Bachelor of Science Program in Development Studies

Mapping HIV in Uganda

A spatial analysis assessing the influence of socioeconomic factors on the spread of HIV on a district-level in the Republic of Uganda

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ABSTRACT

Over the course of almost four decades the world has been left vulnerable by the HIV epidemic. Displaying the biggest public health challenge currently, many scholars aim to further the understanding of the mechanisms of the spread of HIV. This study aims to contribute to the existing body of literature through adding a spatial aspect to research performed on HIV key drivers in Uganda. Furthermore, the aim of this research is to explore the geographical aspects of the HIV epidemic on a district-level in Uganda in order to examine the relationship between the geographical distribution of HIV cases and their socioeconomic background. This was assessed using a quantitative cross-sectional study design relying on Multiple Linear Regression and Geographically Weighted Regression analysis. The analysis was performed using SPSS and ArcGIS. Prior to this, the conceptual framework in the shape of a risk-chain framework led by the concept of vulnerability, identified seven socioeconomic factors based on a thorough literature review which were measured in eight variables. The study assessed that HIV and the identified socioeconomic factors have a global and stationary relationship which accounts for 26.1% of the variance in HIV rates. The variables for conflict, wealth, access to health care and gender equality were assessed to be statistically significant. However, this was not enough to create a properly specified statistical model, hence potential key factors which could improve the analysis were discussed.

Keywords: Multiple Linear Regression, HIV, Geographically Weighted Regression, Socioeconomics, Vulnerability

Word count: 17 519

ABBREVIATIONS

AIDS	Acquired Immune Deficiency Syndrome
ANC	Antenatal Care
ART	Antiretroviral Therapy
DHS	Demographic and Health Survey
EMIS	Ministry of Education and Sports
GDP	Gross Domestic Product
GIS	Geographic Information System
GWR	Geographically Weighted Regression
HIV	Human Immunodeficiency Virus
OLS	Ordinary Least Squares
PEPFAR	President's Emergency Plan for AIDS Relief
PLHIV	People living with HIV
SPSS	Statistical Package for the Social Sciences
STI	Sexually Transmitted Infection
UAIS	Uganda AIDS Indicator Survey
UBOS	Ugandan Bureau of Statistics
UNAIDS	Joint United Nations Program on HIV/AIDS
VIF	Variance Inflation Factor

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"The AIDS epidemic brought the world to its knees before bringing people to their feet."

Michel Sidibé,
Executive Director of UNAIDS

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1. INTRODUCTION

In this very first chapter of this thesis the problem will be formulated, aims identified, research questioned post and the remainder of the thesis outlined.

1.1. PROBLEM FORMULATION

Globally, every 15 seconds a person gets infected with the human immunodeficiency virus, HIV. That is 2.1 million people per year. In the Republic of Uganda alone, a person catches the virus every fourth minute (UNAIDS, 2014a:A45-A47) [1].

The HIV epidemic is heterogeneous. The vast majority, almost 70%, of all people living with HIV (PLHIV) are located in Sub-Saharan Africa which only hosts 15% of the world's population (The World Bank, 2016d; UNAIDS, 2014a:A18-A23). In comparison, Western and Central Europe together with North America are host to barely 10% of all infected people (UNAIDSa, 2014:A18-A23). Within Sub-Saharan Africa the epicenter is Southern Africa where the nine highest national HIV prevalence rates are registered. However, the East African country Uganda reports the tenth highest HIV-prevalence rate with 7.4% (ibid:18, A8f). Uganda also accounts for the third highest proportion, 7%, of all new HIV infections, globally. Within Uganda, HIV prevalence is highest in the Central region (10,3%) and lowest in the Northern Region (6,5%) (UNAIDS, 2014b). HIV rates vary across geographic areas and those variations are crucial to identify in order to design well-functioning HIV prevention and treatment programs (Weir et al. referenced in Wabiri et al., 2015).

Michel Sidibé, executive director of UNAIDS, underlines the importance of recognizing the spatial variation of the HIV epidemic in his foreword in the UNAIDS Gap Report 2014, where he states:

> *"Never has it been more important to focus on location and population – to be at the right place for the right people."*
>
> (Michel Sidibé in UNAIDS, 2014a:5)

[1] Calculation based on estimates from 2014

With limited resources at hand it becomes even more important to narrow down the problem and design location- and people-centered approaches (Kandala et al., 2012; UNAIDS. 2014a:14). Such approaches are necessary to reach the ambitious 90 – 90 – 90 target brought forward by UNAIDS. 90 – 90 – 90 stands for: 90% diagnosed and knowing their HIV status; 90% of all people diagnosed with HIV receiving sustainable treatment; and 90% of people on treatment having viral suppression (UNAIDS, 2014c). In order to create well-functioning narrowed down HIV-prevention and treatment programs, it is crucial to develop a full understanding of the epidemic and its spatial characteristics.

Spatial analysis has become increasingly popular in the field of health studies and a tool for public health practitioners and policy makers (*see for example:* Feldacker et al., 2010; Grabowski et al., 2014; Kandala et al., 2012; Wabiri et al., 2016). Uganda, in the 1990s praised as public health success due to its successful approach towards combating HIV (Gordon and Gordon, 2013:231), now reports increasing HIV-infection rates (UNAIDS, 2014a:30). The majority of research conducted concerning the HIV-epidemic in Uganda explores solely single districts, overall regional characteristics, key drivers or specific risk groups (*see for example:* Chhoudry et al., 2014; Chimoyi and Musenge, 2014; Grabowski et al., 2014). Therefore, this study, using a global and local regression model, will contribute to the establishment of more in-depth knowledge on the spatial characteristics of the HIV epidemic in Uganda.

1.2. AIMS AND RESEARCH QUESTIONS

The aim of this paper is to explore the geographical aspects of the HIV epidemic on a district-level in Uganda in order to examine the relationship between the geographical distribution of HIV cases and their socioeconomic background.

Performing a global stationary regression analysis and a local non-stationary regression analyzing the district-level HIV estimates provided by UNAIDS and the recently published results from the census in 2014, this study will answer the following question:

> *To what degree do socioeconomic factors account for a variance in HIV spread on a district-level in Uganda?*

To answer this question properly, following subsidiary research questions have been identified:

a. *What is HIV and how does it spread in the context of Uganda?*
b. *How is HIV spatially distributed across districts in Uganda?*
c. *What socioeconomic factors commonly influence HIV spread in Uganda?*
d. *Is there a local and non-stationary relationship between the identified socioeconomic factors and HIV spread?*

1.3. THESIS OUTLINE

This thesis consists of eight chapters. Chapter 1, the introduction, finishes here. It is followed by Chapter 2, which will provide background knowledge with a brief summary of the human immunodeficiency virus, the Republic of Uganda and HIV in Uganda, respectively. The conceptual framework is presented in Chapter 3. It introduces the proximate and structural causes of HIV transmission and concludes with the presentation of a risk-chain framework based on the concept vulnerability to HIV spread. The risk-chain framework consists of three chain links, exposure, capacity and consequence. Chapter 4, the methodology chapter, outlines the chosen research design, study measures and methods for spatial analysis. Additionally, the statistical datasets are discussed. After assessing the limitations of the thesis in Chapter 5, the findings of the analysis will be presented in Chapter 6. Findings will be split into three sections: descriptive statistics and thematic mapping, results of the multiple linear regression, and the findings of the Geographically Weighted Regression. Thereafter, Chapter 8 will interpret the findings guided by the conceptual framework. Finally, Chapter 9 will conclude this research.

2. BACKGROUND

2.1. HUMAN IMMUNODEFICIENCY VIRUS

Currently, 35 million people worldwide are infected with the human immunodeficiency virus, HIV. The epidemic, perhaps the worst since the Black Death of the 14th century (Sachs, 2008:513), has so far killed almost 40 million people since its first occurrence in the early 1980s. HIV is incurable. The United Nations addressed the emergency and importance of fighting the epidemic in its Millennium Development Goals as Goal 6. Neither of the targets which aimed to "have halted by 2015 and begun to reverse the spread of HIV/AIDS" (United Nations, 2015:44) and "achieve, by 2015, universal access to treatment for HIV/AIDS for all those who need it" (ibid:45) were achieved by 2015 when the UN introduced the Sustainable Development Goals (SDGs). Within the post-2015 agenda, combating HIV has retreated to a target under SDG 3 which concerns "good health and wellbeing" (United Nations, 2016). A major actor in halting the spread of HIV is the Joint United Nations Program on HIV/AIDS, UNAIDS. The UNAIDS is the only UN organization dedicated to a disease (Barnett and Whiteside, 2002:4), which has affected millions of people since the 1980s.

What soon was to turn into a global epidemic, began in the United States, where doctors noticed the clustering of rare diseases e.g. Kaposi's sarcoma, a cancer[2]. With the majority of cases being homosexual men, the disease soon became known as GRID, which stands for Gay Related Immune Deficiency Syndrome. However, with the increasing occurrence of cases in other population groups (e.g. blood transfusion receiver and injection drug users), researcher changed the name to Acquired Immunodeficiency Syndrome, AIDS (Barnett and Whiteside, 2002:28ff). Simultaneously, AIDS began to spread in other regions of the world, such as Africa resulting in international realization of the syndrome. In 1983, HIV-1 was identified as the virus leading to AIDS, followed by the identification of HIV-2 in 1985 (ibid). The media of transmission were studied and identified only a few years after the initial recognition of AIDS.

[2] This thesis focuses on the mainstream medical documentation; this thesis will not go into the debate of the origins of HIV

Early etiology patterns identified among homosexuals and blood transfusion patients already hinted at the means of transmission of HIV. HIV transmits through the body fluids: blood, breast milk, semen, pre-semen, rectal fluids and vaginal fluids (aids.gov, 2016a). Therefore, HIV is considered, amongst others, a sexually transmitted infection (STI). In the early stages of the epidemic, HIV tends to cluster as human contact is needed for transmission. With an increasingly globalized world, it has become easier to transmit HIV more rapidly over large spaces. Nevertheless, etiology still varies across continents. In the United States, for example, the predominant risk groups are homosexual men and drug users. In Africa, heterosexual sex and mother to child transmission are identified as main reasons for transmission (Iqbal and Zorn, 2010). A way to inhibit transmission is for PLHIV to be on sustainable treatment and achieve viral suppression.

After the introduction of antiretroviral therapy (ART) AIDS-related deaths decreased by about 30% (Lubogo et al., 2015). Prior to ART, HIV was a death sentence, globally. While ART does not act as a cure, it allows for the HIV to be controlled. In simple terms what ART aims to do is to halt the multiplication of HIV and eventually decrease the virus level in a person's body. Less HIV results in a stronger immune system which is, again, able to fight off infections and diseases. Therewith, allowing the PLHIV on ART to have increasing chances of survival. Problematic is that ART remains a burden to take. Not only can many not afford the medication, but also does it require meticulous following of prescription (aids.gov, 2016b). This sometimes is hindered by insufficient access to health care or other factors outside the individual's power. A lack of medication leads to ill-health and eventually to death.

Consequences treated and untreated HIV brings are several. On an individual level it can lead to isolation, economic struggle, ill-health, and death. On a societal level, HIV leads to higher amount of orphans, so called AIDS-orphans whose parents died of the syndrome, surcharge of health care, and lower productivity in the labor market (Hickle, 2012). Latter is explained through the increased of prime working age adults catching the virus and falling sick, hence being absent or worse dying. Also, it leads to early termination of schooling as, for example, older siblings recently orphaned have to take care of their younger brothers and sisters (Uganda AIDS Commission, 2015). On an

international level, HIV is seen as discouraging to international foreign investment with investors deeming the environment unsafe and unpredictable (Hickle, 2012).

2.2. THE REPUBLIC OF UGANDA

The Republic of Uganda, henceforth called Uganda, is located in eastern Africa. As a landlocked country it borders South Sudan to the north, Kenya to the east, Tanzania to the south, Rwanda to the south-west and Democratic Republic of Congo to the west. Lake Victoria serves as water access in the south of the country. Its capital, Kampala, is located in the south-east by Lake Victoria. The official language, due to its colonial legacy, is English.

Uganda became independent from Britain on 9 October 1962, but until today remains part of the Commonwealth. In 1963 it became a presidential republic (Redaktion Weltalmanach, 2015:468ff). After a military coup General Idi Amin gained power in 1971 and continued to lead the country through eight years of dictatorship (ibid). After the Uganda-Tanzania war in 1979, Amin's regime ended and introduced a seven-year period of struggle for power between different actors. In 1986, General Yoweri Kaguta Museveni with the support of his National Resistance Army gained power after the Ugandan Bush War which he initiated. Museveni has been in power since and recently reelected. He is one of the longest ruling leaders in the world.

While at first being praised for his politics and actions, Museveni soon lost international recognition. Under Museveni's leadership, Uganda invaded and occupied the Democratic Republic of Congo during the second Congo War and engaged in other wars in the Great Lake region. Uganda's civil war against the Lord Resistance Army (LRA) gained international recognition on Social Media when Invisible Children launched their campaign Kony 2012, which called for the capturing of one of the leaders of the LRA, Joseph Kony. Kony, just as the LRA, is accused of child slavery and several other crimes against humanity (Human Rights Watch, 2012).

Anticipating the facilitation of administration and service delivery, Uganda has constantly increased its amount of administrative units since shortly after its independence (Redaktion Weltalmanach, 2015:468; UBOS, 2016:1). Currently, the country divides into four regions, 112 districts, 181 counties, 1382 sub-counties and 7241 parishes. While the

amount of regions stayed the same since the 1960s, the amount of districts has increased from 21 in 1969 to 112 (111 districts plus the capital) in 2014, an increase of over 400% (UBOS, 2016:1). Counties, in comparison, "merely" rose by 63%, from 111 to 181, in the same time period (ibid). Districts and counties vary in size, population, education level, economic activity and the such.

On a national level, Uganda's socio-demography and –economy have generally improved over the past decades. With an increase of about 10 million people since the last census in 2002, Uganda now counts a population of 34.6 million (UBOS, 2016:8). This is partially due to its still high total fertility rate of 5.8 children per women, while mortality rates have fallen (ibid:16-17). In the younger ages (0 - 14 years) males dominate the sex ratio, however, on an overall level there is slightly more women than men (ibid:13). Gender disparity in education is decreasing. Primary education is almost completely gender balanced, whereas in secondary education females still indicate slightly lower enrollment rates. This is also reflected in the literacy rate which varies between males (77%) and females (68%). Overall, urban population performs better in education than rural (ibid:25-26). This can be linked to the distribution of working and non-working population. People work to enhance their quality of life, and work includes productivity for own consumption as well as for sales. While urban areas indicate less people working (60.6%, compared to 72.7% in rural areas), the majority of non-working people are full time students (ibid:27,30). After peaking in 2006 with 10.8%, Uganda's Gross Domestic Product growth fell since, with a short outbreak in 2011 (9.7%), to most recently 4.8% in 2014 (The World Bank, 2016a).

2.3. HIV IN UGANDA

In the early 1990s Uganda started what soon became one of the most successful HIV-campaigns in Sub-Saharan Africa – Uganda became a public health success. After increasing HIV infection rates in the late 1980s, Uganda recognized as first African country that it faced an epidemic and needed help (Gordon and Gordon, 2013:231). The country implemented the ABC-approach, wherein ABC stands for Abstinence, Be Faithful and use Condoms. As the main tool of the National HIV Strategy, the ABC-approach is "a combination of structural, behavioral, and biological interventions" (Ministry of Health Uganda, 2012:1). This intervention strategy targets the most

prominent transmission cause in Uganda, sexual intercourse (Iqbal and Zorn, 2010; Ministry of Health Uganda, 2012:69). During the late 1990s the East African state recorded a decrease in prevalence and infection rates, which, however, by today have stagnated (Ministry of Health Uganda; 2012:1; Opio et al., 2008).

HIV-prevalence peaked around 1991/92 with 13.4% (The World Bank, 2016c) and declined to 6.3% in 2004/05. Since then HIV-prevalence has steadily increased, most recent indicating that 7.3% of the population between 15 and 49 years old live with HIV (ibid; UNAIDS, 2014b[3]).The rise in HIV prevalence could be related to the improved access to antiretroviral therapy (ART), and hence more people infected with HIV surviving. Problematic is that ART does not spread as fast as the virus. Gordon and Gordon (2013:236) present the calculation that recently there were 200 000 PLHIV on drugs, 500 000 PLHIV in need of treatment and 110 000 people have gotten newly infected. Still, while claiming to have among the best access to ART in the region, Uganda also has, with about 6%, the fifth highest of all AIDS-related deaths in the region (UNAIDS, 2014a:27-28). Another reason for the increase, the reshaping of policy, will be discussed in the following paragraph.

Scholars argue that the rise in HIV prevalence is not necessarily solely linked to improved access to medication and more people infected with the virus surviving, they instead see a correlation between the implementation of the United States President's Emergency Plan for AIDS Relief (PEPFAR) and the increase in prevalence. PEPFAR, under the Bush administration, supported a prevention policy heavily focused on abstinence. The approach found particular big support from President Museveni and his wife First Lady Janet Museveni as evangelical revivalist. With PEPFAR's conditional funding and the support of the president, organizations and government bodies adapted to PEPFAR's requirement and omitted the "C" – use Condoms – from their agenda in fear of losing funding (Goldberg referenced in Gordon and Gordon, 2013:235; Gordon and Gordon, 2013:232-235). Reasons for the failure of an "abstinence-only" approach are, among others, gender inequality (Gordon and Gordon, 2013:235) and socioeconomic pressures

[3] Note: UNAIDS (2014b) indicated an estimated HIV-prevalence of 7.2 % instead of 7.3 %

that won’t let the individual control their behavior (Hickle, 2012). Those issues will be further discussed in the Conceptual Framework in Chapter 3.

Uganda therewith represents a very peculiar case for the spread of HIV. A model country in terms of fighting the HIV epidemic, but recently reporting increasing rates of prevalence.

3. CONCEPTUAL FRAMEWORK

To guide the interpretation of the results of the spatial analysis, this chapter provides concepts, hypotheses and ideas about the key drivers behind HIV spread in a risk-chain framework led by the concept of vulnerability.

First, the two major school of thoughts, proximate causes and structural causes, are introduced. Within the section on structural causes several socioeconomic factors are presented and later on linked underneath the concept of vulnerability to a risk-chain framework which serves as conceptual framework for this dissertation.

3.1. PROXIMATE CAUSES

Several studies have documented changes in sexual behavior in Uganda leading to a decrease in risk taking during the 1990s, and various researchers have used these observations to explain the declines observed in the HIV epidemic during that period.

The first school of thought introduced in this chapter focuses on proximate causes as key drivers of HIV spread. In Uganda, where HIV transmission mainly takes place through heterosexual intercourse (Assimwe-Okiror et al., 1997; Iqbal and Zorn, 2010), those proximate causes are inherently linked to risky sexual behavior. Risky sexual behavior is the opposite of what the ABC approach calls for: non-abstinence, multiple sexual partners and extramarital partners, and unprotected sex. The WHO and UNAIDS provide following guidelines on risk indicators: (1) low age at sexual debut (2) high number of sexual partners, and (3) low condom use (Biraro et al., 2009). Many studies conducted in this field involve those three factors complemented with additional indicators about e.g. alcoholic behavior, secondary abstinence[4] or participation in transactional sex (*for examples see* Opio et al., 2008; Musinguzi et al., 2014; Asiimwe-Okiror, 1997). Studies are predominately conducted in a quantitative nature, running statistical analyses on datasets provided by the Demographic and Health Survey, Census data, or AIDS Indicator Surveys. The objective of the majority of the studies reads along the lines of explaining changes in HIV spread with recent trends in sexual behavior.

[4] Secondary abstinence: Initial sexual contact but then no sexual contact in the past 12 months

Research identifies between male and female and sometimes between rural and urban, still researchers hardly ever draw conclusion based upon the gender or residence. Opio et al. (2008), who distinguish between men and women in their study, conclude that recently a shift towards more risk-taking sexual behavior in both genders is noticeable. They argue that such change in behavior might have caused the stagnation in HIV prevalence in ANC sentinel surveillance sites and cohorts that previously reported decreasing trends. While the authors try to further analyze the root of the shift in sexual behavior, they do not go into structural causes, such as education rates or wealth but problematize the normalization of the HIV epidemic. Over the past three decades, they explain, the majority of the Ugandan population has been affected in one way or another by the epidemic, hence they, by now, see it as a "normal part of life" (Opio et al., 2008:325). Authors recognize the importance of certain demographic factors, but do not make the further association to structural causes, which might be due to several reasons.

During earlier studies, such as Asiimwe-Okiror et al. (1997), a focus on solely proximate causes may be related to a lack of data on more structural causes. The authors refer in their discussion to social factors, i.e. the demobilization of the army, migration, and the departure of Rwandan immigrants, that may account for the changes in HIV incidences. However, they note that "the influence of these factors on the stability" of the urban[5] population is unknown (Asiimwe-Okiror et al., 1997:1761). After shortly mentioning women's participation in non-regular partnerships[6] as a mean to cater to economic needs and the critical relationship between genders in a partnership, they finalize their research with a call for more socio-demographic data collection to allow for further comparison between the general population and PLHIV (ibid).

With the major success of the ABC-strategy in the mid-1990s and the claim that the provision of people "with comprehensive information on reducing HIV risk including abstinence, reduction of number of sexual partners, and correct condom use is most effect at preventing new infections" (Opio et al., 2008:325), it becomes clear why numerous authors, many of them with a medical background, focus their research on the proximate causes of the disease. Hence, they attempt to find the cause for the increase in HIV rates

[5] Study focused on the urban areas Jinja and Kampala
[6] "All relationships lasting less than 12 months were classified as 'non-regular' relationships." (Assimwe-Okiror et al., 1997:1758)

in the population's non-adaption of the ABC-strategy. The majority of studies find a correlation between decline in HIV prevalence or incidence and the increased uptake on safer sexual behavior. However, lately an increase in HIV-related risk behavior and HIV rates keep the authors distressed as this indicates that the current population struggles living the lifestyle proposed by the ABC-policy. Little has the structural influence on the uptake on risky behavior been studied by this school of thought, exhibited by Biraro and his co-authors to whom "it is unclear why some people […] began engaging in more risky sexual behavior" (Biraro et al., 2009:10). Some clarity to this issue is provided by the school of thought, which is concerned about the influence socioeconomic and demographic factors have on the sexual behavior of the population. Hence, they argue that the key drivers to the spread of HIV are not the proximate causes of HIV infection, i.e. riskier sexual behavior, but rather the underlying structural causes which push the population to engage in more risk-taking behavior.

3.2. STRUCTURAL CAUSES

Sanjay Basu skillfully summarizes the main objective of this school of thought: "The issue is not so much [risky sexual] behavior, as the condition under which such behavior occurs." (Basu quoted in Hickle, 2012:515). Basu refers to the inability, or lack of capacity, of a population to translate knowledge about HIV into safer sexual behavior. Most authors in this field recognize risky sexual behavior as the predominant medium of spread, however, they focus their studies on the broader political, social and economic structures as "underlying causes of disease are embedded in political and economic systems" (Gatrell and Elliott, 2009:33). Many scholars involved, such as Hickle (2012) and Bezner Kerr and Mkandawire (2012), go one step further and connect the involuntary risky sexual behavior to the "structural violence of *neoliberal* economic policy" (Hickle, 2012:514, emphasis added) for Swaziland and Malawi, respectively.

To further explain how structural factors influence and display the key drivers to HIV spread, the following section will shortly introduce the most predominately discussed socioeconomic factors in the literature in the context of Uganda and explain their connection to HIV infection.

3.2.1. EDUCATION

Education shapes the behavior and knowledge of young adults and children and, hence, influences their risk of infection with HIV. In 1997 and 2003, Uganda introduced the Universal Primary Education and Universal Secondary Education, respectively. With those educational reforms, Uganda aimed at abolishing all education-related fees, i.e. school tuition as well as parental donations. Especially, for the primary education this has led to rising enrollment and decreasing discrimination of economic status. Lately, more and more studies have provided strong evidence for a causal relation between higher educational attainment and a decreasing risk for HIV infection (Tsai and Venkataramani, 2015). Jukes et al. (in Behrman, 2015) introduce a mechanism how formal schooling influences the risk of HIV infection. Firstly, education develops socio-cognitive skills, which allow for knowledge, attitudes and controlled behavior to be built. Information on safer sexual practices are very likely to influence the sexual behavior of young adolescents in the future (Choudhry et al., 2015). This may be one of the reasons why ABC campaigns target schools to spread knowledge about HIV (Behrman, 2015). The claim made by Iqbal and Zorn (2010) that literacy among society inherently increases the effectiveness of HIV prevention programs is quite straight forward and self-explanatory as a literate population will be able to read information pamphlets or posters distributed. Secondly, school attendance shapes the social and sexual networks of individuals. High stigmatization of PLHIV negatively influence the testing behavior of the population (Tsai and Venkataramani, 2015). Hence, it is crucial to teach children about such stigmas and prejudice to shape their social environment. Also, schooling delays the onset of sexual activity by, for example, delaying marriage (Behrman, 2015). In his study on transactional sex, Choudhry et al. (2015) find a negative relation between higher education and the likelihood to pay for sex. Sex workers due to their sexual engagement with multiple partners are at a high risk for HIV infection (ibid). Lastly, it improves economic circumstances which lead to a change in sexual behavior. The debate on how economic circumstances, or wealth, relate to HIV infection risk is further elaborated on below. Behrman (2015) concludes that an increase in schooling by one additional year leads to a decline in the probability for a woman to get infected with HIV. For the purpose of this dissertation, increased education for the aforementioned reasoned is said to have a negative relation to higher HIV rates.

3.2.2. WEALTH

AIDS is commonly perceived as a disease of the poor, however increasing evidence leads to believe that it is the rich that engage in riskier sexual behavior (Gillespie, 2008). On the one hand, Gordon and Gordon (2013:228ff) provide biological evidence on why the poorer parts of the population are more likely to contract HIV. Most of the times, economically disadvantaged have poorer nutrition levels which link to an instable immune system and therewith a higher chance of infection with a disease, including HIV (Gordon and Gordon, 2013:228ff). On the other hand, wealthy people tend to live longer and hence have a higher life time risk of getting infected with HIV. Also, wealthy people are more likely to have sustainable access to ART and counseling. Therefore, instead of contributing to the number of AIDS related deaths, they are more likely to contribute long term to HIV prevalence which refers to the amount of people living with HIV and is not to be mistaken with HIV incidence rate. The incidence, or new infection, rate counts the amount of new infections in a certain time period e.g., year or month. Further, by dissecting the ABC approach and the risky sexual behavior it targets, it becomes noticeable that such behavior is predominately common among the rich. This is especially apparent, after the recent involvement of PEPFAR and the strong focus on abstinence and the reduced attention paid on condom use. Wealthy people are more likely to have a higher amount of changing partners due to their "greater personal autonomy and spatial mobility" (Gillespie, 2008:11). Additionally, the prevalence of transactional and age-disparate sexual relationships is higher among the wealthy, more specifically older rich men and younger less rich women (Choudhry et al., 2015; Stenhammer, 2007). However, Hickle (2012) argues in his study of HIV in Swaziland, that the rich are more likely to be targeted by behavior change campaigns, such as ABC, whereas the poor are more economically driven in their sexual behavior and hence not targeted by the campaign (ibid; Gillespie, 2008). So, while engaging in riskier sexual behavior, wealthy people are also more likely to use safer sexual practices (Gillespie, 2008). Additionally, the wealthy's risk-taking sexual behavior is most commonly the results of an individual's choice and not the results of external structural pressures. Structural pressures affect the poor much more, which are more likely to, while knowing about HIV and how to protect themselves, form irrational decisions in sight of immediate survival (Hickle, 2012). This thesis recognizes the high risk exposure of the wealthy but at the same time sees their

capacity to cope with the exposure or potential infection. Therefore, the expected influence of higher wealth levels on HIV rate is negative.

3.2.3. HEALTH CARE

A crucial actor in the prevention, diagnoses and treatment of HIV is health care. Prevention means that health facilities not only provide preventives, such as condoms or family planning counseling, but also treat previous diseases or infections that could lead to a lowering of the immune system and hence higher infection risk. Especially, previously untreated sexually transmitted infections (STI) display a higher risk for the infection with HIV (Gordon and Gordon, 2013:236; Hickle, 2012). HIV testing informs the person about their HIV status and therewith allows that person to seek treatment. ART eventually can reduce the HI-virus level in the blood of the patient to such a miniscule amount that the patient is considered "not transmittable" anymore (aids.gov, 2016a). For this to happen however, it is of utmost importance that treatment is taken according to prescription and continuously. Patients, therefore, need constant access to health care in order to receive medication and counseling. Distance to health facility is thus an important issue (Lubogo et al., 2015). But not only distance matters, counseling and testing, as well as previous treatment of other diseases, need to be conducted to high quality standards. High quality includes education of staff but also the supply of clean and good utensils and treatment. Unclean needles, for example, increase the risk of HIV infection (Oppong, 1998). Musinguzi et al (2014) raise the awareness that access to ART can lead to an increased sexual activity due to improvements in the quality of life of the patient and this may lead to increased spread of HIV. Also, important to note is that PLHIV with good access to quality health care are more likely to survive and hence contributing long term to HIV prevalence numbers. This, however, is to be taken with care. The ART-coverage of people eligible for treatment[7] is merely 50% (Ministry of Health Uganda, 2012:133). Also, ART provision increases only half as fast as new infections rise (Gordon and Gordon, 2013:236). With the effectiveness of ART in question, this study assumes a negative relationship between HIV prevalence and the increased accessibility and quality of health care.

[7] Eligibility status measured using a CD4 cutoff of 350 cells per μL (Ministry of Health Uganda, 2012:132)

3.2.4. GENDER EQUALITY

> *"We tell women to abstain when they have no rights. We tell them to be faithful when they cannot ask their partners to be faithful. We tell them to use a condom when they have no power to do so."*
>
> (Former Deputy Executive of UNAIDS Kathleen Cravero quoted in Crawley, 2004:6 in Gordon and Gordon, 2013:235)

Gender inequality is a critical point in the discussion on the spread of HIV. In Uganda, 8.2% of all women are infected with HIV, compared to 6.1% of all men. While women are biologically more susceptible to HIV infection, that susceptibility is unlikely to account for the 1.1% difference between the genders. Lubogo et al. (2015) find in their study that women have less access to health care or are less likely to seek health care (Galvin and Cohen referenced in Bezner Kerr and Mkandawire, 2012) and account it to the higher discrimination and stigma women face compared to men (Galvin referenced in Bezner Kerr and Mkandawire, 2012). Nevertheless, there is a correlation between countries with high gender inequality and high HIV prevalence (Bezner Kerr and Mkandawire, 2012). Where does this correlation derive from? How are women more exposed to or less capable of dealing with HIV? A majority of the literature focuses on the disempowerment and lack of agency of women (*see for example*: Bezner Kerr and Mkandawire,2012; Hickle, 2012; Lubogo et al. 2015; Behrman, 2015; Wagman et al, 2016, Gordon and Gordon, 2013:235ff). The powerlessness of women decreases their ability to speak up. Many women are financially dependent on their husbands or partners, who often refuse the use of condoms (Bezner Kerr and Mkandawire, 2012; Hickle, 2012). Because of their economic instability, some women complement their income with transactional sex (Hickle, 2012). Transactional sex might result in unwanted pregnancies or infection with STIs. Women, especially in transactional sex, face a greater risk of being coerced to have sex (Bezner Kerr and Mkandawire, 2012; Choudhry et al., 2015; Wagman et al., 2016; Ministry of Health Uganda, 2012:84ff). The Uganda AIDS Indicator Survey (Ministry of Health Uganda, 2012:84ff) differentiates between forced and coerced sex, wherein forced sex indicates the use of physical force and coerced sex does not. While 7% of men have experienced sexual coercion, more than twice as many women (16%) have been coerced to have sex (Ministry of Health Uganda, 2012:85). This difference becomes even more prominent in the context of physically forced sex, where 3% of men reported and 15% of women to have been physically forced to sexual intercourse (ibid:86). Coerced or forced sex is often performed without protection and

exposure to such is related to higher HIV infection among females (Dunkle et al. referenced in Wagman et al., 2016). Decreased access to health care, lack of agency, participation in transactional sex and higher exposure to sexual violence lead to an increased risk for women particular to contracting HIV. Hence, for this paper we conclude that the more gender equal a society, the lower the HIV prevalence.

3.2.5. MIGRATION

Migration can take various shapes and types. For the purpose of this research a focus on the concept of short-term circular labor migration and its relation to HIV spread was chosen. Short-term circular labor migration means individuals leaving their home to find labor in most commonly urban areas or foreign countries and returning home on a regular basis (Cassels et al., 2013; UNAIDS, 2014a:156-170). Many migrant workers decide to leave their homes in order to support their families and partners, who stay back home, by, e.g. sending remittances. Not only are migrants themselves at a higher risk of contracting HIV, but they increase HIV transmission in their home cities and villages by infecting their at-home partners upon return. This is due to several reasons. Firstly, migrants are less likely to attend to health care. Often migrant laborers are not registered in the local residential area of their work and hence are denied access to health care while away working (Gillespie, 2008; UNAIDS, 2014a:156-170). This leaves only the short visits at home as a possibility to visit health facilities. A lack of access of health care for migrants becomes especially problematic if the migrant has already been infected with HIV and loses his access to medication to keep his or her virus level in check (UNAIDS, 2014a:156-170). Secondly, most migrant workers are male and move to urban areas (Gordon and Gordon, 2013:207/208, 228ff) to provide for their families back home (Cassels et al., 2013; Hickel, 2012; UNAIDS, 2014a:156-170). The moving away and leaving of the familiar and known environment can enhance a feeling of isolation, as the UNAIDS' GAP report (2014a:156-170) explains. Such feeling, in addition to stress and other negative emotions, enhances the chances of migrant workers engaging in risky behaviors. Those risky behaviors include drug abuse, but also participation in commercial sex or unsafe sex with non-regular partners (Gordon and Gordon, 2013:228ff; Hickle, 2012; UNAIDS, 2014a:156-170). As HIV rates tend to be higher in urban areas, an even higher risk of infection arises. Thirdly, potentially newly infected migrant workers return home to their partners and therewith put them at risk for infection (Cassels et al., 2013;

UNAIDS, 2014a:156-170). This contributes to the spread of HIV from urban to rural areas (Cassels et al., 2013). Lastly, left at home spouses or family members might still face economic constraints and food insecurities, which procured the partner or family member migrating in the first place. Hence, those left at home are more likely to engage in risky sexual behavior, i.e. transactional sex, to secure survival (Gordon and Gordon, 2013:228ff; UNAIDS, 2014a:156-170). To sum up, as Cassels and her co-authors state: "Migrants not only exhibit higher risk for acquisition of HIV and other STIs than non-migrants, but disproportionately transmit those infections to others." (Cassels et al., 2013:2302). Therefore, this study assumes the relationship between high migration and HIV to be positive.

3.2.6. URBANITY

HIV in Uganda followed a hierarchical disease diffusion pattern, meaning that it spread from urban areas to rural (Gould referenced in Oppong, 1998). Today, urban areas still report higher HIV rates than their rural counterparts with 8.7% and 7.0% respectively (Cassels et al., 2013; Ministry of Health Uganda, 2012:105). But why? Simply put, people in urban areas engage in riskier sexual behavior: more participate in transactional sex, the urban population has more partners and of those partners more are non-regular and sexual violence occurs more frequently (Gillespie, 2008; Stenhammer, 2007; Ministry of Health Uganda, 2012:70-85). This is because urban population is more mobile, allowing for several partners and non-traditional relationships (Stenhammer, 2007). A big part plays the "urban anonymity", which encourages engagement in transactional sex or age-disparate relationships (ibid). Both of which are linked to higher risk in HIV infection (Choudhry et al., 2016). Informal settlements, or slums, which are parts of the urban areas, face a problem of overcrowding. Such high density of population is connected to early sexual debuts, alcohol abuse, unemployment and crime (Stenhammer, 2007) and therewith to HIV as those aspects fuel risk-taking sexual behavior (Musinguzi et al., 2014). Additionally, urban populations face poorer sanitations standards, especially in informal settlements. Poor living conditions weaken the immune system and allow for greater susceptibility for any kind of infection. With all those factors in mind this study assumes that the relationship between urbanity and HIV is positive.

3.2.7. CONFLICT

Uganda is afflicted by domestic and international conflict (UBOS, 2014:64). In 2000, the UN Security Council note "that the HIV/AIDS pandemic is […] exacerbated by conditions of violence and instability" (UN Security Council, 2000:1). The devastating effects the epidemic has may also be the cause of conflict or a risk to stability and security due to its impact on society and the desperation it spreads. Conflict leads to massive amounts of population movements within and out of the region concerned. Therewith, HIV is transmitted to previous less infected societies (Iqbal and Zorn, 2010; McInnes, 2010). Additionally, conflict leads to the damaging of medical facilities and infrastructure, impeding the quality of and access to HIV testing, treatment and counseling. A prerequisite for this is, of course, an already in place health infrastructure. Hence, districts with little access to health care prior to conflict might see less impact of the conflict itself (McInnes, 2010). Such damage if not only shown by physically destroying health facilities, but also through cuts in health care spending to reinvest into the defense and resolution of conflict (Iqbal and Zorn, 2010). Such destruction of infrastructure assumingly also effects the educational infrastructure in the places concerned. The resolution 1308 also stresses the needed increase in awareness of prevention measure for peacekeeping forces (UN Security Council, 2000). Uniformed forces are often noted to have above average HIV rates (International Crisis Group in McInnes, 2010). This might lead to an increased infection rate of the local population where the military is stationed. Sexual violence often surges during times of conflict with the rape of women becoming increasingly a tactic of war (Iqbal and Zorn, 2010; McInnes, 2010; Spiegel et al., 2007). Consequently, conflict heightens the risk of exposure and contracting HIV by worsening the overall socioeconomic situation explained throughout the other factors. Therefore, a positive relation between the existence of conflict and HIV is expected.

Many structural factors have not been described in detail and include e.g., religion, sexuality, or unemployment. To include them all would simply exceed the scope of this dissertation, hence prioritizations had to be made. Reasons for omission were several. Literature asserts that religion has little influence on HIV (Ministry of Health Uganda

2012:106). Religious leaders were supportive of the ABC approach regardless of their faith (Gordon and Gordon, 2008:228ff). Sexuality was excluded as biases in data collection are assumed to be very high. Uganda passed an anti-LGBTQ law in 2012, which it received international criticism for. This law prevents sexuality to be lived freely and hence hard to capture in statistics. Unemployment was omitted from this conceptual framework due to practical reason. While unemployment reflects on great insecurities among society (Hickle, 2012), numeric indicators are not available on a district-levels. Neither were appropriate proxies. After an email request it has been confirmed via email by UBOS that such data is not collected on a district-level. The same issues arose for income, GDP or other economic indicators. Nevertheless, the concepts chosen represent a broad range of socioeconomic factors in society and therewith fulfill their purpose for this study. Now, what remains is the linkage among the factors and the overall connection to HIV. The concept of vulnerability will serve as a crucial contributor to understanding the risk-chain framework explained in the following section.

3.3. VULNERABILITY TO HIV TRANSMISSION – A RISK-CHAIN FRAMEWORK

> *"We recognize that risk is distributed unequally between poor and rich, between one place and another, and that actions by a few create risks and hazards for the many."* (Barnett and Whiteside, 2002:4)

Why is the HIV epidemic more disastrous in the Global South than in the Global North? A virus such as HIV does not discriminate between continents, nationalities or social class. It does not care about the race of the person or the level of education. Neither does it care about the language spoken. Biologically, susceptibility to HIV is merely influenced by a poor health status with a weak immune system. Previous infection with diseases deem one more susceptible, so does poor nutrition. However, the preceding section showed how the performance of socioeconomic factors can influence the susceptibility to the infection with HIV. With this knowledge, this section now aims to connect the factors with a risk-chain framework based on the concept of vulnerability. After vulnerability has been defined, factors according to their prior explanation and hypotheses will be categorized into three chain links: exposure, capacity and consequence.

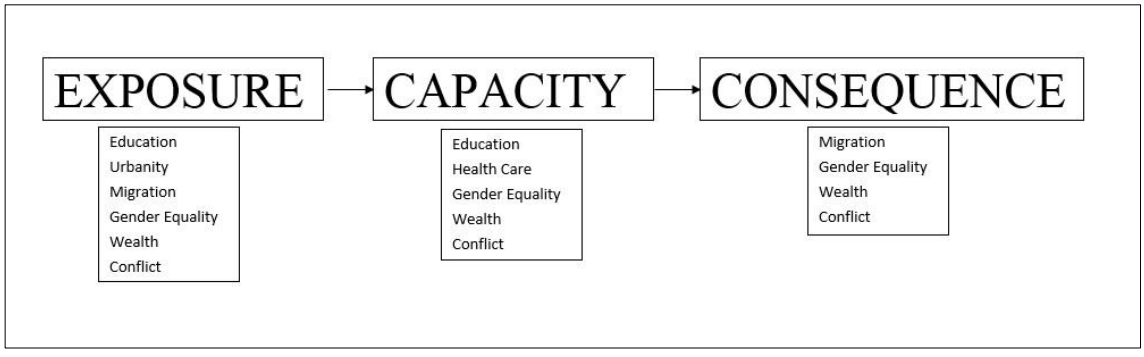
Vulnerability is a state determined by social and economic factors. It is the "absence of security, basic needs, social protection, political power and coping options" (Webb and Harinarayan cited in Prowse, 2003:21). In the major body of literature, poverty either predicates being vulnerable or vulnerability is seen as a results of being poor. In the developing world, "where more than half of the population lives below the poverty line […] it seems that the majority of the population is already 'at risk'" (Bezner Kerr and Mkandawire, 2010:465). Such categorization in risk groups, the authors argue, results in increased stigmatization and blaming of the groups (Bezner Kerr and Mkandawire, 2010), while simultaneously creating a false sense of security for populations identified as non-vulnerable (Marcus and Wilkinson referenced in Prowse, 2003). However, the benefit of identifying such groups as being vulnerable is the ability to track them and therewith the issue, in this case the transmission of HIV, they are vulnerable to (Oppong, 1998). For this thesis, a society, or district, is considered more vulnerable to HIV if it has insufficient health care and education, is poor, faces high amounts of gender inequality and short-term circular labor migration, is located in urban areas and/or is exposed to conflict. However, before identifying patterns of the determinants of vulnerability to HIV, their specific effect in the risk-chain framework will be explained.

Vulnerability to HIV transmission is three-fold: exposure, capacity and consequence (see Figure 3.1). Exposure to HIV does not necessarily lead to an infection. However, the higher the frequency or intensity of exposure to HIV, most likely through heterosexual sex, logically, the higher the chance of infection. Populations exposed to HIV more frequently and intensely are less educated (Behrman, 2015), are poorer and driven by economic need to riskier sexual behavior (Hickle, 2012), are affected by outward migration (Cassels et al., 2013), live in urban areas (Stenhammer, 2007), and are affected by conflict (Iqbal and Zorn, 2010). Once exposed it depends on the capacity to respond to the potential transmission. Populations with a better health status, more knowledge about prevention and safer sexual practices, assets to purchase preventives, and more gender equal societies are likely to have higher capacity to prevent themselves (Gordon and Gordon, 2013:228ff). The last link in the chain, consequences, reflects the state when HIV has been contracted. The level of vulnerability decides upon access to medication, stigmatization faced, resignation and the handling of care. Socioeconomic factors that play into this stage are health care, migration, level of wealth and conflict. Overall, we

see that the risk-chain framework indicates how more vulnerable societies are more likely to be exposed, less likely to have the capacity to cope with, and less likely have the means to handle the consequences of HIV.

To answer the question from the beginning of this section: The HIV epidemic is more disastrous in the Global South than in the Global North because for a hazard to turn into a disaster it requires a vulnerable population. And on a comparison, the Global South's population, while not homogenously, is more vulnerable than the Global North's. What the risk chain framework touches upon, is how the issues of frequent and intensive exposure and the inability to cope with the exposure, as well as the lack of handling the consequences are linked to the socioeconomic situation in Uganda. It explains that difficult situations, such as diseases like HIV, do not have the same effect on all groups in society. Indeed, the socioeconomic condition of that group most likely influences the way they are able to cope with the disease. A variation in patterns of HIV are noticeable, just like patterns of accessibility to e.g., education or health care. Socioeconomic status just like HIV is not homogenous across nations. It varies between nations and within those nations it varies between regions and, how this study will further look into, districts. HIV does not discriminate whether you are wealthy or not. However, being wealthy might as well provide you with the assets needed to avoid exposure, or with the capability to handle the exposure, or have access to adequate options to handle the consequences. This is what this risk chain framework deals with.

FIGURE 3.1 CONCEPTUAL FRAMEWORK



4. METHODOLOGY

This chapter is divided into six sections: research design, data collection, study measures, data management, data analysis and the limitations of the study. How the research is placed within the empirical world is illustrated in the research design by introducing the design, strategy and approach chosen for the study. The data collection focuses on the main reports which provide the numerical data for the research and offer a justification for the usage of secondary data. The numerical data was operationalized in and divided into independent and dependent variables in the study measures section. Adjustments made to the data in order to optimize the research are explained in data management. The statistical treatment in form of a multiple linear and geographical weighted regression is explicitly described in data analysis. Finally, the chapter concludes by outlining the limitations of the study.

4.1. RESEARCH DESIGN

This study will take the shape of a cross-sectional research design with a deductive approach which is led by a quantitative research strategy. The research design is necessary to position the researcher in the empirical world. It provides a description of the planning and execution of the study (Punch, 2005:62f). With the knowledge of the background and conceptual framework of the study, this section aims to provide the reader with an insight into the research design, strategy and approach chosen for this study.

As a non-interventionist study researching the current tendencies in HIV spread due to socioeconomic status in Uganda, a cross-sectional research design was adopted. An experimental research design calls for the researcher's intervention to "artificial[ly] manipulat[e] […] some treatment variable(s) for research purposes" (Punch, 2005:65). This was deemed as a not only impractical, but also unethical design for the stated research objectives (Bryman, 2012:61; Punch, 2005:70f). A quasi-experiment, studying the occurrence of a natural treatment groups (i.e. without the researcher's intervention) (Bryman, 2012:56; Punch, 2005:64-66,71) was not feasible for this study, since no such setting occurred in the past years which effected the overall structural and socioeconomic environment of the population concerned (for a quasi-experiment on the influence of the *educational* reform's on HIV see Behrman, 2015). Instead, we see naturally occurring

variation, or variations that cannot be accounted to one single manipulation, in the socioeconomic factors and HIV rates across Uganda. Such kind of variation calls for a non-experimental (Punch, 2005:71ff), or how Bryman (2012:62) and this research refer to it, cross-sectional research design. In cross-sectional design aims to detect patterns or correlations between two or more variables collected at a single point in time (Bryman, 2012:62ff). While secondary data was collected in the spring of 2016 at a single point in time, the date of the secondary data (i.e. official reports) might vary. Hence, for the purpose of this study, "a single point in time" is defined as the most recent point in time where data was made available. To further understand how this design contributes to reaching the aim of this research, it is crucial to place it into context with the deductive research approach and quantitative research strategy chosen to frame this study.

A quantitative research strategy allows for a large population size to be examined simultaneously (Bryman, 2012:175ff). This is a crucial aspect for this research as it aims to find out to what degree socioeconomic factors account for a variance in HIV spread *across districts* in Uganda. Uganda consists of 112 districts each host of a population between about 55 000 to almost two million. Such large population size is nearly impossible to be captured by a qualitative research strategy, which aims to provide in-depth understanding (Bryman, 2012). However, it is necessary to sustain the large population size, in order to be able to reflect upon the overall socioeconomic structures of society. Additionally, quantitative researchers are interested in exploring the causes of a phenomena, such as the HIV epidemic. They display independent (say socioeconomic factors) and dependent (say HIV spread) variables as causes and effect, respectively. Yet, only a pure experimental research design allows for "little ambiguity about the direction of causal influence" (Bryman, 2012:175). In cross-sectional research designs, causal influence of variables is not as clear and therefore calls for theoretical inference, or a deductive reasoning (ibid).

In a deductive research approach, research is guided by theory. Theory serves as foundation to how phenomena are to be understood and findings to be interpreted (Bryman, 2012:20). In this case, theory is based upon previous literature in the field and presented as a conceptual framework linking crucial concepts of socioeconomic factors to the idea of vulnerability. The conceptual framework provides the research with the

theoretical inference needed to employ causal relationships between variables and allowed hypotheses to be derived. The overall design and strategy of the research will guide the selection of the methods for collection and analysis of the data used to test the hypotheses.

After having positioned the researcher in the empirical field with a deductive quantitative cross-sectional study and explained the research plan and execution, it is now necessary for a more detailed account of the data collection to further on lead this research through the study measures, data management and data analysis.

4.2. DATA COLLECTION

This section will introduce the statistical secondary data collected for this research. Data explored in this study was taken from five different reports. One report is published by UNAIDS, while the remaining four are government publications including statistical abstracts and census data. Prior to describing each dataset in detail, the section will offer a justification of the usage of secondary data for statistical analysis.

No questionnaires or interviews were conducted specifically for this research. Questionnaires or interviews, while allowing for a more individual level insight into the matter, are time and resource intensive (Bryman, 2012:311ff) and were practically not manageable within the scope of this thesis. Additionally, led by a quantitative research strategy, this research aims to scrutinize the overall structural effect of socioeconomic factors and therefore a large sample size of the population was needed. Another benefit of secondary data is that it does not contribute to survey-fatigue of the population and tends to be of higher quality than self-conducted surveys could achieve (ibid). As HIV is a sensitive topic it is important to properly reflect upon the risk of biases of the researcher and the respondents. By using secondary data, the researcher's biases are to be held in check. The respondents' biases, however, still exist but it can be assumed that the surveys used were conducted properly, respectfully and in regards to sensitivity of the subject. Secondary data also restricts the availability of indicators needed as it offers a given dataset. Primary data would allow for specific questions aimed at indicators of need. Nevertheless, the secondary data chosen offered useful information and indicators if needed where adjusted or computed. For the merging and managing of the data please

refer to section 4.4 Data Management, where merging and manipulation processes are described in detail. After having gone into the advantages and disadvantages of secondary data, the chosen reports will now be introduced and reflected upon.

The UNAIDS provides the data on HIV prevalence used for this studies. In their reference publication they aim to generate data at the second administrative unit, i.e. districts, in order to nurture local needs against the spread of HIV. UNAIDS (2014b) base their estimates upon the AIDS Indicator Survey 2011 of Uganda. Before the publication, information for smaller administrative units than national and the first administrative level was non-existent. Therefore, UNAIDS (2014b) offers the first data on such geographical scale for Uganda. Estimates were generated through the prevR method, which should be regarded with caution. However, the method still offers an insight into local trends of HIV prevalence. Estimates are categorized into four quality levels, i.e. good, moderately good, uncertain and very uncertain[8]. Most of the estimates for Uganda are ranked as uncertain. This low quality level needs to be treated with care, however this is currently the only, and therefore best, available data on HIV on a district-level. With this being said, this study will utilize the provided data for its dependent variable, HIV prevalence.

The Uganda Bureau of Statistics (UBOS) provides statistical information "that meet the international standards quality requirements" (UBOS, 2015: foreword). In their annual Statistical Abstract, UBOS informs about socioeconomic, environmental, demographic and economic indicators collected through surveys, censuses and administrative records for Uganda. Data is presented on a national, regional, district or sectoral level. Data provided in this report will serve as source for the independent variables on quality and access to health care.

The Education Abstract 2013 published by the Ministry of Education and Sports (EMIS, 2013) collects data based on the Annual School Census which relies upon surveys send out to and information provided by educational institutions. The Annual School Census provides basic data on school enrollment, infrastructure, teacher background and students. Problematic is that, especially private, schools often fail to return their surveys in time or

[8] See Appendix 4 for each district's categorization

provide wrong information. Nevertheless, two indicators have been chosen out of the comprehensive dataset to account for quality of education and gender equality.

Finally, the remaining data for the independent variables has been drawn from the Main Report of the National Population and Housing Census 2014 published in March 2016 (UBOS, 2016). As the fifth population census, this publication aims to provide socioeconomic and demographic data for evidence-based decision making and to improve service delivery. The data collection was performed during July and August 2014 and the Provisional Results Report published in November 2014. Count for Population, as well as the urbanization, wealth and migration indicator were taken from this report, while information on conflict areas were taken from the Provisional Results Report.

Eight indicators were taken from the previous introduced five reports (counting the two census' result reports as separate). There are no ethical restrictions perceived, as the data analysis is based upon secondary data which is publically available and the author was not involved with the direct collection of the reports used.

4.3. Study Measures

Concepts aim to explain a specific aspect of the world or a phenomenon. In this studies, concepts, introduced in Chapter 3, take the shape of socioeconomic factors. In order to utilize them for a quantitative research it is necessary to measure them. Measuring of socioeconomic factors can be difficult as they are not directly quantifiable, therefore indicators representing the socioeconomic factors have been chosen. The measured socioeconomic concepts, the independent variable, will aim to explain the spread of HIV, measured as the dependent variable. In the following, concepts and their chosen indicators are presented and justified. Additionally, a short reflection on the sample size, which is represented by the spatial unit, is provided.

4.3.1. Dependent Variable

The dependent, or outcome, variable indicating the spread of HIV is HIV prevalence of the population 15 years and above. This study aims to study the underlying factors to risky sexual behavior, hence, it seemed only adequate to choose data for the population

of 15 years and older. This variable has been calculated by the author, for more information see the section on data management.

4.3.2. INDEPENDENT VARIABLES

Eight independent, or explanatory, variables chosen are based upon the conceptual framework (see Chapter 3) in order to represent a broad range of structural factors influencing the outcome of HIV. While some of the indicators are direct, others require some explanation. In the following all factors and their chosen measures are shortly introduced and justified.

EDUCATION: For education, this study chose to focus on the quality of education and measures it by looking at the student teacher ratio in secondary education. Behrman (2015) claims that secondary education measure may suffer from selection bias as attendance of secondary school depends more on the social and economic situation of the student than the attendance of primary school. Again, as this study predominately looks at the sexual transmission of HIV, the author felt that secondary education is a more reliable source as it indicates the quality of education of the teenage population. This is a crucial age group as it is during the teenage years that a majority of Ugandans experience their first sexual intercourse (Ministry of Health Uganda, 2012: 69). Also, with the Universal Secondary Education introduced in 2003, economic constraints preventing somebody from attending school, while still existent, are less prevalent.

WEALTH: There was no economic or fiscal data on a district-level for Uganda. Unemployment rates, GDP growth, household income and the such are only available on a regional or national level. Hence, the proxy for wealth is a weighted composite score based on the energy source for cooking per household in a district. For more details on the computing and weighting see the following section on data management.

HEALTH CARE: Health care is divided into two parts: access to and quality of health care. Access to health care is represented by total amount of health facilities per 10 000 population. This includes government, NGO and private health facilities. Physical distance might still vary as health facilities tend to cluster in urban areas, but so does population. Therefore, this study assumes that health facilities and population are fairly similarly spread out. Quality of health care is measured by the percentage of the universal coverage of pregnant women receiving four antenatal care visits. Four antenatal care visits is the minimum amount suggested by the World Health Organization (World Health Organization, 2016).

GENDER EQUALITY: As no gender equality index is provided on a district-level, female gross enrollment rate (GER) in secondary school will indicate the status of gender equality achieved per district. Assumingly, the higher the female enrollment, the more gender equal.

MIGRATION: If a district experiences short-term circular labor migration, will be measured according the percentage of total households receiving remittances. Explained in the conceptual framework, labor migrants leave their homes to work and earn money for their family. The earnings are send back home in forms of remittances; hence it can be assumed that districts with a high proportion of households receiving remittances also experiences high amounts of short-term circular labor migration.

URBANITY: Urbanity is measured in urbanization level in percentage. This measure takes into account population and space.

CONFLICT: Conflict is measured by a dummy variable. Wherein 1 stands for conflict, and 0 for no conflict. Information of international conflict has been merged with information of conflicts between districts and within districts. A better measurement would have been amount of incidences or similar, however, data on conflict is not collected by UBOS for their own safety and to not get involved.

Only the districts and border regions affected by conflict were stated (UBOS, 2014).

4.3.3. SPATIAL UNIT – STUDY POPULATION SIZE

The spatial unit of this study is the second administrative level. The second administrative level currently consists of 112 districts. The capital Kampala accounts for one district and has been omitted from this study due to its uniqueness as an urban actor and capital. District-level was chosen as a level of aggregation, as it is the smallest possible area unit provided with socioeconomic indicators. With 111 districts as study features remaining, this study fulfills the quantitative rule of thumb for sampling

4.4. DATA MANAGEMENT

Several adjustments were performed in order to optimize the research process. At first, data was merged from the five publications into one database using Excel 2013. In order to allow for the most suited fit of the statistical model and to avoid outliers and skewness of data, several manipulations have been performed. All manipulations were performed in Excel 2013 except for the computing of the proxy variable for wealth, which was performed in IBM SPSS 23.0. GIS data was manipulated using Esri's ArcCatalog 10.2 and ArcMap 10.2.

(1) HIV prevalence for the population of 15 years and older: Prevalence data was only available for the population of 15 years to 49 years, yet life expectancy is about 58 in Uganda (The World Bank, 2016b). Therefore, the variable was calculated by dividing people age 15 and older living with HIV in a specific district by the district's total population. This calculation omits a large part of society from the HIV data (i.e. everyone underneath the age of 15) but it still represents the approximately correct covariance between the districts. This is the case as the age distribution is very similar across districts. However, it is important to note that the prevalence calculated does not reflect the true prevalence.

(2) HIV prevalence for Kiboga: UNAIDS (2014) did not include the district Kiboga in their dataset. The mean of the HIV prevalence of the remaining districts is used instead.

(3) Secondary female GER: Butambala was identified as an outlier with 99% enrollment rate. EMIS (2013) calls for specific care with its data and the remaining of Butambala's educational performance was average. Thus, the value was exchanged with the mean of secondary female GER across districts.

(4) Urbanization: The data for urbanity was positively skewed and has been transformed with log to reduce the skewness.

(5) District names: Some districts names were spelled differently (ex. Namayingo and Namiyango) throughout the reports and GIS shapefiles. This study has decided to use the spelling used in the UNAIDS (2014b) publication, adding Kiboga. Greater disparities were noticeable between the reports and the GIS data. After confirming with google maps, three district names (Katerere, Kibingo, and Nsiika) were changed to their UNAIDS - counterparts (Rubirizi, Sheema, and Buhweju, respectively).

(6) Wealth-variable: Information what energy source, i.e. electricity, gas, paraffin, charcoal or firewood, absolute numbers of households are using for cooking was transformed into a weighted computed variable indicating wealth. Electricity as a source of energy requires density to urban areas and is not independently transportable. With a risk of a collinearity to urbanity, electricity as a source of energy was therewith omitted from the dataset. After creating the percentage of households using the respective energy source, the remaining four energy sources were weighted according to their economic value resulting in the following equation[9]: *Gas + 0.42 * Paraffin Stove + 0.07 * Charcoal + 0.03 * Firewood = Proxy for Wealth.*

(7) GIS Shapefiles: All shapefiles were projected to the same projected geographic coordinate system which is *WGS_1984_World_Mercator*.

(8) The amount of health facilities per district was originally provided as total number per district. In order to increase the comparability, the variable was standardized

[9] Based on economic data from GTZ (2007)

by calculation health facilities per 10 000 population. Population data was taken from the Census Main Report (UBOS, 2016).

Previously mentioned were the omission of Kampala as district and the creation of a dummy variable for conflict. With the completed adjustments to the data to guarantee the well-functioning analysis, the methods of analysis are to be introduced.

4.5. DATA ANALYSIS

The data analysis consists of three steps. First, the dependent and independent variables are visualized as thematic maps showing the spatial patterns of each variable respectively. Afterwards, the data is treated statistically. First, by an ordinary least squares model performing a multiple linear regression. Then, by a Geographically Weighted Regression. The results were captured in numeric terms as well as in maps. The softwares IBM Statistical Package for the Social Science version 23.0 (SPSS) and Esri's ArcMap 10.2 served as tools for this analysis.

The visualization, as well as the statistical methods chosen, do not allow for the interaction of individual level and higher level (i.e. district) data simultaneously. Another method, multi-level modeling, however takes into account the two, individual and higher level data, and "establish[es] whether health variations from place to place arise simply because different sorts of people live in different places (so-called *compositional* effects), or because places themselves differ in terms of environmental quality or other attributes (*contextual* effects)." (Gatrell and Elliot, 2009:61). Nevertheless, as this research aims to gain further insight into the structural or "contextual" drivers of HIV and not the individual's sexual behavior, there is no need for a multi-level model.

Also, it is important to note that this study will not only look at the correlations of the variables. Instead, the multiple linear regression and especially the Geographically Weighted Regression, will explore to what extent change in an independent variable would potentially lead to positive or negative change in the dependent variable.

For the remaining of this chapter, the two statistical methods, OLS and GWR, will be explained, followed by the limitations of the study.

4.5.1. ORDINARY LEAST SQUARES

Ordinary least squares (OLS) is a common starting point for spatial analysis. Therefore, before performing a Geographically Weighted Regression (GWR), an OLS model was run as a method to conduct a multiple linear regression. OLS explores global and stationary relations between the dependent variable, namely HIV prevalence, and the independent variables introduced previously. As the independent variables were chosen upon theory, they were not alternated to find the best fitting model. The OLS model is based upon following equation:

Eq. 4.1. $HIV\ Rate_i = \beta_0 + \beta_1 * Education_i + \beta_2 * Wealth_i + \beta_3 * Access\ to\ Health\ Care_i + \beta_4 * Quality\ of\ Health\ Care_i + \beta_5 * Gender\ Equality_i + \beta_6 * Migration_i + \beta_7 * Urbanity_i + \beta_8 * Conflict_i + \varepsilon_i$

The global intercept is represented by β_0 and the regression coefficients are represented by the βs. *HIV Rate* is the outcome variable, i.e. the variable to be predicted or explained. The different districts are symbolized by *i*. The error term is indicated by ε. The regression was performed in ArcMap and SPSS, respectively. SPSS was chosen additional to ArcMap as a software due to its better provision of descriptive statistics.

Multicollinearity issues were assessed by examining the variance inflation factor, VIF. Multicollinearity occurs if two or more of the independent variables are redundant. VIF-values greater than 7.5 are expected to be multicollinearity (Desktop Arc GIS, 2016). Additionally, spatial autocorrelation using Moran's Index was explored. Spatial autocorrelation assesses if residuals are spatially independent. A negative autocorrelation indicates that different values appear in adjacent locations. When similar values cluster together, the data is positively spatially auto correlated. A statistically significant spatial autocorrelation of the regression residuals means that the model is misspecified and most likely key variables are missing.

4.5.2. GEOGRAPHICALLY WEIGHTED REGRESSION

The utilization of Geographically Weighted Regression in health research has increasingly gained recognition (Wabiri et al, 2016). In comparison to the OLS model, a Geographically Weighted Regression explores the non-stationary and local relations between the dependent and independent variables. A GWR therewith allows to create an understanding of, in this case, district-level variation of the variables. The GWR model,

run in ArcMap 10.2.2, includes the same variables, dependent and independent, and calculates the local coefficients of the independent variable for each district in a continuous function. The model uses a fixed kernel type and does not the conflict variables, as the regression does not work with binary or dummy variables. The other variables remained in the model.

4.6. LIMITATIONS

This study was conducted as a quantitative desk study and the limitations it faces will be explained below.

Firstly, it is important to explain the issue of reverse causality, but also note that correlation does not mean causation. Reverse causality, that is, acknowledging that while for example education is seen as influence on HIV, HIV also impacts education and other socioeconomic factor. As a cross-sectional study, it is difficult to properly reflect upon the issue of reverse causality. Statistically, this issue could have been improved using an instrumental variable, however, this would have been outside the scope of this thesis.

Secondly, there is issues with working with administrative data. The areal unit of the data is the secondary administrative level, the district level. It is important to reflect upon the modifiable areal unit problem, explained by Gatrell and Elliott (2009:52). Analyzing the distribution of data, is highly affected by the configuration of the areal units. The data provided cannot be geocoded as points, but is part of an areal zone. The creation of hotspots is hence biased, as spatial distribution of the incidence within the district is unknown. Another problem to reflect upon is the amount of cases. A small amount of cases offered in the dataset do not allow for a stable analysis, "since the addition or subtraction of only a single case can greatly alter the estimate" (Gatrell and Elliot, 2009:53).

Lastly, the choice of indicator for the dependent variable, HIV rate. All indicators have been chosen carefully to work with the available data. The biggest offset is identified with the dependent variable, HIV rate, which is measured by HIV prevalence. Which at first seems like an adequate measure, is soon noticed to fail in capturing the dynamic and temporal structures of the epidemic. Wherein HIV prevalence accounts in all PLHIV and therefore does not reflect upon the actual spread, but in more recent studies rather tends

to be an indicator of well-distributed and sustainable access to ART. HIV incidence rate or new infection rate would have been a more adequate measure. However, the UNAIDS currently provides the only data on a district-level on HIV. The data provided is HIV prevalence rate or total amount of PLHIV. For future research, it is advisable to adjust to this measure, but currently this study is using the best data available and is acknowledging its limitations.

5. FINDINGS

This chapter will present the results in the order on how the analysis was performed.

5.1. DESCRIPTIVE STATISTICS | THEMATIC MAPPING

The mean and standard deviation of each variable is presented in Table 5.1. Map 5.1 displays the spatial distribution of the variables. The map enhances visual comprehension of the correlation between variables[10].

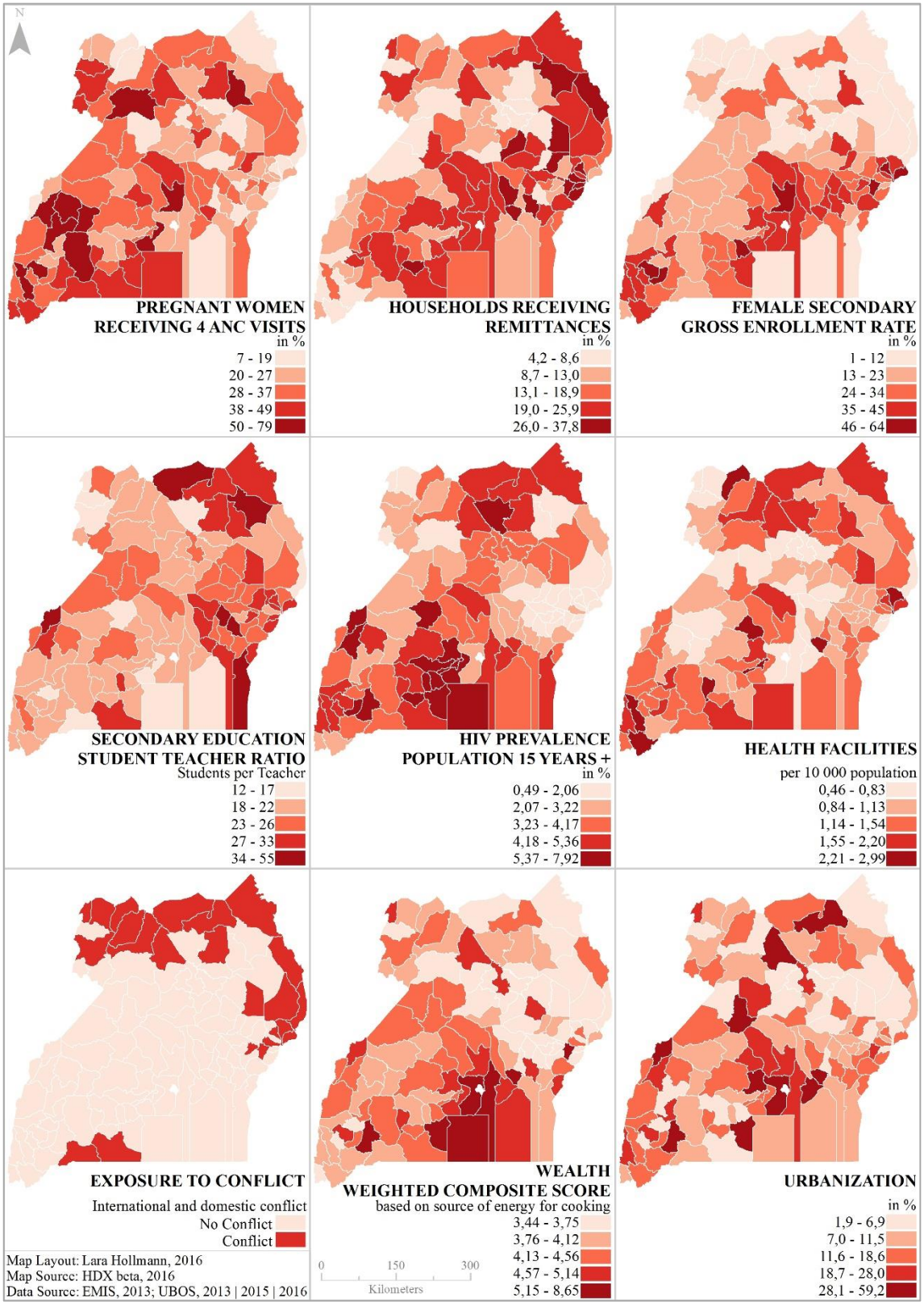
High quality of health care clusters in five districts in the south of the Western region, namely Kabarole, Kamwenge, Kyenjojo, Kyegegwa, and Kiruhura. A similar pattern is visible in the access to health care which is generally high (between 1.14 to 2.99 health facilities per 10 000) in the same region. However, Kyegegwa and Kyenjojo indicate very high quality of health care with over half of the pregnant women receiving four ANC visits (55% and 79%, respectively), but the access to health care is among the lowest with 0,533 (Kyegegwa) and 0,616 (Kyenjojo) health facilities per 10 000.

High HIV rates cluster in the Central region with Kalanga, Masaka, Lwengo, Bukomansimbi, Kalungu, Mpigi, Butambala, Gomba and Mityana indicating a HIV prevalence from 5.37% to 7.92%. Interestingly, the cluster is interrupted by Wakiso. Wakiso, similar to the districts with high HIV rates in the Central region, has high levels of urbanization and high levels of wealth as indicated by the weighted composite score, however the HIV prevalence is 2,6%.

Another cluster of HIV rates, with not as high HIV rates, is visible in the Northern region, bordering South Sudan. Except for the cluster, HIV rates are low to very low in the North. The North hosts the vast majority of the districts exposed to conflict, surprisingly associated with predominately low HIV rates. Also, high out-migration and gender inequality and low quality of education are visible in the North. Furthermore, low levels of urbanity clusters in the Northern region.

[10] For detailed information on the variables see Appendix 3

MAP 5.1 THEMATIC MAPS OF VARIABLES



NOTE: For reference map and labeling see Appendix 1 and Appendix 2.

TABLE 5.1 VARIABLES, DESCRIPTIVES & EXPECTATIONS

Variables	Operationalization (Source)	Mean	Standard Deviation	Expected Influence
HIV Rate*	HIV prevalence, % of population 15 years plus (UNAIDS 2014)	3.58	1.66	----
Education	Secondary education student teacher ratio (EMIS 2013)	23.23	600	Negative
Wealth	Weighted composite score based on energy source for cooking (UBOS 2016)	4.20	0.75	Positive
Access to Health Care	Amount of health facilities per 10 000 population (UBOS 2015)	1.26	0.54	Negative
Quality of Health Care	Percentage of pregnant women receiving four antenatal care visits (UBOS 2015	31.73	13.19	Negative
Gender Equality	Female secondary education gross enrollment rate in % (EMIS 2013)	25.49	14.07	Negative
Migration	Percentage of households receiving remittances (UBOS 2016)	16.72	7.92	Positive
Urbanization	Urbanization (adjusted with log10) (UBOS 2016)	1.06	0.29	Positive
Conflict	Dummy (UBOS 2014)	0.21	0.407	Positive

Note: N = 111. "Expected Influence" indicates the predicted effect on HIV spread. For more detail see Chapter 3.
* Dependent variable

5.2. MULTIPLE LINEAR REGRESSION

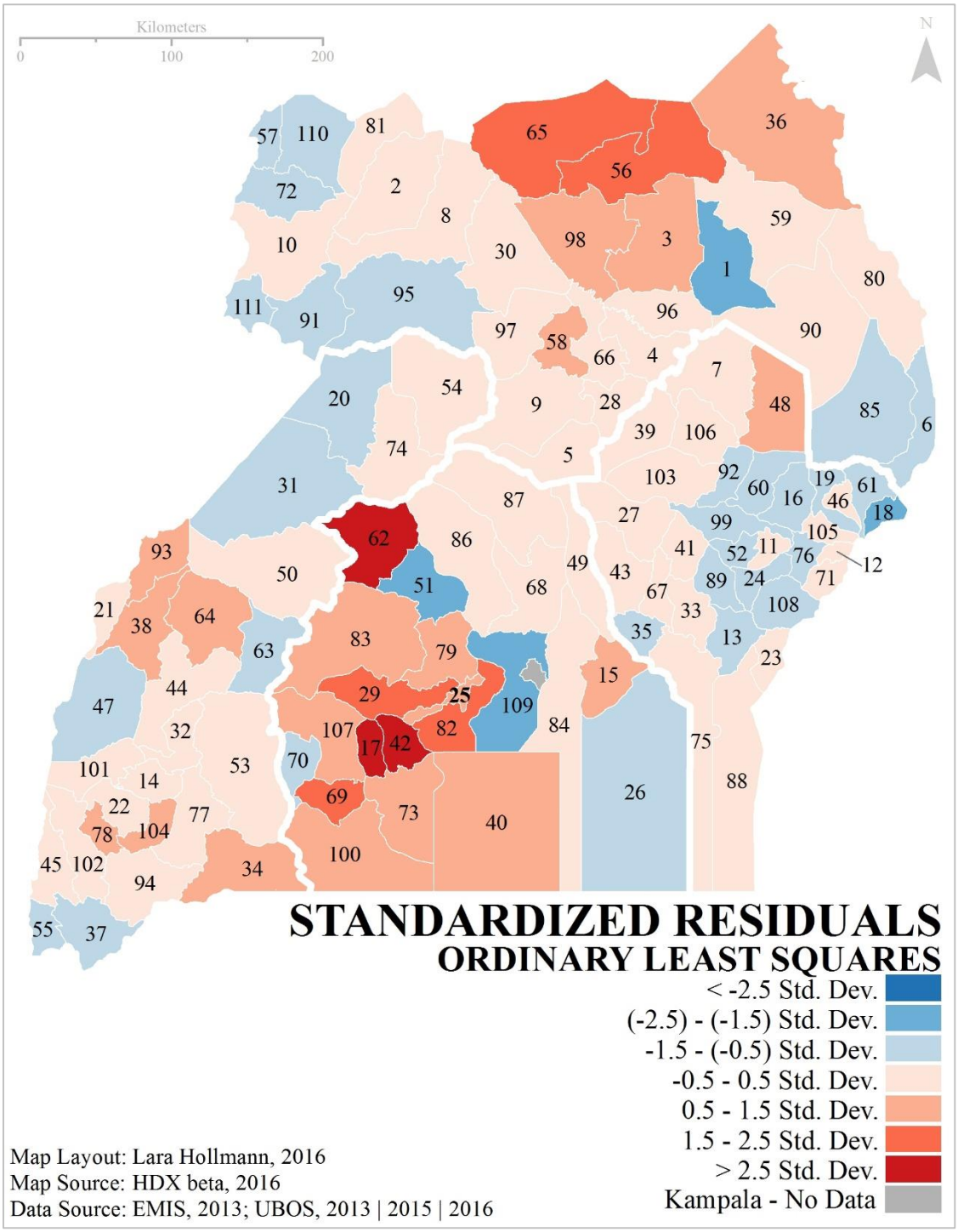
The multiple linear regression performed with ordinary least squares represents the global stationary relationship between the variables. The regression results are presented in Table 5.2 and visualized in Map 5.2. From the results, the following regression equation is derived:

Eq. 5.1. $HIV\ Rate_i = 0.289 - 0.021 * Education_i + 0.754 * Wealth_i + 1.025 * Access\ to\ Health\ Care_i + 0.012 * Quality\ of\ Health\ Care_i - 0.020 * Gender\ Equality - 0.025 * Migration + 0.075 * Urbanity_i - 0.949 * Conflict_i + \varepsilon_i$

Overall, the global model accounts for 26.1% of the variance in HIV prevalence in Uganda with three coefficients being statistically significant at a 5% level (conflict, access

to health care and wealth) and one coefficient being statistically significant at a 10% level (gender equality).

MAP 5.2 OLS – STANDARDIZED RESIDUALS



NOTE: For reference map and labeling see Appendix 1 and Appendix 2

Contrasting hypotheses, both wealth and access to health care have a positive influence on HIV rate, hence an increased access to health care or higher levels of wealth account

for increased HIV rates. Surprisingly, conflict, also non-confirming hypothesis, has a negative influence on HIV rates in the global model. More gender equal districts show, as expected, lower HIV rates. In comparison between those four, the coefficient for wealth accounts for the most variation in the regression with the standardized coefficient being 0.340. However, access to health care indicates the strongest unstandardized coefficient with 1.025 meaning that one-unit increase in health facilities per 10 000 would results in a 1.025 increase in HIV prevalence. Nevertheless, informative value of the model has to be assessed before drawing inferences.

TABLE 5.2 MULTIPLE LINEAR REGRESSION RESULTS

	Unstandardized Coefficient		**Standardized Coefficient**		**Collinearity Statistics**
	B	**Standard Error**	**Beta**	**Significance (P-value)**	**VIF**
Constant	0.289	1.134	----	0.799	----
Education	- 0.021	0.025	- 0.076	0.394	1.185
Wealth	0.754	0.257	0.340	0.004 *	1.994
Access to Health Care	1.025	0.266	0.335	0.000 *	1.119
Quality of Health Care	0.012	0.011	0.095	0.286	1.173
Gender Equality	- 0.020	0.011	- 0.173	0.066 **	1.282
Migration	- 0.025	0.019	- 0.120	0.180	1.187
Urbanization	0.075	0.637	0.013	0.907	1.880
Conflict	- 0.949	0.364	- 0.233	0.011 *	1.187
Adjusted R^2	0.261				
AICc	406.74				
Moran's Index	0.356 ***				
Koenker (BP) Statistics	6.071				

NOTE: *significant at 5%. **significant at 10%. *** significant at 1%. N = 111.

To assess the informative value of the model the standard residuals are visualized on a hot-cold-scheme in Map 5.2. The red fields indicate that the actual values are larger than the estimated values and the blue fields indicate that the actual values are smaller than the estimated value. The darker each color the higher the standard deviation. The pattern of the standard residuals is clustered, an indication for missing key variables which is confirmed by the low adjusted R^2 (26.1%). Assessing the spatial autocorrelation with Moran's Index confirmed the visually identified clustering with a significant ($p < 0.01$)

Moran's Index of 0.356. There is no distinguishable collinearity between the variables measured with the variance inflation factor (VIF). All variables indicated a VIF of below 2. The highest VIF is associated with urbanity and wealth. The Pearson correlation coefficient indicate a strong positive correlation of 0.632 between those two independent variables. Even though the VIF values are favorable for the model, the spatial autocorrelation and low determination coefficient, R^2, indicate an unreliable model. To improve the model, other key variables have to be identified.

5.3. GEOGRAPHICALLY WEIGHTED REGRESSION

Despite the spatial results of the OLS indicating spatial autocorrelation and the Koenker test, a measurement for non-stationary relationship between the variables, not being significant, a Geographically Weighted Regression was performed. The regression was performed anyway as it offers an understanding of the variables' effect in a specific location and therefore offering a non-stationary local regression in comparison to the global stationary multiple linear regression. The summary results are presented in Table 5.3 and the local R^2 and the spatial distribution of the standardized residuals is visualized in Map 5.3 and Map 5.4, respectively.

TABLE 5.3 GWR RESULTS

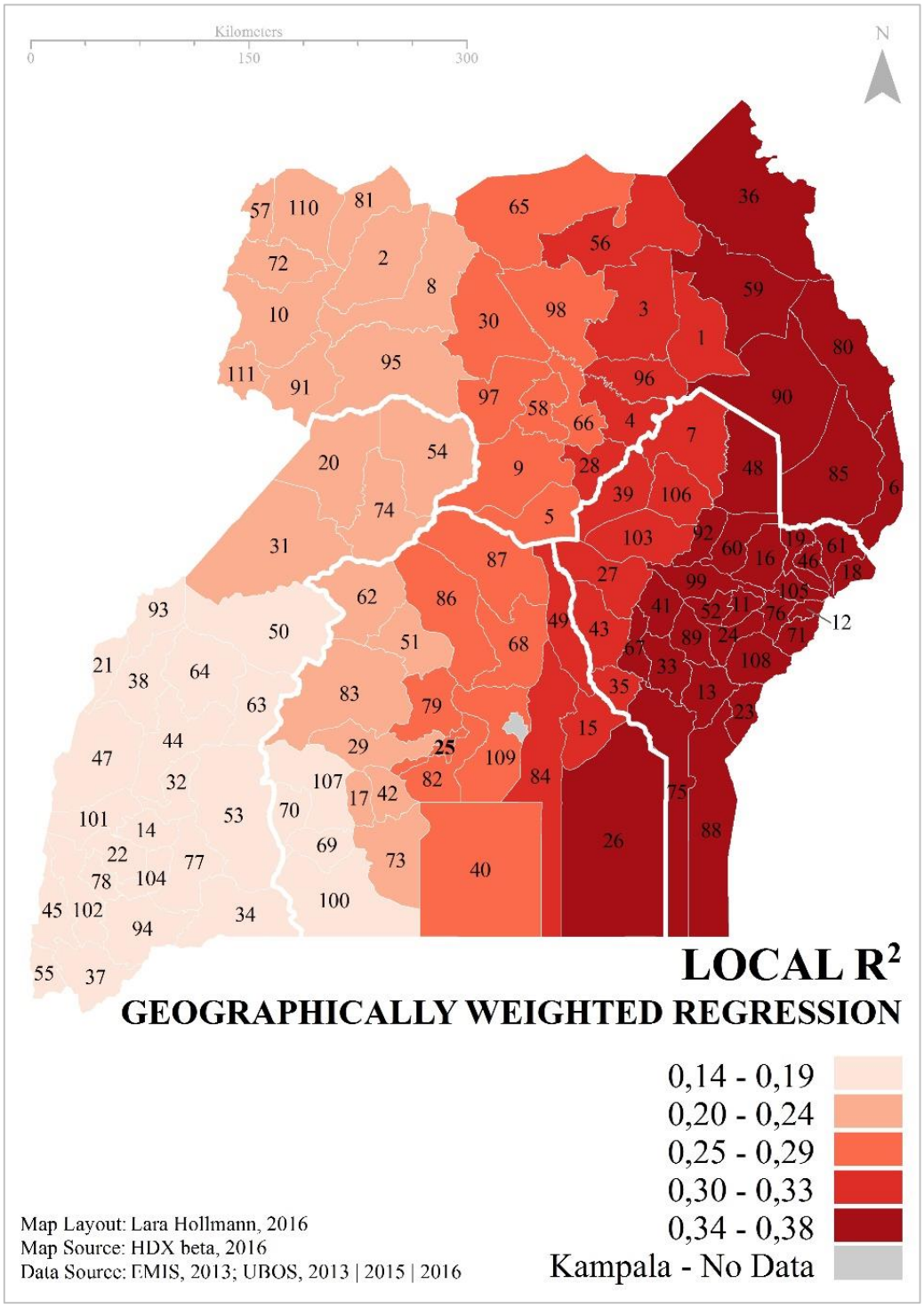
AICc	163.498
R^2	0.385
Adjusted R^2	0.246
Moran's Index	0,322*

NOTE: * significant at 1%

For the Geographically Weighted Regression, which excluded the conflict variable as it was a dummy, performed poorly. While the lower AICc for the GWR model (163.498) indicates a better fit to the observed data in comparison the global model (406.74), the adjusted R^2 decreased from 26.1% to 24.6%. The standardized residuals are again clustered with a less than 1% likelihood that the pattern is the result of random chance according to the Moran's Index. However, with the spatially autocorrelated result of the OLS, this was to be expected. Condition numbers ranging from 27.6 in Alebtong in the Northern region to 41.4 in Kayunga in the Central region indicate local collinearity between the independent variables. The mapping of the local R^2 shows that the variables

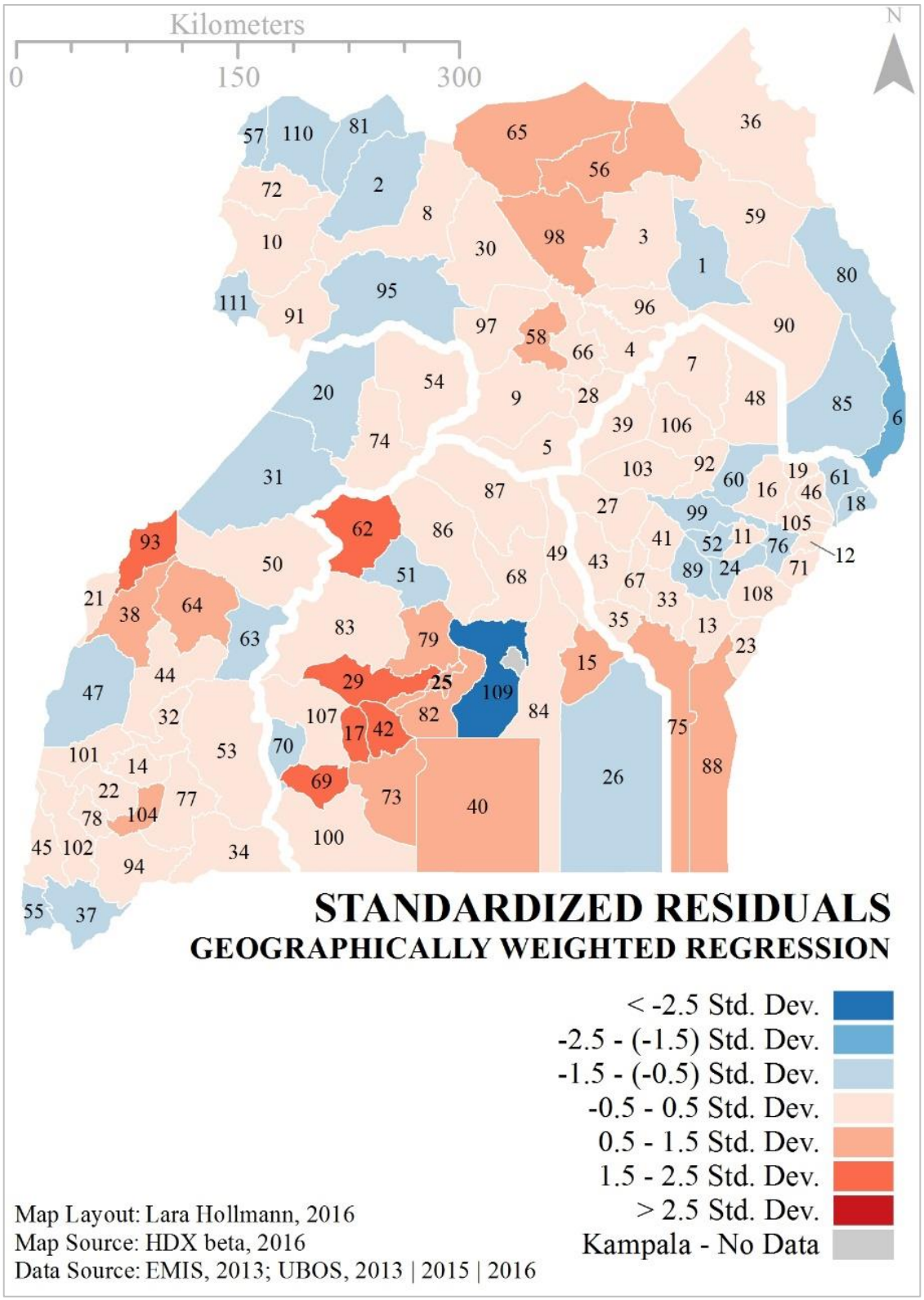
chosen create a much stronger model for the north-east then for the south and south-west. In Namayingo the local R^2 peaks with 37.5%, meaning that in Namayingo the variables chosen account for 37.5% of the variance in HIV rate. Overall, the model is unreliable and to be interpreted with extreme care.

MAP 5.3 GWR– LOCAL R^2



NOTE: For reference map and labeling see Appendix 1 and Appendix 2

MAP 5.4 GWR– STANDARDIZED RESIDUALS



NOTE: For reference map and labeling see Appendix 1 and Appendix 2.

6. DISCUSSION

The discussion will be split into two parts. First, the findings presented in the previous chapter will be discussed and inferences drawn guided by the conceptual framework. Afterwards, the quality of the analysis and potentially missing key variables needed to improve the statistical determination will be assessed.

6.1. FINDINGS

This section will discuss the four statistical significant variables from the multiple linear regression separately, followed by a general discussion on the implications of the Geographically Weighted Regression.

6.1.1. CONFLICT

Based upon previous literature, the conceptual framework hypothesized conflict to have a positive influence on HIV spread, meaning that it was expected that districts with high HIV rates would be exposed to conflict. This hypothesis was rejected by the OLS, according to which conflict has a negative influence on HIV. What could be possible reasons for that? In order to explain this fully more research has to be conducted. Hence, this section will bring forward assumptions and draw upon previous literature.

Conflict exacerbates the HIV epidemic and the factors associated with it. Linking to the idea of vulnerability it is about the population which turns a hazard into a disaster. What if the population at stake is not very vulnerable? Health care variables, for example, are performing average to above average in the majority of the districts concerned (see Map 5.1 and Appendix 3). This might indicate that the population was not as susceptible to the virus. However, with high out-migration patterns, low gender equality, low education quality and poor wealth levels in the same districts it seems that claiming that the population is not very vulnerable is far-fetched. Two other possible explanations remain. First, conflict is a focus area of many charity organizations. Such organization might be focusing on the provision of health care, HIV prevention programs and treatment distribution. Secondly, on more practical terms, data collection in conflict regions is difficult. UBOS (2014) refrained from collecting extensive data in conflict regions. This may result in PLHIV being undocumented and data being skewed.

While this research's findings indicate that exposure to conflict decreases the likelihood of HIV, it is to be assumed that the reason for this is to be found through further research within the background reasons of conflict and not within the violence and instability of conflict itself.

6.1.2. WEALTH

The overall vulnerability of the poor, the higher biological susceptibility through poor nutrition levels and the economic despair that might lead to high risk-taking sexual behavior, led to the hypothesis that increasing wealth decreases the chances for high HIV rates. As noted in the Chapter 7, this hypothesis was rejected.

Wealthier people are more likely to have HIV. Wealth correlates with urbanity and this might play a role in the rejection of the hypothesis. Two possible explanations: Firstly, linking to the limitation of the operator of the dependent variable, HIV prevalence. Wealthy people are more likely to be able to afford sustainable treatment as a consequence to HIV infection and therefore contributing more long-term to HIV prevalence. Secondly, focusing on the first chain link of the conceptual framework, exposure. Wealthy people are more likely to be exposed to HIV by practicing risky sexual behaviors such as having multiple sex partners and age disparate relationships (see Chapter 3 for more detail on the debate). The capacity of the wealth to cope with the exposure to HIV, however, remains financially high and the ability to cope is merely rejected due to individual behavioral choices.

Most likely, wealthy people are targeted by already existing HIV prevention methods (Hickle, 2012) but choose to not engage with them. A risk factor is exemplified by the decreased focus on the role of condoms in HIV spread. A longitudinal study of HIV rates of the wealthy and their behavior might indicate if there is a correlation to the change is policy approach.

6.1.3. GENDER EQUALITY

Gender equality was the only coefficient which was statistically significant only at a 10% level. In the conceptual framework it was hypothesized that gender equality has a negative effect on the spread of HIV by encouraging women's empowerment and giving them agency. This hypothesis was confirmed by the empirical results of this thesis.

Female secondary gross enrollment rate, the indicator for gender equality, is exceptionally low in the Northern regions. But this is not the issue, the issue is that the district with the highest female secondary gross enrollment rate[11], Kalungu in the Central region with 64%, has not even two thirds of all girls enrolled. The conceptual framework explains how women are disproportionately more exposed to the risk of HIV infection, have less capacity to deal with a possible infection and usually face more devastating consequences once infected. The power to speak up and the power of information is predominately distributed by education, therefore the operator indicates a very important aspect of gender equality. This paper argues, that projects to empower girls and young women do not necessarily have to be in the context of HIV, but the reduction in HIV rate is merely a side effect. Projects focused on the overall education of girls will allow them to be more informed and to increase their economic status through access to higher paying jobs. This increase in economic status will make them less dependent on abusive partners, which they will be more likely to leave. What non-HIV-focused approach also does, is avoiding the dependence on funding of sexual education campaigns which strongly rely on the donors' perception on what is "right" (a prominent example being pro-life versus pro-choice supporters, or the stance on the distribution of condoms). By providing girls with education, with agency, with economic stability the exposure to HIV infection is decreased substantially and therewith leading to a further decreasing rate of HIV.

The more gender equal a district, the less HIV prevalence it indicates. However, the current level of gender equality is still worrying. General projects aimed at the empowerment of women, not only facilitate to further decrease HIV rates by increasing gender equality, but also offer women a better life overall.

6.1.4. ACCESS TO HEALTH CARE

Access to health care, one of the two indicators accounting for health care, was hypothesized to allow for sustainable and faster treatment and therefore having a negative influence on HIV rates. However, with the lowest p-value, access to health care accounts for a positive influence on HIV rates. Therewith, rejecting the original hypothesis. This will be explained in two possible ways, a practical and a structural.

[11] Note: during the data management process the outlier of 99 % in Bulambala was replaced with the mean

This results seem very counterintuitive and conflicting with previous research, it will, hence, firstly, be argued for in practical terms. As mentioned in the limitations, HIV rate is not indicated by its most dynamic measurement, HIV infection rate, but instead by HIV prevalence. The original logic of the mechanism runs as follows: A person is a) more likely to have the capacity to cope with the exposure to HIV if access to health care is increased, and b) if infected, that person will be able to access sustainable treatment, reach viral suppression which will decrease the chances of transmitting the virus further. However, with the rejected hypothesis, this is not the complete case. In order to explain the current results, option c) has to be added to the mechanism: c) on treatment, the PLHIV will be more likely to live longer and therefore contribute longer to the HIV prevalence count. Over long term as more and more people access sustainable treatment and survive HIV, a higher HIV prevalence will result. This, however, is not a bad sign and is actually encouraged outcome by public health professionals.

Secondly, health facilities underlie structural biases and influences. Feldacker et al. (2010) who presented a similar result in their study on HIV in Malawi, claim that "clinics serve as a proxy for small market centers where women may engage in higher risk behavior such as extramarital partnerships" (ibid:1000). This argument is not quite applicable to this research, as Feldacker et al. measured distance to health facilities in kilometers, wherein this study looks at the population ratio. Nevertheless, this paper argues that health facilities, while physically accessible, are not necessarily structurally accessible to everyone. Health facilities might be private and costs money, or health staff might be corrupt. Two aspects which limit the poor from accessing health care. Another issue would be assessing the quality of health care to exclude the chance of HIV transmitting through unclean equipment.

To sum up, while seeming counterintuitive at first, a rejection of the hypothesis might be logically explained or even reveal structural problems within the health system especially since other authors, such as Feldacker et al.(2010), found similar results in different countries.

6.1.5. GEOGRAPHICALLY WEIGHTED REGRESSION

The Geographically Weighted Regression accounts between 14 and 38 percent of the variance in HIV rates. A statistically significant Moran's Index, not only for the GWR,

but also for the prior performed OLS, indicates that key variables are missing and the model is not reliable.

The results may still be interpreted with extreme care to not draw major inferences from it. Interesting to note, however, is that the GWR is a predicting almost 40% of variance in HIV prevalence in the Northern region compared to not even 20% in the south Western region. While the Koenker-test during the OLS, indicating a stationary relationship of the variables, a small variation in local relationships is measurable. This would indicate the need for more regional or locally based policy approaches. This research refrains from drawing further implication from the GWR model as it is the more unreliable one of the two models performed. In order to improve the models, key variables, which are currently missing, have to be included. Potential candidates will be presented in the next section.

6.2. MISSING KEY VARIABLES

The low determination coefficients of both models together with the spatial autocorrelation indicate that perhaps the increased uptake of risky sexual behavior and the therewith associated HIV rates is not caused by the socioeconomic factors chosen in this study, but instead that this study is lacking the key variables. This section will expand on the possible variables going beyond the scope of socioeconomics and further into demographics.

As mentioned before, better economic data was inaccessible as it was not yet processed or collected. However, for further research, this paper encourages scholars to look into measures for inequality of income, unemployment and GDP growth. Additionally, as indicated in the discussion on access to health care, corruption might play a role in the spread of HIV by inhibiting certain groups of the population to access services. Another issue that leads to denied access to services is discrimination.

In Uganda, homosexuality is a crime and also sex work is not legal. The groups in society concerned with this are already highly stigmatized groups. This study assumes, that many of the people associated with one or both of these groups would refrain from seeking health care in fear of enclosing one's sexuality or profession. Numerical data on the amount of homosexuals, sex workers or their perception might allow for further insight into the situation in Uganda and contribute to a better specified model.

Demographic factors are not commonly influenced by structural influences, as the economic status of one's parents is not able to define one's sex. However, sex ratio and age distribution might offer an interesting insight into the characteristics of the district's population. Additionally, marital status should be considered in future research.

7. CONCLUSION

Almost four decades have past and the HIV epidemic still dominates the life of the majority of the Ugandan population. Identifying key risk factors contributing to the spread while accounting for the geographical disparities of the virus is crucial for effective policy programs. Being the first of its kind performed in the context of Uganda, this research, by using multiple linear and Geographically Weighted regression, identified to what degree socioeconomic factors account for a variance in HIV spread on a district-level in Uganda. Led by a risk-chain framework, this study came to the overall conclusion that the socioeconomic factors chosen for this research merely accounted for approximately 30% of the variance in HIV spread. This inference was drawn by previously explaining and identifying that, in the context of Uganda and overall Sub-Saharan Africa the etiology of HIV varies and is driven by heterosexual sex in comparison to the U.S. where injection drugs and homosexual sex are identified as etiology. Further, this study has shown the spatial distribution and the clustering of high HIV rates in the Central region in Map 5.1. Led by a risk-chain framework surrounding the concept of vulnerability this research identified based upon a thorough literature review seven socioeconomic factors which later on were measured in eight variables. The seven socioeconomic factors are: education, wealth, health care (split into the variables access to and quality of health care), gender equality, migration, urbanity and conflict. However, statistical significant were only the variables for wealth, access to health care, gender equality and conflict. Additionally, it has been assessed that the relationship between the identified socioeconomic factors and HIV is global and stationary rather than local and non-stationary. This has been assessed by the Koenker statistics of the global model, the multiple linear regression. Additionally, the worsening of the model fit of the GWR confirmed the assessment. While all research questions were answered, the chosen socioeconomic variables were not the key variables and hence the statistical models are misspecified. In order for future research to be able to draw general conclusion, which currently is not possible due to the low model fit, recommendations on possible key variables were presented and discussed in Chapter 7.

While especially the GWR is a strong tool for policy recommendations, the low determination coefficient values of the performed analysis, refrain the author from doing

so. In regards to more detailed district-level data to be published by the Uganda Bureau of Statistics in the following years, the possibilities for more properly specified GWR models arise and should be grasped. HIV in Uganda is no longer an issue of risky sexual behavior, but of the factors driving such behaviors. Those factors need to be identified, to be able to design policy targeting not the individual's behavior but rather the root causes of the driving factors. As stated in the beginning of the research "The AIDS epidemic brought the world to its knees before bringing people to their feet." (Michel Sidibé in the GAP report, UNAIDS, 2014a). The current generation has the chance to be brought to their feet with the increasing collection on individual, social, demographic and socioeconomic data and the therewith associated chances of focusing the scare resources on an effective policy leading towards reaching the 90 – 90 – 90 target set out by the UN. It would be a shame to not see this generation rise to their feet.

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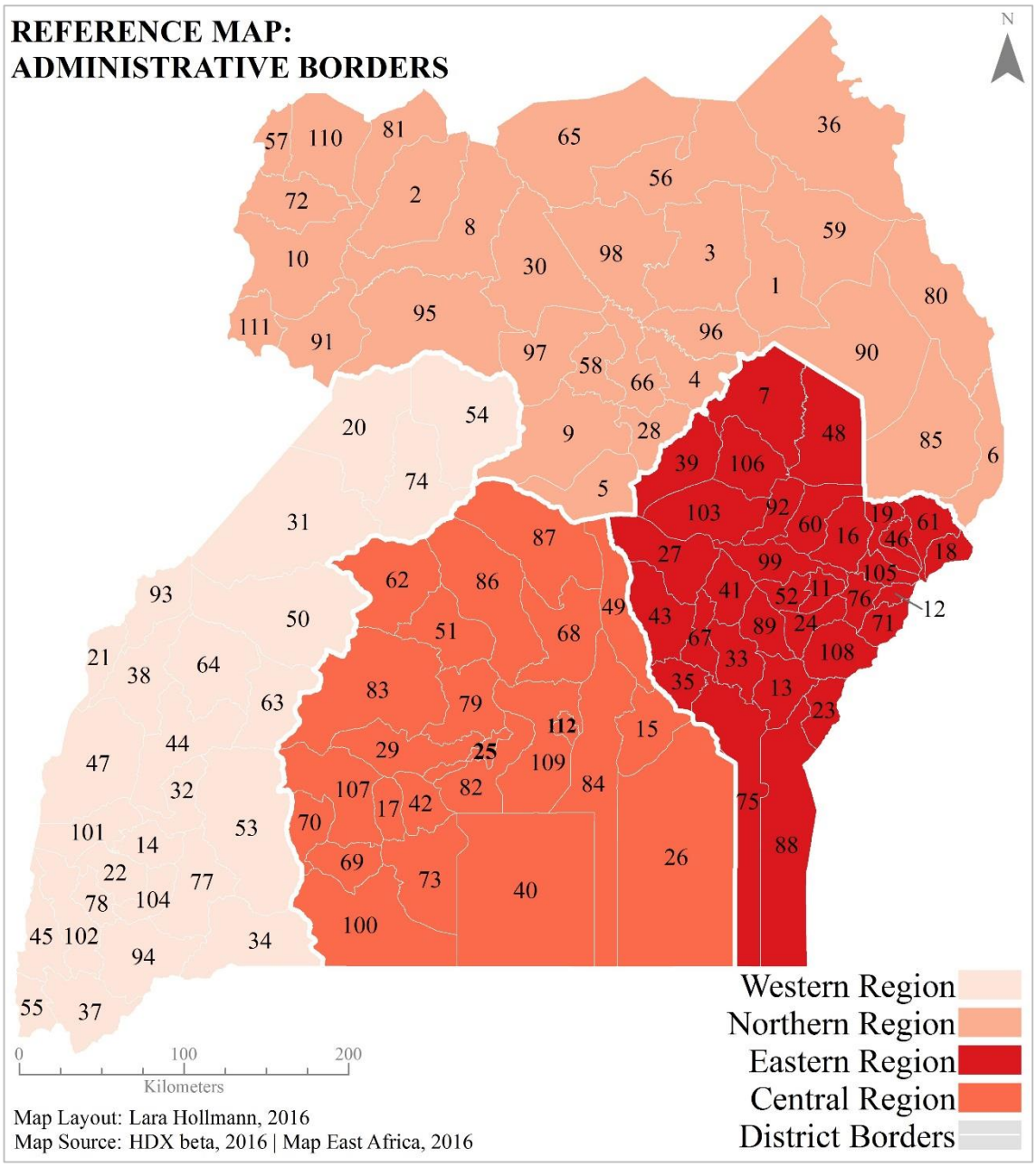
APPENDIX

APPENDIX 1 REFERENCE MAP: ADMINISTRATIVE BORDERS



NOTE: The borders display the administrative areas and do not reflect upon geographical features such as islands.

APPENDIX 2 REFERENCE TABLE

Code	District	Code	District	Code	District	Code	District
1	Abim	29	Gomba	57	Koboko	85	Nakapiripirit
2	Adjumani	30	Gulu	58	Kole	86	Nakaseke
3	Agago	31	Hoima	59	Kotido	87	Nakasongola
4	Alebtong	32	Ibanda	60	Kumi	88	Namayingo
5	Amolatar	33	Iganga	61	Kween	89	Namutumba
6	Amudat	34	Isingiro	62	Kyankwanzi	90	Napak
7	Amuria	35	Jinja	63	Kyegegwa	91	Nebbi
8	Amuru	36	Kaabong	64	Kyenjojo	92	Ngora
9	Apac	37	Kabale	65	Lamwo	93	Ntoroko
10	Arua	38	Kabarole	66	Lira	94	Ntungamo
11	Budaka	39	Kaberamaido	67	Luuka	95	Nwoya
12	Bududa	40	Kalangala	68	Luwero	96	Otuke
13	Bugiri	41	Kaliro	69	Lwengo	97	Oyam
14	Buhweju	42	Kalungu	70	Lyantonde	98	Pader
15	Buikwe	43	Kamuli	71	Manafwa	99	Pallisa
16	Bukedea	44	Kamwenge	72	Maracha	100	Rakai
17	Bukomansimbi	45	Kanungu	73	Masaka	101	Rubirizi
18	Bukwo	46	Kapchorwa	74	Masindi	102	Rukungiri
19	Bulambuli	47	Kasese	75	Mayuge	103	Serere
20	Buliisa	48	Katakwi	76	Mbale	104	Sheema
21	Bundibugyo	49	Kayunga	77	Mbarara	105	Sironko
22	Bushenyi	50	Kibaale	78	Mitooma	106	Soroti
23	Busia	51	Kiboga	79	Mityana	107	Ssembabule
24	Butaleja	52	Kibuku	80	Moroto	108	Tororo
25	Butambala	53	Kiruhura	81	Moyo	109	Wakiso
26	Buvuma	54	Kiryandongo	82	Mpigi	110	Yumbe
27	Buyende	55	Kisoro	83	Mubende	111	Zombo
28	Dokolo	56	Kitgum	84	Mukono	112	Kampala

APPENDIX 3 DATASET: DEPENDENT AND INDEPENDENT VARIABLES

			EDUCATION	WEALTH	HEALTH CARE		GENDER EQUALITY	MIGRATION	URBANITY	CONFLICT
Code	**District**	**HIV prevalence (15+ years old)***	**Secondary Education Student Teacher Ratio**	**Weighted composite score for wealth***	**Health Facilities per 10000 population***	**Pregnant women receiving 4 ANC**	**Female secondary GER**	**Households receiving remittances (in %)**	**Urbanization (Lg10)***	**Conflict (merged dummy)**
1	Abim	1,575	30	3,805	1,760	67	42	9,5	1,201	0
2	Adjumani	2,841	21	4,302	1,465	19	6	14,6	1,253	1
3	Agago	4,829	28	3,818	1,449	41	7	5,9	1,104	1
4	Alebtong	3,384	18	3,485	0,791	24	10	7,4	0,462	0
5	Amolatar	3,330	20	3,806	0,815	22	17	7,1	1,167	0
6	Amudat	0,737	15	3,613	0,756	7	1	13,9	1,045	1
7	Amuria	3,691	25	3,648	1,403	12	11	7,2	0,806	0
8	Amuru	3,696	21	4,064	1,714	33	11	12,8	0,699	1
9	Apac	3,527	22	3,656	0,868	21	9	12,4	0,785	0
10	Arua	2,813	17	4,255	0,908	39	18	22,6	0,898	1
11	Budaka	1,301	28	3,472	0,915	37	43	9	1,061	1
12	Bududa	1,713	33	3,732	0,761	17	20	37,8	0,820	0
13	Bugiri	2,481	26	3,985	1,306	19	20	22,9	1,225	0
14	Buhweju	3,976	13	3,747	1,408	21	18	20,1	0,380	0
15	Buikwe	5,204	22	5,140	0,781	29	31	12,2	1,693	0
16	Bukedea	1,473	28	3,557	0,982	20	28	13	0,732	0
17	Bukomansimbi	6,604	29	3,851	0,859	23	27	10,5	0,929	0
18	Bukwo	0,492	29	3,961	1,791	27	50	9,8	1,130	1
19	Bulambuli	1,719	31	3,718	1,203	21	41	22,6	0,987	0
20	Buliisa	2,563	24	4,299	0,619	29	16	6,3	0,806	0
21	Bundibugyo	4,055	23	4,438	1,114	19	8	5,5	1,201	0
22	Bushenyi	5,119	20	4,629	1,536	53	47	9,6	1,310	0
23	Busia	3,708	28	4,601	1,050	25	34	14,2	1,228	0
24	Butaleja	1,556	26	3,620	1,024	27	29	12,6	1,134	0
25	Butambala	7,438	19	4,532	2,380	29	26	11,6	1,179	0
26	Buvuma	3,782	12	4,979	1,224	17	8	10,6	1,045	0
27	Buyende	2,291	31	3,619	0,712	29	25	18,9	0,857	0

			EDUCATION	WEALTH	HEALTH CARE		GENDER EQUALITY	MIGRATION	URBANITY	CONFLICT
Code	District	HIV prevalence (15+ years old)*	Secondary Education Student Teacher Ratio	Weighted composite score for wealth*	Health Facilities per 10000 population*	Pregnant women receiving 4 ANC	Female secondary GER	Households receiving remittances (in %)	Urbanization (Lg10)*	Conflict (merged dummy)
28	Dokolo	2,895	21	3,558	0,928	40	11	16,4	1,041	0
29	Gomba	6,878	18	3,961	1,188	20	22	9,2	0,892	0
30	Gulu	4,584	19	5,090	1,673	42	25	23,8	1,535	1
31	Hoima	3,141	25	4,312	0,942	37	23	6,5	1,267	0
32	Ibanda	3,766	19	4,147	1,803	24	40	23	1,413	0
33	Iganga	2,578	26	4,656	1,131	25	44	27,7	1,265	0
34	Isingiro	4,112	17	3,854	1,295	49	19	9,9	1,057	1
35	Jinja	4,669	27	6,107	2,398	41	43	31,5	1,563	0
36	Kaabong	4,408	27	3,438	2,204	18	2	23	0,839	1
37	Kabale	3,218	19	3,905	2,631	40	35	7,7	1,158	0
38	Kabarole	6,180	27	4,482	1,279	53	38	10,7	1,415	0
39	Kaberamaido	2,325	24	3,596	0,930	23	21	27,6	0,279	0
40	Kalangala	7,920	12	6,425	2,026	41	9	15,2	0,964	0
41	Kaliro	1,821	37	3,644	0,889	33	44	24,6	0,851	0
42	Kalungu	7,095	21	4,463	1,310	38	64	19,1	0,643	0
43	Kamuli	2,468	28	3,962	1,110	35	33	29,3	1,090	0
44	Kamwenge	3,137	22	3,805	0,917	53	20	13,8	0,740	0
45	Kanungu	4,363	21	3,826	1,864	37	35	7,3	1,307	0
46	Kapchorwa	1,996	27	4,194	1,901	19	52	36,8	1,107	1
47	Kasese	3,597	19	4,486	1,540	36	23	9,6	1,241	0
48	Katakwi	3,730	27	3,710	1,624	22	14	28,4	0,748	1
49	Kayunga	2,989	21	4,184	0,652	32	37	24,6	0,869	0
50	Kibaale	2,802	20	3,809	0,662	32	19	16,3	0,898	0
51	Kiboga	3,579	18	4,468	2,699	44	27	11,7	1,354	0
52	Kibuku	0,990	20	3,444	0,841	17	31	14,9	0,934	0
53	Kiruhura	3,962	19	4,301	1,189	53	14	22,2	0,978	0
54	Kiryandongo	3,118	23	4,217	0,826	18	19	17,8	1,320	0
55	Kisoro	2,769	21	3,593	1,242	40	23	10,2	0,954	0

			EDUCATION	WEALTH	HEALTH CARE		GENDER EQUALITY	MIGRATION	URBANITY	CONFLICT
Code	**District**	**HIV prevalence (15+ years old)***	**Secondary Education Student Teacher Ratio**	**Weighted composite score for wealth***	**Health Facilities per 10000 population***	**Pregnant women receiving 4 ANC**	**Female secondary GER**	**Households receiving remittances (in %)**	**Urbanization (Lg10)***	**Conflict (merged dummy)**
56	Kitgum	4,901	32	4,229	1,078	30	26	24,4	1,568	1
57	Koboko	1,889	17	4,840	0,726	22	12	24,7	1,447	1
58	Kole	3,593	19	3,642	0,460	18	15	9,3	0,568	0
59	Kotido	1,988	37	3,543	1,049	24	6	31,2	0,886	0
60	Kumi	1,421	23	4,012	1,003	49	17	29,5	1,185	0
61	Kween	1,281	26	3,538	2,349	12	42	14,7	0,839	1
62	Kyankwanzi	7,918	15	4,021	0,978	22	14	11,2	1,057	0
63	Kyegegwa	2,343	19	3,906	0,533	55	20	17,4	0,968	0
64	Kyenjojo	4,500	24	3,892	0,616	79	19	17,4	1,188	0
65	Lamwo	5,358	37	3,707	1,712	34	5	18,1	1,210	1
66	Lira	4,166	23	4,994	0,711	31	27	6,6	1,394	0
67	Luuka	2,479	26	3,719	1,176	12	38	9,7	0,633	0
68	Luwero	3,939	21	4,901	1,422	79	54	20,6	1,320	0
69	Lwengo	6,910	22	4,237	1,382	30	26	28,6	1,193	0
70	Lyantonde	4,800	20	5,071	2,987	48	33	24,2	1,167	0
71	Manafwa	1,922	29	3,750	0,650	15	30	28,6	1,161	0
72	Maracha	2,471	16	3,624	0,752	39	12	4,2	0,699	0
73	Masaka	6,397	18	6,063	1,077	38	38	22,6	1,542	0
74	Masindi	3,779	24	4,562	1,477	36	22	23,7	1,511	0
75	Mayuge	3,804	28	4,122	0,888	23	26	12,5	0,851	0
76	Mbale	1,902	25	5,802	0,961	30	60	30,7	1,401	1
77	Mbarara	5,713	19	5,806	1,227	41	33	14,2	1,616	0
78	Mitooma	4,252	22	3,746	1,199	31	39	8,5	0,792	0
79	Mityana	6,080	20	4,696	1,611	36	39	19,5	1,517	0
80	Moroto	2,900	19	4,291	1,450	36	6	29,2	1,137	1
81	Moyo	4,172	21	4,054	2,949	11	6	9,1	0,881	1
82	Mpigi	6,386	15	4,679	1,317	54	45	24,3	1,238	0
83	Mubende	4,238	24	4,237	1,038	31	22	21,2	1,215	0

			EDUCATION	WEALTH	HEALTH CARE		GENDER EQUALITY	MIGRATION	URBANITY	CONFLICT
Code	**District**	**HIV prevalence (15+ years old)***	**Secondary Education Student Teacher Ratio**	**Weighted composite score for wealth***	**Health Facilities per 10000 population***	**Pregnant women receiving 4 ANC**	**Female secondary GER**	**Households receiving remittances (in %)**	**Urbanization (Lg10)***	**Conflict (merged dummy)**
84	Mukono	4,524	20	6,035	0,754	25	41	25,9	1,436	0
85	Nakapiripirit	1,149	25	3,687	1,276	33	4	23,3	0,380	1
86	Nakaseke	4,053	18	4,516	1,216	33	32	20,5	1,301	0
87	Nakasongola	4,841	23	4,434	1,815	45	42	21,1	1,017	0
88	Namayingo	4,270	35	4,079	1,485	30	11	14,3	0,863	0
89	Namutumba	1,584	35	3,600	1,386	29	35	5,7	0,869	0
90	Napak	3,516	19	3,550	0,844	30	7	19,9	0,519	0
91	Nebbi	2,772	24	3,779	1,008	36	12	11,8	1,164	0
92	Ngora	1,902	26	3,792	0,846	34	37	8,3	1,029	0
93	Ntoroko	5,820	55	4,718	1,343	20	4	12,2	1,550	0
94	Ntungamo	3,927	21	3,983	0,847	30	33	6,5	1,097	0
95	Nwoya	2,022	20	3,691	1,273	56	24	7	1,009	0
96	Otuke	3,549	20	3,509	1,343	19	19	6,6	0,778	0
97	Oyam	3,649	22	3,661	0,756	28	9	9,2	0,681	0
98	Pader	6,180	17	3,916	1,966	25	8	11,6	0,875	0
99	Pallisa	0,879	26	3,621	0,853	20	29	22,2	0,991	0
100	Rakai	5,036	29	4,253	1,917	44	31	19,9	0,820	1
101	Rubirizi	4,259	19	3,960	1,239	34	36	8,6	1,124	0
102	Rukungiri	4,449	24	3,980	2,796	52	44	14,9	1,143	0
103	Serere	2,064	24	3,639	0,769	17	20	21	0,633	0
104	Sheema	5,788	20	4,164	1,688	35	48	8,9	1,124	0
105	Sironko	2,351	21	4,445	1,155	23	26	33,2	1,149	1
106	Soroti	2,830	25	4,646	1,044	29	38	25,6	1,223	0
107	Ssembabule	4,751	18	4,023	0,950	27	25	15,7	0,826	0
108	Tororo	2,901	26	4,322	1,431	27	36	20,1	1,146	0
109	Wakiso	2,603	19	8,653	0,516	23	41	19,8	1,772	0
110	Yumbe	1,134	23	3,796	0,578	20	7	14,4	0,857	1
111	Zombo	1,999	19	3,900	0,791	43	8	12,1	1,270	0

			EDUCATION	WEALTH	HEALTH CARE		GENDER EQUALITY	MIGRATION	URBANITY	CONFLICT
Code	**District**	**HIV prevalence (15+ years old)***	**Secondary Education Student Teacher Ratio**	**Weighted composite score for wealth***	**Health Facilities per 10000 population***	**Pregnant women receiving 4 ANC**	**Female secondary GER**	**Households receiving remittances (in %)**	**Urbanization (Lg10)***	**Conflict (merged dummy)**
112	Kampala	4,247	21	12,780	9,236	47	26	24,3	2,000	0

*rounded to 3 decimals

Source: EMIS (2013) | UBOS (2014) | UBOS (2015) | UBOS (2016) | UNAIDS (2014)

APPENDIX 4 DATASET: BASELINE DATASET 1

			HIV ESTIMATES				CONFLICT*		
Code	**District**	**Total Population**	**PLHIV (15+ years old)**	**Quality of HIV estimates**	**Urbanization (in %)**	**Total Number of Health Facilities**	**Inter-national Boundary**	**Between Districts Boundary**	**Within Districts Boundary**
1	Abim	107966	1700	uncertain	15,9	19	0	0	0
2	Adjumani	225251	6400	uncertain	17,9	33	1	1	0
3	Agago	227792	11000	uncertain	12,7	33	0	1	0
4	Alebtong	227541	7700	uncertain	2,9	18	0	0	0
5	Amolatar	147166	4900	uncertain	14,7	12	0	0	0
6	Amudat	105767	780	uncertain	11,1	8	0	1	0
7	Amuria	270928	10000	uncertain	6,4	38	0	0	0
8	Amuru	186696	6900	uncertain	5	32	1	1	0
9	Apac	368626	13000	uncertain	6,1	32	0	0	0
10	Arua	782077	22000	uncertain	7,9	71	0	1	0
11	Budaka	207597	2700	uncertain	11,5	19	0	1	0
12	Bududa	210173	3600	uncertain	6,6	16	0	0	0
13	Bugiri	382913	9500	moderately good	16,8	50	0	0	0
14	Buhweju	120720	4800	uncertain	2,4	17	0	0	0
15	Buikwe	422771	22000	moderately good	49,3	33	0	0	0
16	Bukedea	203600	3000	uncertain	5,4	20	0	0	0
17	Bukomansimbi	151413	10000	uncertain	8,5	13	0	0	0
18	Bukwo	89356	440	very uncertain	13,5	16	0	1	0
19	Bulambuli	174508	3000	uncertain	9,7	21	0	0	0

Code	District	Total Population	HIV ESTIMATES		Urbanization (in %)	Total Number of Health Facilities	CONFLICT*		
			PLHIV (15+ years old)	Quality of HIV estimates			Inter-national Boundary	Between Districts Boundary	Within Districts Boundary
20	Buliisa	113161	2900	uncertain	6,4	7	0	0	0
21	Bundibugyo	224387	9100	uncertain	15,9	25	0	0	0
22	Bushenyi	234440	12000	uncertain	20,4	36	0	0	0
23	Busia	323662	12000	uncertain	16,9	34	0	0	0
24	Butaleja	244153	3800	uncertain	13,6	25	0	0	0
25	Butambala	100840	7500	uncertain	15,1	24	0	0	0
26	Buvuma	89890	3400	uncertain	11,1	11	0	0	0
27	Buyende	323067	7400	uncertain	7,2	23	0	0	0
28	Dokolo	183093	5300	uncertain	11	17	0	0	0
29	Gomba	159922	11000	uncertain	7,8	19	0	0	0
30	Gulu	436345	20000	moderately good	34,3	73	0	1	0
31	Hoima	572986	18000	moderately good	18,5	54	0	0	0
32	Ibanda	249625	9400	uncertain	25,9	45	0	0	0
33	Iganga	504197	13000	moderately good	18,4	57	0	0	0
34	Isingiro	486360	20000	uncertain	11,4	63	1	0	1
35	Jinja	471242	22000	moderately good	36,6	113	0	0	0
36	Kaabong	167879	7400	uncertain	6,9	37	1	0	0
37	Kabale	528231	17000	uncertain	14,4	139	0	0	0
38	Kabarole	469236	29000	moderately good	26	60	0	0	0
39	Kaberamaido	215026	5000	uncertain	1,9	20	0	0	0
40	Kalangala	54293	4300	uncertain	9,2	11	0	0	0
41	Kaliro	236199	4300	uncertain	7,1	21	0	0	0
42	Kalungu	183232	13000	uncertain	4,4	24	0	0	0
43	Kamuli	486319	12000	moderately good	12,3	54	0	0	0
44	Kamwenge	414454	13000	uncertain	5,5	38	0	0	0
45	Kanungu	252144	11000	uncertain	20,3	47	0	0	0
46	Kapchorwa	105186	2100	uncertain	12,8	20	0	0	1
47	Kasese	694992	25000	moderately good	17,4	107	0	0	0
48	Katakwi	166231	6200	uncertain	5,6	27	0	1	0

Code	District	Total Population	HIV ESTIMATES		Urbanization (in %)	Total Number of Health Facilities	CONFLICT*		
			PLHIV (15+ years old)	Quality of HIV estimates			Inter-national Boundary	Between Districts Boundary	Within Districts Boundary
49	Kayunga	368062	11000	uncertain	7,4	24	0	0	0
50	Kibaale	785088	22000	moderately good	7,9	52	0	0	0
51	Kiboga	148218	10526		22,6	40	0	0	0
52	Kibuku	202033	2000	uncertain	8,6	17	0	0	0
53	Kiruhura	328077	13000	uncertain	9,5	39	0	0	0
54	Kiryandongo	266197	8300	uncertain	20,9	22	0	0	0
55	Kisoro	281705	7800	uncertain	9	35	0	0	0
56	Kitgum	204048	10000	uncertain	37	22	1	1	1
57	Koboko	206495	3900	uncertain	28	15	1	0	0
58	Kole	239327	8600	uncertain	3,7	11	0	0	0
59	Kotido	181050	3600	uncertain	7,7	19	0	0	0
60	Kumi	239268	3400	uncertain	15,3	24	0	0	0
61	Kween	93667	1200	uncertain	6,9	22	0	1	0
62	Kyankwanzi	214693	17000	uncertain	11,4	21	0	0	0
63	Kyegegwa	281637	6600	uncertain	9,3	15	0	0	0
64	Kyenjojo	422204	19000	uncertain	15,4	26	0	0	0
65	Lamwo	134379	7200	uncertain	16,2	23	1	0	0
66	Lira	408043	17000	uncertain	24,8	29	0	0	0
67	Luuka	238020	5900	uncertain	4,3	28	0	0	0
68	Luwero	456958	18000	moderately good	20,9	65	0	0	0
69	Lwengo	274953	19000	uncertain	15,6	38	0	0	0
70	Lyantonde	93753	4500	uncertain	14,7	28	0	0	0
71	Manafwa	353825	6800	moderately good	14,5	23	0	0	0
72	Maracha	186134	4600	uncertain	5	14	0	0	0
73	Masaka	297004	19000	uncertain	34,8	32	0	0	0
74	Masindi	291113	11000	uncertain	32,4	43	0	0	0
75	Mayuge	473239	18000	uncertain	7,1	42	0	0	0
76	Mbale	488960	9300	moderately good	25,2	47	0	1	1
77	Mbarara	472629	27000	uncertain	41,3	58	0	0	0

Code	District	Total Population	HIV ESTIMATES		Urbanization (in %)	Total Number of Health Facilities	CONFLICT*		
			PLHIV (15+ years old)	Quality of HIV estimates			Inter-national Boundary	Between Districts Boundary	Within Districts Boundary
78	Mitooma	183444	7800	uncertain	6,2	22	0	0	0
79	Mityana	328964	20000	uncertain	32,9	53	0	0	0
80	Moroto	103432	3000	uncertain	13,7	15	0	1	0
81	Moyo	139012	5800	uncertain	7,6	41	1	1	0
82	Mpigi	250548	16000	uncertain	17,3	33	0	0	0
83	Mubende	684337	29000	moderately good	16,4	71	0	0	0
84	Mukono	596804	27000	moderately good	27,3	45	0	0	0
85	Nakapiripirit	156690	1800	uncertain	2,4	20	0	1	0
86	Nakaseke	197369	8000	uncertain	20	24	0	0	0
87	Nakasongola	181799	8800	uncertain	10,4	33	0	0	0
88	Namayingo	215442	9200	uncertain	7,3	32	0	0	0
89	Namutumba	252562	4000	uncertain	7,4	35	0	0	0
90	Napak	142224	5000	uncertain	3,3	12	0	0	0
91	Nebbi	396794	11000	moderately good	14,6	40	0	0	0
92	Ngora	141919	2700	uncertain	10,7	12	0	0	0
93	Ntoroko	67005	3900	very uncertain	35,5	9	0	0	0
94	Ntungamo	483841	19000	uncertain	12,5	41	0	0	0
95	Nwoya	133506	2700	uncertain	10,2	17	0	0	0
96	Otuke	104254	3700	uncertain	6	14	0	0	0
97	Oyam	383644	14000	moderately good	4,8	29	0	0	0
98	Pader	178004	11000	uncertain	7,5	35	0	0	0
99	Pallisa	386890	3400	uncertain	9,8	33	0	0	0
100	Rakai	516309	26000	moderately good	6,6	99	1	0	0
101	Rubirizi	129149	5500	uncertain	13,3	16	0	0	0
102	Rukungiri	314694	14000	uncertain	13,9	88	0	0	0
103	Serere	285903	5900	uncertain	4,3	22	0	0	0
104	Sheema	207343	12000	uncertain	13,3	35	0	0	0
105	Sironko	242422	5700	uncertain	14,1	28	0	1	1
106	Soroti	296833	8400	uncertain	16,7	31	0	0	0

Code	District	Total Population	HIV ESTIMATES		Urbanization (in %)	Total Number of Health Facilities	CONFLICT*		
			PLHIV (15+ years old)	Quality of HIV estimates			Inter-national Boundary	Between Districts Boundary	Within Districts Boundary
107	Ssembabule	252597	12000	uncertain	6,7	24	0	0	0
108	Tororo	517082	15000	moderately good	14	74	0	0	0
109	Wakiso	1997418	52000	good	59,2	103	0	0	0
110	Yumbe	484822	5500	moderately good	7,2	28	1	1	0
111	Zombo	240082	4800	uncertain	18,6	19	0	0	0
112	*Kampala*	*1507080*	*64000*	*good*	*100*	*1392*	*0*	*0*	*0*

* Conflict is collected as dummy variable. “1” indicating the presence of conflict, “0” indicating the presence of no conflict
Source: UBOS (2014) | UBOS (2015) | UBOS (2016)

APPENDIX 5 DATASET: BASELINE DATASET 2

		DISTRIBUTION OF HOUSEHOLDS BY THE MAIN SOURCE OF ENERGY FOR COOKING						
Code	**District**	**Electricity**	**Gas**	**Paraffin-Stove**	**Charcoal**	**Firewood**	**Others**	**Total amount of households**
1	Abim	112	53	63	1963	15706	118	18081
2	Adjumani	348	165	211	8284	31238	465	41159
3	Agago	331	131	329	3153	38840	160	43354
4	Alebtong	378	110	222	1346	43828	121	46258
5	Amolatar	261	99	112	2706	24318	223	27983
6	Amudat	71	42	73	853	14252	137	15496
7	Amuria	323	185	124	2584	44826	228	48317
8	Amuru	475	188	284	3382	31585	160	36702
9	Apac	588	241	319	4021	65437	578	71655
10	Arua	1425	493	1152	24567	118155	663	146675
11	Budaka	326	61	117	2205	34145	201	37122
12	Bududa	486	150	234	1387	34295	112	36824
13	Bugiri	720	263	293	10383	61870	277	74511
14	Buhweju	495	131	155	892	22416	85	24845
15	Buikwe	2481	444	881	36107	56409	1046	97933
16	Bukedea	242	78	149	2150	33346	165	36304
17	Bukomansimbi	521	73	334	3118	29691	376	34335
18	Bukwo	172	94	116	736	15491	29	16638
19	Bulambuli	277	113	180	2066	31074	201	34038
20	Buliisa	146	74	134	4144	17018	136	21652
21	Bundibugyo	593	254	418	6562	36665	274	44818
22	Bushenyi	1088	332	747	6827	41827	293	51378
23	Busia	579	267	461	15734	47289	354	64788
24	Butaleja	355	130	136	2982	40348	379	44376
25	Butambala	431	53	308	4444	16184	160	21601
26	Buvuma	133	51	184	10267	13561	739	25184
27	Buyende	668	174	239	4082	55193	269	61228
28	Dokolo	210	87	178	1474	32541	110	34882
29	Gomba	619	101	269	4142	29788	296	35285
30	Gulu	966	453	685	29118	54839	448	86924
31	Hoima	1604	585	812	20954	100696	703	125554

		DISTRIBUTION OF HOUSEHOLDS BY THE MAIN SOURCE OF ENERGY FOR COOKING						
Code	**District**	**Electricity**	**Gas**	**Paraffin-Stove**	**Charcoal**	**Firewood**	**Others**	**Total amount of households**
32	Ibanda	851	248	464	6483	46141	499	55006
33	Iganga	1322	376	587	29707	69284	757	102672
34	Isingiro	1431	284	751	10377	86303	2033	101590
35	Jinja	3965	1176	877	48848	49229	816	105463
36	Kaabong	187	52	50	2017	26336	520	29210
37	Kabale	2073	429	519	13609	100102	918	117854
38	Kabarole	2272	722	1372	12058	88833	1012	107260
39	Kaberamaido	283	121	123	2080	35891	147	38797
40	Kalangala	182	45	509	11655	7225	484	20100
41	Kaliro	568	97	158	3870	37681	160	42935
42	Kalungu	742	129	635	6868	32432	444	41437
43	Kamuli	1138	329	376	12914	77791	445	93998
44	Kamwenge	1247	383	423	6356	78958	447	88686
45	Kanungu	880	201	347	4508	49306	274	55975
46	Kapchorwa	287	117	180	2456	19071	71	22334
47	Kasese	2947	526	1498	28120	103826	1233	139066
48	Katakwi	310	118	118	2019	27750	94	30766
49	Kayunga	891	172	509	14594	59197	449	76073
50	Kibaale	2178	565	748	15735	147707	758	168322
51	Kiboga	408	86	303	8086	24765	377	34072
52	Kibuku	277	60	120	1788	32869	117	35468
53	Kiruhura	830	427	592	7154	57153	583	67224
54	Kiryandongo	464	177	357	8776	41949	273	52158
55	Kisoro	1099	192	248	4342	54543	1533	62247
56	Kitgum	369	132	233	7282	31289	309	39688
57	Koboko	293	176	264	7656	21442	277	30290
58	Kole	447	182	292	1169	45907	178	48426
59	Kotido	247	45	54	2640	22487	349	26170
60	Kumi	460	218	213	3668	35767	192	40804
61	Kween	152	61	90	585	16393	47	17852
62	Kyankwanzi	448	133	263	7075	39407	385	47771
63	Kyegegwa	754	308	199	5068	53331	302	60061

		DISTRIBUTION OF HOUSEHOLDS BY THE MAIN SOURCE OF ENERGY FOR COOKING						
Code	**District**	**Electricity**	**Gas**	**Paraffin-Stove**	**Charcoal**	**Firewood**	**Others**	**Total amount of households**
64	Kyenjojo	1327	427	575	5961	82572	574	91534
65	Lamwo	165	96	191	1053	25346	137	27251
66	Lira	1208	460	710	28611	56352	1091	89133
67	Luuka	552	119	163	4294	38733	197	44371
68	Luwero	3105	455	1074	31732	67861	784	105346
69	Lwengo	1028	177	592	10322	49014	446	61800
70	Lyantonde	284	120	337	4941	14641	160	20639
71	Manafwa	670	241	571	3582	66740	588	72903
72	Maracha	305	120	218	1054	34290	97	36263
73	Masaka	2927	536	2160	27166	41617	945	75765
74	Masindi	2083	283	652	14199	47046	288	64935
75	Mayuge	1358	358	471	16609	73675	737	95307
76	Mbale	2771	1348	1342	35249	63931	823	108538
77	Mbarara	3786	1152	2250	33677	69924	1439	112849
78	Mitooma	747	144	296	1946	36237	327	39816
79	Mityana	1427	383	757	19125	57360	744	80087
80	Moroto	375	135	77	3848	17044	286	22091
81	Moyo	146	40	170	4525	20690	170	25872
82	Mpigi	1008	269	635	14621	42417	646	60521
83	Mubende	2681	619	976	25155	120675	841	151277
84	Mukono	3349	1464	1940	59563	76018	1383	144632
85	Nakapiripirit	199	80	130	1560	23088	260	25400
86	Nakaseke	807	170	401	9428	31922	328	43315
87	Nakasongola	937	144	318	7695	26558	394	36378
88	Namayingo	229	154	235	6500	34837	509	42970
89	Namutumba	447	95	137	3845	40327	188	45323
90	Napak	196	84	73	1736	23905	403	26857
91	Nebbi	428	249	510	6497	66896	251	77397
92	Ngora	226	118	100	1420	21246	98	23648
93	Ntoroko	134	63	113	3771	9445	392	13942
94	Ntungamo	1385	420	623	11392	85832	1750	101796
95	Nwoya	132	74	77	2233	23520	63	26230

		DISTRIBUTION OF HOUSEHOLDS BY THE MAIN SOURCE OF ENERGY FOR COOKING						
Code	**District**	**Electricity**	**Gas**	**Paraffin-Stove**	**Charcoal**	**Firewood**	**Others**	**Total amount of households**
96	Otuke	272	48	94	1029	20360	98	21955
97	Oyam	668	244	561	2962	70437	378	76493
98	Pader	302	96	277	3989	28206	156	34160
99	Pallisa	617	205	288	3528	60270	202	65764
100	Rakai	1713	431	1302	15751	95817	916	116492
101	Rubirizi	395	74	265	3090	24618	172	28789
102	Rukungiri	1135	302	491	6437	60244	439	69497
103	Serere	492	170	210	2634	43079	238	47676
104	Sheema	732	201	512	4914	38583	797	46050
105	Sironko	698	512	553	3944	47516	239	55026
106	Soroti	883	293	382	13023	39591	475	54946
107	Ssembabule	847	189	486	6798	45046	319	55185
108	Tororo	1518	725	868	11816	83963	426	102634
109	Wakiso	22292	10706	13714	342921	99136	4723	502089
110	Yumbe	475	275	339	4801	55056	255	63362
111	Zombo	383	265	331	3430	44662	165	50869
112	*Kampala*	*33792*	*22802*	*17947*	*321686*	*10612*	*7726*	*416094*

Source: UBOS (2016)