Chapter 3 offers a discussion of different phases of the armed conflict and how demographic impacts on all three components of population change can be hypothesised to vary according to these phases.

Chapter 3 Background to the DRC armed conflict

Introduction to Chapter 3

As a country the DRC is located in the central African region. With a national territory covering 2.3 million Km^2, the size of the DRC is four times the size of France and eighty times the size of Belgium, the former colonial power (MONUC, 2009) with an estimated population size of around 70 million in 2013.

The historical course of the DRC has its long paths and its short ones; it has its continuities and its interruptions, its dynamics and its recurrences and in the current chapter the aim is to give a comprehensive account of selected dates, actors and events which have influenced the history of the country and probably affected its population dynamics. For Ndaywel (1998), up to the 1990s, the historical course of the DRC can be summarised in three key periods including: the pre-colonial period, the colonial period and the post-colonial period. For clarity, the post-colonial period has been divided into two main parts where the broader political developments and the course of the studied armed conflict are explored. Therefore, this study has divided the historical course of the DRC in the following way:

- The pre-colonial period going from 1483 to the mid-1880s
- The colonial period going from the mid-1880s to the early 1960s
- The post-colonial period going from the early 1960s to the early 2010s
    - The Mobutu regime going from the early 1960s to the mid-1990s
    - The recent period going from mid-1990s to now as of early 2010s.

The above-mentioned periods can all be linked to recurring episodes of armed conflicts, violence, political struggles and many other crises which have the potential to affect population change both in the short and the long term. In the current study, analyses on population change as a consequence of armed conflict are based on the recent period starting from the early 1990s to the early 2010s.

This chapter's main aim is to provide a chronological synopsis on the context in which key events related to both, the country and the armed conflict, have occurred and their potential to affect population change. In this respect, the chapter is divided into three main parts of equal importance. The first part gives a succinct historical overview of the period going from as far back as the late 15th Century to the mid-1990s when the Mobutu regime was overthrown. The second part looks at the period going from the mid-1990s when the studied conflict started to more recent developments, as of year 2011. The last part presents a summary and evaluation of the above mentioned two parts.

3.1 Historical overview

Starting from the pre-colonial period, in 1483, a Portuguese naval captain named Diogo Cão set off to sail close to the west coast of Africa. He ended up further south, discovered the Congo River's mouth into the Atlantic Ocean and baptised it Zaïre. The encounter between the Portuguese expeditions and the people of the Kongo Kingdom – mainly composed of the Congo basin's riverside populace – was based on good political relations that led to the first evangelisation of African people and the introduction of schools in the capital of Kongo, Mbanza Kongo, which in year 1596 became São Salvador (Hochschild, 1998). It was around the 17th Century, when the

Portuguese abandoned what was then known as Kongo, that the country started to lose its pre-colonial configuration. Soon after the Portuguese left what was then known as the Kongo kingdom started to disintegrate, alongside other prominent political entities located in the Congo basin region. Such political entities included the Luba, Kuba, Lunda, Azandé and Mangbetu, to name just a few. All of these entities weakened progressively due to slavery campaigns and the destabilisation prompted by the European colonisation which followed up (Kanyarwunga, 2007). Up until the 19^{th} century the complete length of the Congo River and most of what is now known as the territory of the DRC were still not well known by Europeans and indeed the rest of the world.

It is only when British expeditions funded by the Royal Geographic Society became attracted by this part of Africa that interest in the Congo started to grow. This was seen from 1852 to 1873 in reports by the Anglican humanist Dr David Livingstone. These reports and those from other explorers who travelled the Congo from West to East and from North to South attracted more media attention. It was because of his growing interest in commerce and his ambitions to possess a private preserve in Africa that, in 1865, the Belgian King Leopold II sought the services of the Welsh explorer Henry Morton Stanley to find out more about the vast territory at the heart of Africa (Hochschild, 1998, pp. 61-74; Kanyarwunga, 2007).

During the colonial period, the DRC was established in its current geographical borders during the Berlin Conference of 1884–1885, an international meeting aimed at settling disputes related to European colonies in Africa (Hochschild, 1998). At the conference, the geographical space representing most parts of the current territory of the DRC was first called Etat Indépendant du Congo (EIC), in French, translated as the Congo Free State in English (Hochschild, 1998). According to its constitutive status, the country was administered as a private preserve of Léopold II, the Belgian King (Shapiro & Tambashe, 2003). In 1908, under growing international pressure due to many abuses related to the rubber trade, King Léopold II ceded the Congo Free State to the government of Belgium and from that point the country became known as the Belgian Congo. The Belgian government administered the country as its colony until 1960 when the country obtained its independence (Hochschild, 1998).

The post-colonial period began on 30 June 1960 when the DRC obtained its independence. This date also marks the start of the first republic which was politically autonomous and called République Démocratique du Congo in French, translated as the Democratic Republic of Congo (DRC) in English. However, only a few months after independence was proclaimed, the DRC was confronted with several political crises. Claiming to want federalism in the country, some provinces started secession wars in order to claim autonomy (Shapiro and Tambashe 2003, p. 13).

The early 1960s period is associated with personalities such as Patrice Lumumba, the first Congolese prime minister; Joseph Kasavubu, the first Congolese president or Joseph Mobutu Sese Seko, the army officer who deposed both Lumumba and Kasavubu through a military coup. In January 1961, following a political crisis, P. Lumumba was arrested and then assassinated. Despite various efforts from the UN to help the Congolese state, profound divisions within the central government weakened the state and led, in November 1965, to another military coup headed by an army Colonel Joseph Mobutu Sese Seko (De Witte, 2000; De Witte, Wright, & Wright, 2002, p. 25).

3.2 Recent developments

What is now known as the DRC has changed its name several times from the pre-colonial period to as recently as 1997. After Mobutu consolidated his power in the early 1970s, he renamed the country the Republic of Zaïre, and signed a decree making it compulsory for each citizen to adopt an authentic African name (Nzongola-Ntalaja, 2002).

The end of the cold war in the 1990s and the perestroika[14] wave in the former Soviet bloc shook dictatorial regimes around the world and prompted democratisation processes in many countries, including the DRC. In 1990, there was a growing tension in the country with the population wanting more political reform and an improvement in their living conditions. In order to contain popular aspirations the Mobutu regime decided to establish political pluralism for the first time since he took power in the mid-1960s. However, the democratisation process did not quite materialise in the way many could have anticipated. The promised process went through a series of transition governments without delivering the changes the population was hoping for and allowing the Mobutu regime to cling on to power for another seven years. In 1997, the Mobutu regime was toppled by the rebels led by Laurent Desire Kabila and his allies, changing the constitution and hence the name of the country from Zaïre to the Democratic Republic of Congo.

[14] Starting with the opening up of the ex-USSR under Gorbachev, Perestroika meant overcoming the stagnation process, breaking down the braking mechanism, creating a dependable and effective mechanism for acceleration of social and economic progress and giving it greater dynamism. (Gorbachev, 1987; as cited in Kishlansky, 2001).

Amongst many other changes provoked by the perestroika wave, the most important was the fact that the importance of the DRC as a strategic ally of the West in the Central Africa region during the cold war, diminished significantly as a result. From the early years of the 1990s, the support the Mobutu regime benefited from western countries such as the United States, France and Belgium became almost insignificant, leading to the decay of the regime and later to its complete collapse (Nzongola-Ntalaja, 2002, pp. 141–213).

From the early 1990s the DRC went through a state of complete decay coupled with devastating events such as the 1992 and 1993 mass looting that dismantled and destroyed most of the country's economic infrastructure. Nationwide and systematic lootings were prompted by months of unpaid wages to members of the armed forces, the police and civil servants. With these entities being the biggest source of income for most households in urban areas, the situation culminated with mass lootings often started by members of the army or the police with civilians following behind. These pillages were widespread and did not spare any area of economic activity. The impact on the economic situation was so devastating that it hastened the collapse of not only the national economy but also the state as the main provider of public services and security from the mid-1990s.

Adding to this was the mass influx in eastern Congo, more specifically in the province of Nord Kivu neighbouring Rwanda, of an estimated 1.2 million (Human Rights Watch, 1996) refugees fleeing armed conflict in Rwanda that culminated in what is now known as the 1994 genocide. This situation led to a sharp rise in social and political tensions and the deterioration of the security situation that saw, in May 1997, a rebel group led by Laurent Désiré Kabila oust the weakened Mobutu regime.

Kabila took power with the help of his allies, mainly Rwanda and Uganda, grouped into an alliance known as AFDL[15] from 1997. However, in August 1998, almost two years into the alliance and one year after the Mobutu regime was removed, Kabila fell out with his allies and the war between L D Kabila's regime and several rebel groups (backed militarily by Rwanda and Uganda) started. The war saw around seven foreign armies intervening directly or indirectly in the conflict. Some of these countries sided with the rebel groups and others with the government led by L D Kabila. In January 2001 Laurent Désiré Kabila was assassinated by one of his bodyguard and his son Joseph Kabila became the new president; he tasked himself with ending the conflict (Nzongola-Ntalaja, 2002). The circumstances surrounding the death of L D Kabila were unclear back in 2001 and the trial on the case is still open.

From what has been said above, it is worth noting that the war started in 1998 after the fall out between AFDL allies, and the subsequent excess population loss linked to it are the main focus of the assessment conducted in the current study.

Despite the fact that the DRC is not new to violence and armed conflicts, the nature and reasons of violence and armed conflict that have happened in the country have changed over time. If in the past, say from the colonial rule to the dictatorship under the Mobutu regime, armed conflicts in the DRC were mainly sparked by internal

[15] *Alliance des Forces Démocratiques pour la Libération du Congo* : Alliance of Democratic Forces for the Liberation of Congo

civilian unrests followed by violent repressions from the authorities, more recent conflicts[16] are of a different nature. Recent conflicts in the DRC have seen the intervention of regional actors and entities. Before looking at the timeline of the most recent armed conflict, it is important to consider, succinctly, the understanding the current study has on the origin of the armed conflict. The origin of the most recent conflicts in the DRC can be articulated around at least three main layers deployed in a local context which is in itself quite complex. The three layers are equally important, they overlap and mutually reinforce one another; but, none of them can be substituted or reduced to any of the other ones.

3.2.1 Causes of the studied armed conflict

It has to be noted that the current study is not intended to address the questions linked to demographic causes of the DRC conflict. In the current study the main focus is on the demographic consequences of the armed conflict on components of population change and more specifically on excess population loss. However, to provide a context for the studied demographic consequences it seemed important for this study to present briefly its take on the causes or origins of the studied conflict.

To go back to the above-mentioned three layers around which the DRC armed conflict can be articulated, it can be said that there are many theories trying to depict the origin of the current armed conflict in the DRC. First, some have argued that the prominence of the DRC's mineral resources is the main cause of the current conflict and that the presence of mineral resources led to a conspiracy, by some

[16] Conflicts seen from the mid-1990s

multinationals and their allies, to divide the country into small areas to facilitate the plunder of its mineral resources. Second, others think state failure and the inability of the DRC central government to provide basic services and security to the population is the main cause of the armed conflict. Finally, some others think the spill-over of the Rwandan conflict is the main cause of the conflict (Turner, 2007; Prunier, 2009; Stearns, 2011). As far as this study is concerned, the three layers around which the recent conflict can be articulated can be summarised in the following way:

First, the dismantling of the Congolese state started in the early 1960s right after the independence culminated into a situation of general crisis observed in recent years. Only a few months after the independence, the country fell into a deep institutional crisis that saw the government, the presidency and the army undermining one another. This situation got worse with the country becoming a chess piece in the cold war. In this respect, major players in the cold war preferred a political system in the DRC that was less democratic or accountable to its citizens to a system where the role of the country in the region could be scrutinised by democratically elected institutions. As a result, a crisis of legitimacy ruined the state, and institutions and public mandates started to be considered as a tool for personal enrichment. The absence of legitimate instruments of a state to impose the rule of law rendered it unable to protect its citizens and to maintain conditions for sustainable peace both in the country and in the region.

Second, the 1994 armed conflict and the ensuing genocide in Rwanda spread to the DRC. This followed the threat posed by elements from the defeated government, also known as the Forces *Démocratiques de Libération du Rwanda* (FDLR), as they regrouped inside refugee camps in the DRC and organised deadly incursions into Rwanda to kill and terrorise civilians. The intervention by the new Rwandan government and its allies, the governments of Uganda and Burundi, plus the Congolese rebels led by Laurent Kabila, culminated in the fall of the Mobutu regime. Despite the intervention of the allies who toppled Mobutu, the FDLR's presence in eastern DRC was not completely finished.

To this day, the FDLR continues to be a threat to stability in the region although its ability to cause nuisance has diminished significantly over the years. Since the fall out between the allies who toppled Mobutu, the Rwandan military has maintained a proxy presence through the support of armed groups led by Congolese Tutsi in east DRC. Such groups include the RCD[17] 2002–2006; CNDP[18] 2006–2009 and more recently the M23 also known as the March 23 2009 movement[19], which has been active from 2012 to date. More details on the different changes observed in the Rwandan-backed armed groups in the DRC are well documented by the United Nations group of experts, whose main mission is to investigate and report to the United Nations Security Council any violation of the UN's regime of sanctions on the DRC (UN Security Council, 2004a). The continued presence of armed groups with ties to Rwanda on the DRC soil has had a significant impact on the armed conflict as well as the fate of millions of Congolese.

---

[17] Rassemblement Congolais pour la Démocratie. A rebel movement backed by rwanda created to look after the interests of Congolese Tutsis and Rwanda amid a post-election loss of influence in the region.

[18] Congrès national pour la défense du peuple. A political armed militia led by Laurent Nkunda that inherited the RCD's legacy as this one failed to establish itself as a political entity through the 2006 elections.

[19] This is another armed group that inherited both the RCD and the CNDP military structure and ideology although with a different leader.

Third, the mineral richness of the DRC’s soil has also played a role in exacerbating the struggle and the ensuing violence and armed conflicts in this country. This situation started in the colonial period and continues to be the case to this day. During the colonial period most of the revenue from the exploitation of natural resources benefited the Belgian king Leopold the Second and his kingdom. During the Mobutu regime, revenues from the exploitation of natural resources escaped the control of the state as these were channelled through parallel structures directly controlled by the Mobutu regime. More recently, resources from war affected areas are not only exploited illegally but also channelled through outside networks, having both Kigali and Uganda as delivery points. The competition to control mineral trade in eastern DRC may not be the unique cause of the continued armed conflict but it constitutes, to a great extent, one of the important layers.

As can be seen, it is not an easy task to provide a simple answer to the question regarding the cause of the more recent conflict in the DRC. The answer provided by this study is that as above-mentioned, the three layers interweave on top of a complex situation involving complex relationships between local and regional communities. The same thing can be said with the presence of rather disparate demographic realities where some countries have a significant demographic pressure whilst others are experiencing the opposite effect. Yet, these countries are in the same region with porous borders sometimes separated by only a few yards, if not less. To keep to the main topic on consequences of conflict on population change, events around armed groups linked to Rwanda are explored further due to their link to population loss.

3.2.2 Link between more recent conflict and population loss

From what has been said above, it can be argued that recent violence in DRC could be expected but no one could predict with certainty what its consequences on population change are going to be. It can be said that past experience of brutal repressions have changed the way the Congolese population participates in violent confrontations. In the same way, it can be said that recent violence and armed conflicts can be perceived as being imposed upon a defenceless Congolese population with dear demographic consequences (Ndaywel, 1998).

A few examples can be taken from recent events to show how the population in war affected areas have been passive victims of warring factions. In February 2002 the Rwandan and Ugandan armies fought with extreme violence on Congolese soil, in Province Orientale, Kisangani, causing severe direct and collateral damages to both the population and the environment. Reports have mentioned hundreds of civilian killed as a consequence of the fighting (Turner, 2007). The city of Kisangani in Province Orientale is the third largest city of the DRC with a total population estimated at 317,000 in 1984 and a population density of 166/km^2. Province Orientale as a region is home to a wealth of natural resources including timber, gold, and diamonds to name but a few. Taking into account population density and growth rate between 1984 and 2002, it can be seen that the fierce fighting between the two foreign armies, far from any Congolese protection and far from any media had the potential to cause significant human losses amongst civilians.

It is in this context that both Rwanda and Uganda found and armed local tribes – the Lendu (backed by Rwanda) had a political movement called *Front national* *d'Integration* (FNI) and the Hema (backed by Uganda) had a political movement called *Union des Patriotes Congolais* (UPC) – inside the DRC with whom they shared ethnic ties. These new allies were backed militarily by the two countries respectively to exert influence, and also to control mineral areas and forests where timber is exploited in Province Orientale on behalf of these two countries. This situation led to further violence and the escalation of armed conflicts of ethnic nature within this region. These alliances with local or regional forces were also made at the level of provinces where Rwanda backed the RCD-Goma and Uganda backed the RCD-K. More on these alliances is further explored in the relevant section. Thomas Lubanga, one of the leaders of a local militia backed by Uganda, is now serving a sentence at The Hague after he was convicted of serious human rights abuses dated from the period he was allied with one of the above mentioned countries (Coalition for the International Criminal Court, 2013).

Another example is the case of gender-based violence where sexual violence is used as a weapon of war not only against adult women but also on children as young as two, the elderly and even men (Panzi Hospital, 2013). In many cases of sexual violence, genital organs of the victims are mutilated or injured with metals or guns carried by the aggressors, hence compromising their chances of reproducing in the future (UN Human Rights, 2008-2009).

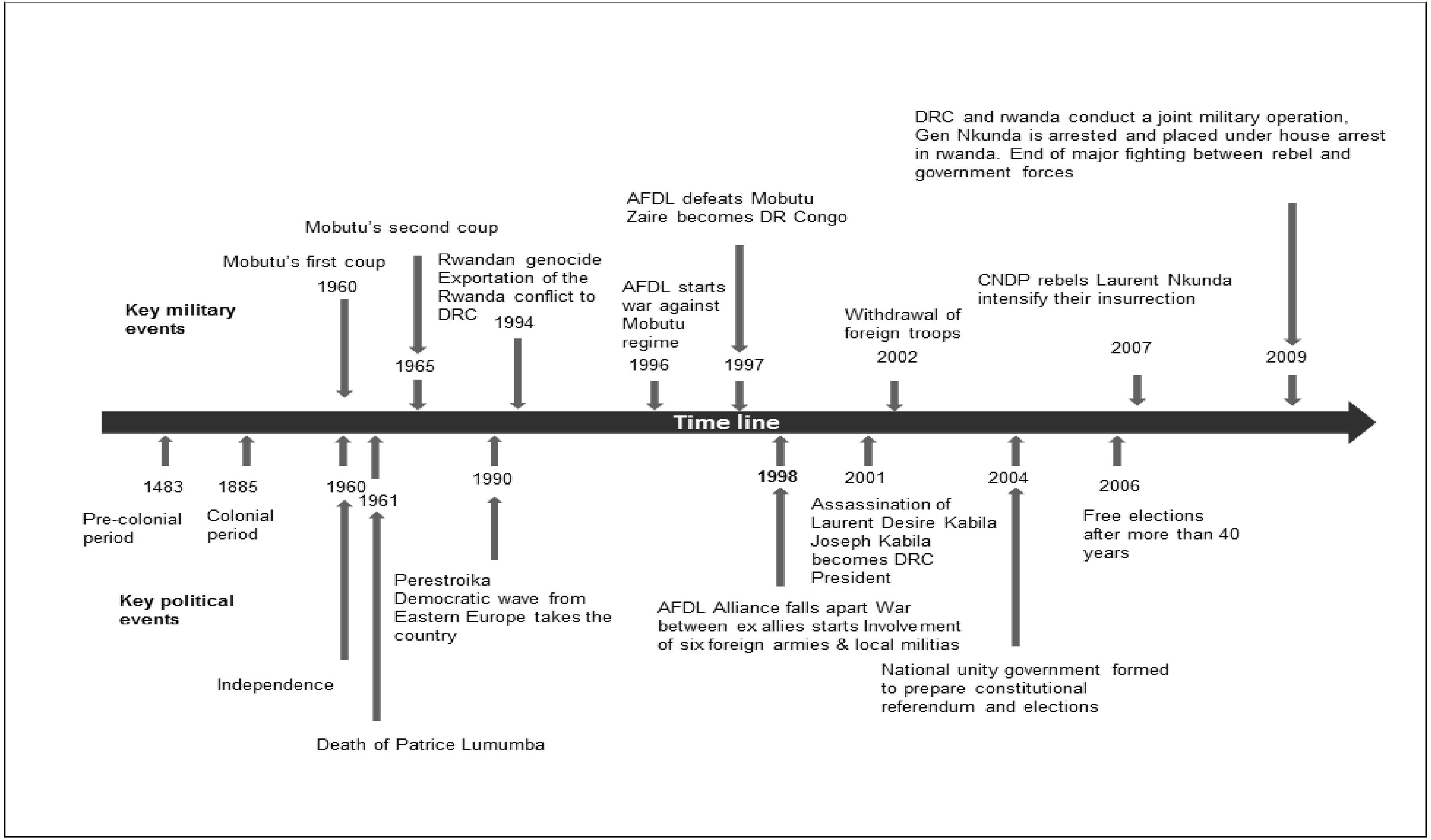
Acts of extreme violence against defenceless civilians are widespread in war-affected areas in the DRC and the cases presented above are far below the actual scale of all violence reported. The level of brutality in which some of the acts presented above are carried out can help predict the trend of the actual human cost associated with the armed conflict in the DRC. It has been claimed that recent or post-1990 armed conflicts in this country have caused unprecedented humanitarian catastrophes and excess death toll (Coghlan, et al., 2006). Most reports on these serious human rights abuses and losses do not offer a quantitative assessment of the demographic consequences. It is in this respect that the study intends to assess the extent of population loss associated with armed conflict using a much more quantitative and systematic approach.

3.3 Chronology of the conflict

The diagram in Figure 3.1, below, gives a succinct chronology to help locate the studied armed conflict among DRC's key events with the potential to affect population change.

It can be seen in Figure 3.1 that throughout its history the DRC has been confronted with events which have the potential to significantly affect population change. This is mainly due to the fact that these events have often been accompanied by severe violence to civilians and the deterioration of living conditions. Some of these events may not have a direct impact on population change the day they happen and the lack of reliable population data and studies in the DRC has made it difficult to keep track of change in the population. The following sub-sections look at selected events marking the armed conflict from 1994 to as recently as 2011. These events were selected based on their potential to affect population change both immediately when they occur, and in the future.

Figure 3.1 Chronology of DRC key events



3.3.1 Spill-over of the Rwandan conflict

It is in a context of a generalised crisis in the DRC that the death, in 1994, of the then Rwandan President Juvenal Habyarimana and the ensuing genocide that the situation in the DRC took a turn for the worse (Turner, 2007; Prunier, 2009).

In the aftermath of the genocide, on 4th July 1994 Tutsi rebels from the *Front Populaire Rwandais* (FPR) or the Rwandan Popular Front captured Kigali, the capital city of Rwanda, sending an estimated millions, mainly Hutu Rwandans, into exile. The biggest proportion of those fleeing, or an estimated[20] 1.2 million people, crossed the border into the neighbouring DRC's provinces of Nord-Kivu and Sud-Kivu. This situation led the French government to launch a two month humanitarian mission called Opération Turquoise[21] with mostly French troops and additional troops from several African states. This operation established a safe humanitarian zone in south-west Rwanda. It was a rapid and forceful military intervention which, according to some, whatever its motivation, had humanitarian benefits. It stemmed the flow of refugees to the DRC, then known as Zaïre, thus saving many lives, given the crisis conditions which prevailed in Rwanda and the region at that time (Landgren, 1995).

Once in the refugee camps inside the DRC, the FDLR and other Rwandan Hutu extremists found in refugee camps very quickly came to constitute a threat to the new regime in Rwanda led by Paul Kagame. The threat posed by those who fled Rwanda gave place to new tensions in the region leaving the DRC more vulnerable

[20] These figures were taken from (Human Rights Watch, 1996). However, it is unclear how these figures were estimated.

[21] A French-led military operation in Rwanda in 1994 under the mandate of the United Nations; see, UN Resolution 929, voted at the U N Security Council on 22nd June 1994 (UN Security Council, 1994).

to armed confrontations (Turner, 2007). In fact, from late April 1994 to early 1996, the defeated Rwandan Armed Forces (FAR) and its political leadership whose majority has been accused of having committed the genocide were hiding among genuine refugees in camps inside the DRC. This was possible because the Zaïrean Armed Forces, the border control agencies and the police were inefficient and could not cope with the sudden influx of thousands of refugees, some of them armed. This situation allowed dangerous and armed individuals eager for revenge to cross the border unchallenged and hide among other vulnerable Rwandan refugees.

The lack of efficient supervision by both the Zairean authorities and the international organisations in charge of refugees allowed those from the defeated regime to start reorganise and mount deadly cross-border raids into Rwanda during late 1995 and early 1996. This situation posed a major threat to Rwanda and consequently led to a build-up of the 1996 war that saw the end of the Mobutu regime in 1997 (Prunier, 1997, p. 196).

On 13th October 1996 in Uvira, a city located at the north shore of Lake Tanganyika in the DRC Province of Sud-Kivu, Congolese Tutsis backed by Rwanda, Uganda and Burundi started a rebel movement against the DRC government; Zaïre at that time. Soon the rebel movement joined forces with other opponents to Mobutu’s regime and formed the *Alliance des Forces Démocratique pour la Libération* (AFDL) with Laurent-Désiré Kabila as leader (Turner, 2007). This alliance resulted from the fact that, faced with the threat caused by the FDLR hiding inside refugee camps in the DRC, the Rwandan regime and its allies wanted an excuse to enter the DRC and deal with the threat. In order to enter the DRC without alerting the international community or being accused of violating the territorial integrity of the DRC, Rwanda and its allies needed a Congolese armed group that was hostile to the government in Kinshasa, which in their eyes was harbouring the FDLR. This is the reason why Laurent Kabila, who had been an opponent to the Mobutu regime since the early 1960s, was seen as a solution to this problem. So these two became allies; although they had two different agendas, their objectives reinforced one another.

In November and December 1996, the alliance dismantled refugee camps in the Kivu Province as these were believed to be infiltrated by ex-Rwandan Armed Forces and extremists Hutu militias. This episode was a humanitarian disaster for thousands of genuine refugees, including many women and children (Turner, 2007).

On 2nd of March 1997, the alliance forces seized a vast refugee camp called *Tingi Tingi* in the city of Kindu, province of Maniema, forcing around 120,000 Rwandan refugees to flee either deep inside the Congolese forest, or mix with the local population. There were also reports of many casualties among them (Turner, 2007; Prunier, 2009).

From February to April 1997, the AFDL movement gained momentum, crushing the Zaïrean Armed Forces (FAZ) on almost every front, and hence controlling, by April 1997, almost the two thirds of the country (Turner, 2007). On the night of 16th to 17th of May 1997, the Alliance forces seized Kinshasa, the DRC's capital city, leading Laurent-Désiré Kabila to declare himself the President of the DRC. Laurent-Désiré Kabila changed the country's name from Zaïre to the Democratic Republic of the Congo. The ex-President Mobutu was forced into exile only a day before the rebel movement led by Laurent-Désiré Kabila entered Kinshasa (Turner, 2007).

The AFDL fought its way through Congo from the East to the West, ending in a victory that saw the end of 30 years of dictatorship reign by Mobutu and his regime. Despite that, it is suggested that this military operation was easy to achieve, and did not cause a significant loss of population. This is because the conflict is said to have been characterised by the surrender of the disintegrated Zaïrean Armed Forces and any other military formations that remained loyal to Mobutu (Turner, 2007; Prunier, 2009). In other words, it has been expressed that, despite the fact that fighters travelled from one end of the country to the other between 1996 and 1997, the war did not cause significant excess deaths amongst civilians but caused mainly minimal disorganisation (Lambert & Lohlé-Tart, 2008b). It is worth noting that these interpretations of what may have been the actual extent of excess population loss for the period 1996–1997 has never been, as far as this study is aware, researched empirically. For this reason, maximum caution is required when drawing conclusions about the actual extent of excess population loss due to the war that toppled the Mobutu regime for the period 1996–1997.

3.3.2 End of the Alliance: war between ex-allies

The year 1998 marks the start of the latest armed conflict in DRC following the quarrel between the AFDL allies. Thus, the hostile end of the alliance that helped Laurent-Désiré Kabila take power in DRC marked the beginning of the latest war in the DRC. It has to be noted that armed conflicts such as the one in the DRC may change their nature and focus over time and space. In this way, the conflict in the DRC has been categorised and interpreted differently by different actors or institutions. The interpretation of this conflict has shifted from categorising it as a civil war, to an international war, a war of occupation, a rebellion; to name but a few. This was done both in the perspective of international humanitarian law and the subjective understanding of the various parties involved (Vité, 2009). The end of the alliance unfolded as explained below.

In mid-July 1998, Laurent-Désiré Kabila dismissed the Chief of Army Staff for the Congolese Armed Forces – the Rwandan General James Kabarebe – who also was overseeing the country's security services and military intelligence. It was on the 27 July 1998 that Laurent-Désiré Kabila publicly announced the end of the alliance, hence putting an end to the Rwandan military presence which helped him topple Mobutu's 32 year-long dictatorship (Turner, 2007). Laurent-Desire Kabila turned on his Rwandan allies, accusing them of trying to control everything in the DRC. This control went from the security sector to the nomination of officials in Congolese institutions and public companies. This could be seen by the share of influential positions held by people of Rwandan descent or those supported by the Rwandan or Ugandan regimes.

On 2nd August 1998, one day after Laurent Kabila officially called off the alliance, a new rebel movement supported by Rwanda started in Kivu and attacked major cities in Eastern Congo. To resist the attack by his ex-allies and protect his power, Laurent-Désiré Kabila turned this time to Angola, Zimbabwe, Namibia, and Chad for military support, which he obtained. By 6th August 1998, the new rebel movement, named *Rassemblement Congolais pour la Démocratie (RCD):* Congolese Rally for Democracy controlled all major cities such as Goma, Uvira and Bukavu in the Great

Kivu[22] region. By 28th August, rebels captured Kisangani[23] (Spittaels & Hilgert, 2010). By the end of that August, new armed groups formed by local militias started to emerge in the east part of DRC (International Crisis Group, 1998). Some of those justified their presence because they wanted to oppose the new rebel movement which they accused of defending Rwandan and Ugandan interests in DRC. Some others were allegedly backed by Rwanda and Uganda (Turner, 2007; BBC, 2001).

On 6th November 1998, Rwanda acknowledged its military support for the Congolese rebels and its military presence in certain eastern DRC territories. On 17th May 1999 the RCD split into two groups. As seen earlier, one of the groups was backed by Rwanda and the other one by Uganda. This split was soon punctuated by fighting between Rwanda and Uganda on DRC soil for the control of Kisangani and other parts of North-East DRC rich in timber, gold and diamond. Between 14th and 17th August 1999 the dispute between Rwanda and Uganda to control Kisangani led to severe armed clashes killing and injuring hundreds of Congolese civilians (Turner, 2007). At this point it seems both Rwanda and Uganda thought they were betrayed by Laurent Kabila as he called the alliance off too early, failing to respect agreements he made when forming the alliance. It is understood that part of the agreement was to allow lucrative deals between the DRC and his allies and conduct development projects aimed at regional integration. However, because details of such agreements were never made public, these two countries, when they admitted their involvement in the DRC through rebel groups, claimed it was to ensure the

[22] Region of the DRC grouping three eastern provinces: Nord-Kivu, Sud-Kivu & Maniema neighbouring to Rwanda and Burundi.

[23] Kisangani is the third city of the country in terms of the size of the population and urbanisation. It is also the capital city of the DRC's Oriental Province.

security of their territory since they suspected Laurent Kabila's regime of having make ties with the FDLR against Rwanda and with the ADF[24] against Uganda.

On 30th November 1999 the UN Security Council adopted Resolution 1279 authorising the deployment of the UN Mission to the Congo, also known by its French acronym *MONUC: Mission des Nations Unies pour la RD Congo* (United Nations Security Council, 1999). The mission was organised around three key steps:

1) To observe the withdrawal of foreign troops from the front line
2) To monitor the withdrawal of foreign troops
3) To oversee a voluntary disarmament, demobilisation, repatriation, reinsertion and reintegration of non-Congolese armed groups.

On 24th February 2000, Resolution 1291 was adopted by the Security Council. The Resolution authorised the reinforcement of MONUC to 5,537 military personnel including up to 500 observers (MONUC, 2009a; Prunier, 2009, p. 247).

From 5th to 10th June 2000, new violent fighting opposed Rwandan and Ugandan armed forces in Kisangani leaving around 600 civilian Congolese deaths (Prunier, 2009; BBC, 2000). Later that year the UN formally asked the Rwandan and Ugandan governments to withdraw their troops from the DRC. On 16th October 2000 a buffer zone separating the warring factions was put in place as government and rebel forces pulled back 15 Kilometres from their respective front lines. On 28th December

[24] The Allied Democratic Forces (ADF) is a rebel group opposed to the Ugandan government. It is based in western Uganda with rear bases in the Democratic Republic of the Congo. It began as a minor group in the forested Ruwenzori mountain range along the border in 1996, but expanded its activities over the next several years.

2000 the UN renewed its call for Rwanda and Uganda to withdraw their armed forces from the DRC.

It can be said that although the period marking the end of the alliance saw more strategic positioning and reforming of new alliances than armed confrontations the period remained very dangerous and saw many targeted killings of both civilians and combatants. During this period, most of the quarrels were strategic and targeted specific military or political entities. However, events such as those in Kisangani when the Rwandan and Uganda clashed in a populated area of the main city remained frequent throughout towns and cities located in the east of the country. Innocent civilians were killed in collateral damage and others were targeted in retaliation when accused of collaborating with either the government or a rival armed group. The same thing happened, up and down the country, to those belonging to an ethnic group judged to be hostile to the armed force in charge of the area. In the same way, the intervention of Angola and Zimbabwe under the SADC banner when they sided with the DRC government occasioned more deaths of combatants backed by Rwanda in the province of Bas-Congo, as they were cut from their rear base and supplies located thousands of miles away at the border with Rwanda. Here again, as far as this study is aware, no empirical study assessing or quantifying the extent of excess deaths for this period exists.

3.3.3 The assassination of Laurent-Désiré Kabila

On 16th January 2001 Laurent-Désiré Kabila was assassinated. The next day, an emergency government and security meeting nominated his son, Joseph Kabila Kabange, who was General of the Army, as the new President of the DRC. On 15th

February 2001 Joseph Kabila backed the implementation of the July 1999 cease-fire[25] agreement signed in Lusaka during a regional summit that saw the participation of countries from the region. Rwanda and Uganda did not participate at this summit but the three main rebel factions including *Mouvement pour la Libération du Congo*; MLC; RCD-Goma and RCD-Kisangani were present. This diplomatic openness led the international community to increase pressure on Rwanda and Uganda to withdraw their troops from the DRC (Prunier, 2009). Following this, on 29th March 2001, MONUC deployed its first contingent in the East of DRC, territory so far held by rebels. On the 4th of April 2001 MONUC contingents were deployed in zones controlled by the government.

Figures on excess death associated with the DRC armed conflict started to come out by 2001, including the release on May 2001 of the US refugee agency International Rescue Committee (IRC) report; cited by the (BBC, 2010a) and in Turner (2007, p. 200) which reported 2.5 million[26] killed both directly and indirectly as a result of the conflict since August 1998. Later, a UN panel also cited by the BBC (2010a) reported that the warring parties in the DRC were deliberately prolonging the conflict to plunder gold, diamonds, timber and coltan[27]. Despite a timid start to peace talks marked by the Inter-Congolese Dialogue in Ethiopia, in June 2002 a third military confrontation opposed Rwandan armed forces and Ugandan armed forces (UPDF)

[25] An agreement marking the commitment of the Congolese Government, the RCD, the MLC and all other Congolese political and civil organisations to hold an all-inclusive National Dialogue aimed at realising national reconciliation and a new political dispensation in the DRC http://www.iss.co.za/af/profiles/drcongo/cdreader/bin/2lusaka.pdf.

[26] Based on early IRC report; more on IRC estimation can be found on the methods chapter below.

[27] Coltan is short for columbite–tantalite and known industrially as tantalite. It is a dull black metallic ore from which the elements niobium also known as columbium and tantalum, used in electronic devices, are extracted.

in Kisangani. It has been claimed that this armed confrontation led to the UPDF being driven out of the City of Kisangani by the Rwandan forces leaving behind around 1,500 civilian dead, some of them caught in cross fire and others in ethnic retaliation as pointed out in the introduction above (Prunier, 2009; Turner, 2007). Note that here again, this figure is an estimation based on personal accounts given by eye witnesses and relatives to non-governmental organisations.

In July and September 2002, the presidents of the DRC, Rwanda and Uganda signed a peace deal, in which Rwanda agreed to withdraw its 30,000 soldiers from the east of DRC and that the DRC government would ensure the disarmament of the estimated 12,000 extremist Hutu rebels (also known as FDLR) who were accused of the killings of Tutsis and moderate Hutus in Rwanda's 1994 genocide. Many elements of the FDLR were able to mix with the local population and avoided being detected by the Rwandan forces present in the east of the DRC. Members of local communities were also afraid of giving away FDLR members in fear of retaliation. By the end of October 2002, both the Rwandan (East / South-East of DRC) and Ugandan (North and North-East of DRC) troops – allied with the DRC rebels – as well as the Angolan, the Zimbabwean and Namibian troops – allied with the DRC government (West and South-West of DRC) – completed their withdrawal from the DRC territory (Turner, 2007). Disarmament, Demobilisation, and Reintegration (DDR) programs were conceived by the UN to help Rwandan Hutus to be repatriated to their countries but its success is mixed (MONUSCO, 2001).

The assassination of Kabila is important because on the one hand many had feared the country would destabilise into another generalised crisis and various act of violence and retaliation. On the other hand, the smooth transition from Kabila's death to the next government gave sense of national consensus and one would expect to see the stabilisation of the security situation in the country and hence a decrease in war related mortality.

3.3.4 Changing nature of conflict since 2002

In December 2002, a peace deal was signed in South Africa between the DRC government and the main rebel groups. Under the peace deal, rebels and opposition members were to be given portfolios in an interim government. The interim government was agreed upon a political arrangement called one plus four, where there would be one President of the republic (Joseph Kabila) plus four vice-Presidents of which two came from the two main rebel groups (MLC and RCD), one from the civil society and one from the incumbent government majority (Turner, 2007). Although by the end of 2002 foreign troops were declared officially out of DRC, violent clashes opposing a myriad of armed groups backed by Rwanda, Uganda or the DRC government intensified in the east of the DRC.

From 2003, the situation in the DRC was marked by the interim government as it had to prepare for a constitutional referendum and lead to the organisation of elections. In July 2003 the four as vice-Presidents were sworn in (Prunier, 2009).

In December 2004, fighting erupted in the east between the Congolese army and renegade soldiers from a former pro-Rwandan rebel group. In April 2004 tension mounted between Rwanda and DRC after the FDLR based in the DRC attacked a village in Rwanda killing many civilians. As said earlier, despite the UN DDR program, and the presence of the Rwandan and Ugandan armies in the DRC under the pretext of dealing with the FDLR threat, this group has not been completely neutralised.

From 26 May to 9 June 2004, violent clashes oppose DRC Army to armed groups from the Banyamulenge[28] community in Bukavu, the capital city of the Sud-Kivu province. The fighting reignited latent tensions between the DRC and its neighbour Rwanda, accused of propping dissidents; accusations which were denied by Rwanda. The transition process in the DRC was also disturbed by the killings perpetrated by a Burundi Hutu militia group based in DRC. It has been claimed that around one hundred and fifty nine people may have died during that killing (UN Security Council, 2004; Prunier, 2009). Again, as far as this study is aware, there are no reports documenting these killings with great detail.

3.3.5 Interim coalition government

On 1st of October 2004 the UN Security Council passed Resolution 1565, extending the MONUC mandate so that it could run up to the end of March 2005. The new mandate authorised an increase of UN troops by an additional 5,900 soldiers (UN Security Council, 2004b). On October 26th 2004, under the aegis of the USA, a peace agreement between DRC, Uganda and Rwanda was signed. The agreement stated that the three countries, which had been in conflict since 1998, committed to cooperate within a commission for the defence and security, with the aim of neutralising negative forces and local militia groups in the region. However, in

[28] The term Banyamulenge describes ethnic Tutsi communities concentrated on the High Plateau of South Kivu, in the eastern region of the Democratic Republic of the Congo, bordering Burundi and Rwanda. Due to their ties to Tutsis in both Rwanda and Burundi, these communities played a key role in the run-up as well as during the 1998-2004 DRC conflict.

December 2004, heavy fighting broke between the same factions who signed the peace agreement.

On March 29th 2005, resolution 1592 of the UN's Security Council extended the MONUC mandate to 1st October 2005 (UN Security Council, 2005). This extension allowed the mission to launch vast military campaigns around Bunia. This a region home to rival ethnic militias mentioned above with the Lendu backed by Rwanda and the Hema backed by Uganda. These local militias refused to be disarmed and reintegrated into the new DRC Army as stated in recent peace agreements signed between the DRC, Rwanda and Uganda (Turner, 2007). In such a militarised environment with the two countries rivalling for areas rich in minerals, these ethnic groups had no other choice than seek the backing or alliance of one of the strong players in the region so that they could up their bargaining power in the region. In this respect, ethnic ties helped the selection of who could be supported by which of the big players.

On 18th December 2005 the new Constitution was adopted through a referendum with 84.31% of votes. The new Constitution came into force on 18th February 2006 annulling the interim Constitution voted on 4th April 2003. On April 25th 2006, the UN's Security Council authorised the deployment of 2,000 European soldiers to provide support to the 17,000 MONUC soldiers (UN Security Council, 2007). The operation was called EUFOR RD Congo; it was under the German command and was aimed at ensuring security during the period of elections which were meant to mark an end to the transition period. On May 20th 2006, DRC Armed Forces and MONUC launched an offensive against a militia from the *Mouvement*

Revolutionnaire Congolais (MRC) in Ituri. This militia had been reported as causing chaos in the region and was ready to derail the electoral process in that region (Human Rights Watch, 2007).

In July 2006, presidential and parliamentary elections were held in what is known as the first free elections in four decades for the DRC. Because none of the presidential candidates obtained an absolute majority, the incumbent president Joseph Kabila and the opposition candidate Jean-Pierre Bemba contested the re-run of the presidential elections on 29 October. Armed forces loyal to both candidates clashed in Kinshasa on numerous occasions before, during and after the electoral period (Prunier, 2009).

Amid troubles, and due to the intervention of both MONUC forces and the EUFOR, in November 2006, Joseph Kabila was declared winner of the presidential elections, with 58.05% of votes by the electoral commission, *Commission Electoral Indépendante* (CEI). The elections were seen as fair and credible by observers, despite some irregularities that were considered as having a non-significant impact on the overall results (UN Security Council, 2007a, p. 2). Joseph Kabila was sworn in on 6th December 2006.

At this point the expectation was that the country would gradually move towards more stability and fewer war-related deaths but again there are not, as far as this study is aware, credible reports or studies documenting mortality trends during these potentially dangerous periods.

3.3.6 Post-election conflicts

After the elections, there were several armed clashes involving the DRC's regular armed forces, sometimes backed by MONUC under various resolutions, against what was left of the rebel movements. These clashes caused major disruptions such as displacing thousands of civilians in the fear of being caught in the fighting, and the death of thousands of civilians (Turner, 2007).

In March 2007 the DRC's government troops clashed with forces loyal to opposition leader Jean-Pierre Bemba in Kinshasa. This was due to the fact that Jean-Pierre Bemba failed to disband part of his armed group or to integrate it into the regular army as had been agreed in the peace deal. The fighting is said to have caused around 600 casualties among civilians since it took part in a very populated area of the capital city of Kinshasa (United Kingdom: Home Office, 2007, p. 23). During this same period, aid agency groups reported an increase in the number of refugees fleeing instability in North-Kivu. It was claimed that the insecurity was caused by troops loyal to Laurent Nkunda, a dissident general from the Congolese army (Internal Displacement Monitoring Centre, 2007).

It has to be noted that the central part of the DRC, which seemed not to be directly affected by the armed conflict, saw in September 2007 a major outbreak of Ebola[29]. Symptoms of the Ebola virus were confirmed in the region of Kasaï Occidental near the provincial capital city of Kananga. During this outbreak, five people were confirmed to have died from the virus in Kananga, but in total there were at least 166

[29] Ebola haemorrhagic fever (EHF) is a viral haemorrhagic fever and one of the most virulent viral diseases known to humankind.

dead for the affected region. According to the World Health organisation (WHO) which has offices in the DRC, it was aware of 206 more cases (World Health Organisation, 2007; United Kingdom: Home Office, 2008). So, as can be seen, there were conflicting figures around the actual number of deaths caused by the Ebola outbreak. The case of Ebola, despite being localised to the Kasaï and Counter-factually related, is an important one since it or any similar case has the potential to have an impact on population loss. Such an impact may conflate with the actual number of estimated war-related excess deaths. This is another reason why adopting the term excess population loss, as is the case in the current study, seems more appropriate than using the term excess death.

In January 2008, the government and existing rebel groups, including the CNDP led by dissident General Laurent Nkunda, signed a peace deal aimed at ending on-going armed clashes that continued in the Kivu region (IRIN, 2008). In August 2008, Gen. Laurent Nkunda pulled out of the peace agreement signed between the DRC government and armed groups leading to heavy clashes in the Nord-Kivu province and around the provincial capital city of Goma. By October 2008, rebel forces led by Gen. Nkunda captured the major army base of Rumangabo[30] .

On 12th December 2008, the DRC and Uganda decided to conduct a joint military operation against the so-called the Lord's Resistance Army (LRA) Ugandan rebel group. In the same way, the DRC and Rwanda agreed in January 2009 to conduct a joint military operation against extremist Hutus accused of involvement in the 1994 Rwandan genocide. The agreement also authorised putting an end to the threat

[30] DRC Army base located about 50 Kilometres (30 miles) north of the Goma in the Province of North Kivu

caused by Gen. Laurent Nkunda (Prunier, 2009). Following this operation, Laurent Nkunda was arrested and placed under house arrest (Amnesty International, 2011) in Rwanda. Up to the moment of writing this paper; as for June 2012, Laurent Nkunda is still, officially, under house arrest in Rwanda.

By the beginning of 2009, the DRC started to experience some relative calm compared to the years when government forces and various armed groups were clashing on a daily basis causing thousands of casualties and waves of internally displaced persons (IDPs). However, in February 2009, the NGO Médecins Sans Frontiers accused UN peacekeepers of failing to protect civilians from LRA rebels (Human Rights Watch, 2009). In April 2009, Hutu militia re-emerged after the end of joint DRC-Rwanda campaign in eastern DRC, prompting thousands of Congolese to flee. In September 2009, the UN High Commissioner for Human Rights, Navi Pillay, stated that violence committed by both the army and the CNDP militia in North Kivu during the period between October-November 2008 may amount to war crimes or even crimes of genocide (UN Office of the High Commissioner for Human Rights, 2010).

In May 2010, the DRC Government stepped up pressure for the UN to terminate its peacekeeping mission in the DRC before the elections in November 2011. In the end MONUC’s mandate was extended to June 2012 and its mission changed to become the UN Stabilization Mission in the DRC (MONUSCO). Although the situation was still fragile in parts of the DRC (especially the east of the country), the Council noted, however, that substantial progress had been made since the deployment of the mission in 1999 to monitor the implementation of the peace process that was intended to end civil war in the DRC (UN, 2010; Human Rights Watch, 2011).

As explained earlier, the current study gives a succinct chronology of war-related events in the DRC. Here, the emphasis was on the periods and space in which war-related events occurred. By doing so, the aim was to help generate the context in which potential demographic changes as they happened before, during and after the latest DRC crisis. It is possible that some events may have not been reported in this paper. The idea was to produce an account that is as close as possible to the accurate events. However, for a detailed account of specific facts, the reader can see the original documents cited here.

3.4 Phases of armed conflict and demographic impacts

Crises that have hit the DRC since the spill over of the Rwandan conflict in the mid-1990s have been relatively harsh on living conditions even by Congo standards. Looking at the case of both Nord Kivu and Sud Kivu, for instance, with a combined population size of almost 5.3 million in the early 1990s, an influx of 1.2 million refugees from Rwandan could be expected to have direct and indirect impacts on population change both in the short and long term. These impacts would affect all components of population change, individually or in combination, with far-reaching consequences to other parts of the country.

3.4.1 Fertility and armed conflict

Existing evidence for the effect of malnutrition on human reproductive capability shows that the rate of conception reached a minimum during famines and prolonged hardship in recent world wars (Bongaarts, Malnutrition and Fecundity, 1980). Unfortunately those correlations between worsening in living conditions due to armed conflict and fertility provide little insight into the nature of the explanatory mechanisms involved. Based on recent cases it is evident that women, children and the elderly are likely to be the most vulnerable in armed-conflict situations (Akaro, 2001). In many cases women are victims of the refugee process (Eriksson, L-G; Melander, G; Nobel, P, 1979). Sometimes women arrive in the host country with unwanted pregnancies and diseases acquired from raping or forced sexual encounters by various individuals or group of individuals. Some of the women get the unwanted pregnancies even after their arrival in the host countries (Akaro, 2001). Similarly the loss of libido, reduction in sperm motility and longevity in males can impair the function of the human reproductive process. Its impacts are strongest and most evident when both fecundity and fertility are reduced due to direct and or indirect effect of induced hardship on living conditions. However, the precise causes and consequences of fertility decline are yet to be determined through empirical assessments taking into account many natural as well as social factors.

Cases mentioned above have the potential to hinder fertility in the short as well as in the longer term. In the case of the DRC the displacement of women as well as violence towards them continued throughout the duration of the conflict, probably due to the nonexistence of adequate policies aimed at counselling refugees to, for instance, disengage from having children during their initial stages of flight. The background presented above show that refugees were left unsupervised for most of the period leading to the 1998 onset of the conflict.

3.4.2 Migration and armed conflict

Various phases of the DRC conflict would affect migration differently. If the 1994 war in Rwanda led to an influx of Rwandan refugees for the period 1995-2000, in areas closer to the Rwandan border, the ensuing change of regime in Rwanda led to an opposite movement for the period 2000-2005. The onset of the 1998 conflict led to the formation of many auto-defence groups and local militias. The proliferation of local militias led to mass displacement of people within provinces. The presence of hostile powerful rebel movements that drove the national army out of certain provinces led to interprovincial mass displacements.

Given that the growth in refugee population and in particular rural refugee population leads to an over exploitation of natural resources, intensification of land use in the host community or country it can therefore be expected that some of the locals would migrate out of their original milieu. In the case of the DRC, it can be expected that the influx of Rwandan refugees in the eastern part of the country would lead to following three scenarios:

a) The out-migration of locals as they flee militias from rival communities or the hardship caused by the excess of their environment's carrying capacity.
b) Rwandans refuges of Hutu descents accused or suspected of 1994 genocide would disperse further inside the DRC
c) Rwandan refugees who are Tutsi or Hutu but not accused or suspected of 1994 genocide would move back to Rwanda as the conflict ended in that country.

3.4.3 Mortality and armed conflict

It can be seen that, the armed conflicts has the potential to cause, both directly and indirectly thousands of casualties in excess compared to what would have been the case should the conflict not happened. However, this will not be clear to establish until an appropriate assessment on excess mortality is conducted. From what has been said above, it can be seen that early stages of the conflict has the potential to cause many casualties among both the armed forces and the civilian population. This is because at the beginning of an armed conflict front lines would not be clear cut and each of the warring parts would want to seize as much ground as they can in order to establish its superiority on the theatre. In the same way, it is expected that many civilians including women and children would be caught in cross fire since they would not have enough time to move out of the fighting zone. There have been cases where even refugee camps and temporary settlements of refugees were attacked (Eriksson, L-G; Melander, G; Nobel, P, 1979). As the conflict last it is more likely that most civilians would move out of the fighting areas and take refuge either outside the country or in refugee camps in order to benefit from shelter and security.

In this respect, it can be expected that the armed conflict in the DRC would cause many direct casualties at the various onsets including 1998 when the alliance fail apart, 2001 with the assassination of Laurent Kabila and in the mid-2000s as other rebel factions were unhappy with the share of power resulting from peace negotiations. In the same way, many civilians would become the target of the various local militias as long as they may be perceived by a rival community as collaborating with the enemy. The Hema and Lendu conflict in the Ituri is an illustration of such score settling killings.

In the longer term, most casualties would result from indirect consequences of the armed conflict. This is because as the conflict persists, many individuals would move out of fighting areas but the ensuing hardship on living conditions is expected to negatively affect health facilities and the socio-economic fabric exposing both the displaced persons and locals in the host communities vulnerable to diseases and precarious living conditions. It can also be anticipated that women and children are more likely to be most affected by indirect consequences of the conflict than adult men.

Summary of Chapter 3

Chapter 3 set out to provide a contextual framework upon which selected key events in the history of the DRC can inform the assessment of the impact of the recent armed conflict on population change.

As Chapter 3 has demonstrated, most key periods in the history of the DRC are marked by armed conflicts, violence and crises. More importantly, each of these events has the potential to significantly affect population change according to the level of violence experienced at various points in time.

During the pre-colonial period, violence was more the result of a repressive colonial regime against an almost defenceless population. During the colonial period violence was more the result of the political struggle for independence. During the Mobutu period violence was a combination of armed struggle and political repression by a dictatorial regime. More recent cases of violence and armed conflicts in the DRC are a complex mix including the gradual collapse of the state, the spill over of the 1994 Rwandan genocide, land disputes and the fight to control certain mineral trades. From Chapter 3 it can be seen that various causes of the studied conflict reinforce one another and cannot be fully understood in isolation from the others.

Another fact highlighted in Chapter 3 is that the effect of violence and armed conflict on civilians depends on how the conflict develops and the location of armed clashes. The chapter has shown that the changing nature and location of armed confrontations would be expected to have an impact on all three components of population change. In this respect, although some provinces have not been directly the theatre of armed clashes between various warring factions, they were nonetheless affected indirectly through the flows of internally displaced persons from conflict affected areas. Knowing that mass inflow of IDP will have consequences on the already poor if not non-existent public services in host communities and provinces, one can expect living conditions to worsen and hence affect population change in both the shorter and the longer term.

From Chapter 3, it can also be seen that despite the occurrence of events which have the potential to affect population change, there is still a lack of empirical studies assessing the extent and scope of population change to be associated with the armed conflict. In other word, the chronological overview presented in Chapter 3 was able to show that many of the narratives on conflict-related human cost happening in the DRC since as far as the pre-colonial period are not corroborated by empirical studies. Very little is known about the methods used to produce figures on population loss in the DRC. The lack of empirical studies reinforces the importance of the current study. This importance is not only related to finding out figures but also to be able to reconstruct missing demographic estimates through the use of both direct and indirect methods.

Chapter 4 Data and methods

Introduction to Chapter 4

This chapter sets out to address this study's research questions in relation to missing demographic estimates, the lack of reliable vital registration systems as well as the steps needed to elaborate an analytical framework upon which to derive missing estimates. Literature shows that when there is lack of reliable statistical sources in conflict situations, various methods and data sources can be used to derive demographic estimates (Heuveline, 1998; Tabeau & Bijak, 2006).

Following Heuveline (1998), a cohort component method of projection under factual and counterfactual scenarios is used in the current study to calculate the excess population loss. Before using a cohort component projection, both direct and indirect methods of estimation are applied to derive missing estimates needed as input in the population projection framework (Preston, Heuveline, & Guillot, 2001; Siegel & Swanson, 2008).

Table 4.1 below gives a summary of how the current study intends to use various data opportunities to derive the needed estimates. It is worth noting that at this stage of the study, analyses were focused at the national with basic assumptions for a closed population. Net migration data will be included in the projection process later on in relevant chapters and further analyses conducted assuming an open population in the final stage of this study.

Table 4.1 Summary of the projection process and utilisation of data sources

PANEL (i): WAR SETTING (REAL-WORLD SCENARIO)

Year	**Data**	**Reconstruction operation**
1984	**Census**	a. Forward projection to **1995**
1995	**MICS 1**	b. Use estimates (**MICS 1**) to adjust the **1984**-based projection (a) then project again to **2001**
2001	**MICS 2**	c. Use estimates (**MICS 2**) to adjust projected population from (b) then project again to **2007**
2007	**DHS**	d. Use the DHS estimates to benchmark the projected rates and then project up to year **2014**

PANEL (ii): COUNTER-FACTUAL SETTING (COUNTERFACTUAL SCENARIO)

Year	**Data**	**Reconstruction operation**
1984	**Census**	A. Forward projection to **2007**
2007	**DHS**	B. Use estimates **(DHS)** to adjust the **1984-based** projection (A) and projected forward to 2007
2014	**Census-DHS**	C. Forward projection to year 2014

Table 4.1 above shows two panels ***(i)*** and ***(ii)*** summarising operations to be conducted under a WAR scenario ***(i)*** and a COUNTER-FACTUAL scenario ***(ii)***. From panel ***(i)*** the reconstruction operation for the WAR scenario proceeds as follow:

a. 1984 census is the baseline population to be projected forward up to year 1995, using realistic assumptions on vital rates.

b. From 1995, MICS 1 estimates will be introduced in the projection to set a new benchmark enabling the population projected forward again up to the year 2001, using realistic assumptions. Here the year 1995 is considered as war-affected due to the fact that instability in the country started since in the early

1990s. To this must be added the major disruptions of vital sectors following the massive influx of more than a million Rwandan refugees in 1994.

c. From 2001, MICS 2 estimates are introduced in the projection to set another updated benchmark enabling the population projected forward again up to 2007. Here the projection will again use realistic assumptions but MICS 2 estimates are war-influenced since the war started around 1996–1998.

d. For this period, a forward projection up to year 2014 will be made using DHS estimates. This projection will help benchmark projected rates so far before taking it forward to year 2014.

Panel ***(ii)*** shows the COUNTER-FACTUAL scenario. Operations similar to those in panel ***(i)*** were conducted but here the main assumption is that the 1984 baseline population has never been disturbed by conflict. In other words, it is assumed that the DRC population as estimated at the latest census in 1984 followed its trend undisturbed – no pervasive events such as armed conflicts influenced it and was only corrected by estimates from 2007 DHS. Therefore, the analysis proceeds as follows:

A. The 1984 baseline population will be projected forward up to year 2007.

B. An interpolation, using realistic assumptions, of survivorship estimates by five year age group and age specific fertility rates allowed to link year 1984 to year 2007.

Forward projection to 2014 keeping 1984 projection as benchmarked by 2007 DHS.The following section introduces each of the data sources used, along with a discussion on their strengths and limitations. This is to help, where possible, draw out their implications on this study's findings.

4.1 Data

As seen in Table 4.1 above, the current study uses four different data sources including the 1984 DRC Census; 1995 MICS1; 2001 MICS2 and the 2007 DHS. There are other data sources between 1984 and 2007 but many of them are not readily available others are not representative of DRC population. The following subsections provide brief details on the strengths and weaknesses attached to the above data sources.

4.1.1 Census data

The 1984 DRC Census has been conducted on the 1st of July 1984 but published in 1991. It has to be noted that, in the case of the DRC, the 1984 Census is the first of its kind to have followed internationally established norms and recommendations to collect quantitative information on individuals and households with the aim to support national development processes (Institut National de la Statistique, 1991). In this respect, one of the strengths of the 1984 DRC Census resides in the fact that it has been an innovation from population enumeration systems inherited from the colonial administration. The colonial system relied on administrative data, it was anachronistic, covered only smaller areas and its main purpose was to account taxable population and update population files at the local level alone (Institut National de la Statistique, 1984). To sum up, the 1984 Census provides a true measure of the population (no sampling error); from it, benchmark data may be obtained for future studies and detailed information about small sub-groups within the population is more likely to be available.

The main weaknesses of the 1984 census reside on the fact that, for instance, some of the census questions were not clearly specified leading to a type III error where right answers were provided to the wrong questions. The implication of introducing the type III error in the census questionnaire led the current study to deriving unreliable estimates of adult women survivorships when compared to those of adult males. More on the type III error mentioned here is explained below when looking at the outcome of widowhood analyses. It may be difficult to collect process and release data for all units of the population within the available time frame. For this reason, the 1984 census only processed a 10% sample of individual residents was coded and analysed in detail. Although this alternative enumeration strategy also known as dual system enumeration helps reduce the burden on the statistical office, it is not simple to conduct and may lead to sampling errors. The consequences of such sampling error will undermine all that is known about DRC population since 1984.

On the balance of the overall strengths and weaknesses of the 1984 DRC Census, it has been opted by the current study to use the 1984 census as the baseline in the assessment of the excess population loss associated with the armed conflict. This choice is also based on the fact that recent estimates of DRC population are based on the 1984 census and hence constitute the only reliable basis upon which to strengthen weaknesses such as those mentioned above.

4.1.2 MICS I and MICS II data

As mentioned in the introductory chapter the Multiple Indicator Cluster Survey (MICS) is a household survey programme developed by the UNICEF in the mid-90's to assist countries filling data gaps when monitoring the situation of children and women. Using indicators from MICS it is possible to produce statistically sound, internationally comparable estimates. In other words, the MICS has been developed not only to fill in data gaps, but also to inform and complement existing data collection methods and instruments including administrative records, census, vital registration to name but a few.

1995 MICS is the first survey of its kind to be conducted in DRC and provided quantified information on the impact of the socio-economic crisis on the wellbeing of women of reproductive age and children. In this way, the survey resulted in an increasing wealth of data needed to monitor the situation of children and women. For the first time, it was possible to monitor trends in and set baselines for many indicators related to women and child wellbeing.

Despite the fact that MICS II drew heavily on experiences from MICS I and its subsequent evaluation, both surveys had limitations due to the fact that they were designed to collect data on women aged 15 to 49 and children under the age of 5. The other advantage of MICS-II on MICS-I is due to the fact that UNICEF put efforts into making technical reports and the micro-data widely available to researchers via the internet, free of charge. Given that the current study is aimed at reconstructing missing demographic estimates, it was crucial to have information for both males and females at all ages. The other problem with MICS data is the risk of sampling error. Given that the conflict did not affect the whole country in the same way, there is a risk of having clusters comprising areas that have not been affected in the same way by the conflict. It is worth noting that MICS data have not been made available at the subnational level. This would have allowed disaggregating to the subnational level analyses conducted at the national level.

The current study suggests ways to overcome some of the weaknesses associated with MICS data and more details are provided in the methods section below.

4.1.3 DHS data

The 2007 The Democratic Republic of Congo is the first of its kind to have surveyed a nationally representative sample of 8,886 households. Similar to the MICS, the DHS has been designed with the aim to provide demographic and health information of children and adults. A total of 9,995 women age 15-49 and 4,757 men age 15-59 were interviewed between March and May 2007 with the help of a detailed questionnaire. Unlike MICS data, DHS scope has expanded to include HIV and malaria, gender-based violence, health behaviours and chronic diseases. DHS data as conducted in the DRC has the potential to support a variety of investigations such as cross-comparative studies and analyses of the population distribution of health by socio-economic status and geography as well as studies assessing associations between mortality and armed conflict.

It is worth noting that the DHS in DRC was intended not to describe populations as a whole, but rather orientated toward women of reproduction age and children aged below 6 years old. This constitutes one of the main weaknesses of the DHS data source since analyses in the current study need to borrow population structure and sex composition from the 1984 census to reconstruct missing estimates. Other DHS weaknesses include their irregularity and their lack of details on retrospective mortality at all ages for both males and females.

4.2 Method

There are potentially four methods which can be used to assess excess population loss associated to armed conflict. These methods include: retrospective mortality survey, matching mortality records from various sources, population projection under factual and counter factual scenarios and body count from mass grave using both manual and advance technology systems. Each of these methods has its strengths as well as its limitations. Nevertheless, the current study had to use one in order to assess population loss linked to the DRC conflict.

As presented in the literature, retrospective mortality surveys can be a reliable method but it is a difficult task which needs immense resources if it has to be conducted successfully. Retrospective mortality survey is costly and needs time between preparing the questionnaire, identifying samples, training the personnel, running the pilot survey, running the actual survey, processing the data and publishing results.

The same can be said with the method consisting of matching mortality records from various sources. This method needs careful preparation and identification of documents and mortality records needed. Separating war-related from non-war related casualties can prove to be difficult if records contain missing information. Further to the cost and the need for resources, matching mortality records can be challenging especially when gatekeepers are preventing access to certain documents or records.

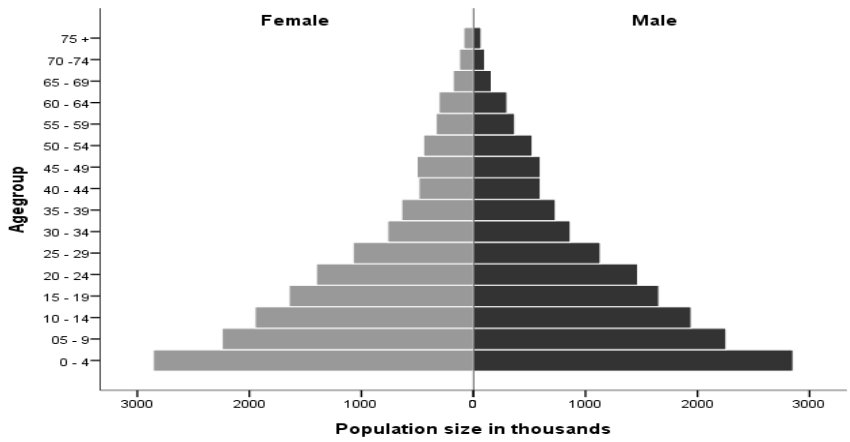
Counting body from mass graves is also costly as this would need specialist equipment and specific authorisations. The other weakness with this method is the fact that the DRC is a very large country, knowing where all mass graves are performing the counts can be an almost impossible endeavour.

Drawing from the literature and based on the obstacles presented above, population projection seemed the most plausible approach left for the current study. This is mainly because the task involved can be office based provided that the correct data are available in the format needed. Reflecting from the difficulty to use any of the above methods, the current study opted for population projection as the main method to assess excess population loss associated with the DRC armed conflict.

4.3 Indirect methods to derive missing estimates

Before conducting projections it is important to look at selected descriptive characteristics of the DRC population as captured by the 1984 census. Figure 4.1 below shows the distribution of DRC population by age-group and gender as captured by the 1984 census and is used in this study as the baseline population.

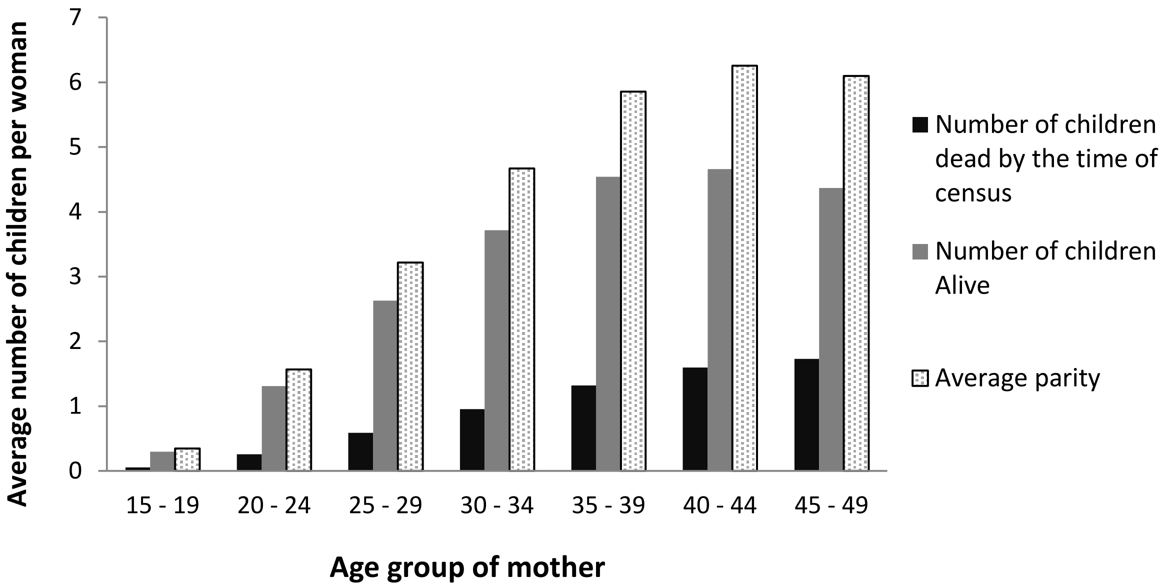
Figure 4.1 Distribution of population by age group and gender in 1984



Source: Own work based on Institut National de la Statistique, (1991)

It can be seen from Figure 4.1 above that in 1984 the DRC population was characterised by a very young population with a very broad-based, triangular profile age pyramid indicating very high proportions of children. This situation is generally associated with large family size, and declining mortality. This situation is confirmed by estimates on the average number of children ever born (CEB) per woman as shown in Figure 4.2 below.

Figure 4.2 Average parity by age group of mothers



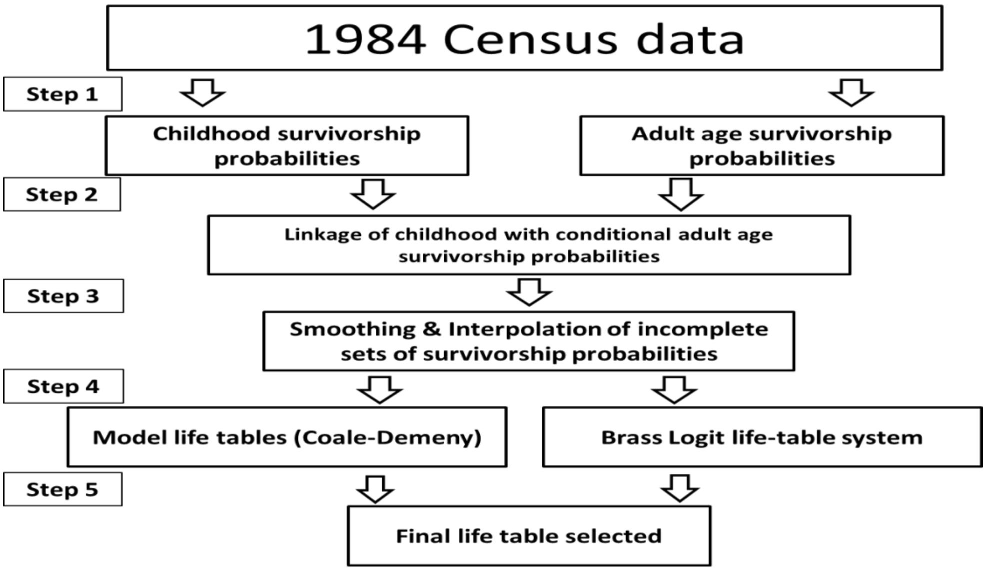
Source: Own graph based on data from DRC Institut National de la Statistique, 1991

It can be seen from Figure 4.2 that, on average, a Congolese woman counted in the 1984 census would be expected, by the end of her reproductive age at 49 years old, to have given birth to around six children. Figure 4.2 also shows that the proportion of children dead is smaller compared to proportion of children alive for mothers aged 15 to 24 years old than it is at late childbearing or mothers aged 40 to 49 years old. This may be due to decline in mortality or the fact that children of older mothers are on average older. This can also be due to the fact that children from multiparous have a higher mortality risk.

Because the 1984 census was the latest available dataset with the necessary information on the total population, its structure and composition disaggregated at both national and sub-national levels; the 1984 population size is used as the baseline for this study's population projections.

To conduct the projections it was important to have estimates of key components of population change. Traditionally, censuses and vital registration systems would be enough to derive demographic parameters; assuming that both the registration of vital events and the census counts are reliable (UN Population Division, 1983). Unfortunately, the DRC does not have reliable data-collection systems or, when the systems exist, their performance is so poor that any estimates they may produce will be flawed (Mapatano & Piripiri, 2005, p. 552). For the above mentioned reason, the use of indirect methods (UN Population Division, 1983) of estimation to derive, estimates related to mortality – infant, child and adult mortality – and fertility are needed to conduct a closed projection for the current study.

Figure 4.3 Producing model life table from census data



It can be seen from Figure 4.3 above that the best fit between survivorship probabilities at younger age (0 to 20 years old) and at adult age (20 to 80 years old and above) was selected as final survivorship probabilities $l(_x)$ to be used in the model life table.

As mentioned above, the selected survivorship probabilities are needed to generate the model life table containing the necessary estimates to go in the projection of base population as captured at the last census in 1984. It is expected that the demographic context of the 1980s DRC would be recreated from the model life table. Estimates from the model life table were then used to bench mark and project forward the 1984 base population. Comparing two projections where one is factual or implying a war situation and the other is a counter-factual implying a situation where it is assumed war did not occur will allow for the examination of potential fertility decline, forced migration, toll of mortality and the extent to which may decrease over time as a result of armed conflict. In other words, the generated model life table is crucial since this is where key demographic estimates needed for the population projection come from, thus providing a basis upon which most of this study's research questions will be addressed.

The fitting procedure shown in Figure 4.3 above can be explained as follows.

Step 1 estimates from the 1984 DRC census data on children ever born and surviving children by women of reproductive aged including 15 and 49 years old are shown in sub-sections below. Estimates were derived following UN Manual X (1983, pp. 73-96) procedures to derive childhood survivorship probabilities. In the same way, census data on widowhood or proportion widowed and on orphan hood were used to derive adulthood survivorship probabilities following UN manual X (1983, pp. 97-128).

Step 2 Childhood and adult age survivorship probabilities are combined together in order to form a complete set of survivorship of the population aged from 0 to 80 and above. Combining these two survivorships is important at this stage since they were calculated using two different mortality assumptions. Mortality assumptions had to reflect the fact that for children aged below 5 years old, for instance, infant mortality is higher when compared to mortality at adult age (25 to 40 years old) or that people aged above 70 would have a higher mortality.

Step 3 After linking two distinct estimates as shown in step 2, problems may occur at pivotal ages of 20 and 30 years old, where the two sets of survivorships are combined. They are called pivotal ages because different mortality assumptions are used for younger age or below 20 years old and for adult age or above 20 years old (UN Population Division, 1983). Due to the fact that we are working with five-year age-group 10 years gap constitute that pivotal gap. For this reason, it was important that the obtained estimates are smoothed using Coale-Demeny regional model life tables[31] – North, South, East, West – and Brass logit life-table system[32] to ensure that there is not a big gap between childhood and adult age survivorship probabilities (Coale & Demeny, 1966; Brass, 1968; UN Population Division, 1983, pp. 13-303). These model life tables were used to assess which one will help derive demographic estimates that are the closest to those found in the DRC 1984 census.

Step 4 For the model life tables, information for the two distinct age ranges were linked together by adopting the life table implied by the average level of the child mortality estimates up to age *y* – regarded as pivotal age – and then completing the life table over age *y* by applying the conditional probabilities of survivorship from age

[31] The tables are based on 326 empirical life tables. Using a regression technique that assumes interdependence of adjacent age-specific mortality rates, from the selected tables, four different mortality patterns were distinguished for each sex. Those patterns were labelled “North; South; East and West”.

[32] Model proposed on the basis that a certain transformation of the probabilities of survival to age x made the relationship between corresponding probabilities for different life tables approximately linear.

y consistent with the average level implied by the adult survivorship estimates. This was done for all four regions proposed by Coale and Demeny. An alternative model by the INDEPTH[33] (INDEPTH Network, 2004) is explored in coming chapters dealing with an open population scenario.

Step 5 All complete ranges for population aged 0 to 85 years old of survivorship probabilities obtained in step D were then introduced into a model life table. Resulting estimates from the life table were then assessed for consistency with the demographic context of the DRC around 1984 when the census was conducted. In this context, consistency means checking for robustness or corroboration using estimates from alternative demographic sources such as the US census Bureau or the UN Population Division; results of which are explored in the coming sections and chapters.

4.3.1 Childhood mortality estimates

In 1984, data on children ever born have been used to supply measures describing patterns of experienced mortality amongst children. These were then translated into probabilities of dying before attaining certain exact childhood ages using methods developed by William Brass (1975); as cited in UN Population Division (1983, p. 73) and shown in the following steps.

Step one, average parity $P(i)$ per woman (where $P(1)$ refers to age group 15-19 $P(2)$ to age group 20-24 and $P(3)$ to age group 25-29) was calculated

[33] The INDEPTH Model Life Tables for Sub-Saharan Africa presents model life tables for developing countries. It gives sets of age-sex patterns of mortality which are based on reliably documented developing country data, thus supplementing the Coale-Demeny model life tables extracted mainly from historical European experience.

$P(i) = CEB(i) / FP(i)$

where *CEB*(i) is the number of children ever born by women in age group *i* and FP(*i*) is the total number of women in age group *i*. It has to be noted that the value of *i* varies from *i* = 1 for age group 15-19 to *i* = 7 for age group 45-49.

In Step two, proportions of children dead for each age group of mother were calculated. The proportion of children dead *D*(*i*), is defined as the ratio of reported children dead to reported children ever born.

$D(i) = CD(i) / CEB(i)$

Where *CD*(*i*) is the number of children dead reported by women in age group *i*.

In Step three, multipliers *k(i)* were required to adjust the reported proportion dead, *D*(*i*), to allow for the effects of the age pattern of childbearing are calculated from the ratios *P*(1) / *P*(2) and *P*(2) / *P*(3), by using the following model:

$k(i) = a(i) + b(i) * P(1) / P(2) + c(i) * P(2) / P(3)$,

where a, b and c are the model coefficients required to estimate the multipliers k(i). Here, multipliers for all four different families (South, North, East, and West) of model life tables were calculated. This was done so that the model with the best fit to the observed data will be selected to derive mortality estimates.

Step four, consists in the calculation of probability of dying between birth and age x *q*(*x*) and of survival *l*(*x*): Estimates of the probability of dying, *q*(x) are obtained for different age (*x*) as the product of the reported proportions dead, *D*(i) and the corresponding multipliers, *k*(i). Once q(x) has been estimated, the probability of surviving at age *(x), l(x)* is obtained as $l(x) = 1 – q(x)$.

Step five is the calculation of the reference period. The reference period *t(x)* is an estimate of the number of years before the census date and to which the child mortality rates, *q(x)*, refer to. The values of *t(x)* are estimated by means of an equation whose coefficients were estimated from simulated cases by using linear regression.

To summarise the five steps presented above, Table 4.2 and Table 4.3 below show child mortality estimates and reference period obtained using data on children ever born from the DRC 1984 census.

Table 4.2 Proportion of children from children ever born: 1984 census

Age-group of women (1)	Age X (2)	Total number of women (3)	Children ever born (4)	Children dead (5)	Children alive (6)	Average parity *P(i)* *(7)=(4)/(3)*	Proportion dead *D(i)* *(8)=(5)/(4)*
15-19	1	1654.6	574.5	86.4	488.1	0.347	0.150
20-24	2	1466.4	2296.3	378.3	1918.0	1.566	0.165
25-29	3	1133.0	3644.4	666.5	2977.9	3.217	0.183
30-34	5	864.7	4036.5	823.0	3213.5	4.668	0.204
35-39	10	732.6	4291.5	965.0	3326.5	5.858	0.225
40-44	15	597.4	3737.3	953.6	2783.7	6.256	0.255
45-49	20	597.9	3644.4	1033.1	2611.3	6.095	0.283

Source: Own calculation based on Institut National de la Statistique (1991)

It can be seen from Table 4.2 above that, for instance, the value of average parity *P*(*i*) in column (7) is the mean number of children born in age group (*i*) divided by the total number of women in that age group or (4)/(3). In the same way, the calculation of proportion of children dead, for each group of mothers was done by dividing the number of children dead given in column (5) by that of children ever born shown in column (4) or (5)/(4). It has to be noted that classification by sex was not available to estimate child mortality for each sex separately. However, assuming that sex differentials in this study are the same as those embodied in the census, it was possible to apply sex ratio from the census to derive the classification by sex.

Table 4.3 below gives an example of how the probabilities of dying from age 1 to 20 have been derived following the East model life table. East model life table has been derived following life tables coming mainly from Austria; Germany before 1900; the Federal Republic of Germany after the Second World War; and northern and central Italy. According to UN's Manual X, when pattern of these tables are compared with standard pattern, exhibited by the majority of tables, their deviations from the standard follow a U shape, revealing their relatively high mortality rates in infancy and at older ages; in this case over 50.

Table 4.3 Probabilities of dying using East model life tables

Age x (1)	Multipliers k(i) (2)	Probability of dying q(x) (3)	Probability of surviving l(x) (4)=1.0 – (3)	Reference period t(x) (5)
1	0.951	0.143	0.857	1.4
2	1.018	0.168	0.832	2.7
3	1.003	0.183	0.817	4.5
5	1.015	0.207	0.793	6.6
10	1.039	0.234	0.766	8.9
15	1.023	0.261	0.739	11.6
20	1.013	0.287	0.713	14.7

Source: Own calculations based on estimates from Institut National de la Statistique, (1991)

From results obtained in Table 4.2, it was possible to derive estimates presented in Table 4.3 and form a key part of the reconstruction of estimates on the probability of surviving at younger age. To do so, the multiplier *k(i)* had to be obtained by adjusting the reported d(*i*) for the effects of the age pattern of childbearing as explained above.

Model life tables for all four regions were explored to see which one will have a mortality level that is more plausible to the one expected in the DRC back in 1984.

Table 4.3 above shows estimates obtained when using the Coale & Demeny's East family model life table. With the values of *k(i)* obtained using the model explained in *step three* above, it was then possible to derive the estimated values of the probabilities of dying, *q(x)* by multiplying the *k(i)* values shown in column (2) by the corresponding proportion dead, *D(i)* in column (8) of Table 4.2. Since every *q(x)* value is the probabilistic complement of the probability of surviving, *l(x)*, the latter value was obtained by subtracting the former from 1. Thus, for instance, *l(5)* = 1 – 0.207 = 0.793.

As explained earlier, when mortality is changing smoothly, the reference period, *t(x),* is an estimate of the number of years before the survey date to which the child mortality estimates, *q(x),* obtained in the previous step refer. The value of *t(x)* shown in column (5) has been estimated by means of an equation whose coefficients were estimated from simulated cases by using linear regression. Reference data was calculated for all four regions model life tables but Table 4.3 above only shows results for east model life tables. Considering that the census took place in July 1984, the *t(x)* values implies that, for instance, estimates of *q(1), q(2), q(3)* and *q(5)* shown in column (5) of Table 4.3 above refers to mortality conditions prevalent approximately one and a half year, over two and a half years, four and a half years and over six and a half years before the survey, respectively. After this trend, the estimated values of *t(x)* increase by over two years, over three years about three years and per age group. Consistency in the values of *t(x)* provides information for the study of child mortality trends over time (UN Population Division, 1983).

4.3.2 Adult-age mortality

Assuming that mortality rates at younger age (0 to 20 years old) as estimated above differ from adulthood mortality (25 to 80 years old and above), this section explains how information on the survival of close relatives were used to make indirect estimates of adulthood mortality. It has to be noted that there are various ways to estimate adult mortality indirectly but different methods will require different types of input data. Considering the data available, this study explored three models:

- **Model 1.** The estimation of conditional adult survivorship on the basis of proportions widowed.
- **Model 2.** The estimation of survivorship from birth to adult ages on the basis of proportions not widowed.
- **Model 3.** The estimation of adult mortality using logit methods.

Model 1

Model 1 estimates conditional adult survivorship seeks, on the basis of the proportions widowed, to derive male and female probabilities of surviving from age 20 to age *n*. Estimates were derived from observed data on the proportion of ever-married women and men who were questioned about the survival status of their first husband and wife during the 1984 census. Using census data related to the question on the survivorship based on proportions widowed following steps were taken to derive estimates on adulthood mortality:

In step 1, proportions of not widowed were calculated. This is the proportion of ever-married women and men whose spouses were still alive at the time of the census.

Thus, the following formula was used to derive these proportions for females and males respectively:

- *$NW_f(n)$ = 1–[Number of women of age (x) whose spouse was dead / Number of ever married females of age (x)]*

- *$NW_m(n)$ = 1–[Number of men of age (x) whose spouse was dead / Number of ever married males of age (x)]*

In step 2, the singulate mean age at marriage (SMAM) was calculated. This value, also known as the average number of years spent in single state by those who marry before age 50, was calculated.

$SMAM = (RS_2 - RS_3) / RM$

The formula above has been used to derive the *SMAM*. In the formula, RS_2 is the total number of years lived in the single state by age of 50; RS_3 the number of years of singleness lived by those not marrying by age 50, and *RM* is the number of those who ever married by age 50. More details on how to compute *SMAM* can be found in the UN Manual X of indirect demographic methods (UN Population Division, 1983, pp. 225-229; Newell 1988 p. 97-101).

For the current study, values of mean age at marriage *(SMAM)* were calculated for each sex yielding 25.41 years for males and 20.65 years for females. In other words, according to the 1984 census, men reported, on average, getting married 5 years later than women.

In step 3, survivorship probabilities l(n) were calculated using age-group specific coefficients *a, b, c* and *d* provided in the UN Manual X and applying equations:

- $l_m(n)/l_m(20) = a(n)+b(n)\ SMAM_f+c(n)SMAM_m+d(n)NM_f(n-5)$ *for* males *and*

- $l_f(n)/l_f(20) = a(n)+b(n)\ SMAM_f+c(n)SMAM_m+d(n)NM_m(n)$ *for* females

Where and *NM* represents the Number of those Married. The relationship between variables calculated in previous steps and certain probabilities of survivorship was established by using least-squares regression to fit the above equations.

In step 4 number of years *t(n)* before the survey to which survivorship probabilities refer were calculated. The following formulas were used:

- $T_m(n) = (n – 2.5 – SMAM_f)\ (1 – u_m(n)) / 2$ *for males and*

- $T_f(n) = (n + 2.5 – SMAM_m)\ (1 – u_f(n)) / 2$ *for females*

Where $u_m(n)$ and $u_f(n)$ are the correction functions for male and female respectively.

Model 2

Survivorship from birth to adult ages on the basis of proportions not widowed was conducted in the following way:

In ***Step 1*** *SMAM* was calculated as shown in step 2 of the model above and the results were the same since the two models are using the same data.

In ***Step 2*** the reference period was calculated. Formulas presented in Step 4 of Model 1 above were used to derive reference periods.

In ***Step 3***, probabilities of surviving from birth to age 2, *l(2),* as estimated above for childhood mortality have been used.

In ***step 4***, the survivorship probabilities from birth were estimated in the following way:

- For men: $l_m(n) = a(n)+b(n)SMAM_f+c(n)SMAM_m+d(n)NW_f(n\text{-}5) + e(n)\, l_m(2) + f(n)\, RSW$

- For women: $l_f(n) = a(n) + b(n)\, SMAM_f + c(n)SMAM_m + d(n)NW_m(n) + e(n)l_f(2) + f(n)RSW$

Where *a(n), b(n), c(n), d(n), e(n) and f(n)* are coefficients that depend both upon sex and upon age; $SMAM_f$ and $SMAM_m$ are the singulate mean ages at marriage for females and males, respectively; *NW(n)* is the proportion of ever-married respondents aged from *n* to *n+4* whose first spouse was alive at the time of the interview; *l(2)* the probability of surviving from birth to age 2 for the spouses; and RSW is the ratio of *l(20)* and *l(2)* in the standard model life table[34]. It has to be noted that the DRC population as captured by the 1984 census had the characteristics of East model life table as put together by Coale and Demeny.

Results on the indicators needed to derive estimates on adulthood mortality for both models are summarised in Table 4.4 below. From these results, each model derived adulthood mortality estimates to be linked with estimates on childhood mortality presented above. Results on adulthood mortality estimates are summarised in Table 4.5 below.

[34] In this case, RSW represents values that were calculated for female level 16 life tables from Coale-Demeny family of East model life table. The value of RSW indicates the relationship between child and adult mortality in estimation of survivorship probabilities from birth on the basis of widowhood data. Mortality levels are the result of regression analysis of empirical life tables for each sex. In steps of five, mortality levels run from 0, corresponding to a life expectancy at birth of just 20 years, to level 115 with a corresponding e_0 of 73.9.

Table 4.4 Calculation of mean age at marriage based on the widowhood data

Indicators needed	Men	Women
Total years of singleness lived before age 50	2692.08	2277.16
Percentage still single at exact age 50	5.74	8.67
Total number of years of singleness lived by those not marrying at age 50	287.00	433.52
Those who experienced marriage	2405.09	1843.64
Number of those who married by age 50	94.26	91.33
Singulate Mean Age at Marriage	25.52	20.19

Amongst many other things, Table 4.4 above shows that the percentage of women who are still single at age 50 is higher than for men. On average, men marry five and a half years later than women.

Table 4.5 Average level of adulthood survivorship probability

Age n	Male probability of surviving based on data from female respondents				
	lm(n)/lm(20)	South	North	East	West
25	0.9898	19.21	22.49	20.65	19.73
30	0.9882	21.52	24.29	22.86	22.64
35	0.9799	21.46	23.91	22.54	22.38
40	0.9618	20.43	22.96	21.47	21.52
45	0.9210	18.56	21.05	19.40	19.88
50	0.8554	16.38	18.63	17.22	18.19
55	0.7389	12.88	15.21	13.89	15.51
60	0.5291	6.93	9.52	7.88	10.69
Age n	**Female survivorship probability based on data from male respondents**				
25	0.9687	10.87	11.18	10.12	12.29
30	0.9931	22.16	23.78	22.28	22.66
35	0.9984	24.00	24.01	24.00	24.00
40	0.9979	24.01	24.01	24.01	24.01
45	0.9920	24.08	24.01	24.01	24.01
50	0.9825	24.00	24.02	24.01	24.01
55	0.9713	24.00	24.02	24.01	24.01

Each *l(x)* value obtained for childhood survivorship, in Step 3 for Model 1 and Step 4 for Model 2, implied a mortality level in a family of Coale and Demeny model life tables. However, as it can be seen from Table 4.5 above, estimates for females were implausible. This can be explained by the fact that the model used does not suit the DRC 1984 census data. In fact the weakness of the widowhood data for male respondents can be suggested by the fact that mortality levels associated with the conditional survivorship probabilities for females as shown in the bottom panel of Table 4.5 fail to increase as the age of respondent decreases.

Taken at face value, the estimates shown in Table 4.5 would imply that the level of female adult mortality in DRC has remained unchanged over time. However, the small likelihood of such an event happening in the context of the DRC makes their accuracy questionable. Further to that, when these levels are combined with child mortality to construct complete model life tables for all four regions, as shown in Table 4.6 below, more inconsistencies and implausibility emerged. One of the reasons can be linked to the fact that the census question did not distinguish between first marriage and marriage in the case of widowhood (Institut National de la Statistique, 1999, p. 25). Not specifying this question in the census can lead remarried husband which is often the case in DRC, to respond that their spouse is still alive when they are talking about remarriage rather than first marriage. For this reason, it can be submitted that the DRC case is a good example of how the application of a variety of estimation methods allows the assessment of data quality.

4.4 Combining sets of mortality estimates

The average child mortality level and the average mortality level obtained from the computation of conditional adult survivorship probabilities were combined by region or family model life table to construct a composite life table. For childhood mortality, averaging the l(x) functions of the life tables was enough to derive the final l(x). For Model 1, the final l(x) value had to be calculated by weighting the values of l(n) / l(20) from age 25 onward over the final l(x) at age 20. This is because the condition, for this model, is that to be included into the adulthood survivorship probability one must be aged 20. Adulthood mortality estimates coming from Model 2 could simply be linked with childhood mortality estimates in order to obtain a complete pattern of mortality or survivorship probabilities.

Estimates of conditional survivorship probabilities derived in Model 1 and Model 2 above were linked with other information about childhood survivorship in order to, make a derivation of a complete life table and incorporate elements of smoothing over the range of survivorship estimates available.

It can be seen from Table 4.5 above that the average mortality level for the South model life table is 17.2, for the North is 19.8, for East 18.2 and for West 18.8. Using Coale-Demeny model life tables and the linear interpolation, it was possible to calculate, for instance, survivorship probabilities for the East model life table by weighting values of *l(n) / l(20)* for levels 17 and 18 where probabilities related to level 18 were weighted by 0.8 and those related to level 17 weighted by 0.2. Results with final *l(x)* obtained by linking childhood with adult survivorship probabilities are shown in Table 4.6 below. Here it was important to conduct an extrapolation at pivotal age in order to smooth out the link between the two age ranges, young age and adult age derived survivorship estimates.

Table 4.6 Smoothed model life table from a set of survivorship probabilities

	Men survivorship probabilities				**Women survivorship probabilities**			
Age	South final *l(x)*	North final *l(x)*	East final *l(x)*	West final *l(x)*	South final *l(x)*	North final *l(x)*	East final *l(x)*	West final *l(x)*
0	1	1	1	1	1	1	1	1
1	0.8632	0.8719	0.8403	0.8542	0.8702	0.8781	0.8466	0.8625
2	0.8212	0.8380	0.8138	0.8208	0.8237	0.8409	0.8153	0.8242
3	0.8019	0.8173	0.8028	0.8061	0.8024	0.8180	0.8019	0.8070
4	0.7915	0.8020	0.7959	0.7965	0.7911	0.8007	0.7932	0.7959
5	0.7858	0.7903	0.7908	0.7894	0.7847	0.7876	0.7871	0.7875
10	0.7703	0.7588	0.7763	0.7722	0.7675	0.7527	0.7701	0.7675
15	0.7617	0.7427	0.7683	0.7601	0.7576	0.7346	0.7601	0.7523
20	0.7489	0.7239	0.7552	0.7427	0.7436	0.7157	0.7462	0.7323
25	0.7370	0.7162	0.7438	0.7317	0.7410	0.7134	0.7434	0.7294
30	0.7253	0.7073	0.7324	0.7202	0.7380	0.7106	0.7400	0.7258
35	0.7116	0.6977	0.7201	0.7075	0.7342	0.7072	0.7358	0.7214
40	0.6962	0.6868	0.7050	0.6920	0.7297	0.7031	0.7300	0.7154
45	0.6760	0.6735	0.6851	0.6718	0.7231	0.6971	0.7220	0.7069
50	0.6500	0.6574	0.6572	0.6441	0.7141	0.6888	0.7097	0.6939
55	0.6140	0.6348	0.6168	0.6058	0.7003	0.6759	0.6913	0.6745
60	0.5652	0.6037	0.5606	0.5524	0.6804	0.6574	0.6640	0.6457

Source: Own work based on 1984 census using Coale and Demeny

Table 4.6 gives a summary of the derived final l(x) survivorship probabilities after childhood and adulthood mortality estimates were linked. Results in Table 4.6 are essentially from the application of Model 1 as described above. It has to be noted that Model 2 produced very similar estimates although in Model 2 these estimates were only slightly lower than those produced using Model 1.

Estimates in Table 4.6 show that, at birth, according to the South model life table a male child has 86% chance of attaining the age of one, and then about 82% chance of attaining the age of two conditional on having survived his first birthday. With regards to adult age, it can be seen that a male adult aged 55 years old has around a 61% chance of attaining the age of 60. The situation observed with south model life table is very similar with that in the other model life tables. However, the higher survivorship probability observed at adult ages is not consistent with the level of mortality observed in the DRC around 1984. In the 1984 DRC census, life expectancy at birth e_0 in DRC has been estimated at around 48 years for women and 45 for men (Institut National de la Statistique, 1994, p. 16). For this reason, estimates derived from applying Model 2 are not to be included in subsequent analyses conducted in the current study.

Model 3

For Brass logit life-table system, pairs of survivorship probabilities, one from birth and another conditional on attaining a certain age, uniquely determine values of the parameters α and β of the equation[35] defining the life table. Because one adult-age survivorship probabilities are conditional on attaining a certain age, the values of parameters α and β were estimated iteratively. Unlike the above two models where sets of model life tables were used to derive mortality estimates, the logit system derives estimates from the following mathematical relationship (UN Population Division, 1983; Newell, 1988, p. 151).

$$\text{Fitted } l_x = 1 / (1 + e^{2\ YFit(x)})$$

The above equation is explained in the following steps:

---

[35] Similar to the simple equation of a straight line, α is the intercept and β is the slope of the line. Here, altering α will affect the level of mortality, while altering β will affect the relationship between childhood and adult mortality.

Step 1 consists in collecting observed data on proportion of surviving children from children ever born and that on parents alive – coming from the question: “is your father/mother alive?” which yielded mortality estimates for each sex.

Step 2 focussed on finding the model life table that best fits estimates coming from observed proportions of surviving children and that on parent alive. Here logits of standard values – UN general standard[36] and African standard[37] – were used through a two-parameter linear transformation against the logits of the observed values found in the census to identify sets of α and β that best depicts life expectancies in DRC as they were back in 1984 (UN Population Division, 1983).

In ***Step 3***, after fitting the line, the values of α and β were calculated. Here the value of α will indicate the overall level of mortality compared to the standard used and the value of β indicates the slope or the ratio between childhood mortality relative to adulthood mortality between the observed and the standard estimates.

$$\alpha = y_c - \beta * x_c \qquad \beta = (y_a - y_c) / (x_a - x_c)$$

Where y_c is the average of observed childhood logits and x_c the average of standard logits; in the same way, y_a is the average of observed adulthood logits and x_a the average standard adulthood logits.

Having identified sets of α and β that transform the UN and the African Standards with plausible life expectancies for males and females, corresponding values of α and β were computed to assess the best fit and results are presented below.

---

[36] This was constructed as an overall average of the mortality patterns found in Coale & Demeny’s South, North, East and West model life table as described in the UN Population Division, Manual X.

[37] Identical to the UN Standard after age 10, but in the African Standard childhood mortality is higher, relative to infant mortality, than in the UN or General Standard.

Table 4.7 Fitting logits for surviving children and parent alive

	Female		Male	
	α	β	α	β
UN Standard	-0.0622 (*P* value=0.57)	0.985 (*P* value<0.01)	-0.046 (*P* value=0.61)	1.01 (*P* value<0.001)
African Standard	-0.209 (*P* value<0.05)	0.699 (*P* value<0.01)	-0.176 (*P* value=0.04)	0.74 (*P* value<0.001)

Source: own calculation based on regression between observed and UN and African Standard

It can be seen from Table 4.7 that fitting logits for observed proportions against the African standard produced a value of α parameter with the smaller *p* value than when fitted against the UN standard. However, the fact of having a smaller *p* value for α alone is not a sufficient justification to select survivorship probabilities derived from the fitted logit of observed proportions and the UN standard for the life table. In addition to a small *p* value, survivorship probabilities from the UN standard must also be the most plausible when compared to those generated from the African standard and the four family model life tables by Coale-Demeny.

In ***step 4***, with the values of *α* and *β* obtained in step 3 logits of the fitted model were calculated using the following equations:

$$Y_{Fit}(x) = \alpha + \beta * Y_s(x); \qquad Y_s(x) = 0.5 * \ln((1- l(x)) / l(x))$$

Where $Y_{Fit}(x)$ is the logits of the fitted model at age *(x)* and $Y_s(x)$ logits obtained from the standard model life tables; this can be the UN General, the African or any other model life table used as the standard.

Finally, in ***step 5***, the fitted l_x*s* were computed by taking the anti-logits or expits of Y_{Fit}(x) using the following equation:

$$\text{Fitted } l_x = 1 / (1 + e^{2\, YFit(x)})$$

Table 4.8 below gives a summary of fitted logit model by plotting observed estimates on both childhood and adulthood mortality from the studied population against those of the two standards. The relationship with the best fit was selected, the parameter values *α* and *β* estimated then used to derive a complete life table. See Appendix 1 for a complete table for both males and females using the UN standard.

Table 4.8 Finding fitted logit model life table: Males, D R Congo, 1984

	Male UN standard			**Male African standard**			
x	*$Y_x(x)$*	*$Y_{Fit}(x)$*	*Fitted l_x*	*$Y_s(x)$*	*$Y_{Fit}(x)$*	*Fitted l_x*	*Observed l_x*
0			1			1	
1	-0.8670	-0.9220	0.8634	-0.9972	-0.9172	0.8623	0.8496
2	-0.7153	-0.7688	0.8231	-0.8053	-0.7747	0.8248	0.8353
3	-0.6553	-0.7082	0.8048	-0.7253	-0.7153	0.8070	0.8171
4	-0.6218	-0.6744	0.7939	-0.6820	-0.6832	0.7968	
5	-0.6016	-0.6540	0.7872	-0.6514	-0.6604	0.7893	0.7961
10	-0.5498	-0.6016	0.7691	-0.5498	-0.5850	0.7631	0.7751
15	-0.5131	-0.5646	0.7557	-0.5131	-0.5577	0.7531	0.7448
20	-0.4551	-0.5060	0.7334	-0.4551	-0.5147	0.7368	
25	-0.3829	-0.4330	0.7039	-0.3829	-0.4611	0.7155	
30	-0.3150	-0.3645	0.6746	-0.3150	-0.4106	0.6945	0.6213
35	-0.2496	-0.2984	0.6449	-0.2496	-0.3621	0.6735	0.4938
40	-0.1817	-0.2298	0.6129	-0.1817	-0.3117	0.6510	0.3387
45	-0.1073	-0.1547	0.5767	-0.1073	-0.2564	0.6255	0.2292
50	-0.0212	-0.0677	0.5338	-0.0212	-0.1925	0.5951	0.1373
55	0.0832	0.0378	0.4811	0.0832	-0.1150	0.5572	0.0826
60	0.2100	0.1659	0.4178	0.2100	-0.0208	0.5104	
65	0.3746	0.3321	0.3398	0.3746	0.1014	0.4495	
70	0.5818	0.5414	0.2530	0.5818	0.2553	0.3751	
75	0.8611	0.8235	0.1615	0.8611	0.4627	0.2839	
80	1.2433	1.2096	0.0817	1.2433	0.7465	0.1835	
85	1.7810	1.7527	0.0292	1.7810	1.1457	0.0918	
90	2.5634	2.5430	0.0061	2.5634	1.7267	0.0307	
95	3.7090	3.7002	0.0006	3.7090	2.5774	0.0057	

Source: Own work based on 1984 census using Coale and Demeny

Table 4.8 above gives two sets of similarly fitted l_x values one from the UN standard and the other from the African standard, both using male estimates. It can be seen, for instance, that for younger age fitted survivorship probabilities, the UN standard shows that almost 86% of new-born Congolese males are more likely to reach age 1 and the African standard gives a similar percentage for the same age. With regards to adult age, whilst the percentage of male Congolese who are likely to reach adult age was decreasing fast when using the UN standard, the African standard shows the same percentage decreasing a little slower with the increase in age. For this reason and given the low life expectancy in the DRC around year 1984, the UN standard was deemed more plausible than the African standard. Therefore, age-specific survivorship estimates derived from the UN standard model life table is more likely to be selected and therefore included in subsequent analyses undertaken in coming sections and chapters of the current study.

4.5 Evaluating model life tables

Before confirming the choice of the model life table adopted for subsequent analyses conducted in the current study, it was important to provide an evaluation of available model life tables. Based on existing literature (Brass, 1968); (Murray, et al., 2003); (Jasseh & Timæus, 2004) and as far as chapters four and five are concerned, the current study distinguished four model life tables from which to select the most plausible: the United Nations model life table; Coale and Demeny regional model life tables; Lederman system of model life tables and Brass logit life table system. An alternative or fifth model life table, INDEPTH, is explored in the chapters looking at the open population scenario and the range of plausible estimates of excess population loss. INDEPTH model life table have the particularity of adding to the models sub-Saharan mortality schedules, the impact due to the prevalence of HIV and the resulting orphan hood patterns on the derived survivorship estimates.

The first three model life table systems belong to the category of mortality models known as empirical. This is because they are derived from sets of existing empirical life tables. Brass logit life table system is said to belong a category of mortality models called relational because derived from a mathematical transformation and can relate standard life table to any life table (Murray, et al., 2003).

Each of the above mentioned model life tables have their strengths as well as their limitations. The current study is interested in some of their shortcomings to decide whether or not a given system is suitable for the approach suggested here to derive age-specific survivorship patterns that are plausible based on the DRC 1984 demographic situation.

The one parameter United Nations model life tables have the weakness of being relatively inflexible when applied to complex mortality patterns. This is not helped by the fact that the quality and quantity of demographic data available for the DRC since 1984 is an issue. Both the one and two parameters United Nations model life tables suffer from the fact that not only were some of the empirical tables included of dubious quality, but moreover, their life tables as derived from the 1984 census are now outdated. For these reasons, though mainly their inability to cope with complex mortality patterns, the United Nations model life tables were not considered to be used for analyses conducted in this part of the current study.

Despite having much higher standards of accuracy for the empirical tables, the Coale and Demeny regional model life tables had only a limited number of non-European countries from which to derive its model life tables. As such, it can be argued that Coale and Demeny tables may not qualify to adequately sketch patterns of mortality existing in developing countries or more specifically in sub-Saharan countries such as the DRC. Studies have pointed to examples of well-documented mortality patterns that lie outside the range of the Coale and Demeny tables (Murray, et al., 2003); (Jasseh & Timæus, 2004). It can also be said that, the fact that one of the parameters represented by the family or region in the Coale and Demeny system is discrete. This makes the system less flexible when compared to other systems such as the logit model life table system where both parameters are continuous. Despite their weaknesses, Coale and Demeny regional model life tables were not as inflexible to apply to this study as the United Nations'. For this reason Coale and Demeny model life tables were included in this study in order to at least help crosscheck with estimates derived from another system.

The Lederman system is complex and almost impossible to apply in most developing countries. The independent variables used in deriving the model refer mainly to parameters obtained from data where both sexes are combined making it impossible to, for instance, estimate a Lederman model life table in which the males' expectation of life exceeds that of females. For these reasons, the Lederman model life system was not considered for this study.

Despite providing the most plausible survivorship estimates, the Brass Logit life table system has a weakness related to the fact that two survivorship functions in logits are not always linear. It is said that deviation from linearity is large when the observed mortality is far from that of the standard. For this reason, the complexity of variations in levels and age patterns of mortality may not be fully captured. This observation led several authors to modify the original model (Murray, et al., 2003).

The above-mentioned modification involved the inclusion of extra parameters that allow for curves in the survivorship function. The modification rendered the model more flexible but also difficult to use in practice. If the suggested modifications were not used in the current study this is mainly due to the criteria applied in the selection of model life tables found in the dataset from which standard functions needed to modify the logit system are estimated. Adding to the criteria of completeness and age- and sex-specific detail, life tables of population during periods of war or those affected by the Spanish Influenza pandemic of 1918-19, data for years prior to 1990, data with atypical age patterns of mortality, small populations with a total size of less than one million were excluded (Murray, et al., 2003).

The resulting set of 1,802 life tables used to develop the model had a preponderance of countries from Europe, North America and Australia. Among the 63 countries represented about one-third are from developing countries. However, the main problem with this system is linked to the fact that the tests of its predictive power is heavily weighted towards populations with life expectancies between 60 and 73 for males and 66 and 80 for females in a sample of high quality life tables (Murray, et al., 2003, pp. 10-16). Adding to that is also a problem linked to the fact it is unclear how well the model system would perform in countries such as the DRC where there are not only incomplete data sources, but also atypical age- and sex-specific mortality patterns as well as high levels of HIV. For these reasons and given that the current study is more interested in applying a model life table system which derives mortality estimates which are plausible and close to the ones found in the DRC 1984 census. For these reasons, the modified logit system was not considered for this study.

The above three empirical model life tables depended heavily on the types of data from which they have been derived. In most cases, the data upon which the above mentioned model life tables were built excluded a significant proportion of possible mortality schedules, especially, those related to developing countries like the DRC. For this reason, this study proposed and decided to use the logit system. This is so that it is possible to account for existing empirical models describing mortality patterns in the DRC such as derived from the 1984 census data. The Coale and Demeny regional model life table was also retained in order to provide an alternative and comparative evaluation of the two systems.

The exercise consisted of implementing gradually both the fitted l_x from the Brass logit system and the l_x from the Coale and Demeny system into a life table led to the selection of the UN standard. The choice to use the Brass logit system is the best because the fitted l_x from the Brass logit system produced more plausible sets of life expectancy estimates by sex when compared to existing estimates found in the literature and indeed the DRC official statistics from 1984 (Institut National de la Statistique, 1994, p. 16). Adding to that is the fact that the DRC 1984 population is the baseline for the population projections conducted in chapters to come.

Table 4.9 below gives figures of life expectancy by sex as derived using both, the Coale and Demeny regional model life tables and the Brass logit system of model life tables.

Table 4.9 Selecting plausible life expectancies

	Coale and Demeny model life tables								**Brass Logit system**			
Age	South		North		East		West		African Standard		**UN Standard**	
	Male	Fem	Male	Fem	Male	Fem	Male	Fem	Male	Fem	**Male**	**Fem**
0	54	41	57	58	59	60	54	60	50	53	**45**	**47**
1	62	46	65	65	69	70	62	69	57	62	**51**	**54**
5	**63**	47	67	68	69	71	63	71	58	63	**52**	**55**
10	**60**	43	65	66	65	67	59	68	55	59	**48**	**51**
15	**55**	38	61	63	61	63	55	64	50	54	**44**	**47**
20	**51**	34	58	60	57	59	51	61	46	51	**40**	**43**
25	**47**	41	53	55	53	55	47	56	43	47	**37**	**40**
30	**43**	38	49	50	48	50	43	52	39	43	**33**	**36**
35	**39**	34	45	45	44	45	39	47	35	38	**30**	**32**
40	**34**	30	40	40	40	41	34	42	31	34	**26**	**28**
45	**30**	26	36	36	36	36	30	38	27	29	**23**	**24**
50	**26**	22	32	31	33	32	26	33	23	24	**19**	**20**
55	**23**	18	28	27	29	27	23	29	19	20	**16**	**16**
60	**20**	14	24	22	27	23	20	25	16	16	**13**	**12**
65	**16**	11	20	20	21	21	16	22	13	12	**10**	**9**
70	**13**	9	17	17	18	18	13	19	10	9	**8**	**7**
75	**10**	7	13	13	15	15	10	15	8	8	**6**	**5**
80	**8**	6	10	10	12	12	8	12	6	7	**5**	**5**
85	**6**	4	6	6	9	9	6	9	4	5	**4**	**4**
90	**4**	4	3	3	6	6	4	6	3	4	**3**	**3**
95	**3**	3	3	3	3	3	3	3	3	3	**3**	**3**

Source: own work based on derived model life tables from 1984 census data

It can be seen from Table 4.9 that the using survivorship estimates as derived from the Coale and Demeny model life tables produced inconsistent distributions of life expectancies that were not plausible when compared to life expectancies on the DRC found in the literature (see the DRC 1984 census). Looking at fitted l_x from the Brass system derived through the African Standard, a higher life expectancy at birth can be seen which cannot be corroborated by any other figures available for the DRC during that period.

Fitted l_x from the Brass system derived through the UN Standard stand out as they produced estimates of life expectancy that are consistent in their distribution by age-group and sex, when compared to the other estimates. Additionally, these estimates corroborate with estimates from the DRC Institut National de la Statistique (1994, p. 16); where at birth females are expected to live up to age 47 and males up to age 45. In this respect, the fitted l_x from the Brass system derived through the UN Standard was selected as this study's model life table.

4.6 Reconstructed model life table

The section above explained how the current study proceeded to adopt a model life table system that is able to produce mortality estimates which fits best existing estimates as produced in the DRC 1984 census. To do so, it was important to conduct a succinct yet comprehensive evaluation of existing model life table systems then justify the decision to select the one used in this study.

As previously mentioned, being the best fit is not a good enough justification for survivorship probabilities from a given model life table to be selected as final estimates to be used in the projection. An appraisal of the more relevant mortality estimates as reflected in life expectancies was needed for the projection. The choice of model life system was made, according to the nature and significance of the data at hand and based on derived model life tables. This is to establish which one is truly compatible with what is known about the DRC mortality patterns around the 1980s. As a result, the UN standard derived from the logit system, as explained by Newell (1988), was selected to produce the model life table where mortality estimates for this study's cohort components projection come from.

Based on information from the complete model life table as constructed using Brass logit system, abidged life tables by sex were constructed. The constructed life tables had to reflect the demographic situation that prevailed in the DRC in the 1980s. For this reason, mortality and fertility estimates as derived from sections 4.1 to 4.3 above were tested one by one in order to select those reflecting a demographic situation which best captured the real situation of the DRC population in 1984. In this respect, mortality estimates from the Brass logit system and the reconstructed fertility schedules were used to produce the following life tables shown in Table 4.10 and Table 4.11 below.

Table 4.10 Model life table for males based on 1984 census

Age	n	$_nM_x$ per 1,000 (m_x)	$_nq_x$	$_np_x$	l_x	l_x*100,000	$_nd_x$	$_nL_x$	T_x	UN std e_x
(1)	(2)	(3)=(8)/(9)*1,000	(4)=(8)/(7)	(5)=1-(4)	(6)=(Fitted l_x)	(7)=(6)*100,000	(8)=(7_x)-(7_{x+n})	(9)= (7)-[0.5*(8)]*[(2)*sex ratio]	(10)=Σ(9_{x+n})+(9_x)	(11)= (10)/(7)
0	1	151.006	0.137	0.863	1.000	100,000	13,657	90,440	4,507,057	45
1	4	23.114	0.088	0.912	0.863	86,343	7,630	330,112	4,416,617	51
5	5	4.633	0.023	0.977	0.787	78,713	1,802	389,058	4,086,505	52
10	5	3.523	0.017	0.983	0.769	76,910	1,343	381,195	3,697,447	48
15	5	5.984	0.029	0.971	0.756	75,568	2,228	372,269	3,316,252	44
20	5	8.201	0.040	0.960	0.733	73,340	2,947	359,333	2,943,982	40
25	5	8.521	0.042	0.958	0.704	70,393	2,936	344,624	2,584,649	37
30	5	8.987	0.044	0.956	0.675	67,457	2,964	329,872	2,240,025	33
35	5	10.191	0.050	0.950	0.645	64,492	3,205	314,449	1,910,153	30
40	5	12.158	0.059	0.941	0.613	61,288	3,616	297,398	1,595,704	26
45	5	15.462	0.074	0.926	0.577	57,672	4,293	277,627	1,298,305	23
50	5	20.527	0.098	0.902	0.534	53,379	5,211	253,868	1,020,678	19
55	5	28.395	0.133	0.867	0.482	48,168	6,385	224,876	766,810	16
60	5	40.542	0.184	0.816	0.418	41,783	7,690	189,688	541,934	13
65	5	59.237	0.258	0.742	0.341	34,092	8,795	148,474	352,246	10
70	5	87.692	0.360	0.640	0.253	25,297	9,097	103,743	203,772	8
75	5	129.834	0.490	0.510	0.162	16,200	7,939	61,151	100,029	6
80	5	188.618	0.641	0.359	0.083	8,260	5,294	28,067	38,879	5
85	5	261.335	0.790	0.210	0.030	2,966	2,344	8,971	10,811	4
90	5	332.757	0.908	0.092	0.006	622	565	1,698	1,840	3
95	5	400.000	1.000	-	0.001	57	57	143	143	3

Source: Indirect survivorship derived from DRC 1984 census data

Table 4.11 Model life table for females based on 1984 census

Age	***n***	**$_nM_x$ per 1,000 (m_x)**	**$_nq_x$**	**$_np_x$**	**l_x**	**l_x*100,000**	**$_nd_x$**	**$_nL_x$**	**T_x**	**UN std e_x**
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
0	**1**	**152.022**	**0.137**	**0.863**	**1.000**	**100000.000**	**13,657**	**89,836**	**4,737,961**	**47**
1	4	23.114	0.088	0.912	0.863	86342.985	7,630	330,112	4,648,125	54
5	5	4.587	0.023	0.977	0.787	78712.903	1,802	392,949	4,318,013	55
10	5	3.523	0.017	0.983	0.769	76910.432	1,343	381,195	3,925,065	51
15	5	5.924	0.029	0.971	0.756	75567.619	2,228	375,992	3,543,869	47
20	5	7.886	0.040	0.960	0.733	73340.077	2,947	373,706	3,167,877	43
25	5	8.115	0.042	0.958	0.704	70393.061	2,936	361,856	2,794,171	40
30	5	8.096	0.044	0.956	0.675	67456.670	2,964	366,158	2,432,316	36
35	5	9.099	0.050	0.950	0.645	64492.172	3,205	352,183	2,066,158	32
40	5	10.303	0.059	0.941	0.613	61287.556	3,616	350,930	1,713,975	28
45	5	13.329	0.074	0.926	0.577	57671.766	4,293	322,048	1,363,045	24
50	5	17.850	0.098	0.902	0.534	53379.154	5,211	291,948	1,040,997	20
55	5	25.813	0.133	0.867	0.482	48167.916	6,385	247,364	749,049	16
60	5	37.194	0.184	0.816	0.418	41782.649	7,690	206,759	501,685	12
65	5	68.088	0.258	0.742	0.341	34092.387	8,795	129,173	294,925	9
70	5	115.384	0.360	0.640	0.253	25297.274	9,097	78,845	165,753	7
75	5	170.834	0.490	0.510	0.162	16199.876	7,939	46,475	86,908	5
80	5	181.363	0.641	0.359	0.083	8260.424	5,294	29,190	40,434	5
85	5	251.284	0.790	0.210	0.030	2966.454	2,344	9,330	11,244	4
90	5	319.958	0.908	0.092	0.006	621.989	565	1,766	1,914	3
95	5	384.615	1.000	0.000	0.001	57.079	57	148	148	3

Source: Indirect survivorship derived from DRC 1984 census data

In Table 4.10 and Table 4.11, columns: (1) represents age; (2) number of years between exact age x and x+n; (3) age specific death rate; (4) probability of dying between exact ages x; (5) probability of surviving from exact age x and age x+n; (6) number of survivors at exact age x; (7) number of survivors at exact age x times 100,000; (8) Number of deaths between exact ages x and x+n; (9) Average number living between exact ages x and x+1; Total population at exact age x and over; (10) expectancy of life from exact age x.

Survival rates from the above life tables – Table 4.10 and Table 4.11 – were used for the cohort components projection in order to calculate the number of people remaining alive through this study's projection period. Deriving these numbers and estimates as explained in Chapter 4 is important as it provides answers to this study's research question three related to steps needed to reconstruct plausible model life table.

Table 4.10 and Table 4.11 above show, for instance, that life expectancy (e_0) at birth in 1984 was 45 years for males and 47 years for females. In the same way, life expectancy at age 50 (e_{50}) was 19 years for males and 20 years for females. In other words, males who have reached age 50 can expect to leave an additional 19 years whilst their female counterparts will expect to live an additional 20 years, assuming death rate is kept constant and there is no war. This is in line with the demographic reality in DRC around 1984 when the census was conducted (Institut National de la Statistique, 1994).

The probability of surviving from birth to age 50 equals l_{50}/l_0 = 53,379/100,000 = 0.53 for males and 54,146/100,000 = 0.54 for females. These probabilities are quite similar for both sexes although females tend to have a slightly better chance of surviving from birth to age 50 than males. In the same way, the probability that a person who survived to age 40 would die before age 60 = $1 - l_{60}/l_{40}$ = 1 – 41,783/61,288 = 0.32 for males and 1 – 42,818/61,827 = 0.31 for females. Again this reflects the fact that females have a slightly better chance of surviving to older age than males do, which thus reflects the demographic patterns that prevailed in the DRC in 1984. It can be seen from Table 4.10 and Table 4.11 that there is a high probability of dying at very young age which is also reflecting the nature of demographic estimates as they were in DRC around 1984, when the census was conducted. The characteristics of the DRC population in the 1980s as shown above also contributed to the choice of the life table derived using UN standard logit model. This is because they corroborate with estimates about the DRC population found in the literature (Institut National de la Statistique, 1991 ; Institut National de la Statistique, 1994).

4.7 Fertility estimates

Future fertility trends are fraught with one of the biggest uncertainties in current demography. There do not seem to be reliable records of births in most parts of the African continent but some have projected the African population to grow fast during this century. Knowing fertility trends and, where possible, keeping reliable records of births in most populated African countries such as the DRC is crucial. Added to this is the fact that the DRC has experienced a devastating armed conflict which has the potential to significantly affect components of population change and more specifically, fertility.

There does not seem to be many empirical studies on fertility in the DRC. The current study draws from two main sources including Shapiro and Tambashe (2003) and Tabutin (1982) to frame its overall approach to fertility in the DRC and derive missing estimates on fertility. The above mentioned studies may not be the gold standard but they offer a basis upon which to develop assessment models and routines needed to prepare estimates needed in the current study.

Shapiro and Tambashe (2003) assessed fertility estimates in the DRC. The study argues that the United Nations' 6.7 DRC fertility rate and the country's own Institut National de la Statistique fertility are of 7.3 are high. Their assessment of the data, based on different factors likely to influence fertility, including mortality, women's education level, socioeconomic development and civil war, suggests a total fertility rate on the order of about 5.5 and that the DRC may have already entered the fertility transition emerging across many sub-Saharan African countries. A close look at the Shapiro and Tambashe (2003) assessment of fertility in the DRC shows limits associated with the lack of reliable recent national data on fertility in the DRC. Shapiro and Tambashe's conclusion as to why the 1984 census estimated fertility of 6.7 was high is based on a comparison made with recorded fertility in other central African countries during in the mid-1980s. According to Shapiro and Tambashe's assessment, a TFR of 6.7 would put the DRC at or near the top in terms of estimated fertility in central Africa, where the average TFR in 1995 was under 5.5 according to Population reference Bureau (1995) and just over 6.0 for the period 1990–1995 according to the United nations (1999); cited in Shapiro and Tambashe (2003, p. 7).

Tabutin (1982) looked at regional movements in fertility in the DRC. In his study, Tabutin grouped results from several surveys conducted in the in the western part of the country between 1955 and 1977. The study shows variation in fertility within the studied region with equatorial areas showing low fertility barely reaching the replacement level in the 1960s and the tropical areas showing high fertility. The study also found that levels of fertility in equatorial areas increased rapidly due to a decrease of endemic sterility among certain ethnic groups (Tabutin, 1982). Although this study was able to provide some interesting insights on the future of fertility in the DRC, the study was only partial and its findings cannot be extrapolated to the whole DRC. Nevertheless, due to a shortage in empirical studies on fertility in the DRC, findings from Tabutin's work as well as Shapiro and Tambashe's (2003) assessment are important in informing the current study's overall approach to estimating fertility in the DRC for the period under study.

For the current study, fertility estimates to be used in the projection are derived from available data using indirect methods. The number of births in each five-year age group of women of reproductive age were added across groups and explored in order to compute the number of births surviving to the beginning of the next projection interval.

Based on the past fertility schedules and the 1984 census data in the DRC, it was possible to derive fertility estimates including the age specific fertility rate (ASFR) to be used in the population projection conducted in this study. Table 4.12 below shows different fertility estimates for the DRC from 1955 to 1990. Estimates in Table 4.12 come from various sources such as the UN's population division estimates, national surveys and other studies. They were used here to inform the method through which to derive this study's fertility estimates. It can be seen from Table 4.12 that, regardless of the source, there has been very little change in the overall fertility estimates for the years preceding 1984.

The estimation process consisted of modelling theoretical age-specific fertility schedules leading to specific ages at childbirth, given the real age composition of the living population and based on the real age-specific fertility schedule at the time of respondents' birth. Despite the fact that fertility in DRC has received considerable attention over the years, there seems to be no agreement on the true level of total fertility rate (Tabutin, 1982; Shapiro & Tambashe, 2003). Results have often shown regional variation in levels of estimated crude birth rates by province ranging from about 25 to about 60 births per thousand persons. However, literature has shown that wide variation in fertility has also been found in other African countries (Brass, et al., 1968).

Table 4.12 Fertility estimates for DRC, 1955 - 1990

Year	Crude Birth Rate	General Fertility Rate	Total Fertility Rate	Source
1955	45.2	203	5.9	DRC 1950 Census
1975	44.6	218	6.3	United Nations
1984	48.1	229	6.7	DRC Census[38]
1984	48.6	192	6.4	This study[39]
1990	46.7	NA	6.4	United nations

Sources: Shapiro & Tambashe, (2003, p. 49); own computation based on 1984 census

[38] As estimated by the DRC Institut National de la Statistique from 1984 census

[39] As estimated in this study based on little information from the 1984 census and existing fertility schedules

For the current study, crude birth rate (CBR) was calculated based on 1984 census data on children aged less than one year old (< 1) divided by total population. However, to account for children who died before the considered year, the calculated CBR was multiplied the number of survivors at exact age 0 over the average number living between exact ages 0 and 1.

➔ This study's CBR = CBR' * (l_0/L_0).

So far, this is done at national level and it can be seen that the result yielded is the lowest when compared with those obtained for previous years. In the same way, general fertility rate (GFR) is smaller than the results obtained in previous years.

It has to be noted that there were no national surveys carried out since the mid-1970s and after the 1984 census. Results from the large scale Enquête Démographique de l'Ouest du Zaïre (EDOZA) study done in the mid-1970s and covering the western part of the country provide a good indication of fertility trends elsewhere in the country during that period (Republique du Zaïre et al. 1977, 1978a, 1978b; cited in Shapiro and Tambashe, 2003, pp, 47-56).

As introduced earlier in this section, according to Shapiro and Tambashe (2003), there was a small increase in fertility of 2 to 3%, when comparing figures from the 1950s with those from the 1970s. It has been argued that the increase reflected the reduction in sterility in the northwest part of the country (Sala-Diakanga 1980; Tabutin 1982; Shapiro and Tambashe, 2003, pp. 49-50). In the same way, fertility estimates from the 1984 census were also recorded to be higher than the 1975 estimates. In contrast, Shapiro and Tambashe's assessment indicates that there was a decline[40] in fertility by 1990. When compared to 1975, Shapiro and Tambashe's own calculation for 1990 shows a more than 20% fertility decline between the two periods. When compared to the 1984 census estimates, the 1990 general fertility rate is almost 14% lower, and the 1990 total fertility rate shows a reduction of more than 26%. This situation led them to claim that such a decline in fertility over a 6-year span was not plausible. Shapiro and Tambashe (2003, p. 50) concluded therefore that the fertility estimates for 1984 are flawed[41]. Because Shapiro and Tambashe's assessment did not provide quantitative details of their calculations, the methods or data used to conduct their assessment it is difficult for the current study to confirm or reject their conclusion. Also, rejecting estimates because they are different from the average central African countries is also questionable since the DRC is not an average central African country where fertility estimates must necessarily be the same as those from other central African countries.

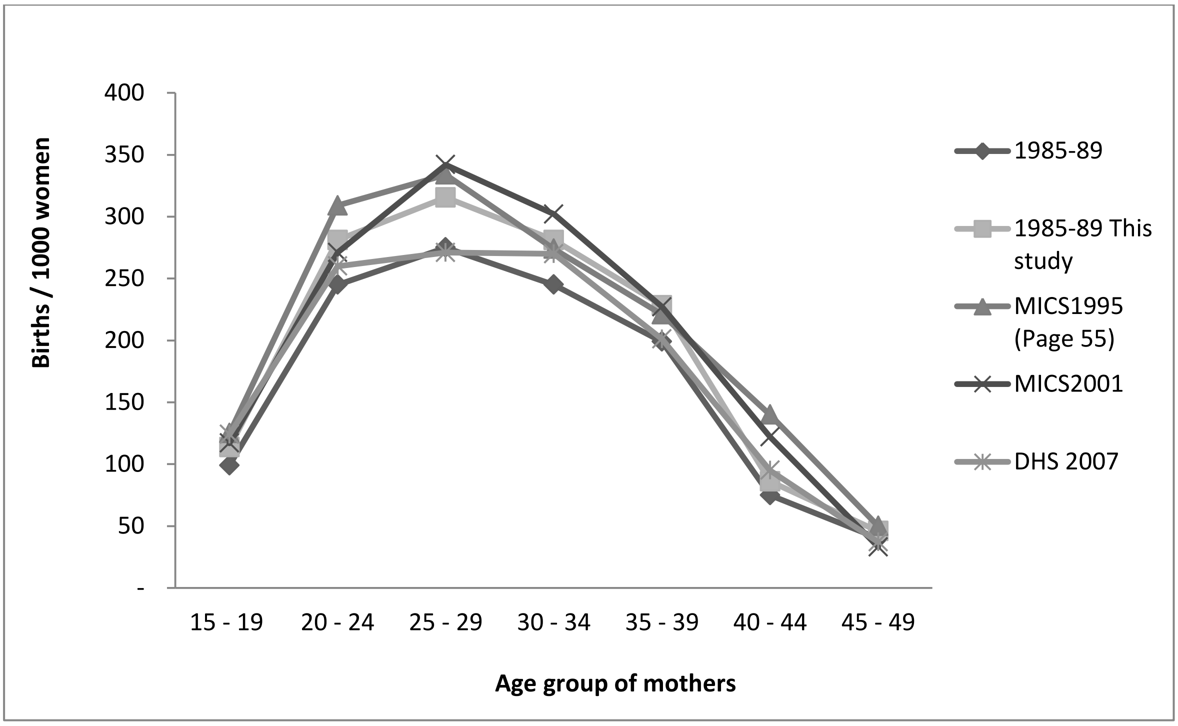
The discussion presented above shows there is a missing fertility schedule for the mid-1980s. Because of the lack of estimates needed to derive fertility indirectly from census data, the current study adjusted Shapiro and Tambashe's estimates for the period 1985-89 by averaging them to the DRC's Institut National de Statistique 1984 TFR to produce the missing age specific fertility schedule presented in Table 4.13 below. Before explaining how total fertility rate used in this study has been derived,

[40] Shapiro and Tambashe fertility estimates for 1990 are direct estimates based on reported birth histories for the 5-year period preceding the survey.

[41] Multiple census reports, e.g. Institut national de la Statistique (1991, p.18) note that fertility estimates were derived using MortPak-Lite; where it is supposed that fertility remains stable in the recent past and yet, using MortPak procedure with data from a single survey when fertility has been falling, will yield incorrect estimates.

Figure 4.4 below shows DRC fertility schedules as derived in various studies from 1985 to 2007.

Figure 4.4 Fertility schedules from 1985 to 2007



It can be seen from Figure 4.4 above that different studies, such as in Shapiro and Tambashe (2003), which looked at fertility in the DRC, came up with similar fertility schedules but not necessarily identical ones. MICS and DHS data provided age specific fertility as obtained using direct methods in their surveys. Except for the years 1985-89, it can be seen that early fertility levels tend to be higher than recent ones, implying a possible decline in fertility.

To derive the harmonised total fertility rate (TFR) used in the current study Shapiro & Tambashe (2003, p. 55) reported[42] number of births per 1,000 by five-year age-

[42] Reported births per 1000 women of reproductive age (15 – 49) distributed in five-year age-groups. Births are for a period of five years (1985 – 1989) preceding Shapiro and Tambashe 1990 survey.

groups of women aged from 15 to 49 was computed with mid-year total number of live births from women aged 15 to 49 as recorded in the DRC 1984 census. Therefore, ASFR used in the current study was calculated by dividing the age-specific mid-year number of births per 1,000 from the Shapiro and tambashe's survey by the age-specific live births observed in 1984 census. This is illustrated in the following two formulas:

*HTFR = B / (TB * CTB)* and

ASFRs = (HTFR / 1000) / (NW)

Where *HTFR* is this study's harmonised mid-year age specific number of births; *B* is Shapiro & Tambashe age-specific live births; *TB* is Shapiro and tambashe total number of births to women 15-49 for years 1985-1989; *CTB* is 1984 Census total live births to women aged 15-49; and *NW* is 1984 census age-specific Mid-year number of women aged between 15 and 49.

Note that in 1984 mid-year number of births to women aged between 15 and 49 was 1,351,000.

From this point it was then possible to apply the estimates to the census population by age and derive age specific fertility rates related to 1984. This is shown in Table 4.13 below.

Table 4.13 Age specific fertility rate: the 1984 census data

Age-group **(1)**	**Number of women** (2)	**Number of births** (3)	**Harmonised number of births** (4)	**Age Specific Fertility rate** (5)
15 - 19	1,655	99	114	0.11
20 - 24	1,466	245	281	0.28
25 - 29	1,133	275	316	0.32
30 - 34	865	245	281	0.28
35 - 39	733	199	228	0.23
40 - 44	597	75	86	0.09
45 - 49	598	40	46	0.05
Total	**7,046.30**	**1,178.00**	**1,351.50**	**1.35**

Source: 1984 census harmonised using DRC fertility schedules from Shapiro & Tambashe 2003

(2) Mid-year number of women aged 15-49 (1984)

(3) Birth/1000 women reported births from (1985-1989) (Tambashe & Shapiro 2003, p. 55)

(4) Shapiro and Tambashe harmonised with census

(5) Harmonised Age Specific Fertility Rate to be used in the study

From the annual total birth, in Table 4.13 above, a crude birth rate (CBR) was obtained using the following formula:

*(B / P) * 1,000* where *B* is the number of births in a year and *P* the midyear population

(1,351.50 / 30,694.60) * 1,000 = 44.03‰.

To calculate CBR, the study had to consider the following assumptions:

- Age of the children and age of women were correctly reported
- All children resided with their mothers
- Mortality is negligible for women and children
- All women and children were covered by the census.

Due to limitations inherent to census coverage and more specifically in the DRC a country characterised by poor data recording and the lack of up to date population studies, it can be said that the DCR produced above did not meet all the required assumptions (Mapatano & Piripiri, 2005).

With regards to age reporting, it has to be noted that in DRC only 19% of women recorded in the 1984 census had an education at secondary school level, 36% at primary school and 43% had no education. This is a significant indicator of the reliability given to age reporting from women in the census can be. In relation to mortality, it can be said that with an Infant Mortality Rate (IMR) of 137 per thousand per year and a Child Mortality Rate of 213 per thousand per year recorded in 1984, it cannot be said that the mortality assumption is met (Institut National de la Statistique, 1994). Added to that is the fact that maternal mortality has not been explored in the census and key estimates are missing for the current study to do the assessment. As for the last assumption related to census coverage, very little is known about the coverage of the 1984 census. However, it cannot be said that all women and children were covered in the census. Given the limitations in the data and the literature around fertility in the DRC for the early 1980s, it can be said that the Crude Birth Rate derived in the current study is more illustrative than accurate.

Age specific fertility rates found in the last column of Table 4.13 above produced the Total Fertility Rate (TFR) of 1.35 * 5 = 6.75. In other words, it will be expected that on average a Congolese woman would have about seven children by the end of their reproductive age.

Summary of Chapter 4

Chapter 4 set out to explore how estimates needed to conduct this study's population projection can be derived and hence prepare the context upon which to answer the current study's second and third research questions related to deriving missing demographic estimates and the steps needed to elaborate upon the projection framework. This chapter includes a section introducing each of the four data sources used in the current study as well as a discussion on their main strengths and weaknesses through subsequent sub-sections. Based on the DRC 1984 census data on children ever born, Chapter 4 of the current study explored assumptions needed to derive age-specific survivorship probabilities and total fertility rates using both direct and indirect techniques of estimation.

In Chapter 4 selected sets of model life tables were explored to derive the most plausible survivorship probabilities as well as the subsequent demographic estimates needed to conduct population projection. Comparing mortality estimates and life expectancy at birth obtained from various model life tables, the logit model life system produced estimates which were consistent enough with existing estimates recorded in the DRC 1984 census along with other existing sources such as the United Nations Population Division.

Fertility estimates used in the current study were obtained by fitting the only fertility schedules available for the mid-1980s with the total number of births to women aged between 15 and 49 as recorded in the 1984 census. Fertility estimates needed to be harmonised by borrowing fertility schedules from one source and applying to it the total number of live births per thousand for the considered period.

It is worth noting that, in the current chapter, data on net migration are not included in the projection model. This is because at this stage, the main aim was to derive estimates needed to run a cohort component projection for a closed population whilst using basic assumptions. The population projection model explored in the current chapter is important to set the calculation routines needed in the projection framework before they can be applied to more advanced assumptions and scenarios assuming an open population as explored in chapters six and seven.

Chapter 4 provides only part of the answer to research questions two and three, which are related to deriving missing estimates and reconstructing a plausible model life table which reflects the DRC demographic situation of the 1980s. The answer provided in Chapter 4 is considered partial because the derived estimates are related to only two components of population change – including fertility and mortality – out of the three needed for a realistic situation. As mentioned above, Chapters 6 and 7 below explore the case of an open population where the other part of the research question is fully addressed. Before exploring scenarios implying an open population, the following chapter explores a cohort component projection model of the derived estimates based on a closed population scenario needed to firm up the routine calculations needed in the projection framework.

Chapter 5 Exploratory analysis

Introduction to Chapter 5

The current chapter draws from the methods and estimates generated in Chapter 4 to collect further elements that will enable the answering of research questions two and three of this study, related to missing demographic data and elaborating on the analytical framework. Using basic assumptions and under a non-war scenario, the current chapter explores the steps needed to project the DRC population. In this projection the 1984 DRC population constitutes the projection baseline and the projection period ends in year 2014.

5.1 Census-based Cohort component projection

At this stage, the 1984 DRC population has been projected initially for thirty years, or from 1984 to 2014 in intervals of five years. Five year intervals were considered as convenient for this study because the base population is divided into five-year age groups.

With regard to research question two of this study; it was important to project the total population size by sex as recorded in the 1984 census for each five-year age group, until a future date covering the armed conflict period. It is through the projection that the number of people who survived or are expected to be alive can be calculated. In the same way, a wide range of assumptions related to population change can be accommodated to the projection model in order to compare and contrast the total size of the population for the projection period.

As mentioned earlier, the 1984 census population was retained as the launch year population. The projection period was determined to be 1984 – 2014 and divided into 5-year projection intervals. The projection period included the conflict affected period. The projection was conducted using the cohort component method for a closed population.

To conduct this projection the following were needed:

- Base year population by five-year age groups from the 1984 census
- Sex specific life tables, as shown in Table 4.13 above.

The projection was applied following the steps below:

The first step of the projection process consisted of establishing the launch-year population and calculating the number of persons who would survive to the end of the projection interval. This was done by applying age–sex survival rates from life tables mentioned above.

The second step consisted of calculating the number of births occurring during the projection interval. This was accomplished by applying age-specific birth rates to the female population of reproductive age in each age group.

The final step was to add the number of births to the rest of the population; before repeating the same process again and again until it covers the whole projection period.

Calculations made provided the population size by age and sex for the projection interval. The obtained population size then served as the baseline or starting point for the following five-year projection interval. The process was then repeated until the end of the projection period in 2014.

It has to be noted that the cohort component method is widely used to produce national population estimates. The method can be traced back to Cannan (1895); as cited in Preston, Heuveline, & Guillot, (2001, p. 119) however, the method was developed in the late 1920s and early 1930s by Whelpton (1928 and 1936); cited in Preston, Heuveline, and Guillot (2001). According to Preston, Heuveline, & Guillot, (2001) the cohort component method has a longstanding tradition in demography and the social sciences in conducting population projections. Its approach consists of dividing the studied population into subgroups differentially exposed to the risks of fertility, mortality, and migration and separately computing the changes over time in each group (Preston, Heuveline, & Guillot, 2001, p. 120).

After deriving mortality and fertility estimates from the 1984 census data, Table 5.1 below gives the summary of a series of estimates to be used to establish a launch-year population.

Table 5.1 Projection model: Input data for launch year (1984) in 1,000s

Age (1)	Life table population at exact ages x and x+n out of 100.000 Lx (2)		ASFR (3)	Actual 1984 DRC population by age group in Thousands Nx (4)		Total in Thousands (5)
	Female	Male		Female	Male	
0 - 4	419,639	420,552		2,854	2,857	5,711
5 - 9	393,219	389,058		2,255	2,243	4,498
10 - 14	381,674	381,195		1,944	1,949	3,894
15 - 19	376,729	372,269	0.11	1,655	1,645	3,300
20 - 24	374,856	359,333	0.28	1,466	1,402	2,869
25 - 29	363,476	344,624	0.32	1,133	1,075	2,208
30 - 34	368,367	329,872	0.28	865	766	1,630
35 - 39	354,934	314,449	0.23	733	641	1,374
40 - 44	354,428	297,398	0.09	597	487	1,084
45 - 49	326,145	277,627	0.05	598	504	1,102
50 - 54	296,738	253,868		525	446	971
55 - 59	252,685	224,876		370	333	702
60 - 64	212,699	189,688		301	307	607
65 - 69	154,262	148,474		161	182	344
70 - 74	109,278	103,743		101	125	225
75 +	94,762	100,029		70	86	156
Total				**15,627**	**15,047**	**30,674**
			1.35			
TFR			**6.75**			

Source: own calculation based on 1984 census data

The projection has been modelled from estimates contained in Table 5.1 where: column (1) gives the age group of the baseline population; column (2) gives the average number living between exact age group x to age group x+5 as worked out in model life tables in Table 4.10 and Table 4.11 above; column (3) gives estimates for age specific fertility rates as adjusted using 1984 census data on children aged below one year old, the crude birth rate of the same period and the fertility schedules from surveys conducted in DRC around the census period in the 1980s; finally, columns (4) and (5) show the DRC actual population number by age group and sex as captured from the 1984 census.

National population projections are conducted for successive years running from one mid-year or baseline. For this to work, five important elements are needed:

- Base population or the starting point for the projections.
- Births or the total number of births in a year is assumed to be divided between males and females following the observed sex ration at the time.
- Deaths or the total number of deaths obtained by adding half inward migrants at each age to the number in the population at the beginning of the year and applying the probability of dying.
- Migration will be explored when dealing with an open population scenario. Because, at this stage of the study, the projection is conducted for a closed population, it is therefore assumed that net migration equals zero for each age-group.
- Variant projections are variant assumptions intended as plausible alternatives to the principal assumptions for future demographic behaviour.

With zero migration, the current projection is left with only two components of population change including births and deaths and the variant projections.

Assumptions related to births were framed in terms of the total number of births as observed in the census year and captured by the number of population aged between zero and one year old. From this figure, it was possible to derive the Crude

Birth Rate, the Age Specific Fertility Rate based on fertility schedules about the DRC around the 1980s when census data were collected.

Assumptions related to deaths were derived from the life table constructed using indirect methods of estimation. The logit system was selected since it offered better flexibility to deal with poor quality data in the 1984 census. Here attention can be drawn to the case of the information on widowhood available in the 1984 census. The question in the census asks respondents of marriage age if their partner is still alive. Answers to the question are skewed with more than 95% of males responding yes whilst only around 60% of women responded yes. It is clear that the answer could have been different if the question referred to first partner rather than partner in general because in the DRC males tend to remarry easily than women (Institut National de la Statistique, 1991).

To obtain, for instance, the projected population in 1989 or 5 years from the launch-year, it was important to have the base year's (1984) population as divided by sex and the components of population change – fertility and mortality – at each age. The projected number of survivors in each column is calculated from the populations in the preceding projection interval and the survival ratios in the launch-year shown in Table 5.1 above.

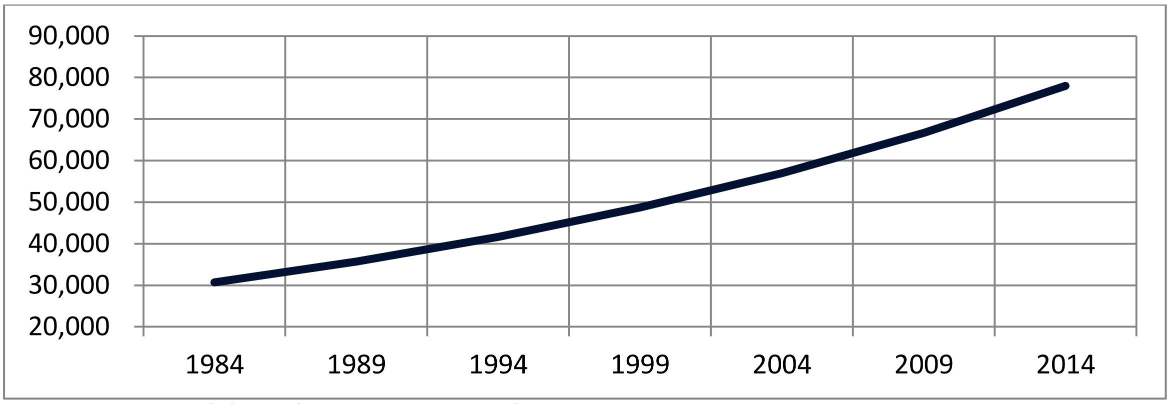
5.2 Components of population change

In this section, results of the 1984-based DRC population projections are presented, with respect to projected size of the population, age structure, and comparison with other projections.

5.2.1 Projected population size

Figure 5.1 below shows the 1984 population as projected when mortality and fertility rates from 1984 are maintained as unchanged for the entire projection period (going from 1984 to 2014) and assuming both a closed population scenario and that there is no armed conflict.

Figure 5.1 DRC Projected population size (in 1,000s)



Source: own work based on 1984 census data

Figure 5.1 and Table 5.2 that the 1984 population is projected to increase by more than the double, to an estimated 78,028,000 or more than the double of the baseline population by 2014.

Table 5.2 DRC Population as projected from 1984: basic assumptions

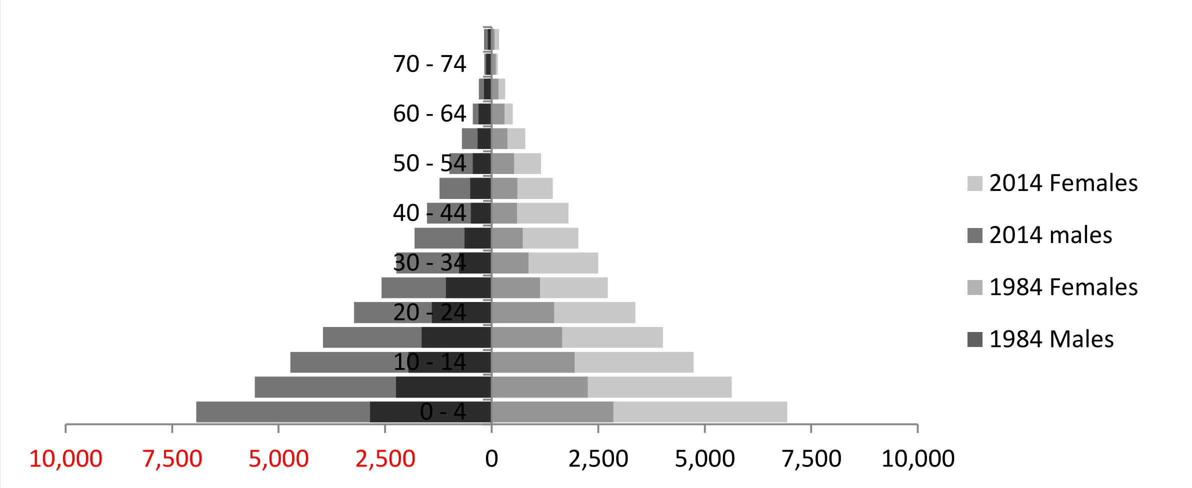
Age-group	1984	1989	1994	1999	2004	2009	2014
0 - 4	5,711	6,725	7,992	9,372	10,896	12,696	14,861
5 - 9	4,498	5,317	6,261	7,442	8,726	10,145	11,821
10 - 14	3,894	4,387	5,185	6,106	7,257	8,509	9,893
15 - 19	3,300	3,823	4,307	5,091	5,995	7,125	8,355
20 - 24	2,869	3,234	3,747	4,222	4,990	5,876	6,984
25 - 29	2,208	2,767	3,119	3,614	4,072	4,813	5,668
30 - 34	1,630	2,177	2,728	3,076	3,563	4,015	4,746
35 - 39	1,374	1,563	2,087	2,615	2,949	3,416	3,849
40 - 44	1,084	1,338	1,522	2,033	2,547	2,871	3,326
45 - 49	1,102	1,004	1,239	1,410	1,883	2,359	2,659
50 - 54	971	1,005	916	1,130	1,286	1,717	2,151
55 - 59	702	842	872	794	980	1,115	1,489
60 - 64	607	591	710	734	669	826	939
65 - 69	344	458	445	534	552	503	621
70 - 74	225	214	285	275	329	341	310
75 +	156	235	222	296	286	343	355
Total	**30,674**	**35,680**	**41,638**	**48,742**	**56,979**	**66,670**	**78,028**

Source: Own projections based on 1984 census

The projection shown in Table 5.2 above was made by sex in order to allow the assessment of sex differentials in each birth cohort and differences in their survivorship throughout the projection period.

As shown above, from 1984 to 2014, the DRC population is projected to increase from 30,674 million to 75,141 million. This shows that the population size is projected to double in the 30 year projection period, given the assumptions and scenario adopted in the current chapter. Based on the assumptions explored so far in the current study, and the sex ratio from the launch year, the female population is expected to rise more rapidly than the male population as shown in age pyramids in Figure 5.2.

Figure 5.2 DRC Age pyramid in year 1984 and as projected for 2014



Source: own projection based on 1984 census data

Based on the projection model explored in the current study, it is possible to look at the extent to which births and deaths contribute to the projected population size and structure.

For the 30 year projection period, it was expected that the gap between births and deaths would continue at almost the same level in line with assumptions made in the current study as shown in Table 5.3 below.

Table 5.3 Population change: summary of projection from 1984 to 2014

	1984 – 89	1989 – 94	1994 – 99	1999 – 04	2004 – 09	2009 – 14
Population at start	30,674	35,257	41,214	48,318	56,556	66,246
+ Births	8,004	9,513	11,154	12,968	15,111	17,688
- Deaths	2,997	3,555	4,050	4,730	5,420	6,330
+ Natural change	5,007	5,957	7,104	8,238	9,690	11,359
Population at end	35,680	41,214	48,318	56,556	66,246	77,605

Source: Own projections based on 1984 population

Table 5.3 shows that throughout the projection period, the DRC is to gain population through natural increase where the difference between births and deaths is the only element to influence the size of population. Changes in population shown in Table 5.3 above result from population estimates as projected under basic assumptions and where migration is considered to be equal to zero. By basic assumptions the current study means assumptions where factual and counterfactual scenarios are not considered. Projections where the above mentioned two scenarios are considered are explored from the next chapter.

5.2.2 Projected age structure

Deriving age patterns from projections conducted in the current study is important since this will help assess the extent to which armed conflict and the ensuing consequences are likely to affect population, differently, according to the age structure or sex composition. Table 5.4 below gives a breakdown of population structure between 1984 and 2014.

Table 5.4 DRC projected age structure (in 1,000s)

Age	1984	1989	1994	1999	2004	2009	2014
0 - 14	14,102	16,428	19,439	22,919	26,879	31,350	36,575
15 - 29	8,376	9,824	11,173	12,926	15,057	17,814	21,006
30 - 44	4,088	5,078	6,338	7,724	9,059	10,302	11,921
45 - 59	2,775	2,851	3,027	3,334	4,148	5,191	6,300
60 - 74	1,176	1,264	1,440	1,543	1,551	1,670	1,870
75 & over	156	235	222	296	286	343	355
All ages	30,674	35,680	41,638	48,742	56,979	66,670	78,028
Median age	16.36	16.62	16.56	16.52	16.22	16.19	16.32
Population Over 65	724	907	952	1,104	1,168	1,187	1,286
% Over 65	2.36	2.54	2.29	2.27	2.05	1.78	1.65
% Under 15	14,102	16,428	19,439	22,919	26,879	31,350	36,575
% Under 5	5,711	6,725	7,992	9,372	10,896	12,696	14,861

Source: This study's projection based on 1984 DRC census.

From this simple model it can be seen that age structure was not projected to change significantly in future years. This is the result of basic assumptions in the number of births, but also the effects of changes in mortality rates. These effects will be introduced with counterfactual scenarios when intermediate estimates will be added to the model. This will then allow a comparison of the difference between factual and counterfactual scenarios as well as the period to which they refer.

As shown in Table 5.4, the percentage of those aged under 5 years old is projected to remain at an almost same level throughout the projection period. It also can be seen that the percentage of those aged 65 years old is very small and is falling after 1999, from 2.36 in 1984 to 1.65 in 2014. This is no surprise since rates are kept constant, leading the projected population size to converge towards a stable population.

Summary of Chapter 5

The current chapter sought to use the methods and estimates generated in Chapter 4 to explore elements needed to answer this study's research questions two and three, related to missing estimates and the framework needed to generate them. Chapter 5 proceeded by using a hypothetical scenario where it is assumed demographic rates of each component remained unchanged throughout the projection period and that the armed conflict did not take place. Results indicate that the DRC population size as projected from 1984 to 2014 is similar to those from other projections conducted by the DRC INS, the UN population division and the US Census Bureau.

The base population, distributed by five year age-group and sex was projected forward from 1984 or 1st of July, which is the reference date of the census, to 1st of July 2014. To find out population size for a specific year, the population size for each projection interval has been interpolated to derive the size of population in a single year belonging to that projection interval. The difference between the highest and the lowest projection during the projected period will be explored in the next stage of this study to refine assumptions and then derive plausible adjustments for future projections.

Based on assumptions explored in the current chapter, age-specific fertility and mortality rates serve to survive the projected population from one projection interval to the next. Age-specific fertility rates were applied to women of childbearing age to derive projected births.

The numbers of children aged between 0 and 1 in 1984 per five year age-group of mothers were combined with existing fertility schedules in the 1980s to derive age specific fertility rates to be used in the projection. The projected births for each projection interval from 1989 were adjusted based on the average ratio of estimated births to projected births for 1984.

Survivorship estimates were taken from life tables constructed using the Brass logit system model life table. Survivorship rates were kept constant throughout the thirty year projection period. In this respect, the projected number of deaths is obtained by the difference between the survived population at the end of each year and the population at the beginning of each year. The projected deaths for each year, starting in 1989, were adjusted based on the difference between projected deaths and estimated deaths for year 1984 as shown in Table 5.3 above.

Chapter 6 Factual and Counter-factual scenarios

Introduction to Chapter 6

Chapter 5 explored a framework upon which to derive missing data and conduct a preliminary population projection based on very simplified assumptions and scenarios. The projection framework derived here in Chapter 6 is set to be a reference upon which to adjust the assumptions needed to answer this study's research questions related to deriving a range of plausible estimates containing the actual excess population loss associated with the armed conflict.

With regard to the baseline population[43], selected estimates – number of years lived between exact age group x and exact age group x+1 *(L_x)* probability of dying between exact age group x and exact age group x+1 *(q_x)* – needed to conduct population projection were derived from the model life table. Direct estimates about infant mortality and age specific fertility rates from three surveys MICS1, MICS2 and DHS were added to the model to benchmark the projection as it proceeded through the projection-period.

Before assessing the factual and counter-factual scenarios, it was important to define the periods demarking the two projection scenarios. After these periods are defined, it was then possible to benchmark them by coupling the periods with estimates, adjusted according to relevant assumptions. Parallel to benchmarking the defined periods, the analysis disentangled individual components of population change for each of the scenarios, before including them in the projection model. At

[43] It is the population constituting the launch year or starting point for the projection.

the end of the process, basic equations were applied to assess changes for each component and according to each scenario.

To ensure that estimates used in both the factual and counter-factual projections reflect the demographic situation as featured in data sources used in this study, it was important to understand the trend followed by each component over the considered projection period. This was to check for plausibility at all levels. In this respect, life expectancy at birth for both male and female, infant mortality (IMR) and child mortality rate (CMR) were assessed.

It can be seen from Table 6.1 that IMR was low in 1984 before increasing and reaching its pick in 1995 then dropping afterward to its lowest level. Life expectancy at birth started off low then gradually increased from 1995 to 2007 where it remained stable until 2010. TFR started high but then dropped by 2001.

Table 6.1 below shows direct demographic estimates needed to benchmark the projections.

Table 6.1 DRC Demographic estimates since 1984

Year	1984	1995	2001	2007	2010
Female (e_0)	48	46	50	58	57
Male (e_0)	45	43	47	55	54
Both sex	46	45	49	56	55
Infant Mortality ($_1q_0$)	137	148	126	92	97
Child mortality ($_5q_0$)	213	220	213	148	158
TFR	6.98	7.27	7.07	6.3	6.3

Source: 1984 census; 1995 MICS; 2001MICS; 2007 DHS and 2010 MICS.

It can be seen from Table 6.1 that life expectancy at birth, for both sex, started from 46 years in 1984 before decreasing to 45 in 1995 and increasing to 56 in 2007 and finally, decreasing to 55 years in 2010. In the same way, 137 children out of 1000 born in 1984 were likely to die before their first birthday. This number became as high as 148 children out of 1000 in 1995 before falling to an estimated 97 children out of 1000 in 2010. As far as fertility is concerned, it was expected, in 1984, that a woman of reproductive age would have a maximum of 6.98 children during her life. This number fell to an estimated 6.3 in 2010.

6.1 Difference between factual and counter-factual projections

Figure 6.1 below shows how the NON-WAR and WAR scenarios were defined. The section reproduces the trend followed by Infant Mortality Rates so that it is possible to distinguish the WAR affected period from the NON-WAR one. This is because IMR influences the trend of the projected population. Table 6.1 above shows that IMR increased from 137 to 148 under-one deaths per thousand per year in 1995 or two years before the start of the conflict. As seen in the background chapter, the DRC was already going through severe crisis in the 1990s.

Figure 6.1 Defining DRC factual and counter-factual affected periods

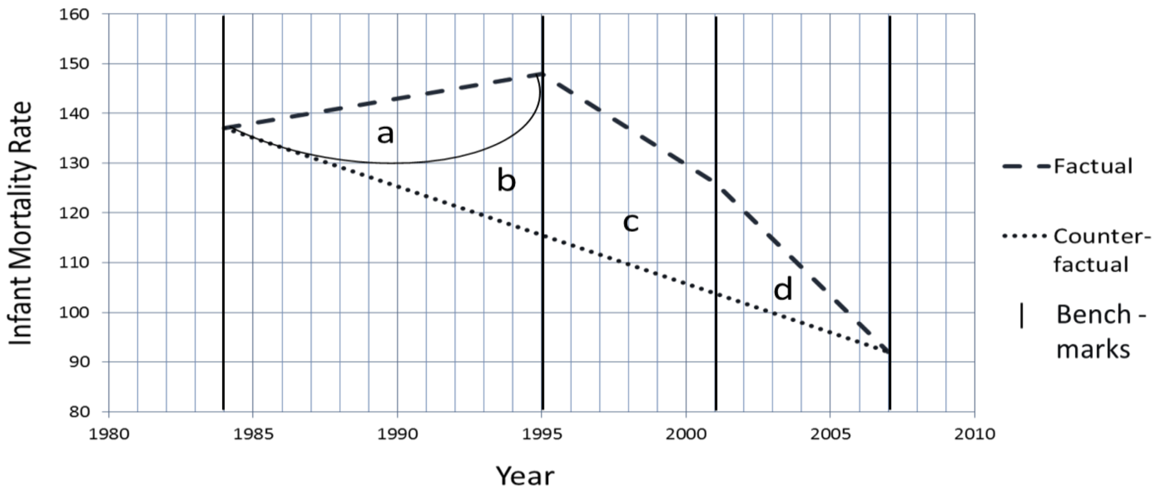


Figure 6.1 has four main areas that helped to define the factual and counter-factual projections and identify the estimates needed to benchmark projections for both scenarios. From this graph, it was possible to allocate the relevant estimates to their projections. The graph can be interpreted as follow:

- The top dotted line in the graph represents the observed or factual IMR as recorded in 1984, 1995 2001 and 2007 datasets. Different points given by these estimates are linked through a linear equation and represent the path followed by infant mortality throughout the projection period.
- The bottom blue line represents IMR in 1984 as recorded in the census and linked, through a linear equation, to IMR in 2007 as recorded in the DHS dataset. The line represents infant mortality throughout the projection period under the counter-factual scenario.
- The line separating areas (a) and (b) is an example of a potential path IMR could have followed between the 1984 census and the 1995 MICS1, with the top line being the maximum values IMR could take between the two periods. In other words, the line separating areas (a) and (b) is an alternative path IMR could have taken and the bottom line represents the minimum values that IMR could take between both the projection interval and the projection period.
- Area (c) shows the path followed by IMR between 1995 and 2001 and
- Area (d) shows the path followed by IMR between 2001 and 2007

With the two scenarios set as shown in Figure 6.1 above, it was possible to adjust the projections following the path traced by IMR and assess the difference between the factual and counter-factual projections.

6.2 Applying assumptions to both factual and counter-factual scenarios

For the NON-WAR scenario the projection period started from 1984 to 2014 and was benchmarked in year 2007 as explained above. For the factual scenario the projection period started from 1984 to 2014 but benchmarked according to war affected periods.

To assess the non-war against the war scenarios, the analysis was conducted as followed.

1. Recreate the number of years lived between exact age group (x) and age group (x+n) also presented as (L_x) in model life table.
2. For each five-year age group x, interpolate the rates to reconstruct missing (L_x) for projection's launch years and benchmark points. The same was done for fertility.
3. Run the projection by incorporating reconstructed rates into the successive steps of the projection.
4. Assess the difference between war and non-war scenarios by comparing the two.

Points 1 to 3 were explored separately for each scenario and in point 4 the two projections were put together in order to be compared.

After explaining how various estimates and periods have been used to benchmark the projection, it was important to explain how fertility estimates have been used in this chapter.

6.2.1 Fertility

For both the factual and the counter-factual projections, TFR by five-year age-group for women of reproductive age were obtained, respectively, from 1995 MICS1 and 2001 MICS2 datasets. These estimates were ready to be used in the projection model without any transformation since they were rates based on 1,000 women of reproductive age as shown in Table 6.2 below.

Table 6.2 Age Specific Fertility Rates per 1,000: benchmark years

Age-group	1995 MICS1	2001 MICS2	2007 DHS
15 - 19	125	117	124
20 - 24	309	271	260
25 - 29	334	342	271
30 - 34	274	302	270
35 - 39	221	227	201
40 - 44	140	122	95
45 - 49	50	33	37
TFR	**7.27**	**7.07**	**6.29**

Source: DRC 1995 MICS; 2001 MICS and 2007 DHS

It can be seen from Table 6.2 and that age specific fertility rates has tended to decrease since age the specific fertility rate in 2007 as captured in the DHS dataset is lower than the age specific fertility rate as captured earlier in MICS1 and MICS2. This is also reflected through the fact that TFR went from 7.27 in 1995 to 6.29 in 2007. There could be many explanations for this; however, it is not surprising that the trend seen here is similar to that observed in many sub-Saharan African countries where fertility rates are either declining or stalling (Bongaarts, 2005; Amoako Johnson, Padmadas, Chandra, Matthews, & Madise, 2012).

After explaining how different inputs were prepared for the projection, the next section shows the results produced by both the non-war and war projections.

6.3 Projection for counterfactual scenario

This section looks at how elements needed for the projection of a counter-factual scenario were prepared and then included into the projection framework. Preparatory tasks are required prior to the projection. These tasks are:

- To recreate the number of years lived between exact age x and age x+n
- Interpolate vital rates from five-year intervals to single year
- Assign interpolated rates to relevant benchmark points

These tasks were needed to conduct projections for the factual as well as for the counterfactual scenarios.

6.3.1 Recreate (L_x)

To recreate the number of years lived between exact age group *(x)* and age group *(x+n)* at launch year at different projection interval's connections, it was important to respect the time points as defined above. The two points in time selected for this purpose were 1984 and 2007. Five year intervals covering the years 1984-1988; 1989-1993; 1994-1998; 1999-2003 and 2004-2008 constituted the projection period for which the interpolated Lx values were needed.

Although war in the DRC, as described in this study, did not start until mid-1996, estimates from year 1995 or MICS1 show a sharp increase in infant and child mortality. Such an increase could be a result of a combination of many other factors including the spill-over of the Rwandan conflict, economic hardship, disease epidemics and HIV. In other words, mortality in the DRC was increasing before the war, as defined in the context of this study. In this respect, it is assumed that the war affected period is comprised in areas, A, B, C and D shown in Figure 6.1.

6.3.2 Interpolation of vital rates

Exponential interpolation was used by considering the ratio of a unit change of (L_x) within the projection period between the two benchmark points (1984 and 2007) and reporting it to the five year projection interval. In this respect, the missing (L_x) were derived by applying the following formula:

$$L_{xn} = L_{x0} * \exp(r*t)$$

Where:

- L_x = the missing number of years lived between exact age group x and exact age group x+1 between known L_x for years x_0 and $x_{1.}$
- L_{x0} = number of years lived between exact age group x and exact age group x+1 at benchmark starting point
- L_{xn} = number of years lived between exact age group x and exact age group x+1 at benchmark end point
- n = Number of years between L_{x0} and L_{xn}
- r = Growth rate for number of years lived between exact age group x and exact age group x+1 between two bench mark points obtained by rearranging Lokta's equation[44] for population change.

[44] $P[t] = P[0] * exp^{(r*t)}$ where $P[t]$ is population size in time $[t]$; $P[0]$ is the initial population; r is the growth rate and t is time elapsed between $P[0]$ and $P[t]$.

6.3.3 Incorporating rates for successive steps of the projection

Using the equation above, missing L_x were obtained for intermediate projection intervals by sex and age-group then lauded into the first two columns (1) and (2) of the projection model as shown in Table 5.1 seen in Section 5.1 above.

From the projection model it was then possible to run the counterfactual projection for the considered period by updating survival rates using the interpolated L_x up until 2014 which marks the end of the projection period. Table 6.3 below shows the population as projected by the 2014 using interpolated estimates based on the connection between 1984 census and 2007 DHS data.

Table 6.3 Projected population in 2014 counterfactual scenario

Age-group	Nx (2014)		Total	Total births
	Male	Female		
0 - 4	8,443	8,426	16,869	
5 - 10	6,774	6,676	13,451	
9 - 14	5,510	5,484	10,994	
15 - 19	4,591	4,522	9,113	2,389
20 - 24	3,849	3,680	7,529	4,893
25 - 29	3,111	2,944	6,055	4,512
30 - 34	2,652	2,374	5,027	3,350
35 - 39	2,162	1,927	4,088	2,334
40 - 44	1,934	1,631	3,564	759
45 - 49	1,552	1,332	2,884	343
50 - 54	1,280	1,095	2,374	
55 - 59	893	797	1,690	
60 - 64	591	523	1,115	
65 - 69	352	386	738	
70 - 74	198	243	441	
75 +	159	202	361	
Total	**44,052**	**42,241**	**86,293**	**18,581**

Source: Own elaboration based on 1984 census data

It can be seen from Table 6.3 above that the population as projected using the counterfactual scenario is estimated to reach 86 million with 44 million females and 42 million males. It is also projected for the same year and under the same assumption that there will be 18.5 million births for the following five years.

6.4 Projection for the factual scenario

This section looks at how elements needed for the projection of a factual scenario were prepared and then included into the projection.

6.4.1 Recreate (L_x)

Recreating (L_x) for the war scenario followed a similar procedure to the one explained above for non-war projection. However, for the war scenario projection, the projection starting in 1984 with indirect estimates derived from 1984 census, before it was benchmarked in 1995 using 1995 MICS1 and then again, this time round, benchmarked in year 2004 in order to reflect demographic estimates as captured by the 2001 MICS2 or 3 years after the war had started.

Because the initial projection was run in five years intervals from 1984; 1989; 1994; 1999; 2004 and 2009, it was important to ensure that changes in rates between the non-war (1984 to 1997) and the war (1998 to 2007) are as shown in the **Error! Reference source not found.** above depicting key events and data opportunities in the DRC. To accommodate those changes in rates between non-war and war periods, interpolations as explained above were conducted.

6.4.2 Interpolation of vital rates

In this respect, two interpolations to derive the appropriate number of person-years lived by the cohort between age group x and x+n were needed. The first interpolation was made between years 1999 and 2004 to derive the number of person-years lived by the cohort between age group x and x+n related to year 2001. The second interpolation was made between years 2004 and 2009 to derive the number of person-years lived by the cohort between age group x and x+n related to year 2007.

It can be seen here that 2001 and 2007 are the selected benchmark where estimates from 2001 MICS2 and 2007 DHS data are needed to adjust population projections. This is because, in theory, moving from 1994 to 1999 meant the country moved from a non-war to a war situation. However, in practice, the 1995 and 2001 MICS data are best placed to reflect the shift in terms of its effect on components of population change. In the same way, moving from 2004 to 2009, the situation on the ground was changing between war and non-war with varying levels of intensity. In this respect, the 2007 DHS dataset is better placed to provide a cross sectional picture of the demographic estimates and hence adjust population projections.

Interpolating rates was necessary due to the fact that the projection is done in five year intervals and the benchmark years did not fit with the sequence of years followed by the initial projection. In the same way, to account for changes in the number of person-years lived L_x by age-group it was important to interpolate its value so that it reflects estimates from each of the benchmark points.

Preliminary projections conducted using the basic assumptions presented in this chapter are shown in Table 6.4 for the counter-factual scenario; where it is assumed the armed conflict did not take place and Table 6.5 for the factual scenario where it is assumed the armed conflict did take place.

Table 6.4 Projected population 1984 - 2014 under the counter-factual scenario

Age-group	1984	1989	1994	1999	2004	2009	2014
0 - 4	5,711	6,812	8,223	9,817	11,661	13,953	16,869
5 - 9	4,498	5,348	6,416	7,790	9,354	11,176	13,451
10 - 14	3,894	4,393	5,230	6,285	7,641	9,188	10,994
15 - 19	3,300	3,829	4,328	5,161	6,212	7,565	9,113
20 - 24	2,869	3,243	3,772	4,274	5,110	6,166	7,529
25 - 29	2,208	2,775	3,146	3,671	4,172	5,003	6,055
30 - 34	1,630	2,184	2,753	3,131	3,665	4,178	5,027
35 - 39	1,374	1,568	2,108	2,667	3,043	3,574	4,088
40 - 44	1,084	1,343	1,539	2,078	2,639	3,022	3,564
45 - 49	1,102	1,009	1,257	1,447	1,963	2,505	2,884
50 - 54	971	1,011	932	1,168	1,354	1,848	2,374
55 - 59	702	850	893	830	1,049	1,227	1,690
60 - 64	607	599	734	781	735	941	1,115
65 - 69	344	438	437	545	590	566	738
70 - 74	225	234	307	314	402	448	441
75 +	156	82	83	124	167	254	361
Total population	**30,674**	**35,717**	**42,159**	**50,082**	**59,758**	**71,617**	**86,293**

Source: own estimation based on 1984 census and 2007 DHS

Table 6.5 Projected population 1984 - 2014 under the factual scenario

Age-group	1984	1989	1994	1999	2004	2009	2014
0 - 4	5,711	6,680	8,107	9,714	11,551	12,749	13,021
5 - 9	4,498	5,318	6,222	7,553	9,117	10,937	12,071
10 - 14	3,894	4,374	5,157	6,017	7,380	8,872	10,643
15 - 19	3,300	3,829	4,309	5,088	5,921	7,306	8,783
20 - 24	2,869	3,253	3,796	4,297	5,004	5,918	7,302
25 - 29	2,208	2,770	3,144	3,673	4,160	4,878	5,768
30 - 34	1,630	2,201	2,792	3,205	3,634	4,239	4,971
35 - 39	1,374	1,564	2,113	2,682	3,086	3,523	4,109
40 - 44	1,084	1,351	1,552	2,119	2,624	3,103	3,543
45 - 49	1,102	999	1,238	1,415	1,977	2,435	2,881
50 - 54	971	1,001	904	1,115	1,302	1,819	2,241
55 - 59	702	832	847	755	979	1,126	1,573
60 - 64	607	588	692	700	648	843	969
65 - 69	344	404	368	411	503	422	549
70 - 74	225	217	245	214	279	327	275
75 +	156	94	107	159	161	223	279
Total population	**30,674**	**35,475**	**41,593**	**49,118**	**58,327**	**68,720**	**78,975**

Source: own estimation based on 1984 census, 1995 MICS1; 2001MICS2 and 2007 DHS

In Tables 6.4 and 6.5 above, population size is projected to continue growing faster under the counterfactual scenario than under the factual scenario. When considering the factual scenario, this can be explained by the fact that an increase followed by a decrease in infant and child mortality between years 1995 and 2001 – as featured in MICS1and MICS2 – were accompanied by a drop in fertility rates. However, when considering the counterfactual scenario it is assumed that mortality will improve as it converges to the 2007 level captured in the DHS.

Based on the information obtained from the two population projections, it was possible to assess the number of population still alive at the beginning of the next projection interval. To do so, the current study computed the number of births for each subgroup over the projection intervals then deducts those missing. As this is projection is conducted for a closed population, it is assumed that the only way to exit the projected population is through death. Scenarios including net migration data in order to assume an open population are explored from the next chapter. Table 6.6 below shows how demographic components changed between the two scenarios.

Table 6.6 Population change for both scenarios from 1984 to 2014

Year		**1984 –1989**	**1989 – 94**	**1994 – 99**	**1999 – 04**	**2004 – 09**	**2009 – 14**
Population	NON-WAR	30,674	35,717	42,159	50,082	58,758	71,617
at start	WAR	30,674	35,475	41,593	49,118	58,327	68,720
Births	NON-WAR	7,989	9,537	11,240	13,180	15,569	18,581
Deaths		2,809	3,096	3,317	3,505	3,710	3,905
Births	WAR	8,004	9,778	11,794	13,508	14,840	16,126
Deaths		2,809	3,660	4,269	4,300	4,448	5,871
Natural	NON-WAR	5,180	6,442	7,923	9,675	11,859	14,676
change	WAR	5,195	6,118	7,526	9,209	10,393	10,255
Population	NON-WAR	35,854	42,159	50,082	59,758	71,617	86,293
at end	WAR	35,868	41,593	49,118	58,327	68,720	78,975

Source: As derived from 1984 census, 1995 and 2001 MICS, 2007 DHS

From Table 6.6 above, it can be seen that the number of births between factual or war and counter-factual or non-war scenarios is higher for the war scenario up to year 1999–2004. However, there has not been an increase between years 1999–2004 and years 2004–2009. This cannot be explained by a decrease in fertility alone since the L_x is also closely linked to the projected number of births. In other words, a drop in L_x can also occasion a decrease in the total number of births during a projection interval.

Regarding deaths, a similar pattern to one followed by fertility between was observed. It can be seen that after a sharp increase in years 1994–1999, in the war scenario, the number of deaths decreased going from 4,269 for projection interval 1994–1999 to 4,300 for 1999–2004 then 4,448 for projection interval 2004–2009. Again, it has to be noted that L_x as derived from model life table has been crucial in setting the level of deaths in a projection interval as it was the case for birth.

6.5 Calculating population loss

From results obtained in Table 6.6 above, projected mortality estimates were interpolated to derive yearly values. To accommodate this study's research question two, yearly values from 1998 to 2007 were taken into account to calculate the excess death to be associated with the conflict period as shown in Table 6.7 below.

Table 6.7 Difference in population loss: factual and counter-factual in 1,000s

YEAR	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Estimated number of deaths as projected										
WAR	803	828	854	855	856	857	859	860	866	872
NON-WAR	645	654	663	671	678	686	693	701	709	717
Difference	**158**	**174**	**190**	**184**	**178**	**172**	**165**	**159**	**157**	**155**

Source: Own calculation based on own projection using basic assumptions on a closed population

Considering the difference between the estimated number of deaths under the war and the non-war affected periods, it was then possible to calculate the number of excess deaths from 1998 to 2007 or *[(8,509,000 – 6,818,000) = 1,692,000]*. Estimated numbers of deaths presented in Table 6.7 were obtained in the following way:

1st five-year number of deaths for each projection interval were obtained by calculating the difference between the total population at the end of projection interval *(n)* add the total number of births between projection intervals *(n)* and *(n+5)* then take away total population at the end of projection interval *(n+5)*.

2nd the five-year number of deaths for each projection interval was divided by five to obtain single-year number of deaths within these intervals. This calculation was conducted for both the factual and counter-factual scenarios.

3rd calculate the difference in single year deaths between the factual and the counter-factual scenarios.

4th summing the difference in the number of deaths between the factual and counter-factual scenario for the considered armed conflict period (1998 – 2007) gave the number of excess population loss used in the current study.

In other words there have been an extra 484,000 deaths in DRC from 1998 to 2007 attributable to the armed conflict. The number of excess deaths obtained at this stage is possibly distorted, with estimates from other components of population change such as migration. Also, the assumptions explored at this stage are preliminary therefore the ensuing results are illustrative of the assessment process rather than indicative of the actual extent of excess population loss, which is a gradual process. It is expected, for instance, to see more indicative results from the next chapter when all components of population change are included in the projection framework and assumptions set accordingly.

6.6 Robustness check

Chapter 6 shows that projections conducted so far in the current study are not far away from those conducted by other institutions. The DRC Institute for National Statistics conducted, in 1999 a series of population projections at national and subnational levels for the period 2006–2010; the US Census Bureau and the United Nations too conducted projections for the DRC and both of them give figures of the estimated midyear population going from 1950 to 2050 and from 1950 to 2100, respectively (Institut National de la Statistique, 1999; UN Population Division, 2013; US Census Bureau, 2013).

As shown in Chapter 6, checking for robustness between projections from different sources is important for comparability and to measure the level of consistency with other estimates and projections from other studies. In the same way, these checks will help assess whether or not the projection process and the derived estimates are plausible and reflect the overall demographic context of the DRC. Overall, comparing with other estimates and projections will determine if there is a need to adjust or reassess the process.

Population projection by the DRC Institute for National Statistics had been published in booklets, but the methods used to generate them have not been made public

(Institut National de la Statistique, 1999). Not knowing the methods used by the Institut National de la Statistique (INS) makes it difficult for the current study to engage critically with the process used. However, estimates from INS projection are used in the current study together with estimates from the US Census Bureau and the UN Population Division to corroborate preliminary findings which also serve as the basis upon which the current study's projection framework is drawn.

The US Census Bureau offers a variety of demographic indicators from countries and areas of the world with a population of 5,000 or more. In this respect, the US Census Bureau's database has provided demographic data and population projections for the DRC from 1950 to 2050. US Census Bureau's estimates are prepared by Census Bureau demographers, who review a wide range of data, including censuses, surveys, and vital statistics provided by the DRC's National Statistics Office and data on international migration and refugee movements. They also consider other information such as public health efforts, socio-political circumstances and historical events such as natural disasters and conflicts when making assumptions to derive estimates.

In the case of the DRC, the US Census Bureau combined data from the DRC 1974 administrative census, 1984 census to constitute the base year. Direct estimates of age specific fertility, infant and child mortality rates for surveys conducted in 2002 and 2007 were used to update estimates and projections. Refugee statistics based on change in refugee stock estimates between two consecutive years were used to generate migration estimates. Other items such as latest HIV prevalence data of 2009 from HIV surveillance and latest HIV antiretroviral (ARV) data of 2008 from official estimates reported to the World Health Organisation (WHO) were also taken into account (US Census Bureau, 2010). Migration data are incorporated from the chapter dedicated to an open population scenario. In the same way, the prevalence of HIV is also accounted for by introducing the INDEPTH model life table in the relevant chapter.

In 2010 the UN reviewed their official population estimates and projections in general including the DRC. This process incorporated new and relevant information regarding past demographic dynamics of the population of each country or area. In the case of the DRC, the UN population division derived population estimates and projections from available data, obtained from the latest census year and benchmarking using all available data on fertility, mortality and migration trends between reference dates. Assumptions regarding future trends in fertility, mortality and migration are also used.

Fertility estimates as modelled by the UN population division assumes that all countries will eventually fall below replacement level but not necessarily by the end of the projection period. Armed conflicts are known to carry various costs which strongly affect the living conditions of households both at the time of the conflict and for many years thereafter, especially in poor countries like the DRC in Africa. An example of how living conditions may be affected by armed conflict can be reflected on fertility. Recent empirical literature has begun to document the costs armed conflicts on fertility. Daguspa (1995) reports increase in fertility amongst households living in uncertain environments. The increases in fertility are thought to compensate for the loss of children in the early years, as well as increasing household labour and creating an insurance mechanism for old age (Daguspa, 1995). For this reason, it is important to assess fertility change in the context of the DRC conflict in contrast to how it is defined by the UN Population Division.

For countries experiencing periods of increased mortality, like the DRC, life expectancy is assumed to increase only by a little until 2010. Once the pace of future expectation of life is determined, survival ratios of five-year age groups and sex consistent with the expectation of life at birth for each five-year interval are calculated. Estimates of annual HIV incidence derived from epidemiological model are converted into age and age-specific estimates of newly infected individuals. The population initially free from the epidemic is projected using a multi-state approach which tracks the transitions of people from at-risk to AIDS, and finally death. For migration assumptions, various pieces of information are included: information on net migration as recorded; data on labour migration flows; estimates of undocumented or irregular migration and data on refugee movements in recent periods. With regards to international migration, it is assumed that recent levels, if stable, continue throughout the projection period. With regards to movements of refugees, it is assumed that refugees return to their country of origin within the next one or two projection periods or within five to ten years (United Nations, 2004, pp. 90-99).

It is worth noting that both the United Nations Department of Economic and Social Affairs/Population Division and the US Census Bureau provide broad explanation of their projection methods concerning all countries not just the DRC. Their literature and related manuals are unclear about their data sources or indeed they determine the benchmark points used to correct past trends of their projections. For this reason, it can be argued that their projection methods are not the standard. However, due to the paucity of empirical studies to assess population change in countries like the DRC, estimates from the US Census Bureau or the UN Population Division are essential since they provide a much needed point of reference for what would otherwise be a country with no demographic estimates of any kind.

From what has been said above, it was possible for this study to use population estimates and projections from the above three sources – the US Census Bureau, the DRC Institute for National Statistics and the UN Population Division's population estimates and projections to check for robustness. Table 6.8 below shows different population projections and how they relate to this study.

Table 6.8 Existing projections from 1980 to 2020: population size in 1,000s

Year	This Study (1984-14) Factual	US Census (1985-2015)	UN Population Division (1985-2015)	DRC INS (1985-2015)
1984/85	30,674	33,348	31,044	
1989/90	35,475	39,151	36,406	
1994/95	41,593	46,705	44,067	
1999/00	49,118	52,445	49,626	
2004/05	58,327	60,698	57,421	
2009/10	68,720	69,851	65,966	64,420
2014/14	78,975	79,375	75,190	74,680

Source: Own work as projected from 1984 census; data from US Census Bureau and the United Nations Department of Economic and Social Affairs/Population Division

Table 6.8 above shows that most of the projections are corroborated throughout the projection period. It can be seen that the US census Bureau's projection is higher than the UN Population Division and the projection from this study. For 2010 and

2015, the DRC's Institute for National Statistics projection gives an estimate that is a bit lower than the other projections.

Summary of Chapter 6

Chapter 6 explored estimates of each component as derived from Chapter 5 in order to conduct a simplified population projection for a closed population. Conducting a simplified projection with a closed population is important because it allows establishing a projection framework upon which various assumptions related to population change are tested and validated. The difference between the projected mortality under factual and counterfactual scenarios gives the number of excess population loss. Given the assumptions and scenarios explored in Chapter 6, preliminary results show an estimated excess population loss of around 1.7 million for the period 1998 - 2007.

Looking at the mortality trend as projected in Chapter 6, it can be seen that population loss as obtained from the difference between factual and counterfactual scenarios did not start in 1998. This trend seems to have started many years before the onset of the armed conflict and is likely linked to the deterioration of living conditions (International Monetary Fund, 2003). This is because, when it is assumed that the situation in DRC started to deteriorate in the early 1990s it would be normal that from that period, mortality as projected under the factual or war scenario was going to be higher than a projection made based on 1984 demographic situation, as was the case with the non-war or counterfactual scenario. The next chapter considers an open population scenario where the estimates and the methods used so far will be broadened using net migration data.

Chapter 7 Open population

Introduction to Chapter 7

This study's fourth research question relates to assumptions needed to derive a range of plausible estimates when projecting DRC population between 1984 and 2014 under factual and counterfactual scenarios. So far, this study has derived estimates and developed a projection framework assuming the studied population was closed to migration. Although working with a closed population as explored so far in the current study is useful to frame and consolidate projection models, real-world examples of them are rare if not non-existent (Rowland, 2003). Given the fact that migration is one of the main components of population change, it was important for the current study to include net migration data at this stage in order to assess the DRC population size and composition between 1984 and 2014. This is needed to derive the range of plausible estimates related to the number of excess population loss associated with the armed conflict. At this stage, cohort-component projection methods conducted so far are therefore replicated using an open population.

Environmental and socio-economic realities are often seen as the main forces driving migration. The importance of these forces is even more evident in places most affected by armed conflicts and violence, which has been the case in the great lakes region of Africa and more specifically in the DRC. For the last few decades, the region has witnessed numerous armed conflicts of various intensities prompting hundreds of thousands into migration (UNHCR The UN Refugee Agency, 2012). Accordingly, due to the generalised crisis and poor governance that have characterised state structures in the DRC for the last few decades, collecting reliable data on migration presents significant challenges. This is understandable when one considers that defining migration let alone collecting reliable data have always been a challenge even in developed countries (Castles & Miller, 2009). In the case of the DRC, efforts to document demographic data in general and migration data in particular have been conducted by international bodies such as the UN through the UNHCR or the population and statistics divisions. Efforts by these bodies are essentially based on national reporting of international migration. Reports on the effectiveness on collecting data on international migration show that there has been a general decline in the level of reporting on international migration data. The fact that no single source of data can produce all the information required by users has been cited as one of the reasons why there is a low response level in reporting migration data (UN Statistics Division, 2004).

The current chapter looks at how the population projections conducted in previous chapters can be applied to an open population where total net migration by age-group and sex is taken into account. The chapter introduces the migration dataset used here, through a summary of selected background information on the way the UN collects and publishes migration data on specific countries. The chapter then expands the methods used in the current study to derive migration estimates. Further from expanding methods used so far, the chapter explores how the derived estimates were incorporated into the projection framework to reconstruct missing demographic data; from the latest census in 1984 to the end of this study's projection period in 2014. Later sections in the current Chapter 7 present selected results from the process of incorporating net migration data into the projection framework and a succinct discussion on key aspects of the projection process explored in this chapter.

The final section of this chapter looks at the implications related to the extent to which demographic estimates derived in this study can be deemed plausible, hence introducing the last chapter of this study dedicated to sensitivity analysis.

7.1 Background

In defining migration demographers often distinguish between internal and international migration, both of which entail a change in an individual's place of residence (Castles & Miller, 2009). Generally, migration is said to be internal when a person moves from one locality to another within the same country and it is said to be international when a person moves from one country to another for a minimum of twelve months. Within these two types of migration, there can be a difference between forced migration and voluntary migration. Since this study looks at demographic consequences of armed conflicts, it can be argued that the main focus of this chapter should be about incorporating forced migration alone into the projection model. Due to the fact that there is a thin line between the definitions of forced migration and voluntary migration especially in times of conflict or other environmental disasters (Oucho, 2009) this study choses to overlook the existing dichotomy at this stage. Added to that is the fact that disaggregating forced migration and voluntary migration from the already scarce and second hand data on migration, as published by the UN, will be almost impossible. It has been argued that although the definitions have practical value and are widely accepted, they can, in some contexts, have a decisive and adverse impact on what is considered relevant and what is discovered about population movement. In other words, distinctions and definitions of types of migration must be appropriate for the situation and comparable with other studies (Rowland, 2003).

To replicate projections conducted so far, this study used international migration data on the DRC produced by the United Nations Population Division. The population division of the United Nations collects data on flows and stock of migrants using the demographic yearbook data collection system. To elaborate the yearbook, countries are requested, by the UN, to provide migration data by completing specific questionnaires (United Nations, 2013).

According to the United Nations Population Division, statistics on international migration flow are collected through questionnaires on international travel and migration. Questionnaires collect data on inflow and outflow of foreigners and citizens as well as information on incoming and departing migrants by purpose, duration, country of birth and/or citizenship. Some of the collected information is cross-tabulated by age and sex (United Nations, 2013). In the same way, statistics on international migrant stock are collected through population censuses. Census questionnaires contain tables pertaining to the characteristics of international migrants, such as age, sex, country of birth, country of citizenship and occupation. It is worth noting that the United Nations also collects and compiles, through the UNHCR, data on asylum seekers and refugees. Such information is gathered from asylum application, determination of refugee status, refugee populations, their movements and their demographic characteristics as well as their major locations. Migration data from the UNHCR are used by the United Nations for the case of the DRC. In this respect, the international migration data as produced by the United

Nations and used in this study may be conflated with information on asylum seekers and refugees, thus leading to the risk of double counting. Since this is the only available data source on migration, caution is required when interpreting their implication in the current study's findings.

Substantial analysis is needed to achieve international comparability of migration data and the United Nations does not guarantee this. This is because of (and as explained earlier) the greater heterogeneity and variety of migrant subcategories subsumed within the long-term migrant category, as internationally defined; and the recognition that countries largely use their own definitions in collecting data. In other words, there are shortfalls inherent to the nature of migration data worldwide and as documented by the United Nations. As such, this study chose to rely on migration data for the DRC as compiled by the United Nations. This choice is justified by the fact that, as far as this study is concerned, migration data from the United Nations are the best available. In the same way, it can also be said that migration data from the United Nations help establish analytical procedures which can be readily available should there be better migration data than the ones used currently.

Data from the United Nations Population Division[45] (United Nations, 2013) show that the net migration rate per 1,000, per five-year in the DRC has been estimated at 5.9 during the period 1990-1995; this rate reversed to become -5.8 for the period 1995-2000 before stabilising at around -0.9 for the period 2000-2005 and then -0.3 for the period 2005-2010 (Ngoie & Lelu, 2010). Because migration data from United Nations

[45]Most of the statistics used by the United Nations Population Division to estimate the international migrant stock by country or area are obtained from population censuses. Additionally, population registers and nationally representative surveys provide information on the number and composition of international migrants.

used in this study only include refugees, there are other categories of migrants falling outside the refugee bracket defined by the United Nations. This may be the case of Congolese migrants who left the country during the period under study but did not register with asylum seeker or refugee services in the host country as well as those who left the DRC to settle in other countries for work, study or family reasons. In a similar way, people moving to live in the DRC for various reasons and not registered as asylum seekers or refugees are likely to be omitted in the United Nations migration data. This can be justified, for instance, by the fact that the boom in the mining sector may have played as a significant pulling factor attracting foreign labour into mineral rich areas in the DRC. The country could also be seen as a transit point for migrants from the north whose final destination is the southern part of Africa or migrants from the south whose final destination is northern Africa or Europe (UNHCR, 2007).

To sum up, it can be said that the lack of reliable data left this study with no other alternative than to use the United Nations data on DRC migration. The United Nations data may have weaknesses but on the balance of not having any migration data as an input into the current study's population projections and hence missing a key component for assessing population growth and decline, this study chose to use the available migration data on DRC as documented by the United Nations. The projection framework developed in the current study can be improved if or when reliable migration data on the DRC become available. From that point, one would simply have to implement the reliable data into the projection framework developed in the current study to produce estimates on excess population loss.

The next section explores how data on international migration as produced by the United Nations has been incorporated into this study.

7.2 Broader approach

Before adding the data into the projection framework it was important to prepare the them so that they reflect the actual migration reality being incorporated into this study's population projection as a component. The process ensured that the data to be used is scaled to match estimates from other components and already explored into the projection framework. More details on how this process was implemented are given in the next section.

Rogers, Raquillet, & Castro (1978) have demonstrated that age-specific mortality, fertility and migration schedules of most populations display similar regularities. As such it is therefore possible to summarise and compute such regularities into parameterised hypothetical schedules called model schedules. Model schedules have two important applications among many others; including:

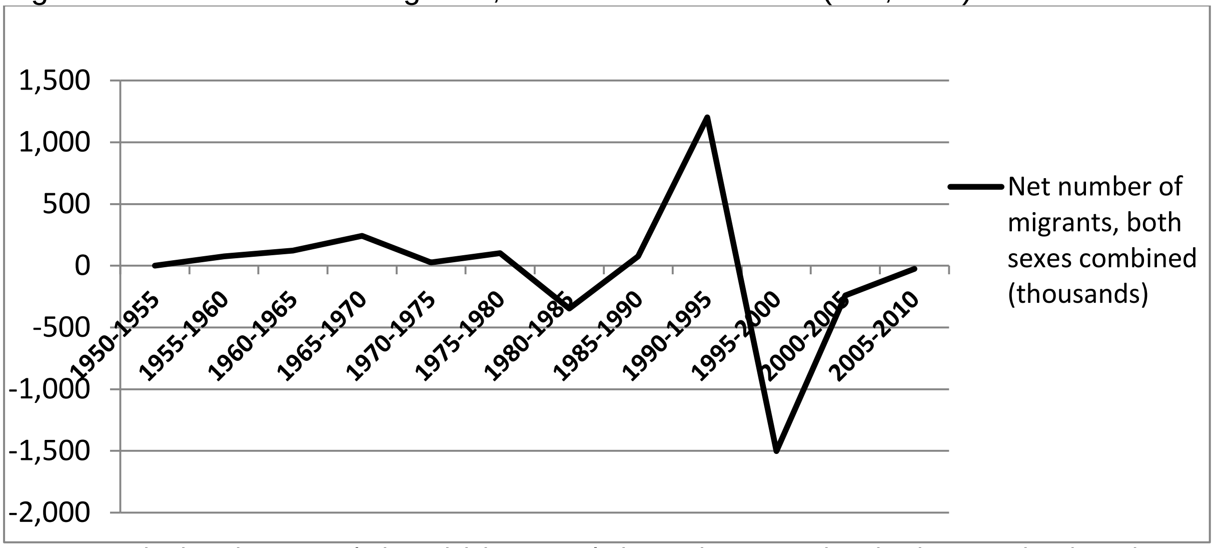
a. They are used to infer empirical schedules of populations for which the needed data is lacking or inaccurate.
b. They are also applied in analytical mathematical examinations of population dynamics.

Due to the fact that obtaining reliable and timely demographic data on the DRC is challenging, the current study explores the first application related to inferring empirical schedules of populations where requisite data is lacking or inaccurate.

7.2.1 Identify source and extract migration data

To achieve a better fit for age profiles this study proceeded as follows: first, identify source and extract migration data; second, model schedule for total net migration counts; finally, derive net migration figures to be used in cohort component projections. Figure 7.1 below shows figures of the DRC net migration counts as provided by the United Nations Population Division from 1950 to 2010.

Figure 7.1 Net number of migrants, both sexes combined (in 1,000s)



Source: United Nations Population Division, population estimates and projections section (2013)

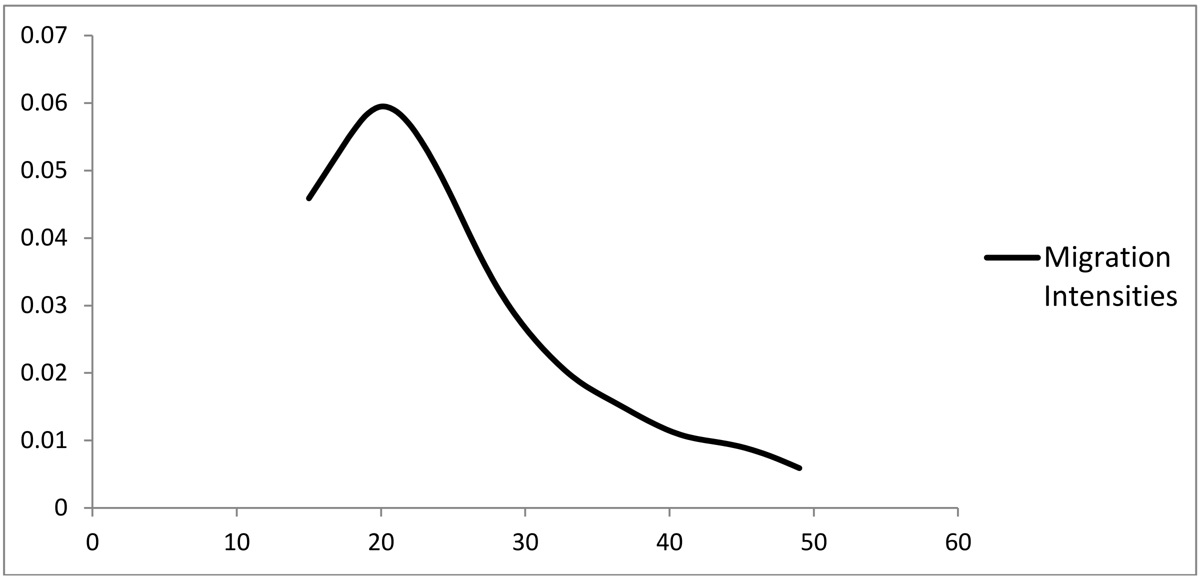
Figure 7.1 shows that from 1960 to 2010 the United Nations Population Division (UNPD) has collected and produced migration data on the DRC. From Figure 7.1 it also can be seen that the level of net migration has fluctuated between zero and 250,000 whilst remaining positive – meaning more people coming into the country than leaving – from 1950 to early 1980s. The level of net immigration peaked between early 1990 and 1995 before dropping to negative figures – meaning more people leaving the country when compared to those coming into the country – between 1995 and 2000. It has to be noted that the 1990-2000 period is also marked by the 1994 Rwandan genocide which saw more than a million people crossing the border from Rwanda to the DRC in 1995; a similar movement was observed almost five years later, but in the opposite direction – from the DRC to Rwanda. From 2005 to 2010 the level of migration has been negative at the beginning of the period and tending to zero or slightly positive values toward the end of the period.

7.2.2 Reconstruct missing migration propensities

Using the DRC 1984 census and 2007 DHS' questions on how long a respondent has lived at current place of residence, it was possible to derive the proportion of migration intensities by sex and age-groups for the projection period. Here the term *migration intensity* refers to a measure representing a natural tendency or inclination by certain individuals to move from one place of residence to another in the last one year. In this way, migration intensities were obtained by dividing the number of respondents who declared to have lived at current place of residence for one year or less out over the number of the general population of the same age-group. The information on migration intensities were complete – all age-groups going from 0-4 to 75 and above – for the 1984 census. However, for the 2007 DHS data, the information on migration intensities were incomplete, because there were only answers for women of reproductive age going from 15-19 to 44-49 age-groups. To complete the information for missing age-groups, the existing answers were extrapolated to all age-groups using the 1984 census distribution of migration intensities.

Figure 7.2 below shows the distribution of migrantion propensisties as recorded in the 2007 DHS.

Figure 7.2 Migration intensities by age in years as captured by 2007 DHS



Source: Own calculation based on DHS question on how long respondent lived at current address

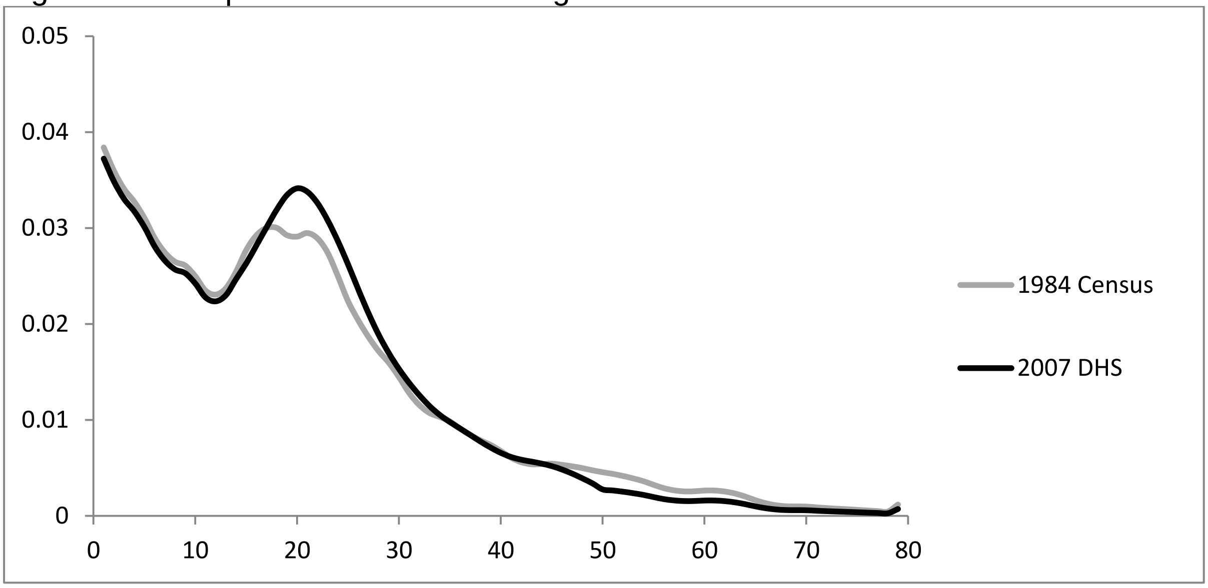
In Figure 7.2 above the *y* axis represents migration intensities in proportions of the total number of migrants aged between 15 and 49 for both males and females in 2007 and the *x* axis shows the respondents' age at the time the census was conducted. Figure 7.2 also shows that the distribution of migration intensities follows an expected trend from age 15 to 49 where the labour curves can be seen ascending up to age 20, when it reaches its peak before dropping thereafter.

7.2.3 Derive net migration figures used in the projection

Using migration intensities as obtained from the 1984 census question, related to how long a respondent has lived at current address, it was possible to model then extend existing migration intensities for the 2007 DHS to all age-groups going from 0 to 75 and above, for both males and females. Based on the total number of migrants at all ages obtained from the 1994 census question on how long the respondent lived at current address it was possible to derive the proportion of migrants at each age by dividing the number of migrants at given age by the total number of migrants. The distribution of migration proportions for individuals aged from 0 to less than 15 and from 50 and above obtained from the 1984 census was used to model the missing migration proportion for the 2007 DHS.

To derive the missing migration intensities, migration data were transformed into proportions of migrants over the general population and Figure 7.3 below shows the proportion of migrants for both the 1984 migration and the 2007 DHS as reconstructed. In Figure 7.3 below, the *y* axis represents the proportion of migrants by the total number of migrants at all ages and the *x* axis represents the actual age of respondents at the time of the survey or census.

Figure 7.3 Complete distributions of migration intensities



Source: own calculation based on migration proportions from 1984 census and 2007 DHS

It is worth noting that the original data reflects the distribution of migration intensities in five-year age-groups by gender; but for analysis purposes, it was important to transform the five-year age-group migration propensities into single-year distributions. The transformation was conducted using Karup King's function as demonstrated in

Bijak & Kupiszewska (2008, p. 136-138).The derived migration rates were fitted to total net migration data from both the 1984 census and the 2007 DHS to obtain migration profiles that served as input representing the migration component into this study's population projections. The completed and averaged migration profile from the 1984 census and the 2007 DHS has been used in the current study to model total net migration counts from the United Nations migration data on the DRC.

The section above explains how migration data had been collected from both the 1984 census and the 2007 DHS, prepared and made into compatible components ready to be input to this study's population projection. The following section details how model migration schedules as plotted in Figure 7.3 above were fitted using Microsoft Excel 2010 and then incorporated into the population projection model.

7.2.4 Fitting model migrations schedules

Using the DRC total net migration data from the United Nations, this study's migration schedules were modelled following the standard model as proposed by Rogers, Raquillet, & Castro (1978).

Due to the fact that migration data used in this study come from a census and a survey, the type of migration measure calculated in this study is migration probability conditional upon survival within the country. For a detailed discussion on how to fit model migration schedules please refer to Rees P, Bell M, Duke-Williams O and Blake M (2000). Based on Wilson's (2010, pp. 200-203) and Wilson's workbook step by step fitting procedure, the migration schedule used in this study has been modelled to fit a sum of five parameters representing migration profiles at different ages including childhood, labour, retirement and the elderly.

The following equations and steps explain how this study modelled migration profiles to fit the model migration schedule (Wilson, 2010):

The full migration schedule is expressed as follows:

> Migration schedule = *Childhood curve* + *Labour force curve* + *Retirement curve* + *Elderly curve* + *Constant*.

Note that retirement may not be very relevant in the context of some areas of the DRC. However, if the model is to be applied at subnational level, areas of the country with a strong industrial or mining tradition and that experienced substantial employments may display interesting patterns based on the retirement curve.

Expressed algebraically, the full model migration schedule, as explored in this study, may be written in the following way:

$$\begin{aligned}\hat{m}(x) = {} & a_1 \exp(-\alpha_1 x) \\ & + a_2 \exp\{-\alpha_2(x-\mu_2) - exp[-\lambda_2(x-\mu_2)]\} \\ & + a_3 \exp\{-\alpha_3(x-\mu_3) - exp[-\lambda_3(x-\mu_3)]\} \\ & + a_4\, exp(\alpha_4 x) \\ & + c\end{aligned}$$

Where

$\hat{m}$ = model migration intensity

x = age

a_1 = height of the childhood curve

α_1 = rate of descent of the childhood curve

a_2 = height of the labour force curve

λ_2 = rate of the ascent of the labour force curve

α_2 = rate of descent of the labour force curve

μ_2 = position of the labour force curve on the age axis

a_3= height of the retirement curve

λ_3 = rate of ascent of the retirement curve

α_3 = rate of descent of the retirement curve

μ_3 = position of the retirement curve on the age axis

a_4 = height of the elderly curve

α_4 = rate of ascent of the elderly curve

c = constant

Migration propensities from both the 1984 census and the 2007 DHS age 0 to 75 and above were entered into an Excel workbook kindly provided by Tom Wilson to whom my gratitude is due. From this point, the original migration intensities were first of all scaled to the sum of unity across all ages. This is to allow profiles of migration patterns to be comparable independently of the overall levels of migration. At the very end of the fitting process, model scaled migration propensities were scaled back to the sum of their original values before they could be used as compatible migration input into the projection framework.

Migration parameters were modelled following the steps below:

Step 1. Estimate the constant

The constant c has been estimated as the mean between age one and fifteen of the lowest non-zero scaled migration propensities.

Step 2. Estimate the childhood curve parameters

The childhood parameters were fitted to the scaled migration propensities, minus the constant as shown below:

$$m_1(x) = m\ (x) - c$$

Modelled values of $m_1(x)$, represented by the function

$\widehat{m}_{1(x)} = a_1 \exp(-\alpha_1 x)$ estimated by creating a log linear model:

$$Y = C + M\ X$$

With

$$Y = \ln(m_1(x))$$

$$C = \ln(a_1)$$

$$M = -\alpha_1$$

$$X = x.$$

From this point it was possible to derive a_1 and α_1 using Microsoft Excel's SLOPE and INTERCEPT functions, values of C and M were obtained as followed:

$$a_1 = \exp(C)$$

$$\alpha_1 = -M.$$

The childhood curve parameter has been applied for the childhood age range going from 0 to 13 years old. The slope of this parameter is given by the rate of descent of the childhood curve (α_1) calculated at – 0.00829.

Step 3. Estimate the labour force curve parameters

The labour force curve parameters were fitted to the scaled migration propensity, minus the constant and the childhood curve. This can be expressed as shown in the equation below:

$$m_2(x) = m(x) - c - \widehat{m}_1(x)$$

The function as shown below is fitted using Microsoft Excel's solver application for nonlinear regression. Using solver to minimise the sum of square errors minimum and maximum age for entering employment is between 14 and 60, on a variety of migration age patterns resulted in good fits most of the time.

$$\widehat{m}_2(x) = a_2\, exp\{-\alpha_2(x - \lambda_2) - exp[-\lambda(x - \mu_2)]\}$$

The labour curve parameter has been applied to an age range going from 14 to 60 years old with the rate of the ascending slope (λ_2) estimated at 0.3 and that of the descending slope (α_2) estimated at 0.09.

Step 4. Estimate the retirement curve parameters

After assessing if migration propensities around the retirement ages were located above the model migration schedule, retirement curve parameters were fitted over a defined age range going from 64 to 70 years old, to the scaled migration intensities, minus the constant, childhood curve, and labour force curve, $\widehat{m}_3(x)$, where

$$m_3(x) = m(x) - c - \widehat{m}_1(x) - \widehat{m}_2(x)$$

Using Microsoft Excel solver function, it was possible to estimate parameters of the equation:

$$\widehat{m}_3(x) = a_3 exp\left[-\left(\frac{x-\mu_3}{\sigma_3}\right)^2\right]$$

The ascending rate for the retirement slope (λ_3) was estimated at 5, the descending rate (α_3) fixed at 0.001 or 0.1% and the retirement age fixed at 64 years old consistent with the DRC law on employment (Les Codes Larcier, 2003).

Step 5. Estimate the elderly curve parameters

The elderly curve parameters were included in the model schedule by fitting the following function over an age range going from 70 to 85 years old to the values of$\widehat{m}_4(x)$, defined as:

$$\widehat{m}_4(x) = m(x) - c - \widehat{m}_1(x) - \widehat{m}_2(x) - \widehat{m}_3(x)$$

At this stage, Microsoft Excel solver function was used to estimate parameters of the function:

$$\widehat{m}_4(x) = a_4 \exp(\alpha_{4\,x})$$

Some of the values taken by $\widehat{m}_4(x)$ are likely to be negative, hence logarithms cannot be calculated; thus the linearization method used for the childhood curve has not been used. The rate of ascent for the elderly curve parameter (α_4) was fixed at 0.1.

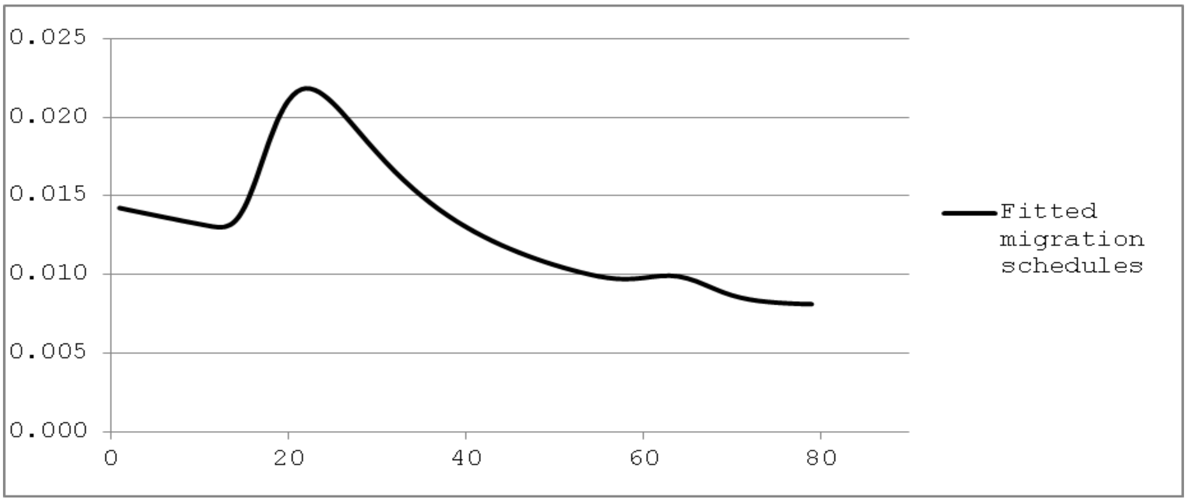
7.2.5 Summary on fitting model migration schedules

Migration data by sex and single-year of age were obtained from both the DRC 1984 census and the 2007 DHS. In this study, migration estimates were derived from census and survey questions related to “how long the respondent has been living at current place of residence?” the number of individuals declaring to have lived at current address for one year or less constituted migration intensities used in this study.

One of the problems when using such an approach is linked to the fact that the number of population considered for migration may confound the risk of mortality. One way to overcome such problem is to divide the number of migrants within one year of census who survived to the next census over the total population at census who survived to the next census. In other words, the probability of such migration is conditioned upon survival within the country between time t and time *t+n*. For the current study, the propensity of population to be considered for migration has been derived directly from the census and the DHS question on how long the respondent has lived at current address. This was possible because the number of migrants recorded at time t+n had already been reduced by mortality and emigration.

After migration data have been processed as explained above, age-specific model migration schedules were fitted and plotted as shown in Figure 7.4 below.

Figure 7.4 Migration schedule averaged between 1984 and 2007



Source: Own calculation based on 1984 census and 2007 DHS data

Figure 7.4 above shows the resulting model migration schedules as fitted following the five steps explained above. In the same way, to avoid repetition, male and female patterns have been computed together with the knowledge that they will be separated in the population projections according to relevant sex ratios. Age in the graphs refers to the mean exact age of each cohort in the one-year interval and the y axis represents fitted migration proportions of total number of migrants.

It is worth noting that no source of migration data yields accurate information. In the same way, computing migration intensity indicators has often been confounded with potential underestimation or overestimation. Reflecting upon common problems associated with migration data, there are cases where respondents fail to state their migrant's origins and status leading to missing or to unreliable data. Judging by the nature and the difficulties encountered when using the DRC 1984 census, it can be said that all of the problems mentioned above apply to DRC migration data used in this study. Some census and survey institutions apply or publish set of age-specific boost factors to compensate for under-enumeration; but as far as this study is aware, such information has not been provided. This study has not been able to make any adjustments in relation to counts of migrants in the DRC. In this respect, the possibility of having under-count age-specific migration data cannot be excluded. However, given the lack of better alternative and considering the robustness when comparing this study's with existing projections from other studies, such deficiencies can only be marginal and hence overlooked.

7.3 Methods and projection assumptions

Migration schedules obtained as explained above were added to the projection framework with the aim of assessing the number of excess population loss for the considered projection period, assuming an open population. Using the UN's estimates of net migration counts between 1960 and 2010 for both sexes combined and as presented in the World population prospects, the 2010 revision (United Nations, 2013), the current study derived total number of migrants and subsequently migration rates by sex and age-group to be used as the migration component in the population projection.

7.3.1 Net migration counts

Considering that 1984 is this study's projection's launch-year for population projection, the derived migration rates were applied from years 1985 to 2010 as shown in the second column of Table 7.1 below. Net migration data were incorporated throughout the projection period following a 5-year interval.

Table 7.1 Net migration based on migration model and UNPD data

Age-group	Migration propensities	1985-90	1990-95	1995-00	2000-05	2005-10	2010-15
0 to 4	0.072	-29	6	99	-124	-20	-2
5 to 9	0.074	-29	6	102	-127	-20	-2
10 to 14	0.072	-29	6	100	-125	-20	-2
15 to 19	0.091	-36	8	126	-158	-25	-3
20 to 24	0.096	-38	8	133	-166	-27	-3
25 to 29	0.083	-33	7	114	-142	-23	-2
30 to 34	0.068	-27	6	93	-116	-19	-2
35 to 39	0.056	-22	5	77	-96	-15	-2
40 to 44	0.047	-19	4	65	-82	-13	-1
45 to 49	0.041	-16	4	56	-71	-11	-1
50 to 54	0.036	-14	3	50	-62	-10	-1
55 to 59	0.034	-13	3	46	-58	-9	-1
60 to 64	0.031	-12	3	42	-53	-8	-1
65 to 69	0.026	-11	2	36	-45	-7	-1
70 to 74	0.024	-9	2	33	-41	-7	-1
75 +	0.021	-8	2	29	-36	-6	-1
Total Net Migration		**-347**	**75**	**1202**	**-1,501**	**-242**	**-24**

Source: Own calculation based on the UNPD data on international migration in the DRC

I Table 7.1 above, negative figures represent the total number of migrants who have left the country within a five-year period, and the figures in black are those of migrants who have entered the country within a five-year period shown in the top row of the table. Original data on migration from the UN only gave totals for both males and females in five-year intervals, throughout the projection period. Total net migration by sex and age-group were derived following the model migration schedule explained above and adjusted to the total number of migrants provided by the UN for the relevant period. Based on the 1984 census and the 2007 DHS question related to how long the respondent lived at their current address, it was possible to derive the sex of respondent and hence the distribution of proportions of migrants by sex.

For a succinct understanding of the nature of the migration data used in this study, it can be seen from Table 7.1 that from the beginning of the projection, between 1980 and 1985, the country saw more people leaving the country than were coming into the country. For the following five years, between 1990 and 1995, there have been, on average, more people coming into the DRC than there were people leaving. Looking at the history and background of the region, the period 1990-1995 includes 1994, a year the Rwandan genocide happened. In this way, an increase in total net migration could be predicted since the conflict in Rwanda led to an influx of immigrants into the DRC around the genocide period in 1994. There has been in 2000, a considerable number of migrants leaving the DRC or a return of Rwandan refugees once the situation in Rwanda stabilised. Given the discussion in the current study's background chapter where it said the conflict started in 1998 and reached its peak around years 2000 and 2001, it can therefore be said that the high number of emigrants can be associated with the period of high intensity in fighting which is more likely to have forced hundreds of thousands out of the DRC.

Table 7.1 also shows that between year 2005 and 2010, the number of migrants leaving the DRC dropped significantly compared to the level of the preceding five years or the period 2000-2005. This can be explained by the fact that a peace deal was signed in 2009, hence bringing an end to violent and high intensity fighting. An end to violent fighting can translate into having fewer people fleeing the country and more people gradually retuning to the country in the following years; provided that the end in violent fighting lasts.

To sum up the understanding of the data being used in this projection, it can be said that total net migration in DRC has been fluctuating significantly making it difficult to estimate trends in migration. Migration data as provided by the UN is enough to be incorporated into the projection as a viable component of population change. The lack of more reliable data on migration can in fact constitute a weakness but as explained earlier, should there be better data on migration, it will still be possible to incorporate them and run the model accordingly.

7.3.2 Calculating cohort component projection

This section is a further attempt to address this study's second research question related to the projected size of the DRC population under factual and counterfactual scenarios, this time assuming an open population. By open population, this study means using similar projection methods to the ones conducted with a closed population but with total net migration taken into account as a component of population change, together with fertility and mortality. The three components of population change are then incorporated and combined through the projection framework.

7.3.3 Components of population change

Population from launch-year was projected forward based on estimates and volumes for net migration from all three components of population change. The important facts to retain from previous projections conducted with a closed population assumption are, for instance, 1984 census population is the population projection's launch-year; a thirty-year period (1984-2014) was retained as the overall projection period and this projection period has been divided into six separate five-year projection intervals.

To conduct the cohort-component projection for an open population, this study needed the following:

- The distribution of population by five-year age groups as recorded by the 1984 census which is also this projection's launch-year.
- Age specific survivorship probabilities by sex as derived from model life tables explored earlier using both direct and indirect techniques.
- Age specific fertility rates (ASFRs) as derived using indirect methods and as taken directly from recent surveys. See and example in Table 4.13 above.
- Total net migration by sex and age-group derived through the model migration schedules explained above.

7.3.4 Projection process

Population projections are generally based either on the most recent census or on population estimates from surveys if considered reliable. Accordingly, this study's projections are based on data from the DRC census and corrected using estimates from intermediate surveys.

The first step of the projection process consisted of defining year 1984 as the projection launch-year. This is because 1984 is also the last census before the period of interest; consequently, the census provides the main dataset input for this study. From this point, age specific survival rates by sex and as calculated from model life tables, were applied to derive the population still alive at the end of each of the six five-year projection intervals.

The second step calculated the number of births occurring within each projection interval by applying age-specific fertility rates (ASFRs) to female population of reproductive age; meaning women aged from 15-19 to 45-49.

The third step incorporates total net migration into the projection framework. Note that in the context of this study the volume of net migration refers to the number of persons aged five and above throughout the projection interval. Total net migration figures for each five-year interval as shown in Figure 7.1 and modelled following the steps explained above were added to specific columns in the projection framework through the application of the following equations:

a. To estimate the number of births within a five-year projection interval.

$$ {}_5B_x(t, t+5) = (5)({}_5F_x)\left(\frac{{}_5N_x^F(t) + ({}_5I_x^F(t,t+5)/2) + {}_5N_x^F(t+5)}{2}\right) $$

Equation 1

Where ${}_5B_x(t, t+5)$ is the number of births to women of exact reproductive age-group x

$({}_5F_x)$ is the Age Specific Fertility Rate (ASFR) for exact age-group x

${}_5N_x^F(t)$ is the total number of women of exact reproductive age-group x at time*(t).*

${}_5N_x^F(t+5)$ is the total number of women of exact reproductive age-group x at time *(t+5)*

${}_5I_x^F(t,t+5)$ is the total net migration at exact age-group x between time *(t)* and time *(t+5)* (Preston, Heuveline, & Guillot, 2001).

Results produced through the application of Equation 1 are shown in cells *(9d)* to *(9j)* or in cells found in *column 9 row d* to *column 9 row j* of Table 7.2.

b. To estimate the population aged 0 – 4 year old population at time *t+5*.

$${}_5N_0\,(t+5) = B(t,t+5)\,\frac{{}_5L_0}{5(l_0)} + \frac{{}_5I_0(t,t+5)}{2}$$

Equation 2

where ${}_5N_0\,(t+5)$ is the total population of exact age-group 0 – 4 at time t+5

$B(t,t+5)$ is the total number of births to women of reproductive age between time t and t+5

${}_5L_0$ is the average number of population living between exact age-groups at exact age-group 0 – 4

$5(l_0)$ is the five-year survivorship probability at exact age-group 0 – 4

${}_5I_0(t,t+5)$ is Net migration probability at exact age-group 0 - 4

Calculations for this estimate for projection interval 1984-1989 are found in the projection spread sheet as shown in Table 7.2 below, see column (7) for age-group 0 – 4 below, which can also be referred to as cell *(7a)*.

c. To survive forward the population in age-groups starting from 5-9 to 70-74.

$$_5N_x(t+5) = \left[\left({}_5N_{x-5}(t) + \frac{_5I_{x-5}(t,t+5)}{2}\right)\frac{_5L_x}{_5L_{x-5}}\right] + \left(\frac{_5I_x(t,t+5)}{2}\right)$$

Equation 3

Where $_5N_x(t+5)$ is the total population of exact age-group x who makes it to year *t+5*

$_5N_{x-5}(t)$ is the population of exact five-year age-group *(x - 5)* in year *t*

$_5L_x$ is the average number of population living at exact age-group x

$_5L_{x-5}$ represents the average number living at exact age-group *(x - 5)*

$_5I_{x-5}(t,t+5)$ is the total net migration at exact five-year age-group (x–5) between time t and time *t+5*.

$_5I_x(t,t+5)$ is the net migration at exact five-year age-group (x) between time t and time *t+5*.

Results on how the population aged from 5-9 to 70-74 for the projection interval 1984-1989 were projected forward are shown in Table 7.2 below; see cells (*7b* to *7o*).

d. Survive forward the population at the open ended age-group or the population aged 75 and above.

$$ {}_{\infty}N_x\,(t+5) = \left[\left({}_5N_{x-5}(t) + {}_{\infty}N_x\,(t)\right) + \left(\frac{{}_5I_{x-5}(t,t+5) + {}_{\infty}I_x\,(t,t+5)}{2}\right)\right] * $$

$$ \left[\left(\frac{{}_{\infty}L_x}{({}_{\infty}L_x + {}_5L_{x-5})}\right) + \left(\frac{{}_{\infty}I_x\,(t,t+5)}{2}\right)\right] $$

Equation 4

Where ${}_{\infty}N_x\,(t+5)$ is the total number of population at the open end age-group at time *t+5*

${}_{\infty}N_x\,(t)$ is the total number of population at exact age-group x for open end age-group at time t or in the previous projection interval.

${}_5N_{x-5}(t)$ is the total population at exact age-group x-5 for open end age-group at time t or in the previous projection interval.

${}_{\infty}L_x$ is the average number of population living between time t and time t+5 for the open ended age-group.

${}_{\infty}I_x$ is the number of net migrants between time t and time t+5 for the open-ended age-group (Preston, Heuveline, & Guillot, 2001).

Results on population aged 75 and above as projected forward using Equation 4 are shown in cells (*7p*) of Table 7.2 below.

7.3.5 Projection framework

For each component of population change, estimating the number of people who survive to the next age interval according to the age-specific probability of surviving, age-specific number of births and the total net migration within the precedent projection interval is essential. The equations shown above are important in implementing all aspects needed in this projection. In this respect, the computing estimates in this way helped estimate the 0–4 population for the next starting point relying on fertility or the number of births to women of reproductive age. In other words, incorporating total net migration data through the equations presented above shows how migration affects or interacts with both mortality and fertility in the projection process.

Table 7.2 summarises the calculations needed to survive the population forward whilst taking into account the effect each of the three components has on one another and subsequently on the projected population. In this table it is possible to see the extent to which DRC population is projected to change starting from the launch-year (1984) then benchmarked using estimates from all three components within the considered five-year projection interval. The projection procedure as summarised in Table 7.2 below was carried forward for the whole projection period going from 1984 to 2014. During the projection process, rates for components of population change fluctuated according to the context and the various scenarios set in this study.

The example used in Table 7.2 below used the case of the counter-factual scenario. See Appendix 2 for a complete set of projections for the period 1984 – 2014 for both scenarios.

Table 7.2 Cohort component projection 1984-1989: open population

	Age-group	Lx		ASFRs	Migration		Nx (1984)		Total	Nx (1989)		Total	Births
	(1)	(2)		(3)	(4)		(5)		(6)	(7)		(8)	(9)
		Female	**Male**		**Female**	**Male**	**Female**	**Male**		**Female**	**Male**		
(a)	0 – 4	419,639	420,552		-14	-14	2,854	2,857	5,711	3,337	3,335	6,763	
(b)	5 – 9	393,219	389,058		-15	-15	2,255	2,243	4,498	2,682	2,658	5,340	
(c)	10 – 14	381,674	381,195		-14	-15	1,944	1,949	3,894	2,185	2,201	4,386	
(d)	15 – 19	376,729	372,269	0.11	-18	-18	1,655	1,645	3,300	1,913	1,907	3,820	1,004
(e)	20 – 24	374,856	359,333	0.28	-19	-19	1,466	1,402	2,869	1,641	1,592	3,233	2,153
(f)	25 – 29	363,476	344,624	0.32	-16	-17	1,133	1,075	2,208	1,418	1,349	2,766	2,013
(g)	30 – 34	368,367	329,872	0.28	-13	-14	865	766	1,630	1,145	1,032	2,177	1,377
(h)	35 – 39	354,934	314,449	0.23	-10	-12	733	641	1,374	830	732	1,562	894
(i)	40 – 44	354,428	297,398	0.09	-8	-11	597	487	1,084	729	609	1,338	281
(j)	45 – 49	326,145	277,627	0.04	-7	-10	598	504	1,102	548	457	1,004	135
(k)	50 – 54	296,738	253,868		-6	-8	525	446	971	543	464	1,007	
(l)	55 – 59	252,685	224,876		-6	-8	370	333	702	447	398	846	
(m)	60 – 64	212,699	189,688		-5	-7	301	307	607	312	284	596	
(n)	65 – 69	134,208	148,474		-5	-6	161	182	344	190	244	435	
(o)	70 – 74	83,051	103,743		-5	-4	101	125	225	100	131	232	
(p)	75 +	94,762	100,029		-4	-4	70	86	156	85	100	185	
	Total				**-166**	**-181**	**15,627**	**15,047**	**30,674**	**18,105**	**17,494**	**35,689**	**7,857**

Source: Own projection based on DRC 1984 census

Table 7.2 above illustrates how different components of population change have been combined within the projection framework.

In this respect, the successive columns have the following interpretation:

(1) Gives the age-groups considered in this study. As explained earlier, population's age is distributed into five-year age-groups in order to match cohorts and projected intervals. Note that the distribution of age-group ends at age 75 and above because the age-group distribution as recorded in the 1984 census end at age-group 75 and above.

(2) Gives the average number living between exact age-groups x and x+5 by gender in the relevant model life table describing the mortality. Figures shown, in this column, calculated then extracted from model life tables. Model life tables and the survivorship probabilities were specific for each of this study's selected scenarios.

(3) Gives Age Specific Fertility Rate (ASFRs) for women aged 15-19 to 45-49. Estimates were obtained through the indirect method as explained in previous chapters when under the hypothesis of a closed population.

(4) Gives age-specific total net migration by sex as recorded in 1985 by the UNHCR. It can be seen that total net migration for both sexes is -166,000 for females and -181,000 for males. The negative sign shows that for the 1984-1989 projection interval emigration was estimated at 347,000 were 166,000 of the emigrants are females and 181,000 of them are male emigrants.

(5) Gives total population at exact age-group *x* by gender as recorded in the DRC 1984 census. Figures of each age-group found in this column have been taken directly from the census data without any modification.

(6) Gives total population at exact age-group x for both males and females at the 1984 census. Same as above, the figure has been taken directly from the 1984 census data.

(7) Gives the number of survivors at each age with age-group 0 – 4 in 1984 yielding survivors aged 5 – 9 in 1989, adjusted for net migration. The column was by applying Equation 2, to obtain population aged 0-4; Equation 3 to obtain population aged 5-9 to 70-74 and Equation 4 to obtain the open-ended population aged 75 and above.

(8) Total number of survivors from the precedent projection interval when adding together both male and female survivors.

(9) Projected total births; depending on the number of females of reproductive age-groups found from cells *5c* to *5j*. Figures in this column are obtained through the use of Equation 1. In five years, or from 1984 to 1989, the total number of births was 7.9 million making up to almost 1.6 million births every year back in mid 1980s.

Note that adding *M* or *F* to specific elements of the equations presented above and as implemented in Table 7.2 helps distinguish between Males and Females. There is no difference in procedure between male and female when surviving the population forward. However, there is a difference when estimating the total number of births ${}_5B_x(t, t+5)$ between year t and year *(t+5)* since this only applies to females as shown in tables provided in Appendix 2.

7.4 Results and discussions

The cohort-component population projection framework presented above has been applied to fit varying assumptions under two main scenarios – factual and counterfactual. This helped to provide appropriate combinations of sensible hypotheses for both this study and those required to examine existing estimates of excess population loss to be associated with the 1998-2004 conflict period in the DRC.

It is worth noting that the current study explores five different assumptions developed from its own approach and contrast the derived estimates with two existing ones. The existing estimates have been produced by the IRC study (Burnham, Roberts, Lafta, Garfield, & Khudhairi, 2004) and by Lambert and Lohlé-Tart (2006).

This study's own assumptions included the following:

1. Open population where fertility and mortality levels observed in 1984 are kept unchanged throughout the projection period. (OPF1984).
2. Open population where 1984 fertility and mortality levels are converged to 2007 fertility level as recorded in the DHS (OPF1984➔2007).
3. Closed population with fertility mortality levels of 1984 are kept unchanged throughout the projection period (CPF1984).
4. Closed population with 1984 fertility and mortality levels converged to 2007 fertility level as recorded in the DHS (CPF1984➔2007).

5. Open population using INDEPTH model life table to produce age specific survivorship probabilities (INDEPTH). Conducted only for an open population since the framework needed to conduct population projections has already been developed in the previous chapter using a closed population scenario.

All of the above-mentioned assumptions used to model this study's projection framework were implemented under the factual and counterfactual scenarios. This is so that at the end of the projection process it is possible to assess the difference between the two scenarios – factual against counterfactual – and derive the number or indeed the range of excess population loss associated with the period of armed conflict as defined in this study.

The projection based on the INDEPTH model life table was equally important in order to reflect and assess the implication of what the INDEPTH Network refers to as "accurate data representing prevailing mortality patterns in Sub-Saharan Africa, taking into account the effect of the HIV/AIDS epidemic" (INDEPTH Network, 2004) will have on estimating the number of excess population loss as modelled in this study.

From what has been explained above, the projection assumptions explored in this study can be presented in the following order. Note that assumptions are abbreviated for clarity and in order to avoid repeating the long sentences explaining what they describe.

1. Open population where fertility and mortality levels as observed in 1984 are kept unchanged throughout the projection period. (OPF1984).

2. Open population where 1984 fertility and mortality levels are converged to 2007 fertility level as recorded in the DHS (OPF1984➔2007).
3. Closed population with fertility and mortality levels of 1984 are kept unchanged throughout the projection period (CPF1984).
4. Closed population with 1984 fertility and mortality levels converged to 2007 fertility level as recorded in the DHS (CPF1984➔2007).
5. Open population using INDEPTH model life table to produce age specific survivorship probabilities used in the projection and now coded here as (INDEPTH).

Estimates derived from the five assumptions introduced above have then been compared and contrasted with existing ones from the IRC and from Lambert and Lohlé-Tart.

7.4.1 Projected size of the population

Table 7.3 below shows the 1984 population as projected under the factual scenario under various assumptions presented above.

Table 7.3 Projected population based on the factual scenario

Assumptions	1984	1989	1994	1999	2004	2009	2014
OPF1984	30,674	35,353	41,449	49,560	58,515	69,227	81,151
OPF1984-2007	30,674	35,578	41,969	50,004	58,282	68,539	80,631
CPF1984	30,674	35,475	41,593	49,118	58,327	68,720	78,975
CPF1984-2007	30,674	35,565	41,644	49,074	58,275	68,586	78,785
INDEPTH	30,674	35,927	42,156	49,788	58,793	69,723	81,746

Source: own calculations based on DRC 1984 census

Judging by population size in 2014 as shown in Table 7.3 above, it can be seen that the current projections indicate more people are expected to survive in the longer term when assuming an open population than they do when assuming a closed population. In other words, it is likely that when the population is opened to migration, projected population is higher by almost two million more people than there is when the same population is closed to migration. This translates on average into a population growth rate of almost 3% for the projection period going from 1984 to 2014. The launch-year population has been projected to grow from 1984 to 2014 under all of the seven sets of assumptions selected in this study.

Further analysis is needed to determine the impact of non-zero migration associated with the conflict period. Such analysis would help determine the exact number of individuals who may have escaped the risk of dying, during the conflict affected period, through migration.

Considering assumptions and scenarios set out in this study to conduct population projections, it has been possible to assess the extent to which births and deaths contribute to the age structure and composition of the projected population. The current study projects DRC population to range between 78 million and 86 million by 2014 and this range is consistent for all five assumptions and under both the factual and counterfactual scenarios. There are significant differences in how various components of population change affect the size of the projected population and this is explored further down in in the sensitivity analysis chapter.

To illustrate the point made in relation to how births and deaths impact on population change, Table 7.4 below presents some results based on the CPF1984 assumption under the factual scenario.

Table 7.4 Summary of change by component 1984-2014 in 1,000

	1984 – 89	1989 – 94	1994 – 99	1999 – 04	2004 – 09	2009 – 14
Population at start of the period	30,674	35,578	41,969	50,004	58,282	68,539
+ Births	8,247	10,102	11,788	12,771	14,117	16,868
- Deaths	3,343	3,711	3,752	4,493	3,860	4,776
+ Natural change	4,904	6,391	8,035	8,278	10,257	12,992
Migration	- 347	75	1,202	- 1,501	- 242	- 24
Population at end of the period	35,578	41,969	50,004	58,282	68,539	80,631

Source: Own calculations based on 1984 census

Table 7.4 shows the total number of births within the projection intervals in the whole projection period has increased at a similar rate. In this respect, the total number of deaths is projected to increase gradually from 3.3 million in 1984 to around 4.8 million deaths by the end of the projection in 2014. The change in the number of births and deaths throughout the projection period vary from one set of assumptions to another. The extent to which various components of population change affect the size of the projected population, under the selected assumptions, is discussed below with respect to the extent of excess population loss.

7.4.2 Projected age structure

Deriving age patterns in the presented projections is important since this will help assess the extent to which the armed conflict is likely to shape the age structure of the DRC population. In the same way, age patterns are also needed to address part of the current study's second research question related to the DRC population size under the counterfactual scenario. For all sets of the assumptions adopted in this study, Table 7.5 below gives a breakdown of selected indicators related to population structure as projected for year 2014.

Table 7.5 Age structure (in 1,000s) as projected to 2014

Assumptions	OPF1984	OPF1984-07	CPF1984	CPF1984-07	INDEPTH
0 - 14	38,033	37,049	35,734	35,734	38,883
15 - 29	21,705	22,170	21,853	21,853	24,119
30 - 44	12,311	12,341	12,622	12,622	12,851
45 - 59	6,807	6,825	6,694	6,694	7,176
60 - 74	2,014	2,025	1,793	1,725	2,084
75 & over	280	220	279	157	201
Total	**81,151**	**80,631**	**78,975**	**78,785**	**85,315**
Median age	16	16	17	17	16
Over 65	1,273	1,220	1,103	913	1,219
% Over 65	1.57	1.5	1.4	1.16	1.43
% Under 15	46.87	45.95	45.25	45.36	45.58
% Under 5	18.04	18.39	16.49	16.53	17.25

Source: own calculations based on DRC 1984 census

Information in Table 7.5 shows that the age structure of the population as projected to 2014 is not very different from one set of assumptions to another. The same can be said from one projection interval to another since for the whole projection period, age structure has remained almost the same. The analysis thus far has demonstrated that the percentage of the population aged below 5 years old fluctuates between 16% and 20%, while that of people aged below 15 years old fluctuates between 45% and 47% of the general population, for all seven assumptions considered in this study. In the same way, the median age is projected to vary between 15 to 17 years throughout the projection period under different assumptions. With regards to median age, year 2004 has a record low median age whilst year 2014 is projected to have the highest median age, for all assumptions perhaps a sign that population is getting older with time, hence an improvement in life expectancy at birth.

7.4.3 Assessing excess population loss for open population

Based on population projections, mortality estimates were interpolated to derive the annual number of deaths for the entire projection period. In order to calculate the number of excess population loss associated with the conflict period, (1998 to 2007) a set of assumptions has been defined to reflect what was known about the demographic situation for the period under study. Table 7.6 below shows the number of excess population loss as calculated during the considered period following the selected assumptions. Population projections conducted under both the factual and counterfactual scenarios to obtain the number of excess population loss.

Table 7.6: Projected excess population loss per year in 1,000s

Assumptions	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	Total
OPF1984	103	98	92	115	139	164	191	219	189	160	**1,470**
OPF1984-07	124	117	110	131	152	175	198	223	189	157	**1,576**
CPF1984	158	174	190	184	178	172	165	159	157	155	**1,692**
CPF1984-07	185	203	222	213	203	193	184	174	175	176	**1,929**
INDEPTH	131	127	122	142	163	185	207	231	284	341	**1,933**

Source: 1984 census as projected using estimates from MICS1 MICS2 and 2007 DHS

Table 7.6 shows that from 1998 to 2007, the difference between the estimated number of population loss, as projected under factual and counterfactual scenarios range from 1.47 to 1.9 million; when considering this study's own assumptions including estimates derived using the INDEPTH model life tables.

With the assumptions related to the open population, Table 7.6 also shows that the excess population loss starts low in 1998 with a calculated excess population loss of 103,000 for OPF1984 and 116,000 for OPF1984-04; then increasing to reach its peak by 2004-2005, with an estimated 219,000 for OPF1984 and 240,000 for OPF1984-04; before dropping thereafter. From the closed population assumptions, the number of excess population loss increased rapidly after 1998 to reach its peak by 2000-2001. This is observed when projected excess population loss goes from 158,000 for CPF1984 and 170,000 for CPF1984-04 in 1998, to 190,000 and 206,000 for CPF1984 and CPF1984-04 respectively in year 2000, before dropping thereafter. The INDEPTH assumption follows a similar trend to that followed when applying the closed population assumptions. The slight difference is due to the fact that its peak is much higher reaching 286,000 in year 2000.

Looking at the period going from 1998 to 2007, as shown in Table 7.6 above, it can be seen that although the difference in mortality between factual and counterfactual scenarios decreases when some assumptions are applied, the overall mortality level, for the DRC, as measured under all assumptions and both scenarios has remained exceptionally high. This can be seen, for instance, when considering crude death rate, which has been estimated at 19.30 per thousand people in 1985 and at 14.64 per thousand people in 2005. When comparing between factual and counterfactual scenarios for the projection period, crude death rate as estimated under the factual scenario is higher than the one estimated under the counterfactual scenario. The same can be said when comparing projections conducted for a closed and an open population assumptions. There it can be seen that the estimated crude death rates for a closed population is slightly higher than the one estimated for an open population.

Many factors can explain the high level of mortality levels projected in this study. Future works may be needed to further assess the overall extent of competing causes of mortality and how this impact on the number of excess population loss associated to the armed conflict. Such assessment would help shed more light, for instance, on the direct and indirect causes of mortality during the war-affected period and narrow significantly the range of the estimated number of excess population loss associated with the conflict period as defined and explored in this study.

Using this study’s four assumptions alone Table 7.7 summarises the range of estimates depicting the number of excess population loss between 1998 and 2007 as measured following factual and counterfactual scenarios. This has been done whilst assuming, on the one hand, that 1984 fertility levels recorded in 1984 remained unchanged over the projection period and on the other hand that fertility as recorded in 1984 converged to fertility as recorded in 2007.

Table 7.7 Population loss between 1998 and 2007 in 1,000s

Counterfactual all components kept unchanged from 1984 to end of projection				
	Number of deaths		**Excess Deaths**	Excess net migration per year
	Counter-factual	Factual		
Open Population	6,762	8,229	**1,468**	-915
Closed Population	6,818	8,509	**1,692**	0
Indirect impact of non-zero migration on excess death estimates	-56	-280	**-224**	N/A
Counterfactual 1984 components estimates converged to 2007 level				
	Number of deaths		**Excess Deaths**	Excess net migration per year
	Counter-factual	Factual		
Open Population	6,574	8,150	**1,576**	-915
Closed Population	6,626	8,509	**1,883**	0
Indirect impact of non-zero migration on excess death estimates	-52	-359	**-308**	N/A

Source: Own estimation based on DRC 1984 census, MICS1, MICS2 and 2007 DHS

The top half of Table 7.7 shows the number of excess population loss derived from the difference between factual and counterfactual scenarios. In this scenario it is also assumed that estimates for all components observed in 1984 remained unchanged for the whole projection period, going from 1998 to 2007. The total number of excess population loss is estimated at around 1.47 million for an open population and 1.69 million when it is assumed the DRC population is closed to migration. The bottom half of Table 7.7 shows the number of excess population loss derived from the difference between factual and counterfactual scenarios when it is assumed that estimates for all components observed in 1984 converged following a linear regression to their 2007 level as recorded in the DRC 2007 DHS. Here the number of excess population loss has been estimated at around 1.58 million for an open population and 1.88 million when it is assumed that DRC population is closed to migration for the whole projection period going from 1998 to 2007.

Under the counterfactual scenario, when it is assumed that estimates for all components as observed in 1984 remained unchanged over the projection period, the indirect impact of non-zero migration is 56,000 fewer deaths and when assuming that the level of each components as recorded in 1984 converged to those recorded in 2007, the indirect impact of non-zero migration is 52,000. Under the factual scenario, when it is assumed that estimates for all components as observed in 1984 remained unchanged over the projection period, the indirect impact of non-zero migration is 280,000 less deaths and when assuming that the level of each of the components as recorded in 1984 converged to those recorded in 2007, the indirect impact of non-zero migration is 359,000

Table 7.7 also shows that excess population loss obtained from the difference between factual and counter-factual scenarios is estimated at 224,000 when estimates for each component observed in 1984 remain unchanged throughout the projection period and 308,000 when 1984 estimates are converged to those observed in 2007. In other words, incorporating net migration data into the projection framework implies that almost 224,000 individuals are removed from the risk of mortality for the period 1998-2007, when fertility as observed in 1984 is kept unchanged for the whole projection period. In the same way, when fertility as observed in 1984 is made to converge to the level observed in 2007 and the population open to migration, around 248,000 individuals are projected to be removed from the risk of mortality during the conflict period. During the whole projection period, each year around 915,000 individuals are projected to have migrated outside the DRC.

Summary of chapter 7

Chapter 7 set out to assess the size of the DRC population by conducting cohort-component projections starting from the last census in 1984, and continuing to 2014; or a thirty-year projection period. The projection was conducted under both the factual and counterfactual scenarios but assuming an open population this time. In doing so, the current chapter is an attempt to address this study's fourth research question related to a set of assumptions needed to derive a range of plausible estimates. The approach adopted in this chapter started by fitting the model migration schedule to migration intensities as derived from the 1984 census and the 2007 DHS. Model migration schedules were fitted in Microsoft Excel to reflect parameters related to childhood, labour, retirement and the elderly migration patterns. The fitted migration schedules were then incorporated to this study's projection framework. The projection was guided by sets of key seven assumptions where the population has been considered to be either opened or closed to migration. For each of the two cases, the recorded level of components of population change in 1984 was assumed to have remained either unchanged for the whole projection period or converging to its 2007 levels as recorded in the 2007 DHS. The remaining three assumptions included a case where this study's projection framework uses survivorship probabilities obtained through the INDEPTH model life table. Resulting estimates were compared to those from to the two existing studies – IRC and Lambert and Lohlé-Tart.

Results on population size as presented in both Table 7.3 above suggest there does not seem to be a significant difference in the size of the population despite the use of varying assumptions as selected in this study. This is because estimates of population size as projected for year 2014 range between 78 and 86 million. In other words, varying assumptions adopted in the current study may indicate changes in the projected population size but it is still not possible to depict the extent to which each component of population change is able to affect population change.

The number of excess population loss derived from this study's own assumptions[46] indicates that overall mortality in the DRC has remained significantly high despite periods of relative calm in fighting. These periods of relative calm coincide with the signing of various peace agreements which intervened throughout the conflict period. Looking at the indirect impact of non-zero migration on the number of excess population loss, the current chapter shows that incorporating migration into the projection framework implies having around 224,000 individuals removed from mortality risks associated with the conflict period when the level of each component as observed in 1984 remains unchanged for the whole projection period. This figure increases to 248,000 individuals when the level of each component as observed in 1984 is converged to that recorded in 2007.

Although the current chapter provides useful insights on the differences of the projected number of excess population loss under varying assumptions and scenarios, it remains unclear how plausible estimates from both existing studies and those explored in this chapter are. In the same way, it is not known to what extent

[46] Assumptions generated in the current study without having to replicate estimates from existing studies or using the INDEPTH model life table.

each component of population change affects the estimate of excess population loss. This is mainly because, for instance, the uncertainty associated with each of the components and the assumptions explored is more likely to propagate throughout the assessment process and hence affect resulting estimates. One way to narrow down the range of uncertainty and that of plausible number of excess population loss is to look at which estimates including those produced by the IRC or the Lambert Lohlé-Tart studies can be deemed plausible given the projection framework developed in the current study.

Through a sensitivity analysis, the next chapter assesses how to select plausible estimates of excess population loss from those derived so far in this study. By doing so, this study will reduce the gap in the range of estimated excess population loss and hence provide elements needed to answer this study's fourth and fifth research questions related to the range of plausible estimates.

Chapter 8 Range of plausible estimates

Introduction to Chapter 8

So far, the current study has used base assumptions to construct the framework upon which to conduct population projections and calculate the excess population loss associated with the 1998-2004 armed conflict in the DRC. As explained earlier, the current study is the first of its kind to combine, and build on, multiple data sources and demographic methods to assess excess population loss associated with the 1998 – 2004 armed conflict in the DRC. Due to the varying nature of both the data sources and the assumptions used, it is inevitable that uncertainties to some extent would be generated then propagated throughout the estimation process. In this respect, the current chapter explores the range representing estimates of excess population loss derived so far in order to narrow it down by retaining only estimates deemed plausible.

To derive the range of plausible estimates representing excess population loss, the current chapter relies on extreme, yet plausible demographic parameters recorded in the DRC at each of the benchmark points used in this study. In this way, assumptions and scenarios explored so far have been evaluated with the aim of retaining only the most realistic results, given this study's approach and the demographic context of the DRC as captured through recent surveys.

As discussed in Chapter 7, estimates representing excess population loss derived so far in this study, range from 1.47 million to just over 1.9 million. Due to the fact that these estimates result from working with aggregate numbers at the national level, it is probable that estimates considered here may not represent extreme yet plausible estimates of fertility, mortality and migration. For this reason, it is important to expand the boundaries meant to contain the full extent of population change as a result of the 1998-2004 DRC armed conflict. To do so, the current chapter set out to meet the following objectives.

- To select assumptions deemed “most plausible” based on their potential to reflect a close demographic picture of the DRC for the considered projection period. The selection of most plausible assumptions is conducted from all the seven assumptions explored so far in this study.
- To identify “extreme” yet plausible net migration figures as well as mortality and fertility rates. These estimates are needed to set the lower and upper variants for the projections needed to determine the range of plausible estimates of excess population loss.
- To conduct population projections by combining extreme estimates of all three components of population change as recorded at each of the benchmark points. This is important in order to derive the extent to which each components of population change have influenced the range of excess population loss.

This chapter is divided into four sections. The first, introductory section sets this chapter’s objectives with the aim of addressing this study’s research questions related to the extent of uncertainty associated with the estimates derived in this study. The second section outlines the overall approach adopted in this chapter and methods used to select the assumptions enabling the derivation of excess population loss deemed most plausible. The third section presents selected results generated in the current chapter, the implications of which are discussed in the last section.

8.1 Methods

This chapter's overall approach is to first of all select the "plausible" assumptions upon which to conduct population projection. The population projections conducted in the current chapter take into account extreme values of mortality, fertility and net migration figures as recorded at each of the benchmark points used in this study (1984; 1995; 2001 and 2007) to constitute the lower and upper bounds of the range of plausible estimates representing excess population loss associated to the armed conflict. These extreme estimates are then computed in the projection framework under two scenarios: factual and counterfactual as discussed in Chapters 6 and 7. The difference in population loss between the two scenarios is set to provide the range of plausible estimates containing the actual excess population loss associated with the 1998-2004 DRC armed conflict.

The main terms and concepts this chapter deals with are defined as follows:

- "Upper bounds" or upper variant refers to demographic parameters needed to derive the top boundary of the range of excess population loss estimates. Such demographic parameters include the highest fertility rate, the lowest mortality rate and the highest net migration figure ever recorded at each of the benchmark points. In other words, the upper bounds are extreme demographic parameters expected to lead – in the projection – to an increased population size.

- “Lower bounds” or lower variant refers to demographic parameters needed to derive the lower boundary of the range of excess population loss estimates. Such parameters include the lowest fertility rate, the highest mortality rate and the lowest net migration figure ever recorded at each of the benchmark points. In other words, the lower bounds are constituted by extreme demographic parameters expected to lead to a decreased population size.
- “Reference” category derives from assumptions used so far in the current study and enabled to produce the initial projection framework.

Note that estimates needed to derive both the upper and the lower bounds of the range containing the actual excess population loss are mean to be added to the counter-factual scenario. This is because the factual scenario is set to represent the true situation hence does not need to be altered with assumptions as those defined to derive the upper and the lower bounds. However, to check the sensitivity of the range these estimates are added to both the factual and counter-factual scenarios as shown later in this chapter.

The range of estimates representing the excess population loss constituted by the lower and upper bounds mentioned above is not a confidence interval. This is because each of the bounds is deterministic and originates from specific demographic assumptions. However, any result between the two extreme boundaries should be regarded as plausible since it will not be in contradiction with what can be derived or expected from the data used in this study.

8.1.1 Base assumptions

The five sets of assumptions explored in Chapter 7 of the current study can be grouped into two different categories as follows:

1. The first category includes OPF1984, OPF1984-07, CPF1984 and CPF1984-07; all derived from the 1984 census using this study's approach.
2. The last category only includes assumptions based on the INDEPTH model life table.

Out of the four assumptions featured in the first category, the OPF1984-07 has been selected to constitute the base assumption. This is due to the fact that the assumption is based on an open population and components of population change for the counterfactual scenario converge to the level observed in 2007. Converging estimates of population change to the 2007 level in this way benchmarked the projection process, thus reducing the uncertainty linked to each of the component for years around the benchmark point. Besides this, the projection made under the OPF1984-07 assumption has the advantage of including net migration figures and correcting the fertility trend with the most recent fertility estimates.

Applying assumptions based on the INDEPTH model life table to derive estimates of excess population loss as defined in this study led to another set of results that can be deemed plausible. The slight concern with estimates derived through the INDEPTH model life table is due to the fact that its assumptions tend to provide a lower mortality baseline. As seen earlier in this study, starting with a lower mortality baseline leads to higher numbers of excess population loss. In this sense, it can be said that estimates derived through the INDEPTH model life assumptions may be deemed plausible, but assuming a lower mortality baseline. As argued before, such mortality baseline may not be a true reflection of the DRC mortality. As seen earlier, the INDEPTH model life table is a summary of various mortality schedules in the sub-Saharan Africa region so they are plausible but they are not necessarily accurate for the DRC. Nonetheless, the INDEPTH-based estimates have been retained in the current analysis for the sake of a comparison.

To illustrate how plausible some of the figures derived using the assumptions presented in the previous chapter, Table 8.1 below summarises life expectancy at birth for the 1984 baseline year.

Table 8.1 Life expectancy at birth by projection assumption

Life expectancy at birth	1984 census	INDEPTH
Male	45	54
Female	48	60

Source: Own calculation based on 1984 Census and INDEPTH

In Table 8.1, it can be seen that life expectancy estimates derived based on the INDEPTH model are higher in comparison to those derived using the other assumptions. This is due to the fact that the model life table from the INDEPTH are probably more optimistic than those produced based on data from the 1984 census and explored through the current study's projection framework.

The range of plausible estimates is meant to include the selected assumption (OPF1984-07) and two extreme values including the highest and lowest boundaries of the range. These boundaries are needed because, as explained earlier, this study's aim is not to produce a single "best" estimate of the number of excess population loss but a range of plausible estimates. Due to the uncertainty attached to various assumptions used to set this study's factual and counterfactual scenarios, it is therefore appropriate to evaluate the plausible range of uncertainty in the DRC context.

8.1.2 Defining the upper and lower bounds

The current study makes full use of selected data to refine the extent of uncertainty linked to estimates containing the actual number of excess population loss associated with the 1998-2004 armed conflict in the DRC. For this reason, it was important to identify and select "extreme" yet plausible values taken by each component of population change.

In this section, the general idea is to explain how "extreme" yet plausible values representing each component of population change have been selected. Such values are taken in pairs, including the lowest and highest rates recorded for fertility and mortality. In the case of migration, the same procedure applies but, this time, using the lowest and highest net migration figures as recorded around benchmark points except the points corresponding with a sudden influx and outflow of Rwandan refugees between 1995 and 2000.

The above mentioned assumptions for fertility and mortality estimates were selected for populations living either in rural or in urban areas. This is justified by the fact that fertility and mortality rates display distinct patterns in rural and in urban areas. In most, if not all, cases the average fertility estimates recorded in rural areas are higher than those recorded in urban areas. In the same way, mortality estimates recorded in rural areas are higher than those recorded in urban areas.

The following sections show the selected extreme values for each component of population change.

8.1.3 Fertility assumptions

For the first benchmark point in year 1984, this study looked at differences by provinces in order to select the highest and the lowest fertility rates recorded. The differences by provinces criterion was applied here because there were no data on fertility distributed by rural and urban areas for that year. The distribution of fertility rates by place of residence – rural and urban – was available for the remaining data benchmark points. According to the 1984 census, the lowest fertility rate has been recorded in Province Orientale with an estimated total fertility rate of 4.8 and the highest rate was recorded in the province of Katanga with an estimated TFR of 7.8 (Institut National de la Statistique, 1994, pp. 14). For the remaining benchmark points in years 1995, 2001 and 2007, this study used the rural and urban divide as the main criterion to select the lowest and the highest fertility rates. Table 8.2 below shows pairs of TFR representing the extreme lowest and highest rates recorded by place of residence for each of the benchmark points.

Table 8.2 Lowest and highest TFR at each benchmark points

Source	Bounds	Benchmark Year	Place of residence	TFR
Census	Lower	1984	Orientale	4.8
	Upper	1984	Katanga	7.8
MICS1	Lower	1995	Urban	7.2
	Upper	1995	Rural	7.4
MICS2	Lower	2001	Urban	6.3
	Upper	2001	Rural	7.4
DHS	Lower	2007	Urban	5.4
	Upper	2007	Rural	7.0

Source: DRC 1984 census, MICS1; MICS2 and 2007 DHS

Table 8.2 above shows that from 1995 to 2007, in the DRC, the lowest TFR has been recorded in urban areas and the highest TFR in rural areas and that range lies between 5.4 and 7.4 for the same period. These estimates were deemed to represent the lower and upper bounds with which to derive the range of "extreme" yet plausible estimates within which the actual number of excess population loss lies.

Adding the reference category, Table 8.2 shows the distribution of fertility estimates or TFRs retained to be used as the fertility component contributing to derive the range of plausible estimates containing the actual number of excess population loss.

With TFRs presented in Table 8.2 above it age specific fertility schedule has been derived based on the model explored in Chapter 4. The derived age specific fertility rates constituted the fertility component input to the projection framework.

8.1.4 Mortality assumptions

Similar to fertility rates, "extreme" estimates of mortality needed to form the lower and upper bounds were selected based on mortality recorded in urban and rural areas. For the benchmark point in 1984, the difference by provinces was used as an alternative solution, since the information on the rural–urban divide was not available.

Table 8.3 below shows infant mortality rates that enabled this study to derive age specific mortality used to benchmark the projection framework used to derive the lowest and highest plausible estimates of the excess population loss.

Table 8.3 Assumptions on infant mortality rates

Year	Lower	Reference	INDEPTH	Upper
1984	155	137	82.7	104
1995	161	148	89.3	101
2001	144	126	86.7	91
2007	108	92	82.9	74

Source: 1984 census, MICS1, MICS2, 2007 DHS and INDEPTH

It can be seen in Table 8.3 above that infant mortality rates for the upper bounds range from 74 per 1,000 per year in 2007, to 104 per 1,000 per year in 1984. For the lower bounds, infant mortality rates range from 108 per 1,000 per year in 2007, to 155 per 1,000 per year in 1984. Infant mortality rates for the lower bounds helped derive age specific mortality rates at all ages for the mortality component needed for population projection. The lower and upper bounds were used here to refer to the population growth rates implied. Thus high mortality implies low population growth and low mortality implies high population growth.

A model life table was needed to produce the age specific mortality rates following the methods detailed in Chapters 4 and 5. It can be seen that using the INDEPTH model life table the derived infant mortality rates are quite low in comparison to those from the other assumptions. This may be caused by the difference in the distribution of age-specific survivorship stemming from each of the assumptions used. Table 8.4 below shows the estimated life expectancy at birth for each of the benchmark points.

Table 8.4 Life expectancy at birth for each bounds at benchmark points

Benchmark Years	1984		1995		2001		2007	
Bounds	Male	Female	Male	Female	Male	Female	Male	Female
Lower	38	41	36	39	42	46	56	59
Reference	45	48	41	44	49	52	62	65
INDEPTH	54	60	58	65	57	63	64	60
Upper	58	61	59	62	63	66	69	72

Source: Own calculation based on extreme values recorded in Census, MICS1, MICS2, 2007 DHS and INDEPTH

From Table 8.4, it can be seen that the range between the lower and upper bounds of life expectancy has increased over the years going from between 38 and 58 years, for males in 1984 to between 59 and 72 years, for females in 2007 when we consider all of the recorded "extreme" estimates for the same period.

Despite the fact the range of life expectancy at birth is large, estimates of life expectancy for the reference category explored in this study, so far, are closer to the lower bounds than they are to the upper bounds.

Having estimates of life expectancy at birth for the reference category closer to the lower bounds as shown Table 8.4, it can be expected that the actual excess population loss as assessed in the current study will be closer to the lower bounds than to the upper bounds. This issue is further discussed in Section 8.3 devoted to the evaluation of the contribution each of the three components brought to the projection.

8.1.5 Migration assumptions

Total net migration produced by the United Nations Population Division and presented in Table 8.5 below was needed to benchmark the projection of upper and lower estimates of population loss.

Table 8.5 DRC Total net migration from 1980 to 2010

1980-1985	1985-1990	1990-1995	1995-2000	2000-2005	2005-2010
-346.86	74.74	1,202.38	-1,500.96	-241.56	-23.98

Source: United Nations Population Division, 2010 Review

Table 8.5 above shows a sharp increase in net migration, to 1.2 million, in the period 1990-1995. This increase was followed by a sharp decrease, to –1.5 million, in the period 1995-2000. As seen earlier in this study, periods 1990-1995 and 1995-2000 relate to the violent armed conflict in Rwanda and the ensuing 1994 genocide. The same period saw the DRC drift into an armed conflict as both the result of the spill over from the Rwandan conflict and also the generalised crisis in which the DRC has been engulfed since the late 1980s early 1990s. It can be said that the deterioration of security conditions in Rwanda during this period led to an influx of an estimated 1.2 million refugees between 1990 and 1995. In the same way, the 1.5 million emigrants recorded for the period 1995-2000 are likely to be the result of the return to Rwanda by those who fled that country around year 1994, and also of the deterioration of the security situation in the DRC from early 1996.

Considering the following two cases:

a. From Table 8.5 above, the mean net migration for the period going from 1980 to 2010 is -139,370 per five years.

b. If events thought to have caused the rapid increase of net migration in 1990-1995 and the sharp decrease in 1995-2000 are left out of the projection framework, the mean number of net migration between 1980 and 2010 is equal to *-134,410*.

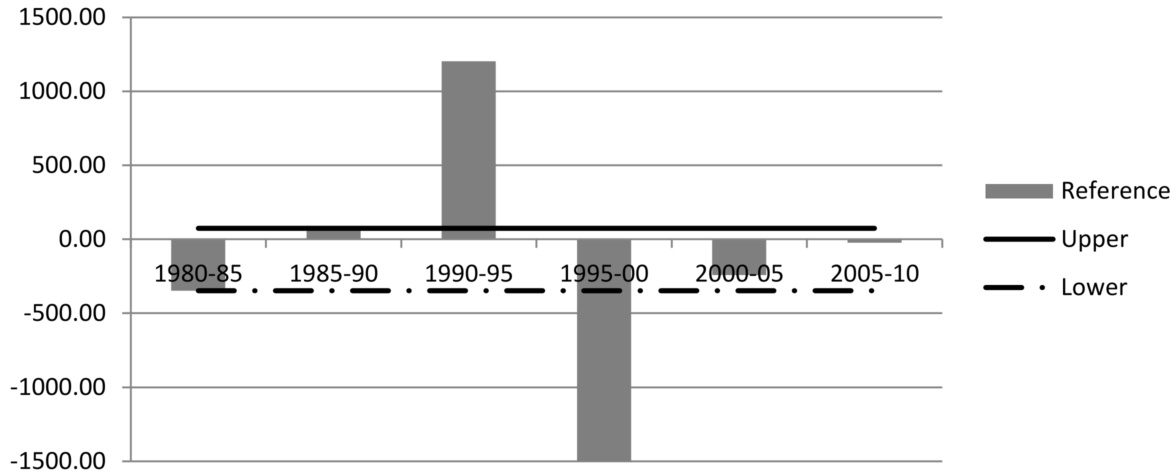
The difference between the mean net migration from the above two cases gives a total of around *-5,000 or (-139.37 + 134.41)* per five years.

In other words, net migration for the period 1990-1995 and that of the period 1995-2000 nearly cancel each other out within a ten year period. When considering the trend followed by DRC net migration, without the period 1990 to 2000, it can be seen that net migration can plausibly bounded by –346,860 and +74,000 per five years; being the highest and lowest in any of the other five-year periods.

In this way, the deviations or sharp increases and decreases in total net migration in the period 1990 – 2000 have been taken out of the projection framework to select the highest and lowest figures of total net migration. The remaining migration estimates have been used as the range of “extreme” yet plausible estimates for deriving the actual number of excess population loss associated with the 1998-2004 armed conflict in the DRC.

Figure 8.1 below shows changes in the number of migrants from 1980 to 2010 under the lower, upper and reference scenarios.

Figure 8.1 Total net migration recorded between 1980 and 2010



Source: Own calculation based on United Nations Population Division, 2010 Review

Based on figures of total net migration shown in Figure 8.1, Table 8.5 and age-specific migration figures explored in Chapter7 above, it was possible to derive migration schedules by age group for each of the benchmark points. The derived age specific net migration figures combined with the extreme values of fertility and mortality estimates constitute all the elements needed for deriving population projections.

8.1.6 Combining net migration, fertility, and mortality rates

The current section explains how selected figures and rates shown above have been combined into the projection framework.

"Extreme" yet plausible assumptions for migration; fertility and mortality rates presented above were incorporated into the projection framework in the following way. Using the OPF1984-07 projection framework, developed earlier in this study, the selected "extreme" values of migration, fertility and mortality were inserted into the counterfactual scenario alone, leaving the factual scenario unchanged. In other words, extreme values were only applied to the counterfactual scenario, keeping the factual scenario unchanged. This was done to allow for comparison and calculate the difference between population losses based on the factual scenario against population loss based on the counterfactual scenario.

Projections have been conducted in two phases. The first phase involved estimates forming the lower bounds for all three components of population change. This projection was corrected using other estimates forming the lower bounds at each of the benchmark points. The second phase involved estimates forming the upper bounds for all three components of population change. The projection was also corrected at each of the benchmark points using “extreme” estimates. The projection process applied the same method and steps explored earlier in this study. The only difference being that for this part of the study, “extreme” yet plausible values were entered for the counterfactual scenarios.

Based on the extreme figures of net migration, fertility and mortality rates presented above, it was possible to derive age specific estimates at each at each of the benchmark points as shown in Table 8.6 and Table 8.7 below.

Table 8.6 Age-specific person years lived and fertility: Lower bounds

Age	Person-years lived **1984**		ASFR	Person-years lived **1995**		ASFR	Person-years lived **2001**		ASFR	Person-years lived **2007**		ASFR
	Females	Males		Females	Males		Females	Males		Females	Males	
0 - 4	370,907	371,714		380,584	380,683		373,050	373,213		379,617	379,883	
5 - 9	347,555	343,877		354,486	349,707		352,034	347,490		365,316	360,913	
10 - 14	337,351	336,927		343,574	342,046		342,292	341,011		356,960	356,001	
15 - 19	332,980	329,038	0.08	338,548	333,369	0.12	338,536	333,643	0.11	355,060	350,382	0.09
20 - 24	331,324	317,604	0.20	336,010	320,817	0.30	337,866	322,944	0.26	357,388	342,173	0.22
25 - 29	321,266	304,603	0.22	324,830	306,586	0.34	328,777	310,748	0.29	351,295	332,737	0.25
30 - 34	325,589	291,564	0.20	328,165	292,365	0.30	334,443	298,475	0.26	361,131	323,140	0.22
35 - 39	313,716	277,933	0.16	315,112	277,553	0.24	323,562	285,599	0.21	353,426	312,958	0.18
40 - 44	313,269	262,862	0.06	313,400	261,247	0.09	324,637	271,308	0.08	359,386	301,518	0.07
45 - 49	288,270	245,387	0.03	286,959	242,431	0.05	300,491	254,663	0.04	338,212	287,999	0.04
50 - 54	262,278	224,386		259,388	219,957		275,507	234,547		316,870	271,366	
55 - 59	223,341	198,762		218,909	192,755		237,091	209,820		280,849	250,435	
60 - 64	187,999	167,659		181,917	160,103		202,599	179,499		250,247	223,931	
65 - 69	118,623	131,232		112,610	122,466		130,718	143,465		171,669	190,959	
70 - 74	73,407	91,695		67,655	82,580		83,700	103,501		120,539	151,857	
75 +	83,757	88,413	0.96	38,735	45,972	1.44	53,039	64,170	1.26	87,996	109,315	1.08
TFR			4.8			7.2			6.3			5.4

Source: Own calculations based on lowest recorded fertility and mortality rates from 1984, 1995, 2001 and 2007.

Table 8.7 Age-specific person years lived and fertility: Upper bounds

Age	Person-years lived 1984		ASFR	Person-years lived 1995		ASFR	Person-years lived 2001		ASFR	Person-years lived 2007		ASFR
	Females	Males		Females	Males		Females	Males		Females	Males	
0 - 4	552,794	553,996		606,673	606,832		590,321	590,578		554,036	554,424	
5 – 9	517,991	512,510		565,071	557,454		557,065	549,874		533,164	526,738	
10 - 14	502,783	502,151		547,677	545,242		541,649	539,622		520,968	519,570	
15 - 19	496,268	490,393	0.13	539,665	531,409	0.12	535,705	527,963	0.12	518,195	511,368	0.12
20 - 24	493,800	473,352	0.32	535,619	511,401	0.31	534,644	511,033	0.31	521,593	499,388	0.29
25 - 29	478,810	453,976	0.36	517,798	488,717	0.35	520,263	491,733	0.35	512,701	485,616	0.33
30 - 34	485,252	434,543	0.32	523,115	466,047	0.31	529,229	472,312	0.31	527,056	471,610	0.29
35 - 39	467,558	414,227	0.26	502,307	442,437	0.25	512,010	451,937	0.25	515,812	456,750	0.24
40 - 44	466,891	391,765	0.10	499,579	416,442	0.09	513,712	429,323	0.09	524,510	440,053	0.09
45 - 49	429,633	365,721	0.05	457,430	386,450	0.05	475,502	402,983	0.05	493,607	420,323	0.05
50 - 54	390,895	334,422		413,479	350,625		435,968	371,152		462,459	396,048	
55 - 59	332,864	296,231		348,954	307,263		375,176	332,022		409,887	365,500	
60 - 64	280,190	249,877		289,986	255,214		320,597	284,042		365,225	326,818	
65 - 69	176,794	195,586		179,506	195,219		206,850	227,022		250,543	278,697	
70 - 74	109,404	136,661		107,847	131,637		132,449	163,781		175,921	221,630	
75 +	124,831	131,770	1.56	61,746	73,282	1.48	83,929	101,544	1.48	128,427	159,541	1.40
TFR			7.8			7.4			7.4			7.0

Source: Own calculations based on lowest recorded fertility and mortality rates from 1984, 1995, 2001 and 2007.

Tables 8.6 and 8.7 above show a difference in the number of person–years lived for each of the benchmark points. The gap between the number of person–years lived ($_nL_x$) between age x and $x+n$ above the age of 40 is greater between the lower and the upper bounds. This is due to the fact that the assumed improvement in life expectancy when changing from high in the lower bounds to low mortality in the upper bounds has led to an increase in the number of person–years lived at older age, as seen in Table 8.7 above.

As far as fertility rates are concerned, it can be seen from Tables 8.6 and 8.7 that other than in 1984, the difference in the level of age specific fertility rate for the two extremes has remained quite proportional for benchmark points 1995, 2001 and 2007. However, there is a big gap in the level of fertility for both variants in 1984.

Concerning the lowest TFR of 4.8, it has to be reminded that an empirical study by Romaniuk found a strong positive correlation between the incidence of venereal disease and sterility within specific ethnic groups in DRC's provinces of Orientale and Equateur in the late 1960s (Romaniuk, 1980). It is not clear to what extent Romaniuk's findings of the late 1960s are still relevant to the low fertility rate recorded for Province Orientale during the 1984 census. However, due to the lack of robust alternatives and for practical reasons, the current study uses the 4.8 TFR recorded for province Orientale in the 1984 census in its analyses aimed at establishing the lower fertility bounds.

Finally, the lower and upper net migration assumptions shown in Figure 8.1 above were computed to derive figures of total net migration by age and sex for the period 1980–2010 as shown in Table 8.8 below.

Table 8.8 Net migration by age and sex from 1980 to 2010

Age-group	**Lower**		**Upper**	
	Males	Females	Males	Females
0 – 4	-14.2	-14.5	3.1	3.1
5 – 9	-14.6	-14.6	3.2	3.2
10 – 14	-14.5	-14.3	3.1	3.1
15 – 19	-18.2	-18.2	3.9	3.9
20 – 24	-19.4	-19.0	4.1	4.2
25 – 29	-17.1	-15.8	3.4	3.7
30 – 34	-14.1	-12.8	2.8	3.0
35 – 39	-12.3	-9.9	2.1	2.7
40 – 44	-10.6	-8.3	1.8	2.3
45 – 49	-9.6	-6.7	1.4	2.1
50 – 54	-8.4	-6.1	1.3	1.8
55 – 59	-7.7	-5.7	1.2	1.7
60 – 64	-6.7	-5.5	1.2	1.4
65 – 69	-5.7	-4.8	1.0	1.2
70 – 74	-4.1	-5.3	1.1	0.9
75 +	-3.9	-4.4	0.9	0.8
Total	**-181.2**	**-165.7**	**+35.7**	**+39.0**

Source: Own calculation based on United Nations Population Division, 2010 Review

Figures of total net migration by age and sex were subsequently entered into the projection framework. After combining the various "extreme" values into this study's projection framework and calculated the difference in mortality between the factual and counterfactual scenarios, the ensuing results and their implications are presented in the following section.

8.2 Results and implications

Table 8.9 below shows selected characteristics of the DRC population as projected for year 2014. The selected characteristics derive from the combination of extreme lower, extreme higher bounds and reference category representing each components of population change. Deriving age patterns through projections conducted in this study is important because, among many other advantages, it helps contextualise the extent to which armed conflict can shape age structure and future population change and this is addressed in Sub-section 8.2.3.

Table 8.9 Age structure as projected for year 2014 (in 1,000s)

PLAUSIBLE ESTIMATES	COUNTERFACTUAL SCENARIO			
Age groups	Lower	Reference	INDEPTH	Upper
0 - 14	24,566	37,894	44,633	59,657
15 - 29	14,412	21,926	25,372	32,071
30 - 44	12,414	12,709	14,089	12,738
45 - 59	6,782	6,959	7,942	6,986
60 - 74	2,204	2,303	2,945	2,313
75 & over	261	282	608	283
Total all ages	60,638	82,073	95,589	114,049
	Percentages of total all age			
0 - 14	40.51	46.17	46.69	52.31
15 - 29	23.77	26.71	26.54	28.12
30 - 44	20.47	15.49	14.74	11.17
45 - 59	11.18	8.48	8.31	6.13
60 - 74	3.63	2.81	3.08	2.03
75 & over	0.43	0.34	0.64	0.25
Median age	20	16	16	13
Population Over 65	1,182	1,220	1,219	1,263
% Over 65	1.95	1.49	1.28	1.11
% Under 15	40.51	46.17	46.69	52.31
% Under 5	23.08	18.07	15.40	13.90

Source: Own calculation based on DRC 1984 Census, 1995 MICS, 2001 MICS and 2007 DHS

Table 8.9 shows DRC population characteristics by age group as projected for 2014 under the counterfactual scenario. Here, it can be seen that the total population as projected for 2014 ranges from 61 million when benchmarked using the lower bounds, to 114 million when benchmarked using the upper bounds as compared to around 82 million for the reference category. Using the INDEPTH model life table, the total population is projected to reach 88.7 million in 2014. Differences in the size of the population between age groups vary from one set of assumptions to another. The difference in the size of population from one age group to another is further justified by the varying nature of migration figures as well as fertility and mortality rates at each of the benchmark points. Out of the three components mortality is the one most influencing the projected population size. More on this is explained in the next section on population change.

The median age is projected to be lower when applying estimates from the upper bounds and the INDEPTH assumptions compared to when applying estimates from the lower assumption. In other words, the median age derived from the reference scenario is projected to decrease when using the upper bounds assumption; going from 16 to 13 years old for both assumptions respectively. Unlike for the upper bound assumption, median age as derived from the reference category is projected to increase going from 16 to 20 years old when considering estimates from the lower bounds. This shows that besides the projected improvement in life expectancy, an increase in fertility also implies a rejuvenation of the population over the projection period.

8.2.1 Population change under extreme, yet plausible assumptions

Reflecting from results presented in Table 8.9 above, Table 8.10 below shows how each of the three components are projected to change the population between 1984 and 2014 when considering the factual and counterfactual scenarios. The assessment has been conducted using the "extreme" yet plausible estimates explored above.

Table 8.10 Projected yearly population change for period 1984-2014

In 1,000s	FACTUAL				COUNTERFACTUAL			
	Lower	**Reference**	Upper	INDEPTH	Lower	**Reference**	Upper	INDEPTH
Natural increase	1,321	**1,665**	1,821	2,387	999	**1,713**	2,164	2,779
Births	2,070	**2,463**	2,596	2,936	1,825	**2,373**	2,513	2,897
Deaths	749	**798**	774	549	827	**659**	349	118
Net migration	-5.52	**-27.87**	-27.87	1.3	0	**-9.07**	-9.07	0
Growth rate	2.76	**3.22**	3.41	4.01	2.27	**3.28**	3.79	4.38
Total population growth[47]	39,633	**49,957**	54,641	71,610	29,964	**51,400**	64,915	83,376

Source: Own calculation based on data from DRC 1984 census, 1995 MICS, 2001 MICS and DHS

One of the most important aspects to retain from Table 8.10 is the difference between the factual and counterfactual scenarios. In this table yearly changes as projected between 1984 and 2014 present significant differences between various bounds or assumptions for both the factual and the counterfactual scenarios using the reference category. See

[47] This is projected population growth for the whole projection period (1984-2014).

Appendix 3 for more complete tables under the reference category.

With regards to the counterfactual scenario it can be seen, for instance, that the overall population size is expected to grow by an additional 83.4 million people between years 1984 and 2014 when assumptions posited for the upper bounds are taken into account. When assumptions posited for the lower bounds are taken into account, population size is projected to increase by an additional 30 million for the same period. In the same way, based on projections conducted under the counter-factual scenario, around 2.8 million births are projected to happen yearly between 1984 and 2014 for upper bounds and around 1.8 million for the lower bound assumption.

Similarly, it can be seen for the factual scenario that all components are projected to change in almost similar proportions between 1984 and 2014, when compared to changes under the counter-factual scenario. In this respect, it can be seen, for instance, that when there is a projected yearly natural increase of around 1.3 million population under the lower bound assumption, there is an increase of around 1.7 million under the reference scenario, 2.4 under the upper bound assumption, and 1.8 million when considering the INDEPTH model life table. Under the factual scenario the projected yearly growth rate is projected at 2.76 following the lower bound assumption, 3.22 following assumptions made under the reference scenario, 3.41 when the INDEPTH model life table is considered and 4.01 under the upper bound assumption.

In other words, the counterfactual scenario plays a crucial role in determining the extent to which each of the components of population change can be expected to affect the projected population. As briefly introduced in the previous section, out of the three components of population change, mortality – shown in Table 8.10 under the number of deaths – has a significant impact on the overall population change. Values presented under the counterfactual scenario represent the range of plausible demographic outcomes for the three components of population change when one assumes the war did not happen.

8.2.2 Overall excess population loss

Based on the methods explored earlier in this study, mortality estimates were interpolated to derive annual numbers of deaths for the projection period. For this part of the analysis the period going from year 1998 to 2007 has again been selected to calculate excess population loss associated with the conflict. Calculations were based on estimates contained in the lower bounds, the reference category, and the upper bounds. As explained earlier, excess population loss calculated under the INDEPTH assumptions is also used for comparison purposes.

Table 8.11 below shows excess population loss as calculated following extreme figures of net migration as well as fertility and mortality rates recorded in the DRC at various benchmark points. Estimates of excess population loss calculated here result from the difference between projections conducted under factual and counterfactual scenarios. Put together, the figures presented in Table 8.11 constitute the range of plausible estimates containing the actual number of excess population loss to be associated with the conflict period (1998-2007). Estimates of population loss from variants have been derived against the reference factual scenario.

Table 8.11 Excess population loss using plausible estimates 1998-2007

Scenario	Counter-Factual					
	Assumptions		Lower	Reference	INDEPTH	Upper
		Population change in 1,000s	9,305	8,150	5,552	2,973
Factual	Lower	8,301	1,004	-151	-2,749	-5,329
	Reference	6,574	2,730	1,576	-1,022	-3,602
	INDEPTH	3,619	5,685	4,531	1,933	-647
	Upper	1,293	8,012	6,857	4,259	1,679

Source: Calculations based on population projections

In Table 8.11, figures presented in the third column represent overall population change as derived for each of the four assumptions (lower, reference, INDEPTH and upper) under the factual scenario and figures in the third row represent population change as derived for each of the four set of plausible assumptions (lower, reference, INDEPTH and upper) under the counter-factual scenario. The population change presented in the above mentioned column and row have been derived for the period 1998–2007 which is the defined period adopted by the current study to assess the excess population loss associated with the 1998–2004 armed conflict in the DRC. Note that negative numbers indicate population gains in the reference period.

It also can be seen in Table 8.11 that when considering the factual scenario, assumptions made to derive the upper bounds are the most optimistic since they only produce a population loss of 1.3 million for the assessed period going from 1998 to 2007. When counterfactual scenario is considered, population change under the upper bounds is around 3 million for the same period. The difference between the two scenarios produced an excess population loss of almost 1.7 million.

Assumptions made under the INDPETH model life table are also optimistic but not as optimistic as those made to produce the upper bounds. For the INDEPTH model life table, population change between 1998 and 2007 is 3.6 million for the factual scenario and 5.5 million for the counterfactual scenario. The difference between the two scenarios gave an excess population loss of 1.9 million which is also the highest when a set of plausible assumptions is considered.

It is worth noting that many pairs of combinations can be formed from all four sets of assumptions as presented in Table 8.11 above. These pairs of combinations produce estimates ranging between 151,000 people in excess and almost 8 million excess population loss, represented by off-diagonal figures. It is highly unlikely that these off-diagonal combinations are reliable. This is because underlying conditions underpinning different assumptions needed to constitute the bounds are not drawn from the same regime[48]. According to literature, it would need a demographic transition or revolution to move from one demographic regime to another (Van de Kaa, 2010). However, as mentioned earlier, these regimes as represented under the various assumptions used in the current study are needed here to check for sensitivity in the assumptions in the factual scenario. For this reason, only estimates found in the dark coloured diagonal are reliable hence they are deemed to constitute this study's range of plausible estimates of excess population loss. The estimates are deemed reliable because they result from the combination within each of the assumptions between the factual and counterfactual scenarios.

[48] By the demographic regime it is meant the characteristic way in which factors of human ecology impact on the whole demographic system of populations.

As explained earlier, the difference between the factual and the counter-factual scenarios provides the extent of excess population loss. In this respect, from 1998 to 2007 the difference between the estimated excess population loss as projected in this study ranges from a minimum of one million, when the lower bound assumption is considered, to a maximum of 1.9 million when the INDEPTH model life table is considered. Results for the difference between the two scenarios within pairs of each assumption can be observed in the dark coloured diagonal found in Table 8.11 above. The off-diagonal figures presented in Table 8.11, result from less likely combinations or scenario.

After producing the range of plausible estimates of excess population loss, it was important to look at the extent of natural change derived from the above mentioned set of plausible assumptions. Table 8.12 below gives the difference in the projected natural change between factual and counterfactual scenarios.

Similar to Table 8.11 above, in Table 8.12 below one needs to note the difference between the diagonal and off-diagonal figures. The diagonal figures represent the difference within assumptions and the off-diagonal represent the difference between assumptions when comparing between factual and counter-factual scenario.

Table 8.12 Natural change from 1984 to 2004: yearly differences

Scenario	Counter-Factual					
	Assumptions		Lower	Reference	INDEPTH	Upper
		Natural change in 1,000s	999	1,713	2,164	2,779
Factual	Lower	1,321	-322	392	843	1,458
	Reference	1,665	-666	48	499	1,114
	INDEPTH	1,821	-823	-108	342	958
	Upper	2,387	-1,388	-674	-223	392

Source: Calculations based on population projections

Figures found in the third column of Table 8.12 represent yearly natural increase or the difference between births and deaths for the period 1984-2004 for the factual scenario. In the same way, figures presented in the third row of Table 8.12 represent yearly natural increase or the difference between births and deaths between 1984 and 2004 for the counter-factual scenario.

In Table 8.12 the combination within the reference category offers the smallest difference in the projected estimates of natural change between the factual and counter-factual scenarios. For the lower, INDEPTH and upper assumptions the difference in natural population change ranges from a yearly decline in population of 322,000 when the lower bounds assumption is considered to a yearly excess in population of 392,000 when the upper bounds variant is considered. This can be seen in the dark coloured diagonal cells of Table 8.12.

The reference category gives the smallest difference in population change between the projection conducted under the factual and the counterfactual scenarios. In other words, keeping the projections under the reference category offers the smallest deviation both in the population projected under factual and in that projected under counter-factual scenarios. Similar to excess population loss, when natural change as projected under each of the plausible assumptions presented above, the range of estimates between assumptions lays from a deficit in population of 1.4 million to an excess in population 1.5 million. Given that only estimates found in the dark coloured diagonal are more likely because they are measured from the difference within each assumption against itself, it can be said that the current study's range of estimates representing natural change or increase ranges from -322,000 to 392,000.

From what has been explained above, it is worth noting that throughout the projection process the counter-factual scenario would evolve under entirely different demographic regime compared to the factual, which is why off-diagonal figures, despite being plausible are however, less likely.

8.2.3 Age and sex structure of population loss

As briefly introduced at the beginning of Section 8.2 above, it is important to assess the extent to which age and sex patterns of the DRC population are likely to be affected by the armed conflict, given the projection framework adopted in the current study. To do so, the difference between population projected under factual and counterfactual scenarios was calculated for a five-year period between 1999 and 2004. This period is only meant to be illustrative rather than exhaustive of the period affected by the armed conflict as defined above in the current study.

The period affected by the armed conflict as defined in the current study goes from the year 1998 to the year 2007. In this respect, choosing the projection interval 1999–2004 is a comprehensive way to illustrate the difference in population change by age-group and sex that is closest to the considered period. The period 1999 –

2004 has been kept in order to fit the five-year projection steps adopted in the projection framework. Table 8.13 below shows the difference between the two projections for the period 1999–2004 for the factual scenario.

Table 8.13 Population change 1999-2004 factual scenario in (1,000s)

Age-group	1994-1999		1999-2004		Difference	
	Female	Male	Female	Male	Female	Male
0 - 4	4,887	4,872	5,542	5,532	656	660
5 - 9	3,923	3,933	4,624	4,550	701	617
9 - 14	3,129	3,111	3,792	3,839	663	728
15 - 19	2,572	2,569	3,064	3,013	492	444
20 - 24	2,166	2,187	2,535	2,456	369	270
25 - 29	1,862	1,855	2,081	2,081	220	226
30 - 34	1,622	1,615	1,873	1,764	251	149
35 - 39	1,391	1,317	1,551	1,533	160	216
40 - 44	1,107	1,034	1,382	1,242	275	208
45 - 49	768	667	1,012	965	243	298
50 - 54	614	520	694	608	80	88
55 - 59	428	346	520	460	92	114
60 - 64	388	329	359	291	-30	-38
65 - 69	236	190	246	261	10	71
70 - 74	120	109	150	132	29	24
75 +	60	76	66	63	6	-13
Total	**25,273**	**24,731**	**29,491**	**28,791**	**4,217**	**4,061**

Source: Own calculations based on population projections

Table 8.13 shows age-group and sex-specific population as projected in the interval 1994–1999 and interval 1999–2004 under the factual scenario. The difference between the two projection intervals is shown in the last two columns. It can be seen that population has increased for almost 8.3 million or 4.2 million for females and 4.1 for males between the two projection intervals.

An identical projection to the one presented in Table 8.13 above has been conducted to show age-group and sex-specific population change for the same period but under the counter-factual scenario, details of which can be found in Appendix 4.

Table 8.14 below shows the difference in population change between the factual and counter-factual projections. This distribution is shown here by age-group and sex for the period 1999-2004.

Table 8.14 Population loss between 1999 and 2004 (in 1,000s)

Age-group	Female	Male
0 - 4	-141	-134
5 - 9	2	-72
10 - 14	51	119
15 - 19	16	-14
20 - 24	-66	-134
25 - 29	-39	-22
30 - 34	-35	-104
35 - 39	-34	31
40 - 44	-32	-48
45 - 49	-31	55
50 - 54	-21	2
55 - 59	-22	7
60 - 64	-9	-14
65 - 69	-13	47
70 - 74	-12	-24
75 +	1	-16
Total	**-383**	**-320**

Source: Own calculation based on population projections for the reference category

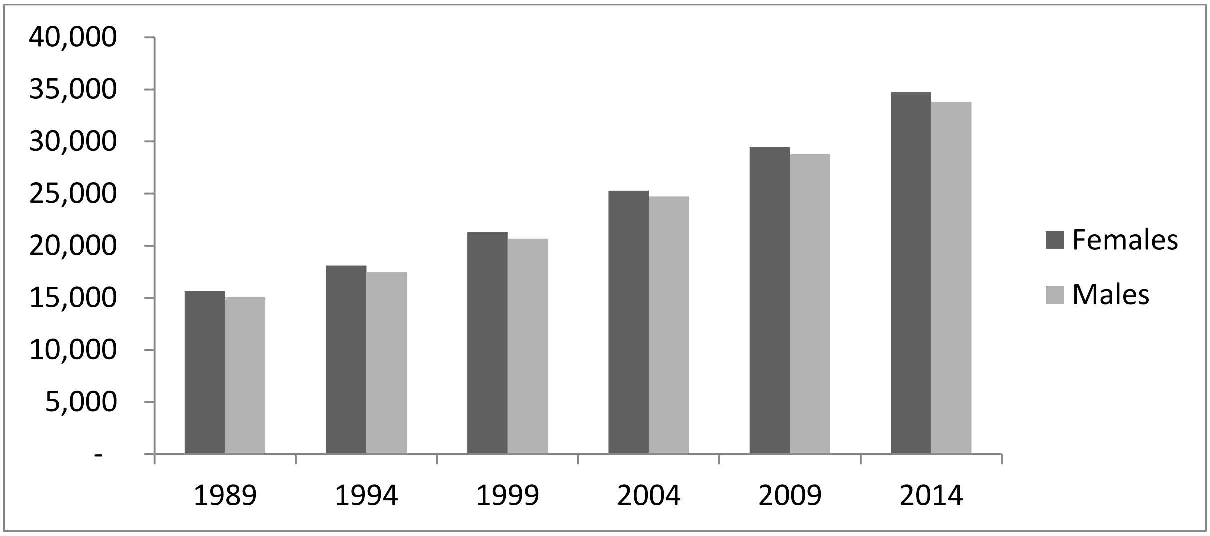
In Table 8.14, population loss between 1999 and 2004 has been obtained by deducting population change under the counter-factual scenario from population change conducted under the factual scenario for the same period (1999-2004). On that basis, negative figures represent a decrease in population and positive figures an increase by age-group, by sex and for the same period (1999-2004).

In Table 8.14, the overall total by sex shows more population loss for males (-320,000) than for females (-383,000). When looking at specific age-groups, it can be seen that just over the quarter of population loss for both sexes has been among children aged below the age of five whilst there has not been many losses between age-groups 10-14 and 15-19 for both sexes. From age-group 20-24 to 40-44 there has been more population loss among both males and females. It can be seen that almost 50% of overall population loss for each sex happen between age 20 and 44. However, the distribution of these losses seem more regular for females than for males.

Despite some increase in population at specific age-groups, the overall population loss between 1999 and 2004 shows that a bigger proportion of those losses involved children of both sexes, aged below five and males aged between 20 and 44. A distribution of population loss by sex and age-group as presented in Table 8.14 above can justify studies which findings asserted that violence is among the leading causes of death for people aged 15–44 years worldwide, accounting for about 14% of deaths among males and 7% of deaths among females (World Health Organisation, 2002).

The difference in size between the two sexes increases with the size of the total population as shown in Figure 8.2 below.

Figure 8.2 DRC population by sex from 1989 to 2014 (in 1,000s)



Source: Own calculation based on population projections developed in the current study

Based on the size of the projected population by sex between the factual and counterfactual scenarios it was possible to calculate the difference or the estimate of population loss for each projection interval.

Assuming all the estimates explored so far in this study and earlier estimates from existing studies are correct, the actual number of excess population loss could range from 200,000 excess deaths obtained by the Lambert and Lohlé-Tart study, to 5.4 million excess deaths obtained by the IRC's study. Given the approach and projection framework adopted in the current study, only estimates deemed plausible are to be retained. In this respect, an excess population loss ranging from 1.0 to 1.9 million produced in the current chapter and shown in Table 8.11 above constitutes the final result of this study's assessment of the extent of population loss associated with the 1998–2004 armed conflict in the DRC. This range of excess population loss is in line with both the data and methods explored in the current study.

Estimates derived when using the INDEPTH model life table are credible too and do fall within the current study's range of plausible estimates. Based on the evidence from recent surveys such as the 1995 MICS I, 2001 MICS II and the 2007 DHS, it can be said that using the INDEPTH model life table provides a rather optimistic mortality profile. By optimistic mortality profile this study means population loss derived when using the INDEPTH model life table are higher than those derived using this study's projection framework.

Using the INDEPTH model life table, the derived life expectancy at birth is 54 for males and 60 for females whereas for this study's reference model life table, the derived life expectancy at birth is 45 for males and 48 for females for the baseline year. As explained earlier, starting with a low mortality level in the projection will lead to higher estimates of excess population loss. In other words, using estimates from the INDEPTH model life table leads to a higher estimate of excess population loss.

When compared to the DRC's life expectancy at birth as calculated in 1984, it can be said that this study's reference model life table is more plausible than the INDEPTH one. This is mainly because estimates used to benchmark the current study's population projections have been recorded in the DRC and thus provide an authentic model of the demographic situation for the considered period. Estimates derived from the INDEPTH model life table are a mixture of many countries' demographic reality which may or may not depict the authentic situation of the DRC for the considered period. For this reason, it can be said that the actual estimate of excess population loss is more likely to lie closer to this study's reference bounds than the INDEPTH's.

Summary of Chapter 8

The current chapter set out to derive a range of plausible estimates deemed to contain the actual excess population loss. Estimates were to be derived based on "extreme" demographic parameters recorded in the DRC between years 1984 and 2007. On this basis, extreme estimates for each of the three components of population change, as recorded at the baseline point in 1984 as well as at each of the benchmark points, were identified and computed using the projection framework. Three bounds including the lower, the reference and the upper values, representing recorded demographic estimates in the DRC between 1984 and 2007 were selected and used to derive the above mentioned range.

In the selection process, implausible assumptions were eliminated, and the assumption[49] OPF 1984-07 was retained as the most plausible and hence used in this chapter as the reference upon which to derive the range of plausible estimates. This assumption implies an open population assumption and allows fertility rates and schedules observed in 1984 to converge with those recorded in 2007 DHS.

With regard to fertility and mortality rates, extreme estimates were selected based on place of the residence at the time of the census or survey. This selection is deemed comprehensive because when considering the place of residence, the difference in fertility or mortality rates between rural and urban areas is very clear cut. The

[49]Assuming the level of demographic estimates recorded at the baseline point in 1984 converged, following a linear trend, to the level recorded in 2007 under the DHS survey.

distribution of fertility or mortality between rural and urban areas also helps identify and select the lowest and highest rates at each of the benchmark points. Rates at each of the benchmark points constituted the lower and upper bounds needed in the projection framework where the excess population loss is derived. “Extreme” figures of migration have been selected then computed based on the trend observed from 1980 to 2010. Analyses in this chapter left out significant peaks observed in migration trends for the period 1990–2000. These figures were left out not only because they resulted from exceptional events, but also because figures for the periods 1990–1995 and 1995–2000 almost cancelled each other out. This has allowed for the selection of the highest and lowest net migration recorded between 1985 and 2010. The two selected extreme figures constituted the migration component needed for the projection.

Combining the selected extreme estimates from each component of population change helped derive the range of plausible estimates of the number of excess population loss. Estimates derived from the INDEPTH model life table were also included in this range. The INDEPTH model life assumptions are deemed plausible to a certain extent since they present some weaknesses. The problems include the fact that demographic estimates derived through the INDEPTH model life table are optimistic given the DRC context, as evidenced by demographic estimates presented in recent surveys. An example of such estimates is, for instance, the derived life expectancy at birth in 1984 as calculated in this study or as provided by the DRC 1984 census. Based on the projection framework developed in the current study, the excess population loss for the period 1997–2008 was calculated as the residual from the difference between population loss as projected under factual and counterfactual scenarios.

As shown in Table 8.11 above, the lower bounds estimates produced an excess population loss of 1.0 million, the reference bounds produced an excess population loss of 1.6 million, the INDEPTH model life table produced an excess population loss of 1.9 million and the upper bounds led to an excess population loss of 1.7 million. In other words, the range of plausible estimates of the number of excess population loss associated with the 1998–2007 armed conflict in the DRC range from 1.0 to 1.9 million individuals.

Given this study's approach and the DRC demographic context as recorded from the 1984 census to the 2007 DHS, it can be submitted that the actual number of excess population loss is more likely to lie between the estimates derived using the lower and those derived using the INDEPTH model life table assumptions. It is important to note that this study is the first of its kind to have combined existing data opportunities in the DRC to derive a range of plausible estimates of excess population loss. In other words, the range of plausible estimates produced in the current study may have weaknesses inherent to the nature of the task involved to derive the various estimates needed, however the range derived in the current study is representative of the demographic changes which have occurred in the DRC and been recorded in various data sources including the 1984 census; the 1995 MICS I; 2001 MICS II and the 2007 DHS.

Chapter 9 Conclusions

Excess population loss associated with the 1998-2004 war in the DRC has been assessed in the current study through a population projection approach reflecting the conflict's complex and volatile dynamics. Drawing from comprehensive country-level data sources, estimates of excess population loss calculated in the current study range between 1 million and 1.9 million people, under plausible assumptions; and between -151,000 (or an excess of 151,000 people) and 8 million people under implausible assumptions. Under plausible assumptions the range is about four times smaller than the IRC's estimate and almost seven times greater than the André and Lohlé-Tart estimate. The approach taken in the current study challenges the use of a single 'best' estimate and the UN policy response which overlooked alternative approaches. The current study offers researchers and policy-makers new tools for assessing excess population loss in conflict affected areas with poor demographic data. Findings from the current study are different from existing ones. These differences are summarised under the following five sections focussed on: first this study's rationale, second its objectives, third its implications fourth the evaluation of its strengths as well as its limitations and finally looking beyond statistics.

9.1 Research rationale

The current study set out to assess and document the extent of excess population loss associated with the 1998–2004 armed conflict in the DRC by meeting a set of objectives. To do so, specific research questions have been set to structure the current study and hence explore the techniques and theories needed to address the assigned objectives.

The current study's first rationale is linked to the newsworthiness and the formation of public opinion around the 1998-2004 armed conflict in the DRC. This study revealed that despite growing interest for the conflict in the DRC, both in terms of media coverage and scientific literature, there are only limited empirical studies assessing actual demographic consequences of this conflict. In this respect, the current study brings an empirical edge to the existing body of studies aimed at furthering the understanding of demographic consequences associated with armed conflicts in general and the 1998–2004 RDC armed conflict in particular.

The second rationale has been linked to the geopolitical importance of the DRC. Howe & Kackson (2012) note that global demographic trends are monitored and studied at the highest leadership levels worldwide and that when expert opinion pushes in the same direction as popular worries about population change, the result is often political action. A better understanding of population change linked to the armed conflict in the DRC as suggested in the current study has the potential to bear significant implications on the understanding of many other demographic as well as socio-economic dynamics in the central African region and far beyond.

The third rationale has been linked to the potential of demographic assessments to inform policy. A previous study on excess population loss linked to the 1998–2004 armed conflict in the DRC has been adopted almost unchallenged by policy makers dealing with the DRC at various levels (Roberts, et al., 2003). This was done despite the controversy surrounding a similar study conducted in Iraq (Burnham, Roberts, Lafta, Garfield, & Khudhairi, 2004).The current study exposed significant weaknesses in the two existing studies which have assessed population loss linked to the armed conflict in the DRC. For this reason, the current study highlights the importance of bringing to the debate an alternative assessment of the demographic consequences associated with the conflict as suggested in the techniques and methods explored in the chapters above.

The fourth rationale has been linked to the quest for the truth. Because the research topic deals with the human cost linked to an armed conflict which is a sensitive subject, there is a potential for lasting consequences on the sense of victimhood, the prospect of peace building, to name but a few, over the collective memory of the affected population (Eck & Hänni, 2013). In this respect, it is important to ensure that reliable or most plausible statistics on the actual extent of human cost are established. This can only be achieved through an objective, empirical assessment framework as intended in the chapters above and explored in the current study. In doing so, it is possible to generate results that are less likely to feed controversy and future conflicts and thus to compromise peace building efforts and undermine the prospects for distributive justice in a post-conflict country like the DRC.

9.2 Research objectives

Two studies before the current one have looked into this topic using different approaches and they ended up finding two contrasting results. The current study explored an alternative approach to derive missing demographic estimates: to develop a cohort component projection framework in which the derived estimates were used. Population projections were conducted under a factual scenario, where it was assumed the armed conflict took place, and a counterfactual scenario where it was assumed the armed conflict did not take place. The difference between the two projections was meant to produce the excess population loss associated with the 1998–2004 armed conflict. To do so, a set of research objectives had to be met. These objectives are related to the existing literature, the demographic methods needed to derive and explore data, ensuring the derived estimates reflect the demographic context under study and finally, making sure that the final results is plausible.

9.2.1 Literature review

This study's first research objective was to review the typology of armed conflict under the International Humanitarian Law (IHL) whilst reflecting on the 1998–2004 armed conflict in the DRC. In other words the first objective was aimed at considering how demography or population studies can contribute to defining armed conflicts in parallel with the IHL definition. Literature shows that under the International Humanitarian Law, armed conflicts are defined following a political or geographical divide. This is because according to the ICRC (1949) armed conflicts can be classified as either international or non-international armed conflicts. The agrees with the fact that the armed conflict as defined by the IHL does is not very comprehensive since conflicts can be dynamic and their definition subject to the perception of warring factions (Bartels, 2009). The current study shows that the 1998-2004 DRC armed conflict has been very dynamic over the years. One way to overcome the typology challenge would be to consider a more inclusive definition of conflict and where population loss is taken into account. This definition has been adopted by the UPPSALA Department of peace and Conflict Research, when they define armed conflict as:

"*a contested incompatibility which concerns government and/or territory where the use of armed force between two parties, of which at least one is the government of a state, results in at least 25 battle-related deaths*" (Wallensteen & Sollenberg, 2001).

Adding the demographic assessment to the definition of armed conflict can also be justified by the fact that excess population loss is one of the most significant consequences of any armed conflict and demography. According to literature, an increasing number of studies have demonstrated a trend where the relevance of distinguishing between international and non-international armed conflicts is diminishing (Zegveld, 2002). For this reason, the current study suggests that regardless of how a conflict is classified, it remains important to assess its demographic consequences and hence inform policy.

9.2.2 Use of direct and indirect demographic techniques

This study's second research objective is related to demographic techniques of estimation and how each of the three components of population change are likely to be affected by the armed conflict. Existing literature shows the predominance of two assessment methods of war-related deaths. Such methods include retrospective mortality surveys (Burnham, et al., 2004; Verpoorten, 2005) and population projections (Heuveline, 1998; Lambert & Lohlé-Tart, 2008). To the above mentioned methods can be added another method where carefully selected sources are analysed to reconstruct war-related deaths with elements of statistical estimation and using assumptions for missing sources (Tabeau & Bijak, 2006). Although the current study focussed on population projection, it is clear from the work conducted above that the leading principle has been to utilise as many data opportunities as possible in developing the projection framework. The advantage of including as many data opportunities as possible in the assessment is that it enables the reduction of some level of uncertainty between benchmark points. However, the study encountered some limitations linked to the data. In this respect, some of the assumptions needed for indirect techniques were deemed unsuitable given some weaknesses in the data.

It can also be submitted that by using cohort component methods of projection the current study was able to assess the extent to which each component of population change has been affected by armed conflict. Compared to existing studies, methods used in the current study have an advantage because by proceeding through cohort-component projection, this study highlights the importance of the term excess population loss. Unlike excess deaths, the term excess population loss covers not only excess deaths but also missing population due to decline in fertility and forced migration associated with the armed conflict. Despite various weaknesses related to the data, it can be argued that the projection framework developed in this study is better suited to meet most of this study's research objectives in a detailed manner but this will require having timely and more detailed data.

9.2.3 Evaluation of the effect of each component

The third research objective is linked to the effect each component of population change has on excess population loss throughout the period assessed. It can be seen in existing literature, most studies focus on mortality to work out the war-related demographic impact of armed conflicts (Coghlan, et al., 2009; Heuveline, 1998). The current study has highlighted the fact that the demographic consequences of armed conflicts are not simply limited to one component of population change, more specifically to mortality. This is because armed conflicts can affect fertility through the deterioration of health facilities or through a decrease in exposure to marriage or reproduction opportunities (Panzi Hospital, 2013). The same has been observed with cases of forced migration where armed conflicts are found to be the driving force affecting both internal and international migration (Castles & Miller, 2009; Ngoie & Lelu, 2010). In other words, not taking into account the effect of all three components of population change when assessing excess population loss linked to an armed conflict may lead to missing out an important piece of information, which has been the case in existing studies.

By incorporating all three components of population change into the assessment as done in the current study, it was possible to see the extent to which each of these components affect the estimated excess population loss. Nonetheless, the current study has been able to show that mortality remains the most prominent component influencing the estimated excess population loss. Added to that is the fact that analyses conducted in the current study reveal the importance of better data collection. Better data collection will allow for the exploration of competing causes of mortality and in much more detail and hence assess the extent to which specific causes of mortality can affect excess population loss as either a direct or an indirect consequence of armed conflict. This has been conducted successfully in the case of Bosnia Herzegovina (Tabeau & Bijak, 2006).

9.2.4 Range of plausible estimates

The fourth research objective is related to deriving a range of plausible estimates of excess population loss, given the data and methods suggested in the current study.

Based on the fact that more than one data sources was involved and that many demographic estimates had to be derived at each benchmark point, it was inevitable that uncertainty of some extent had been generated then propagated throughout the assessment process. For this reason, it was important for the current study to explore a way in which to assess the extent of uncertainty. The current study suggested that considering a range of estimates to define excess population loss was the best way forward rather than using a single estimate.

The current study explored a set of assumptions going from the most basic to the most plausible ones. Given the demographic context in the DRC for the assessed period, and the data and methods used in the current study, it was possible to identify a set of plausible assumptions. With plausible assumptions it was then possible to derive a range of plausible estimates containing the actual excess population loss associated with the 1998–2004 armed conflict in the DRC. By eliminating implausible estimates, the current study was able to narrow down the range of excess population loss to 1.0 – 1.9 million persons for the period 1998 - 2007.

9.3 Implications

9.3.1 Demographic implications

The current study has also been motivated by methodological gaps as well as the lack of empirical studies assessing and documenting the 1998-2004 armed conflict in the DRC. Despite the growing interest on the DRC's armed conflict (Turner, 2007; Nzongola-Ntalaja, 2002) only a few studies have looked empirically into its demographic consequences. Whilst existing studies on the DRC conflict have used either retrospective mortality surveys (Roberts, et al., 2003) or population projections (Lambert & Lohlé-Tart, 2008) to assess the extent of excess death linked to the armed conflict, their approaches have limitations and their findings have prompted controversy especially within the scientific community. The current study drew from the idea of conducting forward projections benchmarked with more recent estimates as suggested by Heuveline (1998) in his work for Cambodia, and the need to explore as many data opportunities as possible (Tabeau & Bijak, 2006) with the aim to contribute to the existing research.

The current study reveals that the demography of armed conflicts is a complex field able to generate a wide range of findings and predictions. In the current study that range of findings and predictions is captured through the assessment of each of the three components of population change. Based on analyses conducted in the current study, DRC population is projected to grow from almost 30 million in 1984 to about 78 million in 2014 with a growth rate of around 3%. As noted in the literature, countries are growing today for two major reasons: high population growth rates and demographic momentum (Goldstone, 2008/2009); the former being evident in South Asia (Nepal and Pakistan), and parts of Africa including the DRC. One of the main implications of this is that despite its high mortality rate and a significant excess population loss associated with the armed conflict, DRC population is growing faster as a proportion of world population. The DRC rapid population growth outpaces its own development process.

As seen earlier in this study, the DRC is becoming crowded and remaining poor. Current impact in fertility and excess population loss associated to the armed conflict are likely to prompt an increase in fertility in the longer term as couples will tend to catch up with postponed nuptiality endured over the conflict period. This situation will become more evident and persistent especially if fertility transition does not happen in the Congo. Because of high population growth rates and population momentum, even when peace becomes effective, it is likely that there will still be a steady flow of children and a younger population into poverty and such flow has the potential to offsets the gains made through the achievement of peace or from schemes such as global poverty reduction.

Geographically, population in the DRC tends to relocate from rural to urban areas and the armed conflict plays as a catalyst in this process as rural and remote areas get increasingly insecure due to the proliferation of local militias. A 2006 special feature in the journal Foreign Policy noted that by 2015 there will be 21 megacities in the world most of them located in developing countries. Cities of the DRC can see a similar increase in population and many of these cities will be faced with new urban challenges and will struggle to address them.

Also of interest from a demographic perspective is the age gap in DRC population. The current study projects the DRC median age to vary between 15 and 17 years old for the next five to ten years. Based on this, it may be feared that if development prospects in this country do not follow population growth and age gap, the volatility of large numbers of undereducated, underemployed young population will have the potential for severe social unrest hence becoming a source for future tensions or youth bulge (Urdal, 2004).

The implications for a rapid population growth cannot only be negative or pessimistic since population change as projected for the DRC also has the potential to either benefit the country or not be as drastic as expected. This is because on the one hand, the DRC may experience fertility transition like in many other sub-Saharan African countries and hence many of the pessimistic predictions stated above may not hold. On the other hand, it has been indicated that population growth leads to the development of coping mechanisms and innovation.

There are three reasons why it can be justified to think that the rapid population growth in the DRC is not the fundamental challenge.

First, despite the rapid population growth, there are many more densely populated countries with fewer natural resources than the DRC. However, studies are yet to demonstrate that any of these countries are in trouble because there are too many people; or because they have exceeded their carrying capacity.

Second, the World Development Reports have shown that population growth and urbanisation go together and that economic development is closely correlated with urbanisation (The World Bank, 2009). In this respect, urbanisation in the DRC can contribute to the economy provided that good governance allows this to happen.

Third, although the rate of population growth in the DRC remains high, its causes are different. As seen in the current study, in the past population growth was mainly driven by increasing numbers of children. More recently, and probably in the longer term, this growth will be driven by longer life expectancies at birth and the population momentum from the previous population boom. In other words, there are now more, younger families in the DRC. If the number of children per family starts to drop as seen earlier in this study; the result in the longer term is that adults will be the fastest growing group in the DRC and not children. Population density increases density associated with rural-urban migration creates higher urban agglomeration. This is important to achieve sustained growth since large urban centres allow for innovation and increase the scope of the economy.

As seen earlier, many see youth bulge as one factor among many to be feared when there is a rapid population growth. This is because youth bulge has the potential to hinder progress made so far to achieve peace. However, as suggested by the 2007 World Development Report, a policy agenda focussing on five key life transitions: learning, work, health, family and citizenship can help mitigate challenges related to youth bulge.

Although it remains difficult to predict with certainty future population change in the DRC, rapid population growth as projected would not necessarily be the main constraint to development as this also has the potential to act as a positive factor in this process. However, the gap between population growth – on the one hand – and realistic education, reproductive health systems – on the other hand – needs to be closed rapidly. In other words, good governance is important if a nation is determined to cope efficiently with a larger and long-living population.

9.3.2 Policy implications

The current study demonstrates that the UN Security Council decision to increase the UN presence and toughen its mandate in the DRC has mainly been motivated by death toll. This can be seen through the relationship between the IRC publications of excess deaths associated with the conflict (Roberts, et al., 2003; Coghlan, et al., 2009), lobbying from advocacy groups (IRIN, 1996; IRIN, 1997; Oxfam, 2002) and the various UNSC resolutions deciding the increase of UN peacekeeping force in the DRC (See Appendix 5). In other words, excess population loss as estimated by the IRC is the main justification upholding the UN's policy related to the DRC armed conflict at both the national and international levels.

Selected case studies presented in the current study show, for instance, that there has been in Cambodia an estimated excess deaths of 2.5 million for the period 1970-1979 (Heuveline, 1998); in rwanda an estimated 800,000 excess deaths during the 1994 genocide or within a period of 100 days (Verpoorten, 2005); in Iraq an estimated 98,000 excess deaths from the invasion to October 2004 (Burnham, Roberts, Lafta, Garfield, & Khudhairi, 2004); in Bosnia and Herzegovina an estimated 102,622 victims including 55,261 civilians between 1992 and 1995 (Tabeau & Bijak, 2006). Except for Bosnia and Herzegovina, figures presented in most of the cases seen above do not distinguish between civilian and combatant deaths. According to literature, battle deaths – including both combatants and civilians – directly resulting from hostilities account for only about 10 % of estimated total war deaths in many contemporary conflicts (Human Security Report, 2011). Most of war deaths are caused indirectly through starvation, the worsening of living conditions and the spread of diseases typical for combat zones.

As seen in the current study civilians, women, children and the elderly make up the overwhelming number of victims in armed conflicts such as the 1998-2004 DRC. The extent to which the role of civilians and combatants are involved in a given armed conflict is open for debate. No matter how tempting the clear-cut logic of the distinction between combatants and civilian deaths may be from a policy point of view, this is not often achieved when assessing excess population loss linked to armed conflict. Armed conflict in politically fragile and economically weak societies such as the DRC will remain a focal point of international security hence at the centre of UN policies for more years to come.

Advancing and developing casualty-recording practices and the use of casualty data in the UN, for instance, would benefit the conflict-affected people served by the UN. This study also shows that good practice and approaches to assess excess population loss already exist even within the UN system and should be learned from. However, assisting the development of consistent and systematic assessment of demographic consequences of armed conflict remains crucial if the ensuing estimates are to be considered as credible by all stakeholders including parties in conflict.

The recommendations presented above are in line with those formulated by Beswick & Minor (2014). In this respect they are directed primarily at UN entities, which are encouraged to take steps to: firstly, understand the application and benefits of demographic assessments of the impact of armed conflict across the UN, and determine how the widest range of these could be effectively served; and secondly, design and implement effective assessment methods in conflict-affected countries, learning from existing practice (UN Security Council, 2013). Better and systematic assessment methods support protection and the reduction of harm to civilians in armed conflict, and contribute to operational planning for humanitarian response and victim assistance.

9.4 Evaluation

Beside many other important outcomes, three main lessons can be learned from the current study:

- Despite the fact that mortality in the DRC is exceptionally high for the war as well as the non-war scenarios, a rapid population growth is projected to continue.
- Regardless of the approach used, the choice of baseline and counterfactual assumptions determine the estimate of excess population loss.
- Considering the use of a range of estimates rather than a single estimate is important due to the extent of uncertainty brought into the assessment by the use of various assumptions and scenarios.

Despite steps taken in the current thesis; for instance: looking into the chronology and dynamics of the armed conflict in order to map its consequences on all three components of population change; the importance of using as many data opportunities as possible to benchmark projection periods and the necessity to derive a range of plausible estimates of excess population loss, there are still unanswered questions. The framework developed in the current study can be used to assess excess population loss at subnational level. This is important because the armed conflict in the DRC did not affect all parts of the country in the same way or with the same intensity. Knowing whether patterns of sex and age-specific excess population loss would have yielded similar distributions at subnational level is not readily evident. Timely and detailed data with subnational characteristics, if available, can be used in this framework to find out more about population change at subnational level.

To take the current study further, future research and policy can focus on the following:

Regular collection of demographic data especially at the subnational level; such data can be collected through censuses, vital registration, surveys or effective casualty recording. With the collected data analyses presented in this study can be propagated at the subnational level. This is important because the armed conflict has not affected the all parts of the country in the same way and will allow gathering figures on the extent and scope of internally displaced people within the country.

Consolidation the projection framework; this is so that more recent and stable computation packages and techniques can be used and hence minimise the risk of losing information in the assessment process. Attempts can be made to write scripts needed to run the method through the use of programs such as Stata or R which give users more flexibility in handling large data such as those used in the current study.

Finally, based on the current study it has been noted that there are severe shortages in the DRC's ability to efficiently source, explore and document demographic data. In this respect, the DRC institute for national statistics could, for instance, promote programs designed to enhance knowledge and infrastructure in population studies. The same effort is needed to explore ways in which to acquire new technologies and equipment needed for a better management of vital statistics. This can be done through regular submissions of realistic research proposals and projects to various partners involved in population studies.

9.5 Beyond statistics

The current study is the first of its kind to have combined more than one data sources, included all three components of population change to assess the extent of population loss associated with the armed conflict. In doing so, the current study combined both direct and indirect techniques of estimation to derive estimates needed for the projection framework. Due to the uncertainty associated with both the data and the method used, the current study emphasises the need to derive a range of plausible estimates rather than a single estimate of population loss to be associated with the armed conflict. In this respect, the approach suggested in the current study is also a way to motivate those involved in the production of statistics related to armed conflicts to think beyond numbers. Bad statistics have the potential to lead to bad policies, undermine any prospects for truth and reconciliation and hence becoming another source for future conflicts (Cranna, 1994; Urdal, 2004; Eck & Hänni, 2013).

Many studies on demographic consequences focus on mortality leaving out fertility and migration. Such approach would only deal with one part of the problem. The current study demonstrates a link between forced migration associated to armed conflict and fertility decline. This study shows that the precise causes and consequences of such link are yet to be determined. However, it can be submitted that an assessment of several behavioural indicators contributing to the decline in fertility in areas affected by armed conflicts can help disentangle competing causes and lead to a better understanding of the extent to which armed conflict can affect fertility.

This study shows that more often refugees – mainly women, children and the elderly – in poor countries such as the DRC are left to their own devices hence vulnerable to violence, diseases and unwanted pregnancy for women. Such exposure to violence has the potential to affect fertility however, further studies would be required to establish how wide spread such exposure is, for how long and the extent to which recorded cases can be generalised. Planning refugees' settlements can help reduce not only out-migration but also reduce environmental hazards that can result from haphazard refugee settlements. Applying modern or traditional methods of contraception could help regulate birth rates among both refugees and natives.

Despite the end of the 1994 war in Rwanda which is considered as the igniting factor of the DRC conflict, the impacts of that conflict and the ensuing consequences on population change in DRC are significant and still enfolding to this day in 2014. Regular demographic assessments are needed for a better understanding on the extent of consequences the armed conflict brought on population change.

As seen in the literature presented in the current study the assessment of demographic consequences of armed conflict is often inhibited by poor data. This is certainly the case with the 1998-2004 DRC armed conflict. Reconstructing missing estimates under factual and counterfactual scenarios was the best way to assess excess deaths. Results presented in the above study need to be complemented by extensive assessments of cause specific mortality in order to extend the understanding of complex consequences of armed conflict.

References

Agadjanian, V., & Prata, N. (2003). Civil war and child health: regional and ethnic dimensions of child immunization and malnutrition in Angola. *Social Science & Medicine. 56.* , 2515 - 2527.

Akaro, R. R. (2001). Population Issues in refugee Settlements of Western Tanzania. *Tanzanian Journal of Population and Development, 8*(1&2), 27-42.

Amoako Johnson, F., Padmadas, S. S., Chandra, H., Matthews, Z., & Madise, N. J. (2012). Estimating unmet need for contraception by district within Ghana: An application of small-area estimation techniques. *Population Studies: A Journal of Demography*, 105-122.

Axe, D. (2010). *War is Boring: DRC Death Toll Debate Raises Questions.* World Politics Review.

Bartels, R. (2009). Timelines borderlines and conflicts: The historical evolution of the legal divide between international and non-international armed conflicts. *International review of the red Cross*, 35 - 67.

BBC. (1999). *World: Africa Analysis Old alliance under strain in Kisangani*. Retrieved September 15, 2011, from Bbc World Service: http://news.bbc.co.uk/1/hi/world/africa/422847.stm

BBC. (2001). *Home Page World Service*. Retrieved January 25, 2012, from Timeline: DR Congo conflict: http://news.bbc.co.uk/1/hi/world/africa/573051.stm

BBC. (2010a). *Timeline: Democratic Republic of Congo*. Retrieved May 27, 2010, from BBC News Chanel: http://news.bbc.co.uk/1/hi/world/africa/country_profiles/1072684.stm

BBC. (2010b). *UN peacekeepers 'failed' DR Congo rape victims*. Retrieved September 20, 2010a, from BBC News Africa: http://www.bbc.co.uk/news/world-africa-11224656

BBC. (2010c). *UN plans to end DR Congo peacekeeping mission*. Retrieved March 4, 2012, from BBC News: http://news.bbc.co.uk/1/hi/8548794.stm

Beswick, J., & Minor, E. (2014). *New ORG Report: The UN and Casualty Recording: Good Practice and the Need for Action.* Oxford Research Group .

Bijak, J., & Kupiszewska, D. (2008). Methodology for the Estimation of Annual Population Stocks by Citizenship Group, Age and Sex in the EU and EFTA Countries. *Central European Forum for Migration and Population Research (CEFMR)*, 133-145.

Bongaarts, J. (1980). Malnutrition and Fecundity. *Studies in Family Planning, 11*(12), 401-406.

Bongaarts, J. (2005). The Causes of Stalling Fertility Transitions. *Population Council*, 1-35.

Brass, W. (1968). *The demography of tropical Africa.* Princeton, New Jersey: Princeton University Press.

Brass, W., Coale, A. J., Demeny, P., Heisel, D. F., Lorimer, F., Romaniuk, A., & VAn De Walle, E. (1968). *The Demography of Tropical Africa.* Princeton, New Jersey: Princeton University Press.

Brunborg, H., & Tabeau, E. (2005). Demography of Conflict and Violence: An Emerging Field. *European Journal of Population*, 131 - 144.

Brunborg, H., Tabeau, E., & Urdal, H. (2006). The Demography of Conflict and Violence: An Introduction. In H. Brunborg, E. Tabeau, & H. Urdal. Springer.

Burnham, G., Roberts, L., Lafta, R., Garfield, R., & Khudhairi, J. (2004). Mortality before and after the 2003 invasion of Iraq: cluster sample survey. *The Lancet, Vol 364*, 1857-1864.

Castles, S., & Miller, M. J. (2009). *The Age of Migration: International Population Movements in the Modern World 4th Edition.* New York: Palgrave Macmillan.

Coalition for the International Criminal Court. (2013). *Cases & Situations > Democratic Republic of Congo > Lubanga Case*. Retrieved from Coalition for the International Criminal Court: http://www.iccnow.org/?mod=drctimelinelubanga

Coghlan, B., Ngoy, P., Mulumba, F., Hardy, C., Bemo, N. V., Stewart, T., . . . Brennan, R. (2009). *Mortality in the Democratic Republic of Congo: An ongoing crisis.* New York: International Rescue Committee.

Cranna, M. (1994). The True Cost of Conflict. In M. Cranna, *The True Cost of Conflict: Seven Recent Wars and Their Effects on Society.* New York: The New Press.

Daguspa, P. (1995). *An Inquiry into Well-Being and Destitution.* Oxford: Oxford Scholarship Online.

De Witte, L. (2000). *L'Assassinat de Lumumba.* Karthala.

De Witte, L., Wright, A., & Wright, R. (2002). *The Assassination of Lumumba.* London: Verso.

Eck, K., & Hänni, O. V. (2013). Male Victimhood in Armed Conflict. *Political violence at a glance*.

Eriksson, L-G; Melander, G; Nobel, P. (1979). *An Analysing Account of the Conference on the African Refugee Problem Arusha.* Scandinavian Institute of African Studies Uppsala 1981 .

Genocide Watch. (2012). *Genocide Emergency: Democratic Republic of the Congo.* Retrieved April 27, 2012, from Genocide Watch: The International Alliance to End genocide: http://www.genocidewatch.org/drofcongo.html

Goldstone, J. A. (2008/2009). *Flash Points and Tipping Points: Security Implications of Global Population Changes".* Environmental Change and Security Program Report.

Heuveline, P. (1998). 'Between one and three million': Towards the demographic reconstruction of a decade of Cambodian history (1970-79). *Population Studies, Vol. 52*, pp. 49-65.

Hochschild, A. (1998). *King Leopold's Ghost: A Story of Greed, Terror, and Heroism in Colonial Africa.* Boston: Houghton Mifflin.

Howe, N., & Kackson, R. (2012). Demography and Geopolitics: understanding Today's debate in Its Historical and Intellectual Context. In J. A. Goldstone, E. P. Kaufmann, & M. D. Toft (Eds.), *Political Demography: How Population Changes Are Reshaping International Security and National Politics* (pp. 31-48). Oxford: Oxford University Press.

Hugues, P. M. (1997). *Global Threats and Challenges to the United States and its Interests Abroad.* Retrieved from US Congressional Hearings Intelligence and Security: http://www.fas.org/irp/congress/1997_hr/s970205d.htm.

Human Rights Watch. (1996). *Human Rights Watch, Human Rights Watch World Report 1996 - Zaire, 1 January 1996.* Retrieved March 2, 2012, from UNHCR The UN Refugee Agency: http://www.unhcr.org/refworld/docid/3ae6a8ac14.html [accessed 9 June 2012]

Human Security Report. (2011). *Human Security Report 2009/2010: The Causes of Peace and The Shrinking Costs of War.* New York: OXFORD UNIVERSITY PRESS.

ICRC. (1949). *The Geneva Conventions of August 12, 1949.* Geneva: International Committee of the Red Cross. Retrieved from International Committee of the Red Cross.

ICRC Opinion Paper. (2008). *How is the Term "Armed Conflict" Defined in International Humanitarian Law?* International Committee of the Red Cross (ICRC).

INDEPTH Network. (2004). *INDEPTH Model Life Tables for Sub-Saharan Africa.* Aldershot: Ashgate Publishing Limited.

Institut National de la Statistique. (1984). *Combien sommes-nous: Resultats Provisoires.* Kinshasa: Departement du Plan Institut National de la Statistique.

Institut National de la Statistique. (1991). *Volume I Zaire/Kinshasa Recensement Scientifique de la Population Juillet 1984: Caractéristiques Démographiques.* Kinshasa: Ministere du Plan et Amenagement du Territoire: Republique du Zaire.

Institut National de la Statistique. (1994). *Profil de la femme au Zaire.* Kinshasa: Ministere du Plan.

Institut National de la Statistique. (1999). *Projections Demographiques Ensemble du Pays et provinces 2006-2010.* Kinshasa: Institut National de la Statistique.

Integrated Regional Information Networks. (1996). *Emergency Update No. 69 on the Great Lakes.* Nairobi: UNITED NATIONS Department of Humanitarian Affairs Integrated Regional Information Network.

Integrated Regional Information Networks. (1997). *Emergency Update No. 131 on the Great Lakes.* Nairobi: UNITED NATIONS Department of Humanitarian Affairs Integrated Regional Information Network.

Integrated Regional Information Networks. (2008). *DRC: Nkunda boycott could leave IDPs stranded*. Retrieved March 1, 2012, from UNHCR The UN Refugee Agency: http://www.unhcr.org/refworld/docid/47cbc625c.html

Internal Displacement Monitoring Centre. (2007). *Democratic Republic of the Congo: Worsening humanitarian crisis as internal displacement escalates in the east*. Retrieved March 6, 2012, from UNHCR The UN Refugee Agency: http://www.unhcr.org/refworld/docid/474fc61e2.html

International Crisis Group. (1998). *Congo at War: A Briefing on the Internal and External Players in the Central African Conflict.* Retrieved March 15, 2012, from UNHCR: http://www.unhcr.org/refworld/docid/3ae6a6ce20.html

International Crisis Group. (2011). *The Lord's Resistance Army: End Game?* Retrieved 2012, from International Crisis Group (ICG) Democratic Republic of the Congo | Uganda: http://www.unhcr.org/refworld/docid/4ec600892.html

International Monetary Fund. (2003). *IMF Country report No. 03/175 Democratic republic of the Congo: Selected Issues and Statistical Appendix.* Washington: International Monetary Fund Publication Services.

Jasseh, M., & Timæus, I. M. (2004). Adult Mortality in Sub-Saharan Africa: Evidence from Demographic and Health Surveys. *Demography, 41*(4), 757-772.

Kallenberg, J. (2009). *Sixty years of the Geneva Conventions: learning from the past to better face the future.* Geneva: ICRC Resource Centre.

Kane, D. (2007, June). *The Lancet Surveys of Mortality in Iraq.* Retrieved from http://cran.r-project.org/web/packages/lancet.iraqmortality/vignettes/mortality.pdf

Kanyarwunga, J. (2007). *République démocratique du Congo. Les générations condamnées. Déliquescence d'une société précapitaliste.* Paris: Publibook.

Kiernan, B. (1997). The Cambodian Genocide. In S. Totten, & W. S. Parsons, *Century of Genocide: Critical Essays and Eyewitness Accounts* (pp. 283-313). New York: Routledge.

Lambert, A., & Lohlé-Tart, L. (2008a). D R Congo's excess death toll during the 1998-2004 conflicts: an excess death estimate based scientifically on demographic methods. Retrieved May 18th, 2010, from http://www.obsac.com/E20090105172451/index.html

Lambert, A., & Lohlé-Tart, L. (2008b). *Observatoire de l'Afrique Centrale*. Retrieved May 18th, 2010, from http://www.obsac.com/E20090105172451/index.html

Lambert, A., & Lohlé-Tart, L. (2008c). Overmortality in Congo (DRC) during the 1998-2004 Conflicts: an Estimate of Excess Deaths scientifically based on Demographic Methods. *ADRASS*, pp. 1 - 18. Retrieved May 18th, 2010, from http://www.obsac.com/E20090105172451/index.html

Landgren, K. (1995). Safety Zones and International Protection: A dark Grey Area. *International Journal of refugee Law*, 436-458.

Les Codes Larcier. (2003). *TOME IV Droit du travail et de la sécurité sociale.* Retrieved from Ambassade RDC Paris: http://www.ambardcparis.com/pdf/Droit%20du%20Travail%20et%20de%20la%20S%C3%A9curit%C3%A9%20sociale.pdf

Mapatano, M. A., & Piripiri, L. (2005). Quelques erreurs courantes d'analyse d'un système d'information sanitaire (RD Congo). *Santé Publique*, pp. Vol. 17. pp.551-558.

MONUC. (2009). *Briefing Materials.* Kinshasa: Public Information Division - United Nations Organization Mission in the Democratic Repubic of Congo (MONUC).

MONUSCO. (2001). *Disarmament, Demobilization, Repatriation, Reintegration and Resettlement of foreign armed groups*. Retrieved from United Nations Organization Stabilization Mission in the DR Congo: http://monusco.unmissions.org/Default.aspx?tabid=10725&language=en-US

MONUSCO. (2012). *MONUSCO Facts and Figures.* Retrieved from United Nations: http://www.un.org/en/peacekeeping/missions/monusco/facts.shtml

Murray, C. J., Ferguson, B. D., Lopez, A. D., Guillot, M., Salomon, J. A., & Ahmad, O. (2003). Modified Logit Life Table System: Principles, Empirical Validation and Application. *Population Studies, 57*(2), 165-182.

Ndaywel, È. N. (1998). Du Congo des rébellions au Zaïre des pillages. *Cahiers d'études africaines*, 417-439.

Ngoie, G., & Lelu, D. (2010). *Migration en République Démocratique du Congo: PROFIL NATIONAL 2009.* Genève: Organisation internationale pour les migrations (OIM) .

Nzongola-Ntalaja, G. (2002). *The Congo From Leopold to Kabila: A People History.* London: Zed Books.

OECD/African Development Bank. (2007). *African Economic Outlook 2007.* doi: 10.1787/aeo-2007-en: OECD Publishing.

Office for National Statistics. (2010). *Results of the 2010-based National Population Projections.* UK: Office for National Statistics.

Organisation of African Unity. (1995). *OAU/UNHCR Regional Conference on Assistance to Refugees, Returnees and Displaced Persons in the Great Lakes Region*. Retrieved March 4, 2012, from UNHCR The UN Refugee Agency: http://www.unhcr.org/refworld/docid/438ec9052.html

Oucho, J. O. (2009). Voluntary versus Forced Migration in Sub-Saharan. *Migration and Displacement in Sub-Saharan Africa The Security-Migration Nexus II* (pp. 11-20). Bonn: Bonn International Center For Conversion BICC.

Oxfam. (2002). *The war in the Democratic Republic of Congo is at a critical juncture is at a critical juncture.* Relief Web.

Panzi Hospital. (2013). *Hopital generale de Panzi*. Retrieved from Hopital Generale de Panzi: http://www.panzihospital.org/

Pedersen, J. (2009). *Re-examining mortality from the conflict in the Democratic republic of Congo, 1998-2006.* Geneva: The Health and Nutrition Tracking Service (HNTS).

Preston, S. H., Heuveline, P., & Guillot, M. (2001). *Demography Measuring and Modelling Population Process.* Oxford: Blackwell Publishing.

Prunier, G. (2009). *From Genocide to Continental War: The 'Congolese' Conflict and the Crisis of Contemporary Africa.* London: Hurst & Company.

Raymer, J., Abel, G. J., & Rogers, A. (2012). Does Specification Matter? Experiments with Simple Multiregional Probabilistic Population Projections. *Environment and Planning A, 44*, 2664-2686.

Rees, P., Bell, M., Duke-Williams, O., & Blake, M. (2000). Problems and Solutions in the Measurement of Migration Intensities: Australia and Britain Compared. *Population Studies*, 207-222.

Reeves, S. R., & Thurnher, J. S. (2013). Are We Reaching a Tipping Point? How Contemporary Challenges Are Affecting the Military Necessity-Humanity Balance . *National Security Journal*, 1-12.

Republique Democratique du Congo. (2006). *Constitution de la RDC.* Retrieved from Francophonie: http://democratie.francophonie.org/IMG/pdf/Constitution_de_la_RDC.pdf

Roberts, L., Ngoy, P., Mone, C., Lubula, C., Mweze, L., Zantop, M., & Despines, M. (2003). *Mortality in the Democratic Republic of Congo: Results from a Nationwide Survey.* New York: International Rescue Committee.

Rogers, A., Raquillet, R., & Castro, L. J. (1978). Model migration schedules and their applications . *Environment and Planning A*, 475-502.

Romaniuk, A. (1980). Increase in Natural Fertility During the Early Stages of Modernisation : Evidence from an African Case Study, Zaire. *Population Studies*, Vol.34, N°2, pp. 293-310.

Rowland, D. T. (2003). *Demographic methods and concepts.* Oxford: Oxford University Press.

Science Insider. (2010). *How Many Have Died Due to Congo's Fighting? Scientists Battle Over How to Estimate War-Related Deaths.* Retrieved from Science Insider Breaking news and analysis from the world of science policy: http://news.sciencemag.org/2010/01/how-many-have-died-due-congos-fighting-scientists-battle-over-how-estimate-war-related

Security Council. (2012). *Letter dated 21 June 2012 from the Chair of the Security Council Committee established pursuant to resolution 1533 (2004) concerning the Democratic Republic of the Congo addressed to the President of the Security Council.* Retrieved June 23, 2012, from United Nations: http://www.un.org/ga/search/view_doc.asp?symbol=S%2F2012%2F348&referer=http:%2F%2Ft.co%2F4MbMbXna&Lang=E

Shapiro, D., & Tambashe, O. (2003). *Kinshasa in Transition Women's Education, Employment, and Fertility.* London: The University of Chicago Press.

Siegel, J. S., & Swanson, D. A. (2008). Methods Materials Demography Second Edition. In J. S. Siegel, & D. A. Swanson, *Introduction* (pp. 1-8). United Kingdom: Emerald.

Spittaels, S., & Hilgert, F. (2010). *Mapping Conflict Motives: Province Orientale (DRC).* European Union and the Belgian Development Cooperation .

Stearns, J. K. (2011). *Dancing in the Glory of Monsters: The Collapse of the Congo and the Great War of Africa.* New York: Public Affairs.

Tabeau, E., & Bijak, J. (2006). War-Related Deaths in the 1992 - 1995 Armed Conflicts in Bosnia and Herzegovina: A critique of previous Estimates and

Recent Results. In H. Brunborg, E. Tabeau, & H. Urdal (Eds.), *The Demography of Armed Conflict* (pp. 217-244). Dordrecht: Springer.

Tabutin, D. (1982). Evolution régionale de la fécondité dans l'ouest du Zaïre. *Population, Vol. 37, No. 1*, 29-50.

The National Geographic Education. (2012). *Africa and the Great Lakes Region*. Retrieved February 25 , 2012, from http://education.nationalgeographic.com/education/multimedia/africa-great-lakes-region/?ar_a=1

The World Bank. (2009). *World development report 2009: Reshaping Economic Geography.* Washington DC: The International Bank for Reconstruction and Development / The World Bank.

Theibault, J. (1997). The Demography of the Thirty Years War Re-revisited: Günther Franz and his Critics. *German History. Vol. 15 No. 1*, 1-21.

Turner, T. (2007). *The Congo Wars Conflict, Myth & Reality.* London: Zed Books Ltd.

UN Human Rights. (2008-2009). *OHCHR in Democratic Republic of the Congo*. Retrieved from United Nations Human Rights: http://www.ohchr.org/EN/Countries/AFRICARegion/Pages/ZRIndex.aspx

UN Monusco. (2010). *MONUSCO United Nations Organization Stabilization Mission*. Retrieved September 26, 2010, from Peacekeeping Missions: http://www.un.org/en/peacekeeping/missions/monusco/facts.shtml

UN News Centre. (2012). *DR Congo: Security Council deplores recent mutiny, killing and abuse of civilians.* Retrieved June 16, 2012, from UN News Service: http://www.un.org/apps/news/story.asp?NewsID=42250&&Cr=democratic&&Cr1=congo

UN Office of the High Commissioner for Human Rights. (2010). *Report of the Mapping Exercise documenting the most serious violations of human rights and international humanitarian law committed within the territory of the Democratic Republic of the Congo between March 1993 and June 2003*. Retrieved March 3, 2012, from UNHCR The UN refugee Agency: http://www.unhcr.org/refworld/docid/4ca99bc22.html

UN Population Division. (1983). *Manual X Indirect Techniques for Demographic Estimation.* New York: Departement of International Economic and Social Affairs.

UN Population Division. (2004). *Methodology of the United Nations Population Estimates and Projections.* United Nations Department of Economic and Social Affairs/Population Division World Population Prospects: The 2004 Revision, Volume III: Analytical Report.

UN Population Division. (2013). Retrieved from United Nations, Department of Economic and Social Affairs Population Division, Population Estimates and projections Section: http://esa.un.org/unpd/wpp/unpp/p2k0data.asp

UN Security Council. (1994). *Security Council Resolution S/RES/955*. Retrieved March 4, 2012, from UNHCR The UN Refugee Agency: http://www.unhcr.org/refworld/docid/3b00f2742c.html

UN Security Council. (1999). *Resolution 1258 (1999) Adopted by the Security Council at its 4032nd meeting on 6 August 1999.* Security Council.

UN Security Council. (2000). RESOLUTION 1291. New York.

UN Security Council. (2004a). *Letter dated 9 July 2004 from the Coordinator o f the Group of Experts on the Democratic Republic of the Congo.* Retrieved March 2011, from UN Security Council Group os Experts for the DRC: http://www.un.org/ga/search/view_doc.asp?symbol=S/2004/551

UN Security Council. (2004b). *Security Council Resolution 1565 (2004) on the Democratic Republic of the Congo*. Retrieved January 12, 2012, from UNHCR The UN refugee Agency: http://www.unhcr.org/refworld/type,RESOLUTION,,COD,42c39a984,0.html

UN Security Council. (2005). *Security Council Resolution 1592 (2005) on Democratic Republic of the Congo*. Retrieved January 12, 2012, from UNHCR The UN Refugee Agency: http://www.unhcr.org/cgi-bin/texis/vtx/refworld/rwmain?page=search&docid=42bc15d54&skip=0&query=resolution%201592

UN Security Council. (2007). *Twenty-third Report of the Secretary-General on the United Nations Organization Mission in the Democratic Republic of the Congo*. Retrieved March 5, 2012, from UNHCR The UN Refugee Agency: http://www.unhcr.org/refworld/docid/461ccb8c2.html

UN Security Council. (2013). *Report of the Secretary-General on the protection of civilians in armed conflict.* United Nations.

UN Security Council. (2013). *UN Documents for Democratic Republic of the Congo.* Retrieved from Security Council Report: http://www.securitycouncilreport.org/un-documents/democratic-republic-of-the-congo/

UN Security Council. (2014). *Security Council Resolutions.* United Nations.

UN Statistics Division. (2004). *United Nations Demographic Yearbook review: National reporting of international migration data Implications for international recommendations.* United Nations, Department of Economic and Social Affairs Statistics Division, Demographic and Social Statistics Branch.

UNHCR . (2012). *2012 UNHCR country operations profile-Democratic republic of the Congo.* Retrieved March 19, 2012, from UNHCR The UN Refugee Agency: http://www.unhcr.org/pages/49e45c366.html

UNHCR. (2007). *Refugees Geneva: UNHCR.* Retrieved from UNHCR: http://www.unhcr.org/45b0930f2.html

UNHCR The UN Refugee Agency. (2012). *2012 UNHCR country operations profile - Democratic Republic of the Congo: Working environment*. Retrieved from http://www.unhcr.org/pages/49e45c366.html

United Kingdom: Home Office. (2007). *Home Office, Country of Origin Information Report - Democratic Republic of the Congo*. Retrieved March 6, 2012, from HUNHCR The UN Refugee Agency: http://www.unhcr.org/refworld/docid/486a52b90.html

United Kingdom: Home Office. (2008). *Country of Origin Information Report - Democratic Republic of Congo*. Retrieved February 10, 2012, from UNHCR The UN Refugee Agency: http://www.unhcr.org/refworld/docid/483535ce2.html

United Nations. (2004). *United Nations Department of Economic and Social Affairs/Population Division.* Retrieved March 2012, from World Population Prospects: The 2004 Revision, Volume III: Analytical Report: http://www.un.org/esa/population/publications/WPP2004/WPP2004_Vol3_Final/Chapter6.pdf

United Nations. (2013). *Population Division, Population Estimates and Projections Section*. Retrieved from United Nations, Department of Economic and Social Affairs: http://esa.un.org/wpp/wpp2012/wpp2012_1.htm

United Nations Security Council. (1999). *RESOLUTION 1279 (1999) Adopted by the Security Council at its 4076th meeting, on 30 November 1999.* Retrieved

February 15, 2012, from UNHCR The UN Refugee Agency: http://www.unhcr.org/refworld/docid/3b00f1e168.html

Urdal, H. (2004). The Devil in the Demographics: The Effect of Youth Bulges on Domestic Armed Conflict, 1950-2000. *Social Development Papers: Conflict Prevention & Reconstruction*, 1-25.

Urdal, H. (2006). People Vs Malthus: Population pressure, environmental degradation, and armed conflict revisited. In H. Brunborg, E. Tabeau, & H. Urdal, *The demography of armed conflict* (pp. 67 - 86). Oslo: Springer.

US Census Bureau. (2010). *International Data Base Population Estimates and Projections Methodology.* Retrieved March 2012, from The U.S. Census Bureau: http://www.census.gov/population/international/data/idb/estandproj.pdf#page=1

Van de Kaa, D. J. (2010). Universal history and population change. *Demográfia*, 5-20.

Verpoorten, M. (2005). The Death Toll of the Rwandan Genocide: A Detailed Analysis for Gikongoro. *Population*, pp. 331 - 367.

Vité, S. (2009, March). Typology of armed conflicts in international humanitarian law: legal concepts and actual situations. *International Review of the red cross*, 69-94.

Wallensteen, P., & Sollenberg, M. (2001). Armed Conflict 1989–2000. *Journal of Peace Research*, 629-644.

Wilson, T. (2010). Model migration schedules incorporating. *Demographic Research, 123*(8), 191-222.

World Health Organisation. (2002). *World report on violence and health: summary.* Geneva: World Health Organisation.

World Health Organisation. (2007a). *Ebola haemorrhagic fever in the Democratic Republic of the Congo.* Retrieved January 20, 2012, from Global Alert and Response (GAR): http://www.who.int/csr/don/2007_09_11/en/index.html

World Health Organisation. (2007b). *Global Alert and Response (GAR)*. Retrieved March 2012, from World Health Organisation: http://www.who.int/csr/disease/ebola/en/

Zegveld, L. (2002). *The Accountability of Armed Opposition in International Law.* Cambridge: Cambridge University Press.

Appendices

Appendix 1

Fitted logit model complete life table: UN standard Males, D R Congo, 1984

x	$Y_s(x)$	$Y_{Fit}(x)$	Fitted l_x	x	$Y_s(x)$	$Y_{Fit}(x)$	Fitted l_x
0			1	25	−0.3829	−0.433	0.7039
1	−0.867	−0.922	0.8634	26	−0.3686	−0.419	0.6979
2	−0.7152	−0.769	0.8231	27	−0.3549	−0.405	0.6920
3	−0.6552	−0.708	0.8047	28	−0.3413	−0.391	0.6861
4	−0.6219	−0.674	0.7940	29	−0.328	−0.378	0.6803
5	−0.6015	−0.654	0.7871	30	−0.315	−0.364	0.6746
6	−0.5879	−0.640	0.7825	31	−0.302	−0.351	0.6688
7	−0.5766	−0.629	0.7786	32	−0.2889	−0.338	0.6629
8	−0.5666	−0.619	0.7751	33	−0.2759	−0.325	0.6570
9	−0.5578	−0.610	0.7720	34	−0.2627	−0.312	0.6510
10	−0.5498	−0.602	0.7691	35	−0.2496	−0.298	0.6449
11	−0.5431	−0.595	0.7667	36	−0.2364	−0.285	0.6388
12	−0.5365	−0.588	0.7643	37	−0.223	−0.272	0.6325
13	−0.5296	−0.581	0.7618	38	−0.2094	−0.258	0.6261
14	−0.522	−0.574	0.7590	39	−0.1956	−0.244	0.6196
15	−0.5131	−0.565	0.7557	40	−0.1816	−0.230	0.6129
16	−0.5043	−0.556	0.7524	41	−0.1674	−0.215	0.6060
17	−0.4941	−0.545	0.7485	42	−0.153	−0.201	0.5991
18	−0.4824	−0.534	0.7440	43	−0.1381	−0.186	0.5918
19	−0.4694	−0.520	0.7390	44	−0.1229	−0.170	0.5844
20	−0.4551	−0.506	0.7334	45	−0.1073	−0.155	0.5767
21	−0.4401	−0.491	0.7274	46	−0.0911	−0.138	0.5687
22	−0.4248	−0.475	0.7213	47	−0.0745	−0.122	0.5605
23	−0.4103	−0.461	0.7153	48	−0.0574	−0.104	0.5519
24	−0.3963	−0.447	0.7095	49	−0.0396	−0.086	0.5430

x	$Y_s(x)$	$Y_{Fit}(x)$	Fitted l_x	*x*	$Y_s(x)$	$Y_{Fit}(x)$	Fitted l_x
50	-0.0212	-0.068	0.5338	75	0.8593	0.822	0.1620
51	-0.0021	-0.048	0.5242	76	0.9255	0.889	0.1447
52	0.0177	-0.028	0.5142	77	0.996	0.960	0.1279
53	0.0383	-0.008	0.5038	78	1.0712	1.036	0.1119
54	0.0598	0.014	0.4929	79	1.1516	1.117	0.0967
55	0.0821	0.037	0.4817	80	1.2375	1.204	0.0826
56	0.1055	0.060	0.4699	81	1.3296	1.297	0.0696
57	0.1299	0.085	0.4576	82	1.4284	1.397	0.0577
58	0.1554	0.111	0.4449	83	1.5346	1.504	0.0471
59	0.1821	0.138	0.4316	84	1.6489	1.619	0.0377
60	0.21	0.166	0.4178	85	1.7722	1.744	0.0297
61	0.2394	0.196	0.4035	86	1.9053	1.878	0.0228
62	0.2701	0.227	0.3886	87	2.0493	2.024	0.0172
63	0.3204	0.277	0.3648	88	2.2051	2.181	0.0126
64	0.3364	0.294	0.3573	89	2.374	2.352	0.0090
65	0.3721	0.330	0.3409	90	2.5573	2.537	0.0062
66	0.4097	0.368	0.3241	91	2.7564	2.738	0.0042
67	0.4494	0.408	0.3068	92	2.9727	2.956	0.0027
68	0.4912	0.450	0.2891	93	3.2079	3.194	0.0017
69	0.5353	0.494	0.2711	94	3.4639	3.453	0.0010
70	0.5818	0.541	0.2530	95	3.7424	3.734	0.0006
71	0.6311	0.591	0.2346	96	4.0456	4.040	0.0003
72	0.6832	0.644	0.2162	97	4.3758	4.374	0.0002
73	0.7385	0.700	0.1979	98	4.7353	4.737	0.0001
74	0.7971	0.759	0.1798	99	5.127	5.133	0.0000

Fitted logit model complete life table: UN standard Females, D R Congo, 1984

x	$Y_s(x)$	$Y_{Fit}(x)$	Fitted l_x	x	$Y_s(x)$	$Y_{Fit}(x)$	Fitted l_x
0			1	25	-0.3829	-0.439	0.7066
1	-0.867	-0.916	0.8620	26	-0.3686	-0.425	0.7007
2	-0.7152	-0.767	0.8225	27	-0.3549	-0.412	0.6950
3	-0.6552	-0.708	0.8046	28	-0.3413	-0.398	0.6893
4	-0.6219	-0.675	0.7941	29	-0.328	-0.385	0.6836
5	-0.6015	-0.655	0.7874	30	-0.315	-0.372	0.6781
6	-0.5879	-0.641	0.7829	31	-0.302	-0.360	0.6725
7	-0.5766	-0.630	0.7791	32	-0.2889	-0.347	0.6668
8	-0.5666	-0.620	0.7757	33	-0.2759	-0.334	0.6610
9	-0.5578	-0.612	0.7726	34	-0.2627	-0.321	0.6552
10	-0.5498	-0.604	0.7699	35	-0.2496	-0.308	0.6493
11	-0.5431	-0.597	0.7675	36	-0.2364	-0.295	0.6434
12	-0.5365	-0.591	0.7652	37	-0.223	-0.282	0.6373
13	-0.5296	-0.584	0.7627	38	-0.2094	-0.268	0.6311
14	-0.522	-0.576	0.7600	39	-0.1956	-0.255	0.6247
15	-0.5131	-0.568	0.7568	40	-0.1816	-0.241	0.6183
16	-0.5043	-0.559	0.7536	41	-0.1674	-0.227	0.6116
17	-0.4941	-0.549	0.7498	42	-0.153	-0.213	0.6049
18	-0.4824	-0.537	0.7455	43	-0.1381	-0.198	0.5978
19	-0.4694	-0.525	0.7406	44	-0.1229	-0.183	0.5906
20	-0.4551	-0.510	0.7352	45	-0.1073	-0.168	0.5832
21	-0.4401	-0.496	0.7294	46	-0.0911	-0.152	0.5754
22	-0.4248	-0.481	0.7234	47	-0.0745	-0.136	0.5674
23	-0.4103	-0.466	0.7176	48	-0.0574	-0.119	0.5591
24	-0.3963	-0.453	0.7120	49	-0.0396	-0.101	0.5504

x	$Y_s(x)$	$Y_{Fit}(x)$	Fitted l_x	x	$Y_s(x)$	$Y_{Fit}(x)$	Fitted l_x
50	-0.0212	-0.083	0.5414	75	0.8593	0.784	0.1724
51	-0.0021	-0.064	0.5321	76	0.9255	0.849	0.1546
52	0.0177	-0.045	0.5224	77	0.996	0.919	0.1373
53	0.0383	-0.024	0.5122	78	1.0712	0.993	0.1207
54	0.0598	-0.003	0.5016	79	1.1516	1.072	0.1049
55	0.0821	0.019	0.4907	80	1.2375	1.157	0.0900
56	0.1055	0.042	0.4792	81	1.3296	1.247	0.0762
57	0.1299	0.066	0.4672	82	1.4284	1.345	0.0636
58	0.1554	0.091	0.4547	83	1.5346	1.449	0.0522
59	0.1821	0.117	0.4417	84	1.6489	1.562	0.0421
60	0.21	0.145	0.4282	85	1.7722	1.683	0.0333
61	0.2394	0.174	0.4141	86	1.9053	1.815	0.0259
62	0.2701	0.204	0.3995	87	2.0493	1.956	0.0196
63	0.3204	0.253	0.3759	88	2.2051	2.110	0.0145
64	0.3364	0.269	0.3686	89	2.374	2.276	0.0104
65	0.3721	0.304	0.3524	90	2.5573	2.457	0.0073
66	0.4097	0.341	0.3357	91	2.7564	2.653	0.0049
67	0.4494	0.380	0.3184	92	2.9727	2.866	0.0032
68	0.4912	0.422	0.3008	93	3.2079	3.098	0.0020
69	0.5353	0.465	0.2829	94	3.4639	3.350	0.0012
70	0.5818	0.511	0.2647	95	3.7424	3.624	0.0007
71	0.6311	0.559	0.2462	96	4.0456	3.923	0.0004
72	0.6832	0.611	0.2277	97	4.3758	4.248	0.0002
73	0.7385	0.665	0.2091	98	4.7353	4.602	0.0001
74	0.7971	0.723	0.1906	99	5.127	4.988	0.0000

Appendix 2

Projected population under factual and counter-factual scenarios 1984-1989

C-Factual

Age	Lx		ASFR	**Nx (1984)**		Total	**Nx (1989)**		Total	Total births
	Female	Male		Female	Male		Female	Male		
0 - 4	419,639	420,552		2,854	2,857	5,711	3,337	3,335	6,673	
5 - 9	393,219	389,058		2,255	2,243	4,498	2,682	2,658	5,340	
10 - 14	381,674	381,195		1,944	1,949	3,894	2,185	2,201	4,386	
15 - 19	376,729	372,269	0.11	1,655	1,645	3,300	1,913	1,907	3,820	1,004
20 - 24	374,856	359,333	0.28	1,466	1,402	2,869	1,641	1,592	3,233	2,153
25 - 29	363,476	344,624	0.32	1,133	1,075	2,208	1,418	1,349	2,766	2,013
30 - 34	368,367	329,872	0.28	865	766	1,630	1,145	1,032	2,177	1,377
35 - 39	354,934	314,449	0.23	733	641	1,374	830	732	1,562	894
40 - 44	354,428	297,398	0.09	597	487	1,084	729	609	1,338	281
45 - 49	326,145	277,627	0.05	598	504	1,102	548	457	1,004	135
50 - 54	296,738	253,868		525	446	971	543	464	1,007	
55 - 59	252,685	224,876		370	333	702	447	398	846	
60 - 64	212,699	189,688		301	307	607	312	284	596	
65 - 69	134,208	148,474		161	182	344	190	244	435	
70 - 74	83,051	103,743		101	125	225	100	131	232	
75 +	94,762	100,029		70	86	156	85	100	185	7,857
Total				**15,627**	**15,047**	**30,674**	**18,105**	**17,494**	**35,599**	

Factual

Age	Lx		ASFR	**Nx (1984)**		Total	**Nx (1989)**		Total	Total births
	Female	Male		Female	Male		Female	Male		
0 - 4	419,639	420,552		2,854	2,857	5,711	3,436	3,432	6,869	
5 - 9	393,219	389,058		2,255	2,243	4,498	2,659	2,644	5,303	
10 - 14	381,674	381,195		1,944	1,949	3,894	2,180	2,180	4,360	
15 - 19	376,729	372,269	0.11	1,655	1,645	3,300	1,909	1,902	3,811	1,054
20 - 24	374,856	359,333	0.28	1,466	1,402	2,869	1,635	1,599	3,233	2,260
25 - 29	363,476	344,624	0.32	1,133	1,075	2,208	1,411	1,342	2,753	2,113
30 - 34	368,367	329,872	0.28	865	766	1,630	1,139	1,048	2,188	1,446
35 - 39	354,934	314,449	0.23	733	641	1,374	825	727	1,553	939
40 - 44	354,428	297,398	0.09	597	487	1,084	725	616	1,341	295
45 - 49	326,145	277,627	0.05	598	504	1,102	544	447	991	141
50 - 54	296,738	253,868		525	446	971	538	456	994	
55 - 59	252,685	224,876		370	333	702	442	383	825	
60 - 64	212,699	189,688		301	307	607	306	276	582	
65 - 69	134,208	148,474		161	182	344	185	213	398	
70 - 74	83,051	103,743		101	125	225	96	116	213	
75 +	94,762	100,029		70	86	156	75	89	164	8,247
Total				**15,627**	**15,047**	**30,674**	**18,107**	**17,471**	**35,578**	

Projected population under factual and counterfactual scenarios 1994-2004

C-Factual	Nx (1994)		Total	Total births	Nx (1999)		Total	Total births	Nx (2004)		Total	Total births
Age	Female	Male			Female	Male			Female	Male		
0 - 4	3,970	3,967	7,938		4,677	4,672	9,349		5,474	5,466	10,939	
5 - 9	3,165	3,123	6,288		3,787	3,736	7,523		4,487	4,425	8,911	
10 - 14	2,612	2,614	5,226		3,087	3,075	6,162		3,699	3,684	7,383	
15 - 19	2,166	2,159	4,324	1,129	2,594	2,567	5,161	1,297	3,070	3,025	6,095	1,518
20 - 24	1,915	1,852	3,767	2,424	2,174	2,101	4,275	2,741	2,609	2,506	5,114	3,153
25 - 29	1,602	1,538	3,140	2,341	1,876	1,794	3,670	2,652	2,135	2,042	4,176	3,006
30 - 34	1,447	1,301	2,748	1,747	1,641	1,487	3,128	2,048	1,926	1,740	3,666	2,326
35 - 39	1,112	992	2,104	1,094	1,410	1,254	2,664	1,396	1,604	1,439	3,042	1,639
40 - 44	836	699	1,535	326	1,124	951	2,075	401	1,431	1,206	2,637	513
45 - 49	679	575	1,253	142	782	663	1,445	166	1,056	906	1,962	206
50 - 54	506	424	929		630	537	1,167		731	623	1,354	
55 - 59	471	419	891		443	386	829		557	493	1,050	
60 - 64	387	345	732		413	368	780		392	343	736	
65 - 69	204	231	436		258	286	545		281	311	591	
70 - 74	125	181	306		138	176	314		179	224	403	
75 +	90	107	197	9,203	99	128	227	10,701	104	131	235	12,361
Total	**21,288**	**20,526**	**41,815**		**25,132**	**24,182**	**49,314**		**29,732**	**28,563**	**58,295**	

Factual

Age-group	Nx (1994)		Total	Total births	Nx (1999)		Total	Total births	Nx (2004)		Total	Total births
	Female	Male			Female	Male			Female	Male		
0 - 4	4,194	4,185	8,379		4,887	4,872	9,758		5,542	5,532	11,075	
5 - 9	3,204	3,197	6,401		3,923	3,933	7,857		4,624	4,550	9,174	
10 - 14	2,579	2,566	5,146		3,129	3,111	6,240		3,792	3,839	7,631	
15 - 19	2,151	2,148	4,299	1,241	2,572	2,569	5,141	1,428	3,064	3,013	6,077	1,588
20 - 24	1,897	1,885	3,782	2,663	2,166	2,187	4,353	3,029	2,535	2,456	4,992	3,259
25 - 29	1,583	1,546	3,129	2,569	1,862	1,855	3,717	2,923	2,081	2,081	4,162	3,109
30 - 34	1,428	1,350	2,778	1,917	1,622	1,615	3,237	2,252	1,873	1,764	3,637	2,396
35 - 39	1,096	1,007	2,103	1,199	1,391	1,317	2,708	1,534	1,551	1,533	3,084	1,683
40 - 44	822	721	1,543	357	1,107	1,034	2,141	440	1,382	1,242	2,624	526
45 - 49	665	566	1,231	156	768	667	1,435	182	1,012	965	1,977	210
50 - 54	493	405	898		614	520	1,134		694	608	1,302	
55 - 59	455	387	842		428	346	774		520	460	980	
60 - 64	368	320	688		388	329	717		359	291	649	
65 - 69	190	175	365		236	190	426		246	261	507	
70 - 74	112	130	242		120	109	229		150	132	282	
75 +	65	77	143	10,102	60	76	136	11,788	66	63	129	12,771
Total	**21,303**	**20,666**	**41,969**		**25,273**	**24,731**	**50,004**		**29,491**	**28,791**	**58,282**	

Projected population under factual and counterfactual scenarios 2009-2014

C-Factual	**Nx (2009)**		Total	Total births	**Nx (2014)**		Total	Total births
Age-group	Female	Male			Female	Male		
0 - 4	6,429	6,418	12,847		7,600	7,585	15,185	
5 - 9	5,283	5,206	10,489		6,239	6,148	12,387	
10 - 14	4,390	4,369	8,758		5,174	5,148	10,322	
15 - 19	3,686	3,630	7,316	1,781	4,379	4,312	8,690	2,093
20 - 24	3,097	2,960	6,057	3,699	3,725	3,560	7,285	4,351
25 - 29	2,571	2,441	5,012	3,468	3,059	2,892	5,951	4,081
30 - 34	2,200	1,987	4,187	2,645	2,656	2,383	5,039	3,061
35 - 39	1,890	1,689	3,579	1,868	2,165	1,935	4,099	2,131
40 - 44	1,636	1,389	3,025	605	1,934	1,637	3,571	692
45 - 49	1,352	1,155	2,507	265	1,551	1,337	2,888	313
50 - 54	994	856	1,850		1,279	1,099	2,378	
55 - 59	651	578	1,229		893	801	1,694	
60 - 64	500	444	944		591	527	1,118	
65 - 69	272	296	568		352	389	741	
70 - 74	200	250	451		199	245	444	
75 +	117	147	264	14,331	124	158	282	16,723
Total	**35,268**	**33,813**	**69,081**		**41,919**	**40,155**	**82,073**	

Factual

Age-group	**Nx (2009)**		Total	Total births	**Nx (2014)**		Total	Total births
	Female	Male			Female	Male		
0 - 4	6,253	6,257	12,511		7,413	7,417	14,830	
5 - 9	5,313	5,235	10,549		5,977	5,904	11,881	
10 - 14	4,510	4,480	8,990		5,183	5,155	10,337	
15 - 19	3,762	3,768	7,531	1,813	4,477	4,400	8,876	2,190
20 - 24	3,073	2,932	6,005	3,664	3,775	3,668	7,444	4,478
25 - 29	2,482	2,379	4,862	3,390	3,010	2,840	5,850	4,085
30 - 34	2,131	2,013	4,144	2,587	2,542	2,302	4,844	3,022
35 - 39	1,825	1,702	3,527	1,820	2,077	1,941	4,019	2,105
40 - 44	1,570	1,471	3,042	587	1,847	1,632	3,479	681
45 - 49	1,294	1,181	2,475	256	1,469	1,397	2,866	306
50 - 54	942	904	1,846		1,203	1,104	2,307	
55 - 59	610	557	1,167		826	825	1,652	
60 - 64	458	407	865		535	490	1,026	
65 - 69	242	244	486		308	339	647	
70 - 74	169	203	372		165	188	352	
75 +	89	79	168	14,117	106	115	220	16,868
Total	**34,726**	**33,814**	**68,539**		**40,914**	**39,717**	**80,631**	

Appendix 3

Population change between 1984 and 2014: Factual scenario

Age-group	1984	1989	1994	1999	2004	2009	2014
0 - 14	14,102	16,532	19,926	23,855	27,880	32,049	37,049
15 - 29	8,376	9,797	11,209	13,210	15,231	18,398	22,170
30 - 44	4,088	5,082	6,424	8,086	9,345	10,713	12,341
45 - 59	2,775	2,810	2,971	3,344	4,259	5,488	6,825
60 - 74	1,176	1,193	1,295	1,373	1,439	1,723	2,025
75 & over	156	164	143	136	129	168	220
All ages	**30,674**	**35,578**	**41,969**	**50,004**	**58,282**	**68,539**	**80,631**
Median age	16	16	15	15	15	16	16
Population Over 65	724	775	751	791	918	1,026	1,220
% Over 65	2.36	2.18	1.79	1.58	1.58	1.50	1.51
% Under 15	45.98	46.47	47.48	47.71	47.84	46.76	45.95
% Under 5	18.62	19.31	19.96	19.52	19.00	18.25	18.39

Population growth components (1984-2014)

Natural increase	1,665
Births per year factual scenario	2,463
Deaths per year factual scenario	798
Net migration in thousands per year for plausible scenario	- 28
Growth rate	3.22
Total population growth	49,957

Population change between 1984 and 2014: Counter-factual

Age-group	1984	1989	1994	1999	2004	2009	2014
0 - 14	14,102	16,399	19,452	23,034	27,233	32,094	37,894
15 - 29	8,376	9,819	11,232	13,106	15,385	18,384	21,926
30 - 44	4,088	5,077	6,387	7,866	9,346	10,790	12,709
45 - 59	2,775	2,857	3,073	3,441	4,365	5,586	6,959
60 - 74	1,176	1,262	1,474	1,639	1,730	1,962	2,303
75 & over	156	185	197	227	235	264	282
All ages	**30,674**	**35,599**	**41,815**	**49,314**	**58,295**	**69,081**	**82,073**
Median age	16	16	16	16	16	16	16
Population Over 65	724	851	939	1,086	1,229	1,283	1,468
% Over 65	2.36	2.39	2.24	2.20	2.11	1.86	1.79
% Under 15	45.98	46.07	46.52	46.71	46.72	46.46	46.17
% Under 5	18.62	18.74	18.98	18.96	18.77	18.60	18.50

Population growth components (1984-2014)

Natural increase	1,713
Births per year factual scenario	2,373
Deaths per year factual scenario	659
Net migration in thousands per year for plausible scenario	- 9
Growth rate	3.28
Total population growth	51,400

Appendix 4

Population loss by age-group and sex between 1999 and 2004

	Factual scenario						Counter-factual scenario							
	1999		2004		Difference		1999		2004		Difference		Difference of Difference	
Age-group	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male
0 - 4	4,887	4,872	5,542	5,532	656	660	4,677	4,672	5,474	5,466	797	794	-141	-134
5 - 9	3,923	3,933	4,624	4,550	701	617	3,787	3,736	4,487	4,425	699	689	2	-72
10 - 14	3,129	3,111	3,792	3,839	663	728	3,087	3,075	3,699	3,684	612	609	51	119
15 - 19	2,572	2,569	3,064	3,013	492	444	2,594	2,567	3,070	3,025	476	458	16	-14
20 - 24	2,166	2,187	2,535	2,456	369	270	2,174	2,101	2,609	2,506	435	404	-66	-134
25 - 29	1,862	1,855	2,081	2,081	220	226	1,876	1,794	2,135	2,042	259	248	-39	-22
30 - 34	1,622	1,615	1,873	1,764	251	149	1,641	1,487	1,926	1,740	286	253	-35	-104
35 - 39	1,391	1,317	1,551	1,533	160	216	1,410	1,254	1,604	1,439	194	185	-34	31
40 - 44	1,107	1,034	1,382	1,242	275	208	1,124	951	1,431	1,206	307	255	-32	-48
45 - 49	768	667	1,012	965	243	298	782	663	1,056	906	274	243	-31	55
50 - 54	614	520	694	608	80	88	630	537	731	623	100	87	-21	2
55 - 59	428	346	520	460	92	114	443	386	557	493	114	107	-22	7
60 - 64	388	329	359	291	- 30	- 38	413	368	392	343	- 20	- 24	-9	-14
65 - 69	236	190	246	261	10	71	258	286	281	311	22	24	-13	47
70 - 74	120	109	150	132	29	24	138	176	179	224	41	48	-12	-24
75 +	60	76	66	63	6	- 13	99	128	104	131	5	3	1	-16
Total	**25,273**	**24,731**	**29,491**	**28,791**	**4,217**	**4,061**	**25,132**	**24,182**	**29,732**	**28,563**	**4,600**	**4,381**	**- 383**	**- 320**

Appendix 5

UNSC Resolutions

Year	Resolutions	Link	Key fact related to military presence
1999	S/RES/1234	http://www.un.org/en/ga/search/view_doc.asp?symbol=S/RES/1234(1999)	
	S/RES/1258	http://www.un.org/en/ga/search/view_doc.asp?symbol=S/RES/1258(1999)	90 UN Mil Liaison personnel With necessary civilian, political, humanitarian & administrative staff
	S/RES/1273	http://www.un.org/en/ga/search/view_doc.asp?symbol=S/RES/1273(1999)	
	S/RES/1279	http://www.un.org/en/ga/search/view_doc.asp?symbol=S/RES/1279(1999)	Equipping of up to 500 United Nations military observers with a view to facilitating future rapid United Nations deployments as authorized by the Council
2000	S/RES/1291	http://www.un.org/en/ga/search/view_doc.asp?symbol=S/RES/1291(2000)	Authorizes the expansion of MONUC to consist of up to 5,537 military personnel, including up to 500 observers, or more
	S/RES/1304	http://www.un.org/en/ga/search/view_doc.asp?symbol=S/RES/1304(2000)	
	S/RES/1316	http://www.un.org/en/ga/search/view_doc.asp?symbol=S/RES/1316(2000)	
	S/RES/1323	http://www.un.org/en/ga/search/view_doc.asp?symbol=S/RES/1323(2000)	
	S/RES/1334	http://www.un.org/en/ga/search/view_doc.asp?symbol=S/RES/1332(2000)	
2001	S/RES/1341	http://www.un.org/en/ga/search/view_doc.asp?symbol=S/RES/1341(2001)	
	S/RES/1355	http://www.un.org/en/ga/search/view_doc.asp?symbol=S/RES/1355(2001)	
	S/RES/1376	http://www.un.org/en/ga/search/view_doc.asp?symbol=S/RES/1376(2001)	

2002	S/RES/1399	http://www.un.org/en/ga/search/view_doc.asp?symbol=S/RES/1399(2002)	
	S/RES/1417	http://www.un.org/en/ga/search/view_doc.asp?symbol=S/RES/1417(2002)	
	S/RES/1445	http://www.un.org/en/ga/search/view_doc.asp?symbol=S/RES/1445(2002)	
2003	S/RES/1457	http://www.un.org/en/ga/search/view_doc.asp?symbol=S/RES/1457(2003)	
	S/RES/1468	http://www.un.org/en/ga/search/view_doc.asp?symbol=S/RES/1468(2003)	
	S/RES/1484	http://www.un.org/en/ga/search/view_doc.asp?symbol=S/RES/1484(2003)	
	S/RES/1489	http://www.un.org/en/ga/search/view_doc.asp?symbol=S/RES/1489(2003)	
	S/RES/1493	http://www.un.org/en/ga/search/view_doc.asp?symbol=S/RES/1493(2003)	Authorizes increasing the military strength of MONUC to 10,800 personnel
	S/RES/1499	http://www.un.org/en/ga/search/view_doc.asp?symbol=S/RES/1499(2003)	
	S/RES/1501	http://www.un.org/en/ga/search/view_doc.asp?symbol=S/RES/1501(2003)	
2004	S/RES/1522	http://www.un.org/en/ga/search/view_doc.asp?symbol=S/RES/1522(2004)	
	S/RES/1533	http://www.un.org/en/ga/search/view_doc.asp?symbol=S/RES/1533(2004)	
	S/RES/1552	http://www.un.org/en/ga/search/view_doc.asp?symbol=S/RES/1552(2004)	
	S/RES/1555	http://www.un.org/en/ga/search/view_doc.asp?symbol=S/RES/1555(2004)	
	S/RES/1565	http://www.un.org/en/ga/search/view_doc.asp?symbol=S/RES/1565(2004)	Authorizes the increase of MONUC's strength by 5,900 personnel, including up to 341 civilian police personnel
2005	S/RES/1592	http://www.un.org/en/ga/search/view_doc.asp?symbol=S/RES/1592(2005)	
	S/RES/1596	http://www.un.org/en/ga/search/view_doc.asp?symbol=S/RES/1596(2005)	
	S/RES/1616	http://www.un.org/en/ga/search/view_doc.asp?symbol=S/RES/1616(2005)	

	S/RES/1621	http://www.un.org/en/ga/search/view_doc.asp?symbol=S/RES/1621(2005)	Authorizes an increase in the strength of the United Nations Organization Mission in the Democratic Republic of the Congo (MONUC) of 841 personnel, including up to five formed police units of 125 officers each
	S/RES/1628	http://www.un.org/en/ga/search/view_doc.asp?symbol=S/RES/1628(2005)	
	S/RES/1635	http://www.un.org/en/ga/search/view_doc.asp?symbol=S/RES/1635(2005)	Authorizes an increase of 300 personnel in the military strength of MONUC
	S/RES/1649	http://www.un.org/en/ga/search/view_doc.asp?symbol=S/RES/1649(2005)	
2006	S/RES/1654	http://www.un.org/en/ga/search/view_doc.asp?symbol=S/RES/1654(2006)	
	S/RES/1669	http://www.un.org/en/ga/search/view_doc.asp?symbol=S/RES/1669(2006)	
	S/RES/1671	http://www.un.org/en/ga/search/view_doc.asp?symbol=S/RES/1671(2006)	
	S/RES/1693	http://www.un.org/en/ga/search/view_doc.asp?symbol=S/RES/1693(2006)	Decides to extend until 30 September 2006 the increase in the military and civilian police strength of MONUC
	S/RES/1698	http://www.un.org/en/ga/search/view_doc.asp?symbol=S/RES/1698(2006)	
	S/RES/1711	http://www.un.org/en/ga/search/view_doc.asp?symbol=S/RES/1711(2006)	
	S/RES/1736	http://www.un.org/en/ga/search/view_doc.asp?symbol=S/RES/1736(2006)	An increase in the military strength of MONUC of up to 916 military personnel
2007	S/RES/1742	http://www.un.org/en/ga/search/view_doc.asp?symbol=S/RES/1742(2007)	
	S/RES/1751	http://www.un.org/en/ga/search/view_doc.asp?symbol=S/RES/1751(2007)	
	S/RES/1756	http://www.un.org/en/ga/search/view_doc.asp?symbol=S/RES/1756(2007)	Continuation until that date of up to 17,030 military personnel, 760 military observers, 391 police trainers and 750 personnel of formed police units
	S/RES/1768	http://www.un.org/en/ga/search/view_doc.asp?symbol=S/RES/1768(2007)	
	S/RES/1771	http://www.un.org/en/ga/search/view_doc.asp?symbol=S/RES/1771(2007)	

	S/RES/1794	http://www.un.org/en/ga/search/view_doc.asp?symbol=S/RES/1794(2007)	Authorizes the continuation until that date of up to 17,030 military personnel, 760 military observers, 391 police personnel and 6 formed police units comprising up to 125 personnel each
2008	S/RES/1797	http://www.un.org/en/ga/search/view_doc.asp?symbol=S/RES/1797(2008)	
	S/RES/1799	http://www.un.org/en/ga/search/view_doc.asp?symbol=S/RES/1799(2008)	
	S/RES/1807	http://www.un.org/en/ga/search/view_doc.asp?symbol=S/RES/1807(2008)	
	S/RES/1843	http://www.un.org/en/ga/search/view_doc.asp?symbol=S/RES/1843(2008)	temporary increase of MONUC's authorized military strength by up to 2,785 military personnel, and the strength of its formed police unit by up to 300 personnel
	S/RES/1856	http://www.un.org/en/ga/search/view_doc.asp?symbol=S/RES/1856(2008)	authorizes the continuation until that date of up to 19,815 military personnel, 760 military observers, 391 police personnel and 1,050 personnel of formed police units
	S/RES/1857	http://www.un.org/en/ga/search/view_doc.asp?symbol=S/RES/1857(2008)	
2009	S/RES/1896	http://www.un.org/en/ga/search/view_doc.asp?symbol=S/RES/1896(2009)	
	S/RES/1906	http://www.un.org/en/ga/search/view_doc.asp?symbol=S/RES/1906(2009)	authorizes the continuation until that date of up to 19,815 military personnel, 760 military observers, 391 police personnel and 1,050 personnel of formed police units
2010	S/RES/1925	http://www.un.org/en/ga/search/view_doc.asp?symbol=S/RES/1925(2010)	authorizes the continuation until that date of up to 19,815 military personnel, 760 military observers, 391 police personnel and 1,050 personnel of formed police units
	S/RES/1952	http://www.un.org/en/ga/search/view_doc.asp?symbol=S/RES/1952(2010)	

2011	S/RES/1991	http://www.un.org/en/ga/search/view_doc.asp?symbol=S/RES/1991(2011)	
	S/RES/2021	http://www.un.org/en/ga/search/view_doc.asp?symbol=S/RES/2021(2011)	
2012	S/RES/2053	http://www.un.org/en/ga/search/view_doc.asp?symbol=S/RES/2053(2012)	
	S/RES/2076	http://www.un.org/en/ga/search/view_doc.asp?symbol=S/RES/2076(2012)	
	S/RES/2078	http://www.un.org/en/ga/search/view_doc.asp?symbol=S/RES/2078(2012)	
2013	S/RES/2098	http://www.un.org/en/ga/search/view_doc.asp?symbol=S/RES/2098(2013)	Decides that MONUSCO shall, for an initial period of one year and within the authorized troop ceiling of 19,815, on an exceptional basis and without creating a precedent or any prejudice to the agreed principles of peacekeeping, include an "Intervention Brigade"
2014	S/RES/2136	http://www.un.org/en/ga/search/view_doc.asp?symbol=S/RES/2136(2014)	