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Examining the Influence of Economic and Political Factors Upon Access to Improved Water and Sanitation in Select African Nations, 2005-2008

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Dlorah Jenkins

Examining the influence of economic and political factors upon access to improved water and sanitation in select African nations, 2005-2008 (Under the direction of Dr. Christine Stauber, Faculty Member)

ABSTRACT

Today, 884 million people worldwide lack access to safe drinking water, and 2.6 billion are without access to improved sanitation facilities. The majority of this burden falls upon citizens of the developing world, wherein nearly 1.2 billion live without any form of sanitation, and one-fifth live without access to safe water sources. Target 3 of the Environmental Sustainability Millennium Development Goal (Goal 7) is to “Halve, by 2015, the proportion of the population without sustainable access to safe drinking water and basic sanitation”. While many nations are on track towards meeting this goal, progress in many developing nations is severely lacking, particularly in sub-Saharan Africa.

The purpose of this study was to determine what influence political and economic factors have upon the availability of improved water and sanitation services in developing nations, with a focus on sub-Saharan Africa. This study addressed the following research questions:

- What is the current availability of improved water and sanitation resources in sub-Saharan Africa?
- Do political factors, specifically political stability (PS) and government effectiveness (GE), have an impact upon the availability of improved water and sanitation resources in sub-Saharan Africa?
- Is gross national income (GNI) associated with the availability of improved water and sanitation resources?
- Is there a disparity in access to water and sanitation resources in urban and rural settings?

Data from the Demographic and Health Surveys of 11 sub-Saharan African nations conducted from 2005-2008 were analyzed using SPSS 18.0. Five WASH-related dependent variables were examined: access to an improved water source, travel time to water source, household water treatment, access to an improved sanitation facility, and shared sanitation facilities. Frequencies were produced for the dependent variables and reported as percentages. Odds ratios were produced by logistic regression analyses to examine the association between continuous independent variables (PS, GE and GNI) and dichotomous dependent variables. Crosstabulated odds ratios were also produced for dichotomous independent variables and dichotomous dependent variables. Chi-square analyses were performed to explore the discrepancies between observed and expected proportions of private and shared sanitation facilities, taking into account the large portion of the population with no sanitation facility at all.

A total of 109,606 observations were included in this study. While the majority of the study population had access to the improved drinking water sources (65.9%) and travel times < 30 minutes (83.3%), most did not use any form of household water treatment (81.1%) and did not have an improved sanitation facility (64.1%). Rural residents were found to have generally less access to improved water/sanitation than urban residents. Overall, the strength and direction of the association between economic/political factors and the five WASH-related outcome variables varied. GE and GNI had the strongest positive associations with access to improved water source and household water treatment. GNI was also positively associated with access to an improved sanitation facility. Political stability was found to have the most influence upon travel time to water source. These associations also varied between rural and urban settings.

The results of this study indicate that GNI, political stability, and government effectiveness have an impact upon water and sanitation in sub-Saharan Africa. Disparities in the availability of improved WASH-related resources in urban and rural settings were also highlighted. With this information, context-specific interventions to improve and expand water and sanitation utilities/facilities in the region can be developed, focusing on building more stable, effective governments, and alleviating the burden of poverty, improving the general health and quality of life for the people.

EXAMINING THE INFLUENCE OF ECONOMIC AND POLITICAL FACTORS UPON
ACCESS TO IMPROVED WATER AND SANITATION IN SELECT AFRICAN NATIONS,
2005-2008

By DLORAH JENKINS

B.S. Science, Technology, and Culture

A Thesis Submitted to the Graduate Faculty of Georgia State University in Partial Fulfillment of
the Requirements for the Degree

Master of Public Health

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CHAPTER I INTRODUCTION

1.1 Background

At the UN Millennium Summit in 2000, 189 nations adopted eight Millennium Development Goals (MDGs) in response to the world's greatest challenges to development. These goals, to be achieved by 2015, are:

- Goal 1: Eradicate extreme poverty and hunger
- Goal 2: Achieve universal primary education
- Goal 3: Promote gender equality and empower women
- Goal 4: Reduce child mortality
- Goal 5: Improve maternal health
- Goal 6: Combat HIV/AIDS, malaria and other diseases
- Goal 7: Ensure environmental sustainability
- Goal 8: Develop a Global Partnership for Development

Under each goal, there are specific targets and quantifiable indicators used to measure progress (United Nations [UN] 2008a). Target 3 of Goal 7 is to “reduce by half the proportion of people without sustainable access to safe drinking water and basic sanitation .” This target is measured by two indicators: the proportion of the world's population using an improved drinking water source and the proportion of the population using an improved sanitation facility. While most nations are on track towards meeting this target, progress in many developing nations is severely lacking.

Today, 884 million people worldwide lack access to clean drinking water, and even more, 2.6 billion, are without access to an improved sanitation facilities (WHO/UNICEF 2010). The majority of this burden falls upon citizens of the developing

world, wherein nearly 1.2 billion live without any form of sanitation, and one-fifth live without access to safe water sources (Lenton et al. 2005; WHO/UNICEF 2008b). The United Nations has described the situation as “a silent humanitarian crisis that each day takes thousands of lives, robs the poor of their health, thwarts progress towards gender equality, and hamstring economic development” (Lenton et al. 2005).

The World Health Organization has coined the years spanning from 2005 to 2015 the “decade of water”, and though some progress has been made in providing water and sanitation resources in developing nations, some regions, particularly Southeast Asia and sub-Saharan Africa are far from reaching their regional targets. For instance, in order to meet the 2015 goal of a 63% coverage rate, access to safe water sources would have to be provided to 359 million people in sub-Saharan Africa and 363 million would have to be provided with improved sanitation facilities (Lenton et al. 2005). Currently, 40% of the population in sub-Saharan Africa is without improved water resources, and 69% are without improved sanitation services (WHO/UNICEF 2010).

1.2 Purpose of Study

The purpose of this study is to determine how political and economic factors influence the availability of improved water and sanitation services in developing nations, with a focus on sub-Saharan Africa (SSA). Exploring the influence of political and economic factors upon the availability of such basic public health services is important in order to develop innovative approaches to addressing this issue. Gaining a better understanding of the impact of economic and political factors upon the availability of water and sanitation services will allow interventions to be tailored to fit the specific

needs and conditions of sub-Saharan Africa, at the regional, national, and local levels (Montgomery 2007; Lenton et al. 2005).

1.3 Research Questions

This study will attempt to determine the influence of economic and political factors, specifically gross national income (GNI), government effectiveness, and political stability, upon access to improved water and sanitation services in sub-Saharan African.

To this end, this study will address the following research questions:

- What is the current availability of improved water and sanitation resources in sub-Saharan Africa?
- Do political factors, specifically political stability and government effectiveness, have an impact upon the availability of improved water and sanitation resources in sub-Saharan Africa?
- Is gross national income associated with the availability of improved water and sanitation resources?
- Is there a disparity in access to water and sanitation resources in urban and rural settings?

CHAPTER II REVIEW OF THE LITERATURE

The purpose of this study was to determine the impact of economic and political factors upon the availability of improved water and sanitation services to citizens in developing nations, focusing on select nations within sub-Saharan Africa. With this knowledge, context-specific interventions can be developed to address water and sanitation issues in the most affected parts of the world. Lack of water and sanitation services in the region is an issue of great gravity and severity. According to the most recent progress report published by the Joint Monitoring Programme, (WHO/UNICEF 2010), the worldwide sanitation coverage rate increased from 54% to 61% from 1990 to 2008. Similarly, from 1990 to 2008, global improved drinking water coverage increased from 77% to 87% (WHO/UNICEF 2010).

However, the developing world, including sub-Saharan Africa continues to lag behind industrialized nations in their progress towards meeting the water and sanitation related MDGS (WHO/UNICEF 2008b, WHO/UNICEF 2010). Current and projected estimates of the proportions of the SSA population without access to improved water and sanitation are shown in Figure 2.1. With the current rate of change, sub-Saharan Africa is not in position to reach its MDG targets.

Sub-Saharan Africa accounts for about one-third of the world's population without access to improved drinking water supplies (UN 2008b). As recently as 2006, the region accounted for three-quarters of the 54 countries globally where less than half

of the population used an improved sanitation facility (UN 2008b). Additionally, eight of the nine countries identified as “high-need” in terms of improved water are in Sub-Saharan Africa, while 13 of the 15 nations identified as high-need in terms of sanitation services are also in Sub-Saharan Africa. The nations were classified by the Joint Monitoring Programme as high-need due to their low (below 50%) coverage rates, and elevated (20-40%) rates of diarrhoeal disease (Lenton et al. 2005).

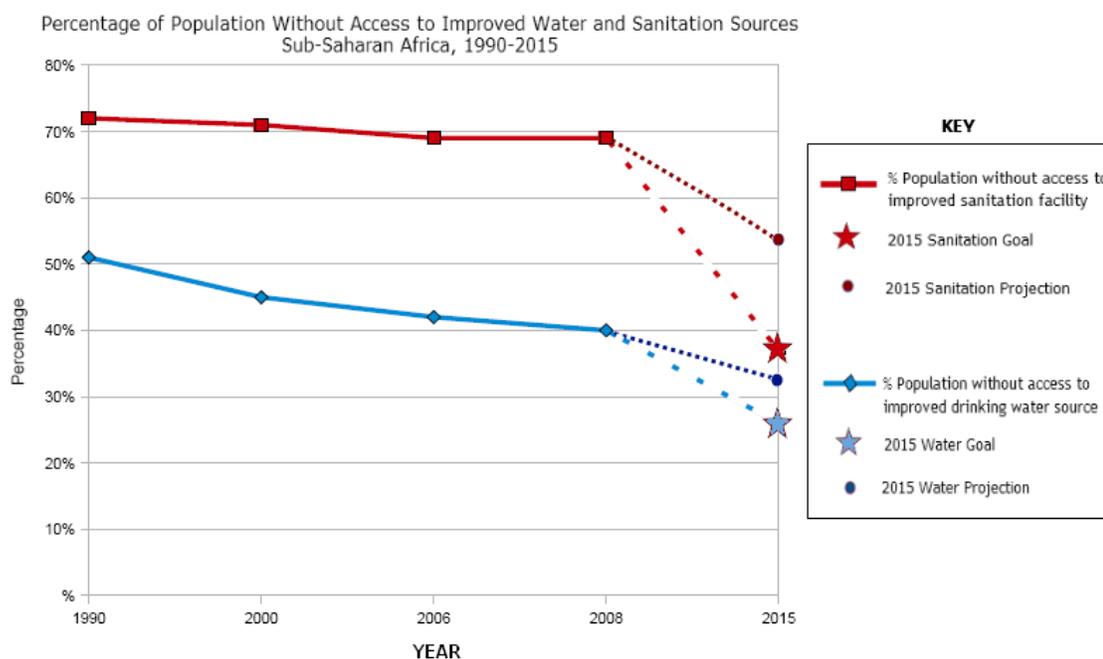


Figure 2.1 Current and Projected Proportion of sub-Saharan African Population without Access to Improved Water and Sanitation (World Bank 2010)

2.1 Sub-Saharan Africa: An Overview

Sub-Saharan Africa is the region consisting of 34 nations that lie south of the Sahara desert (Figure 2.2). General demographic information for the region is displayed Table 2.1.



Figure 2.2 Map of sub-Saharan Africa (WHO/UNICEF 2008b)

Population (2008)	817,956,997
Population Growth (2008)	2%
Life Expectancy at Birth (2007)	52 years
Fertility Rate (2007)	5 births per woman
Under 5 Mortality Rate, per 1,000 (2007)	146
GNI per capita, current USD (2008)	\$1,082
Proportion of the population living on \$1 or less per day (2008)	51%

Table 2.1 Demographic Information, Sub-Saharan Africa, 2007-2008 (World Bank, 2010a)

Research has shown that many civilizations including the ancient Egyptians, Kushites and Meroitics inhabited the area now identified as the Nile River Valley, which stretches from Lake Victoria in Uganda to the Mediterranean Sea (BBC 2000). These civilizations, particularly the Egyptians, created complex irrigation systems that utilized the flooding of the Nile River to their agricultural advantage, flourishing in the region for many centuries (BBC 2000). With the development of trans-Saharan trade routes and the discovery of fertile areas in central Africa, prosperous kingdoms were also established outside of the Nile River Valley, including the kingdoms of Ghana, Mali, Benin, Zimbabwe, and Asante (BBC 2000).

These ancient kingdoms each had their own governments with established infrastructure and laws. In general, public health was the responsibility of the ruling elite class, comprised mainly of chiefs, kings, and priests (Njoh 2009). Water, sanitation, and hygiene (WASH) issues were assigned high priority, and it was common practice for rulers to schedule and assign responsibility for WASH-related tasks such as communal cleanups and protecting and assuring the cleanliness of water sources (Njoh 2009). Open defecation and dumping waste in lakes and rivers was deemed criminal behavior in many kingdoms and some kingdoms, for example, the Kingdom of Asante, established units to enforce sanitation and hygiene practices to protect public health. These units were responsible for enforcing such practices as the daily collection and burning of trash in designated areas (Njoh 2009).

Colonial era Africa is distinctly different from pre-colonial Africa. In the 19th century, Africa experienced many changes due to disease outbreaks, drought, famine, and

interkingdom wars (Njoh 2009). Towards the end of the century, various European nations including Great Britain, Spain, France, Italy, and Portugal entered and claimed control of African nations, overthrowing African rulers and restructuring societies (BBC 2000). Beginning in the late 19th century and continuing into the 20th century, settlement laws were put in place that enforced racial residential segregation (Njoh 2009). Due to preconditions such as language, building material requirements and cost, indigenous Africans were forced to move outside of the urban areas, separating them from White colonists (Njoh 2009). Colonists viewed Africans as disease vectors and built indigenous communities at considerable distance from colonist establishments (Njoh 2009). The designated African communities were not furnished with adequate sanitation facilities to serve the population. For example, Ndola, an indigenous community in Zimbabwe, had a population of 4,000 people (Njoh 2009), however, they were provided with only 1,700 mud huts, 50 pit latrines, and were void of any other type of sanitary facility (Njoh 2009). This type of rule and racial segregation persisted for many decades until Africans began to demand their independence after the second World War (Njoh 2009).

Fighting between Africans and Europeans over African nations' rights to independence were violent and destroyed the infrastructure of both the countries involved and their neighbors (BBC 2000). Excluding Ethiopia, Liberia, and Egypt, which all gained their independence prior to WWII, the independence of African nations began in the 1950's and continued until as recently as 1990, when Namibia finally gained their independence (BBC 2000).

However, it was soon clear that gaining economic independence would be more

difficult than gaining political independence. As mentioned previously, drought and famine had devastated the agriculture sector (BBC 2000) and in other areas, war and political instability both created and resulted from stagnate economic conditions. At times, many African currencies could not even be converted to Western currencies (BBC 2000).

Beginning in the 1960s, International Monetary Fund (IMF) Structural Adjustment Programs were constituted to promote free trade and capitalism throughout Africa (Njoh 2009). Under SAPs, developing nations were forced to curb government spending and to relinquish control of the private sector. These policies effectively cut funding for essential infrastructure such as agriculture, education, health, and utilities (Njoh 2009). Such interventions seem to have hurt many African nations more than they helped, and have contributed to the continuing economic crises, poverty, and political instability that has historically marred many African nations (Njoh 2009; BBC 2000).

Today, the region is still feeling the effects of failed economic policies and political regimes. Over 388 million people, or about 51% of the region's population, live on under \$1 per day (UNSTATS). Some countries bear this burden more than others – in Liberia, for example, 84% of the population lives on under \$1 per day (UNSTATS). The average gross national income in 2008 was \$1,082 USD, much lower than the world average of \$8,613 USD (World Bank 2010a). In 2007, the total debt of sub-Saharan Africa was equal to 5% of its total income and goods/services exports (World Bank 2010a). This represents a significant improvement from 1990 when the region's debt proportion was 13.7%, just below the sustainability threshold of 15-20% (USAID 2003).

This improvement is due in large part to Highly Indebted Poor Country (HIPC) Initiative and the Multilateral Debt Relief Initiative (MDRI) implemented by the IMF and World Bank (USAID 2003). The HIPC distributed \$45.5 billion in debt relief to 29 nations in the region and an additional \$18.3 billion was distributed under the MDRI (USAID 2003). While these initiatives helped to relieve the burden of debt upon many nations in region, these benefits have yet to trickle down to the household level, and poverty is still a serious issue for the majority of the sub-Saharan African population (Ong'ayo 2008).

Extreme poverty and economic burdens have contributed to political instability and conflict in the region (Collier 2002). While conflict in other developing regions has decreased over the years, Sub-Saharan Africa has experienced a rising trend, largely due to its extremely poor economic performance (Collier 2002). In 2000, civil war and conflict were estimated to have caused 310,000 deaths worldwide, with over half of these deaths occurring in sub-Saharan Africa (Murray 2002). According to the Global Peace Index, which offers a numerical measure of internal and external peace for 144 nations worldwide, five out of ten of the least peaceful nations are in sub-Saharan Africa (Institute for Economics and Peace [IEP] 2009).

Governance influences political stability so far as it creates conditions under which conflict is either occurs regularly or is highly discouraged (Marshall and Cole 2009). The majority of the governments in sub-Saharan Africa are either partial democracies or anocracies. Partial democracies are weaker than the democracies exemplified by the United States and other developed nations, and are characterized by weaker checks and balances systems and restrictions on political participation. Partial

democracies are also often unable to fully apply the rule of law to opposition groups , which can lead to political instability and fragile states (Marshall and Cole 2009).

Anocratic governments are neither fully democratic nor autocratic. They are a middling mixture of the two, and are often unorganized and unstable. Anocracies lack the capacity to perform government tasks, and are particularly vulnerable to political conflict including coups d'etat and outbreaks of armed conflict (Marshall and Cole 2009).

Economic development, political stability, and governance are fundamental societal dimensions, and they interact to create national environments that either promote or hinder population health (Marshall and Cole 2009). In sub-Saharan Africa, it seems that failures in these areas have contributed to poor health outcomes, and this study seeks to quantify the influence of these factors upon important WASH-related factors.

2.2 Government Influence on Public Services

Governance is defined as a dynamic system that “consists of the traditions and institutions by which authority in a country is exercised. This includes the process by which governments are selected, monitored and replaced; the capacity of the government to effectively formulate and implement sound policies; and the respect of citizens and the state for the institutions that govern economic and social interactions among them.” (World Bank 2008). To be effective, any interventions to improve water and sanitation resources in developing countries must be context-specific, meaning that among other considerations, the governance of the region and/country must be taken into account (Lenton et al. 2005). As health, education, water, and electricity services are mainly established and funded at the state level, it makes sense to assume that when governments

do not run well, they are unable to provide satisfactory public services (Fry et al. 2008). On the other hand, the more stable a government is at the basic level, the stronger its foundation for providing good public services, such as water and sanitation (World Bank 2004). By providing and regulating such services, governments yield responsibility over the health of their citizens (World Bank 2004).

Because government is responsible for the management of these services, it directly and indirectly impacts human development via the reduction of disease and the promotion of economic growth (World Bank 2004). However, in many developing countries, people have trouble getting prompt, efficient service from the public administration, thus limiting their access to basic services (World Bank 2001). This is due in large part to the fact that public services are many times vulnerable to “patronage politics”, the reward of state resources in exchange for electoral support (World Bank 2001). Under these circumstances, providers of public services become more accountable to governments and policymakers than to the public they serve, which leaves citizens susceptible to the needs and desires of the ruling/upper classes. The needs of the general population are ignored, and public resources are diverted from important infrastructure investments that have the potential to benefit the entire population. Instead, resources are poured into investments that are lucrative for the “higher-ups”, for example, defense contracts (World Bank 2001). It is under such conditions of corruption and governmental irresponsibility that we witness the highest levels of poverty, lack of education, and lack of access to public health services (World Bank 2001).

Governments can promote the health of their citizens in many ways including

boosting economic growth, increasing spending on essential health services, and implementing appropriate technical interventions (World Bank 2004). However, if government fails to develop services that are egalitarian and efficient, any steps forward will not be sustained (World Bank 2004). Developing effective public services, such as water and sanitation, requires policymakers to support citizens in the pursuit of access to these services, and ensuring the quality of the services once established (World Bank 2004).

To gain perspective on how governments function around the world, the World Bank Institute, along with support from the Brookings Institution, began the World Governance Indicators (WGI) project in 1996. The WGI utilizes 35 different data sources in addition to the opinions of thousands of experts from the private, public, and NGO sectors (World Bank 2009) to measure six governance indicators: Voice and Accountability, Political Stability and Absence of Violence, Government Effectiveness, Regulatory Quality, Rule of Law, and Control of Corruption.

The government effectiveness (GE) indicator “ measures the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government’s commitment to such policies.” (World Bank 2009) From 2005, an average of 10 sources were consulted to produce GE scores, and as with PS, these sources were primarily CBIPs. Sources for GE indicators included the Global E-Government Index, the World Economic Forum Global Competitiveness Survey, and the Political Risk Services International Country Risk Guide (Kauffman and Kray 2008). Table 2.2

provides examples of sources and indicators from which GE scores were derived.

Table 2.2 Example Sources and Indicators for Government Effectiveness

Source	Indicators
Global E-Government Index	<ul style="list-style-type: none"> • Global e-environment
Gallup World Poll	<ul style="list-style-type: none"> • Satisfaction with public transportation system • Satisfaction with education system
Institutional Profile Database	<ul style="list-style-type: none"> • Government-citizens relations • Quality of the supply of public goods, education, and basic health
World Economic Forum Global Competitiveness	<ul style="list-style-type: none"> • Quality of general infrastructure

2.3 Impact of Political Instability and Violent Conflict Upon Public Health

In the 1990's, 17 out of 33 of the poorest countries in the world were involved in violent conflict, mostly civil wars (World Bank 2003). According to the 2011 World Development Report, currently, “a quarter of states eligible for assistance from the International Development Association (IDA) are experiencing conflict, and poverty rates in these countries are far worse than in IDA countries as a whole.” (World Bank 2010b). In addition to the loss of human life, such conflicts also produce loss of previous gains in development and assets, and creates an environment in which future conflict is more likely (World Bank 2003).

Violent conflict creates conditions under which morbidity and mortality rise, and communicable disease can flourish (WHO 2002). Factors such as:

- Mass population movement
- Economic collapse
- Environmental destruction

- Loss of shelter
- Food scarcity
- Lack of access to health services
- Collapse of public health infrastructure
- Lack of safe water, sanitation, and waste management
- Loss of public health disease prevention/control programs

all lead to an increase in vector-borne diseases such as malaria and yellow fever, waterborne diseases (for example, typhoid and cholera), and measles and other vaccine-preventable diseases. Likewise, HIV/AIDS and tuberculosis control programs are disrupted, and increases in maternal and child mortality are often observed (O'Hare and Southall 2007; Ugalde et al. 2000; Manoncourt et al. 1992; Martins 2009).

Many conflict-affected nations have demonstrated the impact of civil conflict upon public health. In Somalia, a country that experienced ongoing civil war since 1991, the effects of conflict were seen early. For example, a 1992 study reported that from April 1991-April 1992, the crude mortality rate for children under the age of 5 in Somalia was 115.4 per 1000, compared to a pre-war rate of 67.1/1000 (Manoncourt et al. 1992). Malnutrition was the leading cause of death; malnutrition became a serious problem in Somali due to insufficient and irregular food supply (Manoncourt et al. 1992).

Additionally, insight on the impact of violent upon health can be gained from the experiences of other nations. For example, Garfield et al. (1987) published a study

describing the effects of violent conflict that began in Nicaragua in 1983. By 1987, the public health infrastructure of Nicaragua had been deeply impacted as a result of the conflict – 65 health facilities had been destroyed, leaving 10% of the nation's citizens without access to health services (Garfield et al. 1987). The number of doctors and nurses declined by 10% and 8%, respectively, from 1983-1986. Various health promotion and disease prevention programs were also affected: coverage in a supplemental feeding program for malnourished children fell from 38% in 1983 to 28% in 1985, while coverage in the program that provided postpartum care for low weight births fell from 52% to 33% in one year (1985) (Garfield et al. 1987).

In addition to deteriorating infrastructure, Garfield et al. noted an increase in disease in Nicaragua at this time, particularly malaria. During the war, malaria rates were higher in areas that suffered more direct attacks than in areas that suffered relatively few contra attacks (Garfield et al. 1987). This disparity was likely the result of rapid population movements, lack of vector control activities, and shortages of health personnel in war zones and these factors were also related to increases in dengue and leishmaniasis (Garfield et al. 1987).

From 1980 to 1992, El Salvador experienced a civil war that claimed 80,000 lives (Ugalde et al. 2000). Overall, the government health budget was reduced by almost 50% during the war and both patients and providers acknowledge a loss in the quality of care (Ugalde et al. 2000). The decline in quality of care is evidenced in a comparison of neonatal mortality rates before/during the early years of conflict and in the later years/end of conflict: from 1983-1988, the neonatal mortality rate in El Salvador was 20/1000, this

rose to 23/1000 from 1988-1993 (Ugalde et al. 2000).

In addition to the deterioration of health services, El Salvador was also burdened by rapid urban growth as a result of peasants fleeing the rural areas for refuge within cities (Ugalde et al. 2000). Cities were unable to keep pace with the rapid rate of growth and thus could not provide basic water, sanitation, and waste management services for most people (Ugalde et al. 2000). Interruptions in water service were frequent, and in 1995, only 36% of the 517 tons of garbage generated daily was collected in San Salvador (Ugalde et al. 2000). The garbage that was collected was disposed of in city dumps which contaminated rivers, lakes, reservoirs, and underground water supplies (Ugalde et al. 2000).

More recently, the increase in malaria cases in Sri Lanka has also been associated with the ongoing civil war (Reilley 2002). In Sri Lanka, a country that has experienced over 20 years of civil war, malaria has increased 20-fold since the beginning of the conflict, becoming the leading cause of death in some areas (Reilley 2002). As in Nicaragua, lack of vector control activities and access to health facilities are cited as the causes for this dramatic increase. Population displacement has also resulted in a rise in infectious diseases and malnutrition (Reilley 2002).

A study comparing 21 conflict-affected sub-Saharan nations to 21 SSA nations not recently affected by conflict found that the median under-5 mortality rate in conflict-affected nations was significantly higher than the median in non-affected nations: 197/1000 and 137/1000, respectively (O'Hare and Southall 2007). Likewise, maternal mortality rates (1,000/100,000 versus 690/100,000) and malnutrition (27% versus 22%)

were significantly higher in conflict-affected nations (O'Hare and Southall 2007). In addition, this study suggested that, overall, the governments of conflict-affected nations spent much more on defense and significantly less on health, education, and public services (O'Hare and Southall 2007).

The occurrence of civil conflict within a nation is taken into account in the World Bank's derivation of its Political Stability score. The WGI's Political Stability and Absence of Violence (PS) indicator “measures the perceptions of the likelihood that the government will be destabilized or overthrown by unconstitutional or violent means, including domestic violence and terrorism.” (World Bank 2009) From 2005-2008, an average of eight sources were consulted to produce the PS score. These were primarily commercial business information providers (CBIP) such as the Financial Ethics Index, Global Insight Global Risk Service, and iJet Country Security Risks Ratings (Kauffman and Kraay 2008). Table 2.3 provides examples of sources and indicators from which the PS scores were derived.

Table 2.3 Political Stability and Absence of Violence Sources and Indicators

Source	Indicators
Business Environment Risk Intelligence (BRI)	<ul style="list-style-type: none"> • Fractionalization of political spectrum and the power of these factions. • Organization and strength of forces for a radical government. • Instability as perceived by non-constitutional changes, assassinations, and guerrilla wars.
Global Insight Global Risk Services	<ul style="list-style-type: none"> • Military Coup Risk • Political Terrorism • Civil War
Economic Intelligence Unit Country Risk Service and Democracy Index	<ul style="list-style-type: none"> • Armed Conflict • Violent Demonstrations • Social Unrest • International Tensions

Cingranelli Richards Human Rights Database & Political Terror Scale	<ul style="list-style-type: none"> • Frequency of political killings • Frequency of disappearances • Frequency of torture
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2.4 Income and Health

Goal 1 of the Millennium Development Goals focuses on poverty, with Target 1 being to “Halve, between 1990 and 2015, the proportion of people whose income is less than \$1 a day.” (UN 2008b) Poverty is acknowledged as having a strong association with ill health, lack of health services, and lack of sufficient public services. (King 2003; World Bank 2001, 2003, 2004; UN 2008b). In 2000, the foreign debts of developing countries totaled to over 2 trillion US dollars. This amounts to over \$400 for each citizen in the developing world, where the average income in some countries is less than one dollar a day (King 2003). Such evidence indicates that the developing nations have been “net losers” in terms of the global economy (King 2003).

The beginning of the 21st century witnessed the widest gap between rich and poor in recorded history (King 2003). Economic disparities, and those between developed and developing nations, are glaringly apparent, particularly in the context of health and water/sanitation services. Globally, those in the richest quintile are twice as likely to have access to improved water source than the poorest quintile, and four times more likely to have access to improved sanitation (WHO/UNICEF 2004). In poorer settings, when water and sanitation resources are available, they are often shared among households and citizens many times pay more for these services than do their more well-off counterparts who have piped water and private toilet facilities (World Bank 2004).

Under these conditions, where the quality of services depends on what a

household can afford, individual income becomes increasingly important to health (Marmot 2002). Research indicates that the health of nations with low GNIs (gross national income, defined by the World Bank as the value of a nation's output of services and goods in a year; reported in U.S. Dollars.) benefit substantially from small increases in GNI, as exhibited in large increases in life expectancy. As GNI increases, the increase in life expectancy levels off (Marmot 2002).

The association between health and income can be referred to as a “mutually reinforcing interaction”, and is hard to define in absolute terms (Smith 1999). The discussion revolves around a sort of what-came-first argument: are wealthier people more healthy because higher income leads to better health? Or does being healthy afford people more economic opportunities with which to gain and maintain their health? Conversely, does poor health cause households to lose economic opportunities and thus stay or enter an impoverished state? Or do the impoverished suffer ill health due to their lack of access to health and other basic services vital to maintaining health (Smith 1999)? Whatever the specific interaction of these factors, there is clearly an important association between income and health.

2.5 Water and Sanitation in Developing Regions

To distinguish between improved and unimproved water and sanitation resources, this study employed the definitions established by the Joint Monitoring Programme (JMP). The World Health Organization (WHO) and the United Nations Children's Fund (UNICEF) joined together to create the JMP in 2000, with the goals of monitoring global water and sanitation coverage, as well as tracking progress towards the Millennium

Development Goal's water and sanitation targets (WHO/UNICEF 2004).

One of the main sources of data the JMP uses to produce coverage estimates is the Demographic and Health Surveys (DHS). Sponsored by the United States Agency for International Development (USAID), the DHS began in 1984 as a global research project with the goal of providing decision makers with the information needed to plan, implement, and evaluate programs pertaining to population health, nutrition, women's health, and children's health in developing nations and to increase international understanding of global health trends (DHS 2009). Since 1984, the DHS has completed over 240 surveys in 85 countries. Surveys are generally conducted every five years. They are large nationally-representative surveys, with usually 5,000-30,000 household participants. For the purposes of this study, data were extracted from the section of the DHS covering household characteristics.

Improved Drinking Water Source: Definition and Coverage Estimates

The JMP defines drinking water as “the water used for normal domestic purposes, including consumption and hygiene.” (WHO/UNICEF 2004) In general, an improved drinking water source is one that is protected from contamination (WHO/UNICEF 2008a). Table 2.4 displays the categories and components of improved/unimproved drinking water sources. However, even if water is collected from a safe source, unsafe handling or storage of water can contaminate water, making household water treatment an important means of ensuring water safety (WHO/UNICEF 2008b). It is also important to note that people's basic water requirements can be satisfied if the round trip to the water source is 30 minutes or less (WHO/UNICEF 2004), and while time to water

source is not currently an MDG indicator, there are some proponents who believe this should be taken into account when designating a water source as improved or unimproved (WHO/UNICEF 2008b).

Table 2.4 Improved/Unimproved Drinking Water Source Categories

Improved drinking water sources	Unimproved drinking water sources
Piped water into dwelling, plot or yard	Unprotected dug well
Public tap/standpipe	Unprotected spring
Tubewell/borehole	Small cart with tank/drum
Protected dug well	Tanker truck
Protected spring	Surface water (river, damn, lake, pond, stream, channel, irrigation, channel)
Rainwater	Bottled water

The proportions of users with piped water, other improved water sources, and unimproved water sources are illustrated in Figure 2.3. This figure illustrates the coverage disparities between sub-Saharan Africa and the rest of the world. Overall, sub-Saharan Africa has less access to improved water sources than developed regions, Northern Africa, and other nations in developing regions.

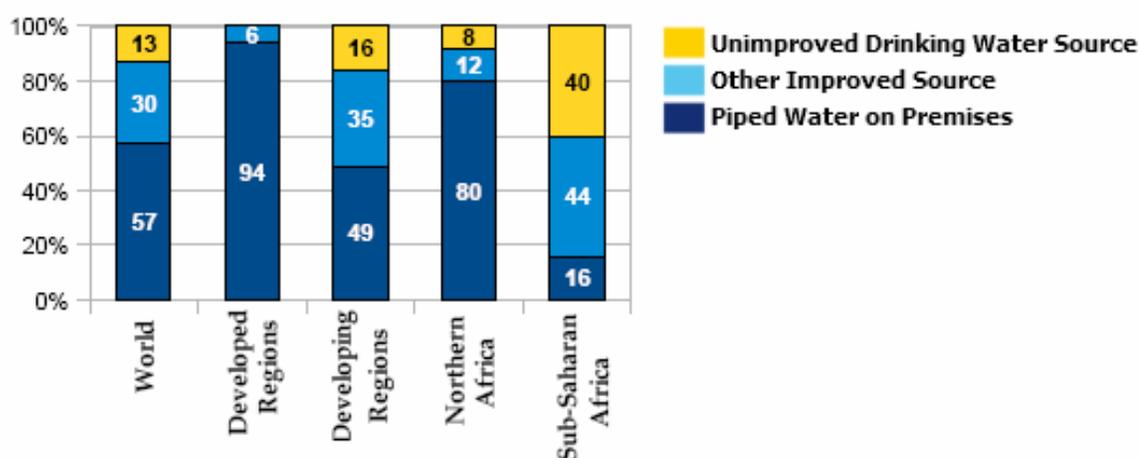


Figure 2.3 Proportion of the population using piped drinking-water on premises, other improved drinking-water source or an unimproved source, by MDG region, 2008. (WHO/UNICEF 2010)

Improved Sanitation: Definition and Coverage Estimates

An improved sanitation facility is defined by the JMP as one that “hygienically separates human excreta from human contact (WHO Snapshot 2008). Additionally, sanitation facilities that are shared or public are not considered improved, as their hygiene, accessibility, and security are often compromised (WHO/UNICEF 2008b). The categories and components of improved/unimproved sanitation facilities are displayed in Table 2.5.

Table 2.5 Improved/Unimproved Sanitation Facility Categories

Improved Sanitation Facilities	Unimproved Sanitation Facilities
Flush or pour-flush to: <ul style="list-style-type: none"> • piped sewer system • septic tank • pit latrine 	Flush or pour-flush to elsewhere (street, ditch, yard/plot, open sewer, etc.)
Ventilated improved pit latrine (VIP)	Pit latrine without slab or open pit
Pit latrine with slab	Bucket
Composting toilet	Hanging toilet or hanging latrine
	No facilities or bush or field (open defecation)

From the map, it is apparent that the majority of sub-Saharan African nations have sanitation coverage rates below 50%. The disparity between SSA and other regions is further illustrated in Figure 2.4. From this figure, it is apparent that sub-Saharan Africa lags behind other nations in the developing region, as well as North Africa and the world in general with only 31% improved sanitation coverage.

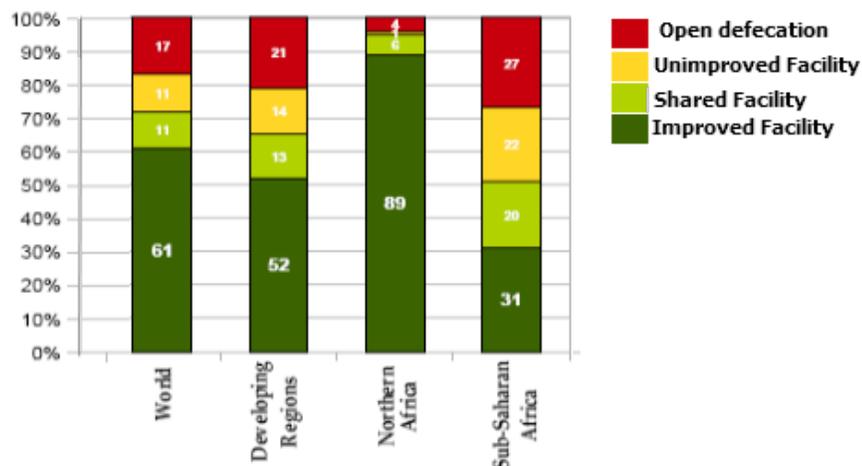


Figure 2.4 Proportion of the population using an improved sanitation facility, shared facility, unimproved facility, or open defecation, by MDG region, 2008. (WHO/UNICEF 2010)

Water and Sanitation Related Disease

Water-related diseases are the most common cause of illness and death among the poorest populations of the developing world (Lenton et al. 2005). At any given time, nearly half of the citizens in developing nations are suffering from one or more of the following illnesses associated with improper water and sanitation resources: diarrhea, ascariis, guinea worm disease, hookworm, schistosomiasis, and/or trachoma (WHO 2004a, 2008). Likewise, people suffering from water-related diseases occupy more than half of the world's hospital beds (Lenton et al. 2005), and WSH-related diseases result in about 82,196,000 DALYS annually worldwide (Montgomery 2007).

About one-tenth of the total global disease burden could be alleviated by increasing access to safe drinking water and improving sanitation and hygiene (WHO 2008; Pruss 2002). Much of this burden falls upon the world's children – disease related to unsafe drinking water claims the lives of 3,900 children under five each day (WHO/UNICEF 2004) and 60% of infant mortality is linked to infectious diseases,

primarily WASH-related (Montgomery 2007). Once they are weaned from breastfeeding, children in developing nations often suffer recurrent worm infections for the rest of their lives. These infections many times cause chronic health problems and developmental deficiencies (UNICEF, 2008).

Each year, safer water and adequate sanitation could prevent 1.4 million child deaths from diarrhoeal disease and 200 million schistosomiasis infections (WHO; Pruss 2002). It is estimated that 39% of diarrhea cases worldwide could be prevented just by improving household water treatment and storage (JMP 2005). In addition, safer water could protect 5 million people from lymphatic filariasis and 5 million from trachoma infection, the leading cause of preventable blindness (WHO 2001). Additionally, citizens of communities within which any members practice open defecation are at greater risk of diarrhoeal disease, worm infection, and hepatitis than those in communities where open defecation is not practiced (WHO/UNICEF 2008b). Table 2.6 shows the burden of WASH-related diseases in sub-Saharan Africa is expressed in terms of deaths, disability adjusted life years (DALYs), and the proportion of total deaths and DALYs in the region attributable to WASH-related diseases. In sub-Saharan Africa, 15% of all deaths and 16% of all DALYs are attributed to illnesses caused by poor water, sanitation, and hygiene (WHO 2004b, 2004c).

Table 2.6 Deaths and DALYS Attributed to WASH-related diseases in sub-Saharan Africa, 2004

Disease	Deaths ¹	% of WASH-related deaths ¹	DALYs ²	% of WASH-related DALYs ²
Diarrhoeal diseases	895,000	55%	28,684,000	47.7%
Intestinal nematode infections	400	0%	1,572,800	2.6%
Trachoma	0	0%	601,000	1.0%
Schistosomiasis	36,000	2%	1,502,000	2.5%
Lymphatic filariasis	–	–	908,000	1.5%
Malaria	335,000	21%	12,867,000	21.4%
Onchocerciasis	0	0%	38,000	0.0%
Total WASH-related	1,631,000	–	60,088,000	–
% of regional total	15%	–	16%	–

¹ Source: WHO, Estimated deaths attributable to water, sanitation, and hygiene ('000), by disease and region, 2004.

² Source: WHO, Burden of disease (in DALYs) attributable to water, sanitation, and hygiene ('000), by disease and region, 2004

Economically, improving water and sanitation services worldwide would have great benefit. It is estimated that each dollar invested in improving water and sanitation could yield \$3-\$34 depending on the region, and \$7.3 billion in health-related costs could be avoided each year (Lenton et al. 2005). Reduced morbidity from WASH-related illnesses would also result in economic gains at the household and individual level. In India, for example, 73 million working days are lost each year to waterborne diseases (Lenton et al. 2005). Improving water and sanitation services in developing nations would have a definite impact upon the quality of life for the people in these nations, and

the general state of world's health.

2.6 Urban-Rural Disparities

In addition to disparities along economic lines, disparities in health and access to basic water and sanitation services are also apparent along urban-rural lines. Worldwide, seven out of ten people living without improved sanitation live in rural areas (WHO/UNICEF 2010) and 84% of the world's population without access to an improved water source inhabit rural communities (WHO/UNICEF 2010). In developing regions, 94% of urban inhabitants use an improved water source compared to 76% of rural inhabitants (Figure 2.6). For sanitation, 68% of urban residents use an improved facility compared to only 40% of rural residents in the developing world (Figure 2.5) (WHO/UNICEF 2010).

In sub-Saharan Africa, disparities in the availability of improved water and sanitation resources to urban and rural populations is significant. While 83% of the urban population has access to an improved drinking water source, only 47% of the rural population uses an improved source (WHO/UNICEF 2010). Likewise, only 24% of the rural population in sub-Saharan Africa uses an improved sanitation facility compared to 44% of the urban population (WHO/UNICEF 2010).

Shared toilets are considered “unimproved” sanitation facilities, and residents of urban areas of the developing world are three times more likely to share their facilities among households than citizens in rural settings (WHO/UNICEF 2010). In sub-Saharan Africa, 42% of urban dwellers, compared to 24% of rural dwellers utilized toilet facilities that are shared among households (WHO/UNICEF 2008b). Shared facilities are more

common in urban areas because they are usually densely populated and lack the space required to install private facilities (WHO/UNICEF 2010). Additionally, it is often the case that the rate of installation of improved sanitation facilities cannot keep up with the rapid rate of growth in urban areas (WHO/UNICEF 2008b).

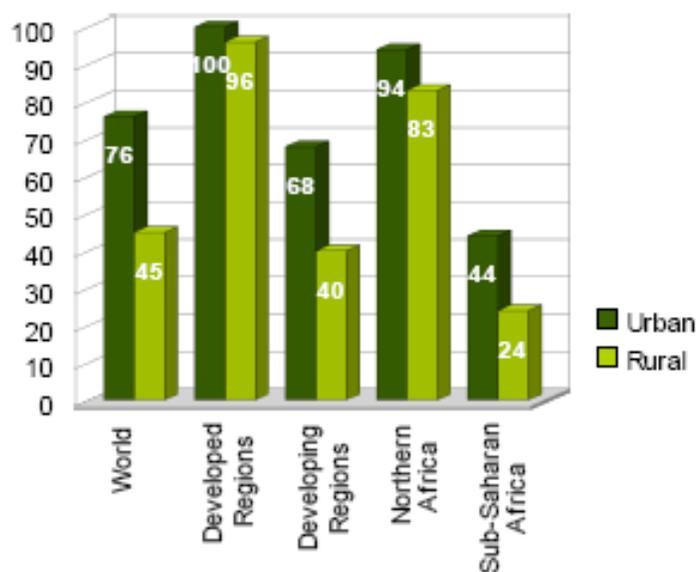


Figure 2.5 Proportion of population using improved sanitation facility, urban versus rural, by MDG region, 2008 (WHO/UNICEF 2010)

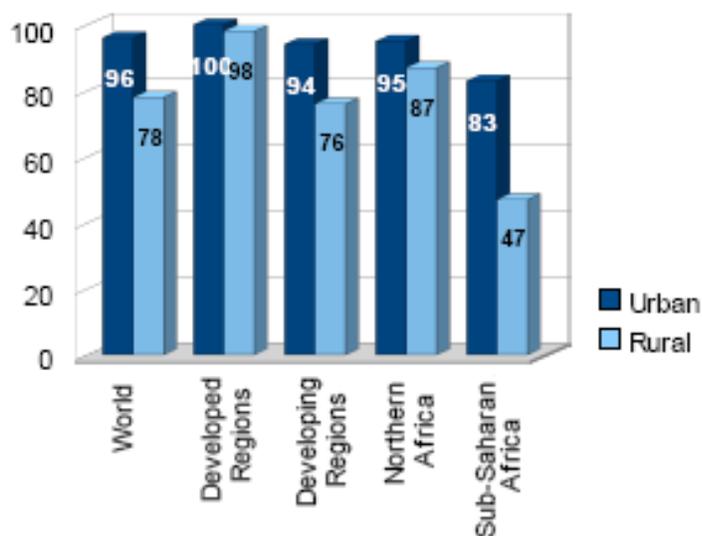


Figure 2.6 Proportion of population using improved drinking water source, urban versus rural, by MDG region, 2008 (WHO/UNICEF 2010)

Overall, the literature shows that rural residents bear the greatest burden of lack of improved water sanitation, both globally and specifically in sub-Saharan Africa. These figures illustrate the vast disparities in access to improved water and sanitation resources between urban and rural settings, both globally and in sub-Saharan Africa. These differences will also be explored in this study.

Chapter III METHODOLOGY

3.1 Study Measures

This study examined the impact of political and economic variables upon five water and sanitation-related variables centered around access to improved drinking water/sanitation facilities.

3.2 Data Sources and Variables

Independent Variables

Data relating to the independent variables: GNI, political stability, and government effectiveness, were obtained from the World Bank Development Indicators database and the World Governance Indicators (WGI) database. As mentioned previously, the WGI project measures six governance indicators: Voice and Accountability, Political Stability and Absence of Violence, Government Effectiveness, Regulatory Quality, Rule of Law, and Control of Corruption. In light of the previously addressed association between governance, political stability, and water/sanitation issues, for this study, two of the six indicators were selected: Political Stability and Absence of Violence (PS) and Government Effectiveness (GE). The indicators ranged in score from -2.5 to 2.5, with a higher score indicating a more stable/effective government (World Bank, 2008). An unobserved components model is utilized to aggregate data from multiple sources and produce the WGI scores (Kauffman and Kray 2008).

The third independent variable, used to approximate a nation's economic status, was Gross National Income per capita (GNI). GNI is the “sum of gross value added by all resident producers plus any product taxes (less subsidies) that are not included in the valuation of output plus net receipts of income from abroad. GNI per capita “is the gross national income, converted to U.S. Dollars, divided by the midyear population.” (World Bank Group 2010). In this study, GNI was divided by 100 for statistical analysis.

Dependent Variables

Data on the five dependent variables were extracted from the Demographic and Health Surveys of the 11 study nations.

Drinking Water Source

Water sources were identified as improved or unimproved according to the JMP definitions (Table 2.3). “Other” responses were categorized as unimproved under the assumption that if one of the designated improved water sources is not being used, the “other” source is likely unimproved. The recoding for this variable and the other dependent and independent variables is displayed in Table 3.1.

Time to Water Source (minutes)

This measured the respondent-reported round trip travel time to their source of drinking water. Responses were classified as having a trip time of a) 30 minutes or less or b) greater than 30 minutes. Responses indicating that the water source was on premises were considered as having trip times of 30 minutes or less. “Don't know” responses were not included in the analysis.

Household Water Treatment

This variable measures household water treatment habits. Responses were categorized as either indicating the use of some form of treatment or no treatment at all. “Don't Know” responses were excluded from the analysis.

Type of Sanitation Facility

As with drinking water source, sanitation facilities were classified as either improved or unimproved according to the JMP guidelines. “Other” responses were categorized as unimproved under the assumption that if one of the designated improved facilities are not being used, the “other” facility is likely unimproved.

Shared Sanitation Facility

This variable indicates if a respondent's household sanitation facility is private or shared (with another household or public/otherwise shared.)

Data Collection Methods

Survey datasets were downloaded from the DHS website (www.measuredhs.com). To obtain access to the data files, registration, including a brief description of the study, and approval were required. WGI data is publicly available from the World Governance Indicators website. Likewise, GNI data is available online from the World Bank's World Development Indicators (WDI) database (www.info.worldbank.org/data). For specific years for which GNI information was not available in the WDI, World Bank publications were referenced for GNI data.

3.3 Study Population

This study examined DHS data from 11 sub-Saharan African nations from 2005-

2008, based on availability of recent data. In total, 109,606 observations were compiled from 11 datasets.

3.4 Analysis

Descriptive Analyses

Frequencies were produced for Drinking Water Source, Time to Water Source, Household Water Treatment, Type of Sanitation Facility, and Shared Sanitation Facility, to gain a general overview of the magnitude of the access issue facing the nations in this study. These results are shown in Table 4.3.

Odds Ratio Analysis

The impact of the three independent variables were examined through the calculation of odds ratios using GNI, PS, and GE as dichotomous variables. Countries were divided into low and high groups based on the 50th percentile for GNI, PS, and GE (Tables 4.2-4.4). The groups were used to calculate odds ratios, chi-square, and p-values. Additionally, urban-rural stratified odds ratios were calculated. For analysis of dichotomous independent variables, low GNI, PS, and GE groups were coded as 0 and high GNI, PS, and GE groups were coded as 1 (Table 3.2).

Logistic Regression

Logistic regression was used to calculate odds ratios and p-values for GNI, PS, and GE as continuous variables. Unadjusted odds ratios were calculated for GNI, PS, and GE individually, and adjusted odds ratios were produced by including all three independent variables in one regression model. Unadjusted odds ratios and p-values were also calculated for GNI, PS, and GE stratifying by urban-rural. GNI values in the

regression model are divided by 100.

Chi-Square

Chi-square proportion analyses were performed to explore the discrepancies between observed and expected proportions of private and shared sanitation facilities, taking into account the large portion of the population with no sanitation facility at all.

Table 3.1 List of Variables and Coding

Variable	Coding
Gross National Income per capita (GNI)	0 = Low 1 = High
Political Stability and Absence of Violence (PS)	0 = Low 1 = High
Government Effectiveness (GE)	0 = Low 1 = High
Type of Residence	0 = Rural 1 = Urban
Drinking Water Source	0 = Unimproved 1 = Improved
Travel Time to Drinking Water Source	0 = > 30 min 1 = ≤ 30 min
Household Water Treatment	0 = No 1 = Yes
Type of Sanitation Facility	0 = Unimproved 1 = Improved
Shared Sanitation Facility	0 = No (Private) 1 = Yes (Shared) 2 = No Facility

Chapter IV

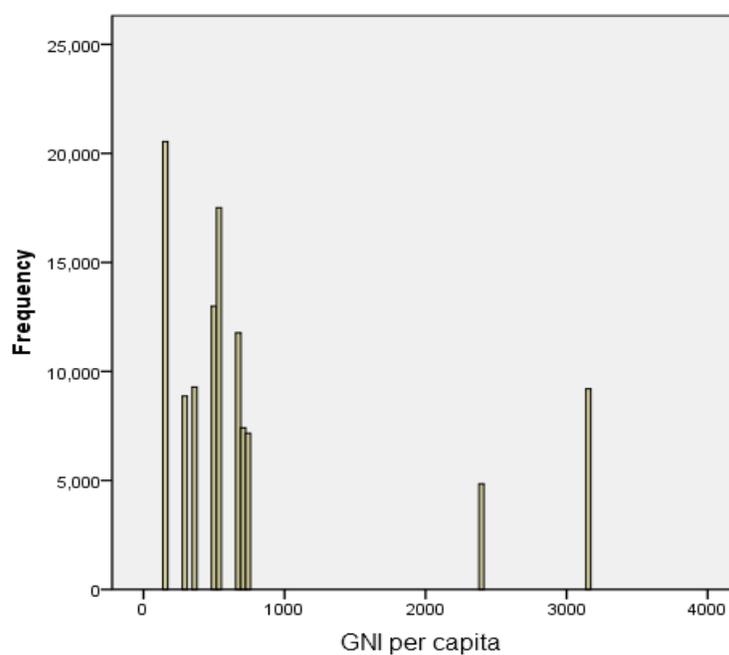
RESULTS

4.1 Descriptive Statistics

This study examined DHS data from 11 Sub-Saharan African nations, from 2005-2008. A total of 109,606 observations were included. The nations included in this study, year DHS surveyed, GNI per capita, and the scores for Political Stability and Absence of Violence (PS) and Government Effectiveness (GE) are shown in Table 4.1. GNIs in the study ranged from \$150 per year in Liberia to \$3,160 per year in Namibia (Figure 4.1). Political stability scores ranged from -1.62 in Zimbabwe to .81 in Namibia (Figure 4.2), while government effectiveness scores ranged from -1.36 in Zimbabwe to .14 in Namibia (Figure 4.3). While Namibia had the highest GNI, PS, and GE, other nations did not exhibit such a consistent pattern. The greatest disparity was seen in Benin, where the difference between the PS and GE scores is .88. Senegal was the only country where the PS and GE scores were equal.

Table 4.1 Observations, GNI and WGI Data for Study Nations, 2005-2008

Country	Year	Observations	GNI	PS	GE
Benin	2006	17511	525	0.34	-0.54
Ethiopia	2005	13721	160	-1.52	-0.93
Ghana	2008	11778	670	0.06	-0.08
Liberia	2007	6824	150	-1.33	-1.19
Mali	2006	12998	505	-0.06	-0.63
Namibia	2006	9200	3160	0.81	0.14
Senegal	2005	7412	710	-0.12	-0.12
Swaziland	2006	4843	2405	-0.13	-0.7
Uganda	2006	8870	300	-1.21	-0.49
Zambia	2007	7164	740	0.14	-0.62
Zimbabwe	2005	9285	360	-1.62	-1.36

**Figure 4.1** Distribution of GNI for study population

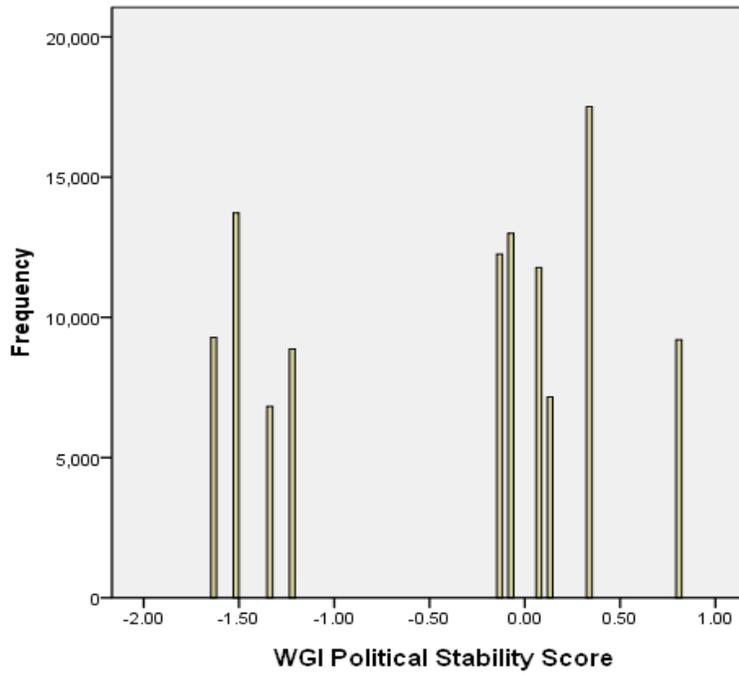


Figure 4.2 Distribution of Political Stability scores for study population

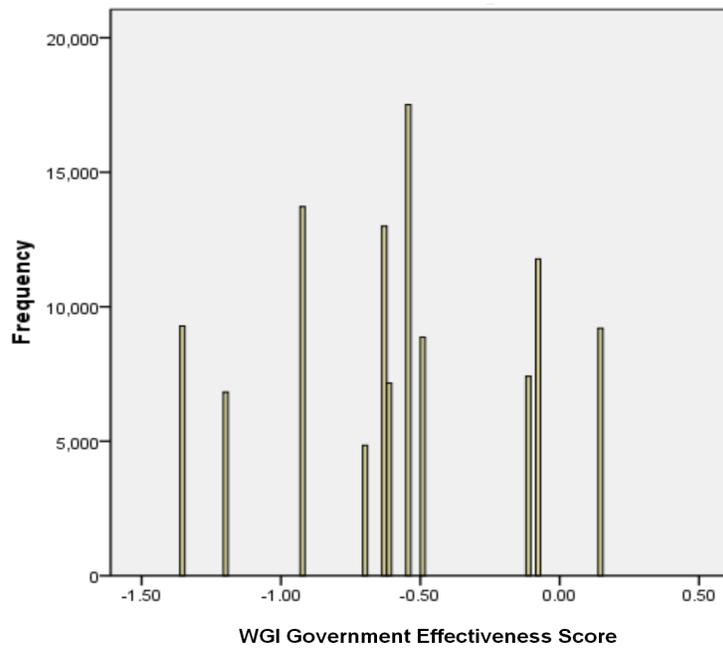


Figure 4.3 Distribution of Government Effectiveness scores for study population

The division of low and high GNI, PS, and GE groups are shown in Tables 4.2-4.4, as well as the total number of observations for each group. The low groups included the nations in the lowest 50th percentile – with the median value included – for a total of six nations. Each high group includes the five countries in the upper 50th percentile.

Table 4.2 High and Low GNI Groups

Country	Low GNI	Country	High GNI
Liberia	150	Ghana	670
Ethiopia	160	Senegal	710
Uganda	300	Zambia	740
Zimbabwe	360	Swaziland	2405
Mali	505	Namibia	3160
Benin	525		
Total Observations	69,209	Total Observations	40,397

Table 4.3 High and Low PS Groups

Country	Low PS	Country	High PS
Zimbabwe	-1.62	Mali	-0.06
Ethiopia	-1.52	Ghana	0.06
Liberia	-1.33	Zambia	0.14
Uganda	-1.21	Benin	0.34
Swaziland	-0.13	Namibia	0.81
Senegal	-0.12		
Total Observations	50,955	Total Observations	58,651

Table 4.4 High and Low GE Groups

Country	Low GE	Country	High GE
Zimbabwe	-1.36	Benin	-0.54
Liberia	-1.19	Uganda	-0.49
Ethiopia	-0.93	Senegal	-0.12
Swaziland	-0.7	Ghana	-0.08
Mali	-0.63	Namibia	0.14
Zambia	-0.62		
Total Observations	54,835	Total Observations	54,771

In total, the 11 DHS surveys yielded 109,606 observations. The number of valid and missing observations for each dependent variable in this study are displayed in Table 4.5. With the exception of the shared sanitation facility variable, all of the variables examined in this study were missing less than 5% of their total observations. Due to the data collection format of the DHS questionnaire, respondents who answered that they had no toilet facility were not required to answer the questions pertaining to shared facilities. This accounts for the substantial number of missing observations for the “Shared Sanitation Facility” variable.

Table 4.5 Observation Data

	Urban-Rural	Drinking Water Source	Travel Time to Water	Water Treatment	Type of Sanitation Facility	Shared Sanitation Facility
Valid	109,606	109,390	105,627	109,126	109,494	66,977
Missing (%)	0	216 (0.2)	3,979 (3.6)	480 (0.4)	142 (0.1)	42,629 (38.9)

Country level frequency data for the five dependent variables: drinking water source, travel time to water, household water treatment, type of sanitation facility, and shared sanitation facility are displayed in Table 4.6. The distribution of the population

between urban and rural areas is also included. The majority of respondents, 64.6%, resided in rural areas. Most had access to an improved drinking water source (65.9%) and travel times of 30 minutes or less to their water source (83.3%). However, an overwhelming majority of respondents, 81.1%, used no form of water treatment prior to drinking, and most used an unimproved toilet facility (64.1%). Those respondents who had access to a sanitation facility were almost equally using shared and private facilities, 49.8% and 50.2%, respectively.

Table 4.6 Summary of Variable Frequencies

Country	Rural Residence	Improved Drinking Water Source	Travel Time to Water, ≤ 30min	Household Water Treatment	Improved Sanitation Facility	Private Sanitation Facility
Benin	41.3%	70.2%	88.8%	5.6%	17.2%	33.8%
Ethiopia	73.3%	65.2%	69.5%	5.9%	20.3%	54.2%
Ghana	56.1%	77.6%	90.5%	8.8%	65.4%	16.3%
Liberia	61.8%	64.3%	96.3%	18.6%	24.9%	27.0%
Mali	68.2%	55.1%	97.3%	33.0%	21.7%	58.5%
Namibia	57.7%	88.1%	92.1%	8.1%	44.0%	73.5%
Senegal	58.0%	65.4%	81.8%	51.6%	35.5%	69.5%
Swaziland	61.2%	71.5%	86.6%	13.0%	82.5%	61.9%
Uganda	84.3%	68.7%	40.1%	39.4%	27.1%	48.2%
Zambia	62.4%	42.5%	87.6%	33.4%	33.0%	59.2%
Zimbabwe	67.1%	50.9%	83.0%	13.0%	63.4%	62.7%
Total	64.6%	65.9%	83.3%	18.9%	35.9%	50.2%

4.2 Analysis of Access to Improved Drinking Water Source and the Association with GNI, Political Stability and Government Effectiveness

As shown in Figure Table 4.7, the majority of respondents had access to an improved water source. The largest disparity was seen in GE; 74% of the population in

the high GE nations had access to an improved water source compared to 57.9% of the population in low GE nations.

Table 4.7 Distribution of Access to Improved and Unimproved Water Source, by GNI, PS, and GE

	Low GNI (N=69209)	High GNI (N=40397)	Low PS (N=50955)	High PS (N=58651)	Low GE (N=54835)	High GE (N=54771)
% Improved	63.0	70.8	63.7	67.8	57.9	74.0
% Unimproved	37.0	29.2	36.3	32.2	42.1	26.0

Logistic regression analyses were performed using GNI, PS, and GE as continuous variables. Results of the logistic regression analysis, shown in Table 4.8, show that GNI, political stability, and government effectiveness were all associated with access to an improved water source, to varying degrees. Government effectiveness was shown to have the strongest association with an unadjusted OR of 2.263.

When GNI, PS, and GE were included in the same logistic regression model, the ORs for political stability and government effectiveness changed significantly. While the GE odds ratio increased by 18.43%, the odds ratio for PS decreased by 41.75%.

Table 4.8 Access to Improved Drinking Water Source: Results of Logistic Regression

Variable	Unadjusted OR (95% CI)	Adjusted OR (95% CI)	p-value
GNI ^a	1.04 (1.04-1.04)	1.03 (1.03-1.03)	<.001
Political Stability	1.28 (1.26-1.30)	0.75 (.73-.76)	<.001
Government Effectiveness	2.26 (2.20-2.33)	2.678 (2.55-2.82)	<.001

^a- GNI/100

Odds ratios were calculated using dichotomous independent variables to further explore the influence of GNI, political stability, and government effectiveness upon the availability of improved water sources and results are shown in Table 4.9. High GE seemed to have the most marked influence upon access, with an OR of 2.07, indicating that the population within the high GE group was more than twice as likely to have access to an improved drinking water source as the population in the low GE group. High GNI and high PS demonstrated a similar effect of increasing the likelihood of access to an improved water source, but both had a lower odds ratio suggesting a lesser degree of association.

Table 4.9 Access to Improved Drinking Water Source: Results of Risk Estimation

Variable	OR Improved (95% CI)	χ^2	p-value
GNI	1.42 (1.39-1.46)	688.93	<.001
Political Stability	1.20 (1.19-1.23)	199.15	<.001
Government Effectiveness	2.07 (2.02-2.12)	3153.69	<.001

To explore the difference in the impact of the independent variables on access to improved drinking water in rural and urban settings, frequencies were produced for each setting. These analyses revealed a significant difference in proportions of urban and rural populations with access to improved drinking water sources. In urban settings, 85.7% of survey respondents had access to an improved water source, compared to only 55% in rural settings (Table 4.10). OR calculations showed that urban residents are almost five times more likely to have access to an improved water source than rural residents.

Table 4.10 Frequency and Odds Ratios for Access to Improved Water Source, Urban-Rural Stratified

	% Unimproved	% Improved	OR Improved (95% CI)	χ^2	p-value
Rural	45.0	55.0	.20 (.20-.21)	10501.9	<.001
Urban	14.3	85.7	4.91 (4.76-5.07)	10501.9	<.001

The results of the stratified logistic regression, displayed in Table 4.11, show some significant differences between unadjusted and urban-rural stratified ORs for political stability and government effectiveness for the continuous variables. Stratifying resulted in an OR of .75 for political stability in the urban stratum, a 41.52% decrease from the unadjusted OR of 1.28. In the rural setting, the OR for government effectiveness increases to 3.08, however in the urban setting, the OR is decreased to .81. Stratifying on urban and rural settings did not impact the unadjusted OR for GNI, as it remained at 1.04.

Table 4.11 Access to Improved Water Source: Urban-Rural Stratified Logistic Regression

Variable	Unadjusted OR (95% CI)	OR Rural (95% CI)	OR Urban (95% CI)
GNI ^a	1.04* (1.04-1.04)	1.04* (1.03-1.04)	1.04* (1.04-1.05)
Political Stability	1.28* (1.26-1.30)	1.33* (1.30-1.35)	.75* (.72-.78)
Government Effectiveness	2.26* (2.20-2.33)	3.08* (2.97-3.20)	.81* (.76-.86)

^a
- GNI/100
*p-value <.001
** p-value <.05

Urban-rural stratification and analysis of dichotomous GNI, PS, and GE variables with respect to access to improved drinking water showed marked differences in odds ratios between urban and rural settings for each independent variable. The results of these analyses are presented in Table 4.12. The direction and magnitude of the changes illustrated different associations between the GNI, PS, and GE and urban-rural settings. The odds ratio for GE increased by 28.8% in the rural setting and decreased by almost 60% in the urban setting. For PS and GNI, urban-rural stratification decreased the odds ratios significantly for both in only the urban setting.

Table 4.12 Access to Improved Water Source: Urban-Rural Stratified Risk Estimation

Variable	Unadjusted OR (95% CI)	OR Rural (95% CI)	OR Urban (95% CI)
GNI	1.42* (1.39-1.46)	1.35* (1.307-1.392)	1.08** (1.015-1.140)
Political Stability	1.20* (1.17-1.23)	1.30* (1.26-1.34)	.49* (.46-.52)
Government Effectiveness	2.07* (2.02-2.12)	2.67* (2.58-2.75)	.84* (.80-.89)

*p-value <.001

** p-value <.05

4.3 Analysis of Time to Drinking Water Source and the Association with GNI, Political Stability and Government Effectiveness

In this population, travel time to water source ranged from minimal, meaning the water source was in the home/dwelling, to 790 minutes. As shown in Table 4.13, most of the population in this study had a round trip travel time of 30 minutes or less to their water source. Among the groups dichotomized into “low” with respect to GNI, PS, and GE, the percentage of respondents with travel times of 30 minutes or less to their water

source ranged from 73.4%-85.6%. The percentage of respondents with travel times of 30 minutes or less ranged from 80.9%-91.4% among the “high” groups.

Table 4.13 Distribution of Travel Time to Drinking Water Source by GNI, PS, and GE.

	Low GNI (N=69209)	High GNI (N=40397)	Low PS (N=50955)	High PS (N=58651)	Low GE (N=54835)	High GE (N=54771)
% ≤ 30 min	80.3	88.8	73.4	91.4	85.6	80.9
% > 30 min	19.7	11.2	26.6	8.6	14.4	19.1

The logistic regression analysis of travel times to drinking water source and continuous independent variables yielded the results displayed in Table 4.14. The unadjusted ORs indicated positive associations between each of the dependent variables and shorter travel times, to differing degrees. The analysis of political stability and time to drinking water source resulted in an unadjusted OR of 2.06, while GNI and government effectiveness have slightly weaker positive associations with shorter travel times with ORs of 1.05 and 1.31, respectively. As in the analysis of improved drinking water source, the adjusted ORs in this analysis differed from the unadjusted ORs, with PS and GE differing significantly. For GNI, the OR decreased slightly to 1.00. The government effectiveness OR decreased dramatically to .11, while the OR for political stability increased substantially to 5.11.

Table 4.14 Time to Water Source: Results of Logistic Regression

Variable	OR (95% CI)	Adjusted OR (95% CI)	p-value
GNI ^a	1.05 (1.045-1.051)	1.00 (1.000-1.000)	<.001
Political Stability	2.06 (2.02-2.10)	5.11 (4.92-5.32)	<.001
Government Effectiveness	1.31 (1.26-1.36)	.11 (.10-.12)	<.001

^a
- GNI/100

Analysis of the dichotomous independent variables and time traveled to water sources produced an OR of 3.85 which indicated that residents in nations with high political stability are almost 4 times more likely than residents in low PS nations to have a travel time of 30 minutes or less to their water source (Table 4.15). GNI was also positively associated with shorter travel times to drinking water sources, with an OR of 1.95. However, government effectiveness appeared to be negatively associated with shorter travel times with an OR of 0.72.

Table 4.15 Time to Water Source: Results of Risk Estimation

Variable	OR ≤ 30 min (95% CI)	χ^2	p-value
GNI	1.95 (1.88-2.02)	1246.83	<.001
Political Stability	3.85 (3.71-3.99)	6092.47	<.001
Government Effectiveness	0.72 (.69-.74)	408.83	<.001

Urban-rural stratification showed that 95% of the urban population had a travel time of 30 minutes or less to their water source, compared to 77% of the rural population

(Table 4.16). Comparing the urban and rural travel time produced an OR of 6.02 suggesting that urban residents were much more likely to have shorter travel times to water sources.

Table 4.16 Time to Water Source: Frequency and OR, Urban-Rural Stratified

	% > 30 min	% ≤ 30 min	OR ≤ 30 min (95% CI)	χ^2	p-value
Rural	23.0	77.0	.17 (.16-.18)	5713.05	<.001
Urban	4.7	95.3	6.02 (5.72-6.34)	5713.05	<.001

The unadjusted and urban-rural adjusted ORs produced by logistic regression analysis of continuous independent variables are displayed in Table 4.17. The stratified ORs for GNI varied slightly from the unadjusted, with the rural OR decreased to 1.04, and the urban OR increased to 1.07. The rural OR for PS was slightly higher than the unadjusted OR at 2.08, while the urban OR was substantially lower at 1.45. In the case of government effectiveness, both the rural and urban ORs were lower than the unadjusted OR at 1.26 and 1.10, respectively.

Table 4.17 Time to Water Source: Urban-Rural Stratified Logistic Regression

Variable	Unadjusted OR (95% CI)	OR Rural (95% CI)	OR Urban (95% CI)
GNI ^a	1.05* (1.05-1.05)	1.04* (1.04-1.04)	1.07* (1.06-1.09)
Political Stability	2.06* (2.02-2.10)	2.08* (2.03-2.12)	1.45* (1.37-1.53)
Government Effectiveness	1.31* (1.26-1.36)	1.26* (1.21-1.32)	1.098 (.98-1.23)

a- GNI/100

*p-value <.001

** p-value <.05

Analysis of dichotomous independent variables, stratified by urban-rural, produced an OR of 1.09 for PS in the urban stratum, a decrease of 50.55% from the unadjusted OR of 3.85 (Table 4.18). The stratified ORs for GE and GNI also differed from the unadjusted ORs, but to lesser degrees. Both the rural GNI OR, 1.81, and the urban OR, 1.95, are slightly lower than the unadjusted OR. Likewise for government effectiveness, the rural and urban ORs are lower than the unadjusted ORs at .68 and .62, respectively.

Table 4.18 Time to Water Source: Urban-Rural Stratified Risk Estimation

Variable	Unadjusted OR (95% CI)	OR Rural (95% CI)	OR Urban (95% CI)
GNI	1.95* (1.88-1.89)	1.81* (1.741-1.889)	1.95* (1.743-2.173)
Political Stability	3.85* (3.71-3.99)	3.90* (3.75-4.05)	1.90* (1.73-2.10)
Government Effectiveness	.72* (.69-.74)	.68* (.66-.70)	.62* (.56-.69)

*p-value <.001

** p-value <.05

4.4 Analysis of Household Water Treatment and the Association with GNI, Political Stability and Government Effectiveness

As illustrated in Table 4.19, household water treatment was very low across the board, regardless of GNI, political stability, or government effectiveness. The highest percentage of the population that reported treating their water was in nations with low political stability (22.1%). This was followed closely by high GNI nations, wherein 21.3% of the population uses some form of treatment for their drinking water.

Table 4.19 Distribution of Water Treatment Habits by GNI, PS, and GE.

	Low GNI (N=69209)	High GNI (N=40397)	Low PS (N=50955)	High PS (N=58651)	Low GE (N=54835)	High GE (N=54771)
% Treatment	17.4	21.3	22.1	16.1	19.4	18.4
% No Treatment	82.6	78.7	77.9	83.9	80.6	81.6

The odds ratios produced by logistic regression analysis of continuous independent variables, displayed in Table 4.20, signified a slightly negative relationship between treatment and GNI, and treatment and political stability. Government effectiveness was the only variable shown to have a positive association with water treatment, with an OR of 1.325. Both GNI and political stability are found to be negatively associated with unadjusted ORs of .978 and .956. The multivariate logistic regression resulted in ORs that followed similar patterns, with GE being the only variable with a positive association with water treatment (OR=2.846). With adjusted ORs of .961 and .800, GNI and political stability are negatively associated with water treatment.

Table 4.20 Household Water Treatment: Results of Logistic Regression

Variable	OR (95% CI)	Adjusted OR (95% CI)	p-value
GNI ^a	0.98 (.98-.98)	0.96 (.958-.963)	<.001
Political Stability	0.96 (.94-.97)	0.80 (.78-.83)	<.001
Government Effectiveness	1.33 (1.28-1.37)	2.85 (2.69-3.02)	<.001

^a- GNI/100

Analysis of dichotomous variables produced generally low ORs for GNI, PS, and GE (Table 4.21). Only GNI was positively associated with the increased likelihood of household water treatment with an OR of 1.29, indicating that the population in high GNI nations were only slightly more likely to treat their water than those in nations with GNI lower than the median. Both PS and GE were negatively associated, with ORs of .68 and .94, respectively.

Table 4.21 Household Water Treatment: Results of Risk Estimation

Variable	OR Treatment (95% CI)	χ^2	p-value
GNI	1.29 (1.25-1.33)	252.77	<.001
Political Stability	.68 (.66-.70)	637.84	<.001
Government Effectiveness	.94 (.91-.97)	16.74	<.001

Analysis of the differences between reported water treatment habits in urban and rural populations are shown in Table 4.22. The analysis indicated that water treatment was slightly more likely in urban settings than in rural settings. Overall, only 20.5% of urban respondents reported treating their water prior to drinking, compared to 18% of rural residents.

Table 4.22 Household Water Treatment: Frequency and OR, Urban-Rural Stratified

	% No Treatment	% Treatment	OR Treatment (95% CI)	χ^2	p-value
Rural	82.0	18.0	.85 (.83-.88)	100.7	<.001
Urban	79.5	20.5	1.17 (1.14-1.21)	100.7	<.001

In the stratified logistic regression (results shown in Table 4.23) the OR for GNI remained effectively unchanged in the rural and urban stratum, decreasing only slightly in the urban stratum to .98. The odds ratio for PS increased to 1.10 in the rural stratum and decreased to .73 in the urban stratum. Likewise, the OR for government effectiveness increased to 1.79 in the rural stratum while it decreased to .83 in the urban setting.

Table 4.23 Treatment of Water: Urban-Rural Stratified Logistic Regression

Variable	Unadjusted OR (95% CI)	OR Rural (95% CI)	OR Urban (95% CI)
GNI ^a	.98* (.98-.98)	.98* (.98-.98)	.98* (.97-.98)
Political Stability	.96* (.94-.97)	1.10* (1.07-1.12)	.73* (.71-.75)
Government Effectiveness	1.33* (1.28-1.37)	1.79* (1.71-1.87)	.83* (.78-.88)

^a- GNI/100

*p-value <.001

** p-value <.05

When stratified by urban-rural setting, the ORs for GNI, PS, and GE changed in both strata (Table 4.24). In the rural stratum, the GNI odds ratio increased to 1.43, while it decreases to 1.05 in the urban stratum. The rural odds ratio for government effectiveness, 1.11, indicated a weak positive association between countries with higher than median GE and water treatment levels. This differed from the negative association between GE and water treatment in urban areas, indicated by an OR of .70, suggesting that in rural settings, high levels of government effectiveness were associated with higher levels of water treatment. The ORs for political stability were consistently negatively associated with water treatment levels at .82 and .47, for the rural and urban strata.

Table 4.24 Treatment of Water: Urban-Rural Stratified Risk Estimation

Variable	Unadjusted OR (95% CI)	OR Rural (95% CI)	OR Urban (95% CI)
GNI	1.29* (1.25-1.33)	1.43* (1.38-1.49)	1.05 (1.00-1.10)
Political Stability	.68* (.66-.70)	.82* (.78-.85)	.47* (.450-.50)
Government Effectiveness	.94* (.91-.97)	1.11* (1.06-1.15)	.70* (.67-.74)

*p-value <.001

** p-value <.05

4.5 Analysis of Access to Improved Sanitation Facility and the Association with GNI, Political Stability and Government Effectiveness

Overall, access to an improved sanitation facility was fairly low at 35% for this study population. Among groups with GNI, PS and GE lower than the median, the percentage of respondents with access to an improved sanitation facility ranged from 26.9% to 38.1%. (Table 4.25). Among the groups with a GNI, PS, and GE groups higher than the median, this ranged from 34.0% to 51.4%. The largest disparity for access to sanitation was seen in GNI, where 51.4% of respondents in the high GNI group had access to an improved sanitation facility compared to only 26.9% of respondents in the low GNI group.

Table 4.25 Distribution of Access to an Improved Sanitation Facility by GNI, PS, and GE

	Low GNI (N=69209)	High GNI (N=40397)	Low PS (N=50955)	High PS (N=58651)	Low GE (N=54835)	High GE (N=54771)
% Improved	26.9	51.4	38.1	34.0	35.7	36.2
% Unimproved	73.1	48.6	61.9	66.0	64.3	63.8

The odds ratios produced by logistic regression, which analyzed the independent

variables as continuous variables, produced ORs of 1.04, 1.03, and 1.28 for GNI, PS and GE, respectively, indicating positive associations between access to an improved sanitation facility and all three independent variables (Table 4.26). After adjusting for all independent variables together in a multivariate logistic regression model, GE had the strongest association with an OR of 1.21. The adjusted OR for GNI increased slightly to 1.06, while the adjusted OR for political stability decreased substantially to 0.66.

Table 4.26 Access to Improved Sanitation Facility: Results of Logistic Regression

Variable	OR (95% CI)	Adjusted OR (95% CI)	p-value
GNI ^a	1.04 (1.04-1.04)	1.06 (1.06-1.06)	<.001
Political Stability	1.03 (1.02-1.05)	0.66 (.64-.68)	<.001
Government Effectiveness	1.28 (1.25-1.32)	1.21 (1.15-1.27)	<.001

^a- GNI/100

Analysis of the dichotomous independent variables suggested that GNI was most strongly associated with access to an improved sanitation facility with the largest OR of 2.87 (Table 4.27). Political stability appeared to be negatively associated with improved sanitation (OR=.84), and although government effectiveness appeared to be slightly positively associated with access (OR=1.02), the odds ratio was found not to be statistically significant.

Table 4.27 Access to Improved Sanitation Facility: Results of Risk Estimation

Variable	OR Improved (95% CI)	χ^2	p-value
GNI	2.87 (2.80-2.94)	6618.55	<.001
Political Stability	.84 (.82-.86)	193.18	<.001
Government Effectiveness	1.02 (1.00-1.05)	2.91	0.088

The differences between urban and rural access to sanitation is shown in Table 4.28. In this study population, 58.7% of urban residents had an improved sanitation facility compared to only 23.4% of rural residents. An OR of 4.66 indicated that urban inhabitants were almost five times more likely to have access to an improved sanitation facility than rural residents.

Table 4.28 Access to Improved Sanitation Facility: Frequency and OR, Urban-Rural Stratified

	% Unimproved	% Improved	OR Improved (95% CI)	χ^2	p-value
Rural	76.6	23.4	.21 (.21-.22)	13596.92	<.001
Urban	41.3	58.7	4.66 (4.54-4.79)	13596.92	<.001

The urban-rural stratified ORs produced by logistic regression analysis of continuous independent variables are displayed in Table 4.29. For GNI, the rural OR, 1.04, was lower than the unadjusted OR, while the urban OR, 1.05 was higher. The opposite was true for political stability – the rural OR was higher than the unadjusted (1.09) while the urban OR was lower (.71). For government effectiveness, both the rural

and urban ORs were lower than the unadjusted at 1.13 and 1.18, respectively.

Table 4.29 Access to Improved Sanitation Facility: Urban-Rural Stratified Logistic Regression

Variable	Unadjusted OR (95% CI)	OR Rural (95% CI)	OR Urban (95% CI)
GNI ^a	1.04* (1.04-1.04)	1.04* (1.03-1.04)	1.05* (1.04-1.05)
Political Stability	1.03* (1.02-1.05)	1.09* (1.07-1.11)	0.71* (.69-.73)
Government Effectiveness	1.28* (1.25-1.32)	1.13* (1.08-1.18)	1.18* (1.13-1.24)

a- GNI/100

*p-value <.001

** p-value <.05

Upon examination of odds ratios stratified for urban-rural setting (Table 4.30), the rural OR, 3.10 was higher than the unadjusted OR while the urban OR, 2.46 was lower than the unadjusted OR for GNI. Political stability demonstrated the same pattern with the rural OR, 0.87, being higher than the unadjusted OR and the urban OR, 0.51, being lower. The rural and urban ORs (1.01 and .85, respectively) for government effectiveness were both lower than the unadjusted OR.

Table 4.30 Access to Improved Sanitation Facility: Urban-Rural Stratified Risk Estimation

Variable	Unadjusted OR (95% CI)	OR Rural (95% CI)	OR Urban (95% CI)
GNI	2.87* (2.80-2.94)	3.10* (2.99-3.21)	2.46* (2.36-2.57)
Political Stability	.84* (.82-.86)	.87* (.84-.90)	.51* (.49-.53)
Government Effectiveness	1.02 (1.00-1.05)	1.01 (.97-1.04)	.85* (.82-.89)

a- GNI/100

*p-value <.001

** p-value <.05

4.6 Analysis of Shared Sanitation Facilities and the Association with GNI, Political Stability, and Government Effectiveness

When examining the distribution of shared and private facilities, it was important to take into account the portion of the population without access to a sanitation facility of any kind. Table 4.31 displays the distribution of private, shared, and no facilities among high and low GNI, PS, and GE groups. Among these groups, the percentage of respondents in this study with access to private sanitation facilities ranged from 26.2% to 35.3%. The range for shared sanitation facilities was 27.4%-34.8%, while the range for respondents with no facility was 29.9%-44%. Overall, the group with the highest percentage was the low GNI group wherein 44% of respondents had no facility.

Table 4.31 Distribution of Private, Shared, and No Facilities Among High and Low GNI, PS, and GE

	Low GNI (N=69209)	High GNI (N=40397)	Low PS (N=50955)	High PS (N=58651)	Low GE (N=54835)	High GE (N=54771)
% Private	28.1	35.3	35.3	26.8	35.3	26.2
% Shared	28.0	34.8	28.3	32.4	27.4	33.6
% No Facility	44.0	29.9	36.4	40.8	37.3	40.2

A chi-square proportions analysis revealed a significant difference between expected and observed proportions of respondents with private, shared, or no facility (Table 4.32). The observed proportions for both private and shared facilities were lower than the expected proportions, while the proportion of residents with no facility was substantially higher. The observed proportions for private and shared facilities were about 92% of the expected values. The number and proportion of those with no facility was higher than the expected value by about 16%.

Table 4.32 Shared Sanitation Facilities: Results of Chi-Square Analysis

	N Observed	N Expected	Residual	Proportion	χ^2	df	p-value
Private	33631	36464.3	-3118.3	0.92	1458.25	2	<.001
Shared	33464	36464.3	-2833.3	0.92			
No Facility	42416	36464.3	5951.7	1.16			

Analysis of dichotomous variables (Table 4.33) produced odds ratios indicating negative associations between political stability and private facilities (.66), as well as government effectiveness and private facilities (.61). GNI had a slightly positive association with private facilities with an odds ratio of 1.01, however, this finding was not statistically significant.

Table 4.33 Shared Sanitation Facilities: Results of Risk Estimation

Variable	OR Private (95% CI)	χ^2	p-value
GNI	1.01 (.98-1.04)	0.42	0.518
Political Stability	.66 (.64-.68)	697.97	0.001
Government Effectiveness	.61 (.59-.63)	1034.69	0.001

The logistic regression analysis of continuous variables produced conflicting results (Table 4.34), displaying reversed associations. Of the three independent variables, government effectiveness has the strongest association with having a private sanitation facility with an unadjusted OR of 1.28. Political stability was also shown to have a positive association with having a private facility with an OR of 1.04. When adjusted to include all the independent variables in the model, the positive associations between private facilities-political stability and private facilities-government effectiveness were

strengthened as demonstrated by higher adjusted ORs of 1.17 and 1.72, respectively. In this analysis, an unadjusted OR of .97 indicated a negative association between GNI and access to a private facility. The adjusted OR for GNI was even lower, .95.

Table 4.34 Shared Sanitation Facilities: Results of Logistic Regression

Variable	OR (95% CI)	Adjusted OR (95% CI)	p-value
GNI ^a	0.97 (.97-.97)	0.95 (.94-.95)	<.001
Political Stability	1.04 (1.02-1.06)	1.17 (1.13-1.21)	<.001
Government Effectiveness	1.28 (1.23-1.33)	1.72 (1.63-1.82)	<.001

a- GNI/100

The distribution of private, shared, and no facilities and results of the chi-square proportions test, stratified for urban-rural setting are displayed in Table 4.35. These results showed that over half of the rural population (51.8%) in this study had no facility, compared to 15.0% of the urban population. 47.2% of the urban population had shared facilities, compared to 21.3% of the rural population, and 26.9% and 37.8% had private facilities in rural and urban settings, respectively.

Table 4.35 Distribution of Private, Shared, and No Facilities & Results of Chi-Square Proportions Test, Urban-Rural Stratified

	%*	N Observed	N Expected	Residual	Proportion	χ^2	df	p- value
Private	26.9	19001	23546.7	-4545.7	0.81	11162.08	2	<.001
Rural Shared	21.3	15053	23546.7	-8493.7	0.64			
No Facility	51.8	36586	23546.7	13039.3	1.55			
Private	37.8	14630	12917.7	1712.3	1.13	6352.64	2	<.001
Urban Shared	47.2	18293	12917.7	5375.3	1.42			
No Facility	15.0	5830	12917.7	-7087.7	0.45			

* Percentage is not a direct translation of number observed. Missing responses are taken into account in the calculation of the expected count.

Urban-rural stratified odds ratios produced by analysis of continuous variables signified important interactions between political stability and urban-rural setting (Table 4.36). The unadjusted OR for PS is 1.04, this increased to 1.16 in the rural stratum while it decreased to 0.88 in the urban stratum. The rural OR for government effectiveness, 1.72, was higher than the unadjusted OR while the urban OR was lower than the unadjusted, .97. The stratified ORs for GNI did not vary greatly from the unadjusted OR, with ORs of .97 in the rural stratum and .96 in the urban stratum.

Table 4.36 Access to Private Sanitation Facilities: Urban-Rural Stratified Logistic Regression

Variable	Unadjusted OR (95% CI)	OR Rural (95% CI)	OR Urban (95% CI)
GNI ^a	.97* (.97-.97)	0.97* (.97-.97)	0.96* (.96-.96)
Political Stability	1.04* (1.02-1.06)	1.16* (1.12-1.19)	0.88* (.85-.90)
Government Effectiveness	1.28* (1.23-1.33)	1.72* (1.62-1.82)	0.97 (.92-1.02)

a- GNI/100

*p-value <.001

** p-value <.05

Chapter V

DISCUSSION AND CONCLUSION

5.1 Discussion

The Joint Monitoring Programme cites poverty, political instability, and lack of government attention to water and sanitation needs as the main obstacles hindering sub-Saharan Africa's progress towards reaching the water and sanitation targets of the Millennium Development Goals (WHO/UNICEF 2004). The purpose of this study was to quantify the influence of specific political and economic factors, namely, GNI, Political Stability and Absence of Violence, and Government Effectiveness, upon water and sanitation related variables in 11 countries in sub-Saharan Africa between 2005 and 2008. The following research questions were addressed:

- What is the current availability of improved water and sanitation resources in sub-Saharan Africa?
- Do political factors, specifically political stability and government effectiveness, have an impact upon the availability of improved water and sanitation resources in sub-Saharan Africa?
- Is gross national income associated with a population's access to improved water and sanitation resources?
- Is there a disparity in access to water and sanitation resources in urban and rural settings?

These are important questions to consider when developing strategies to tackle

water and sanitation issues, as economic and political environments must be taken into account in order to implement effective interventions (Montgomery 2007; Lenton et al. 2005).

Access to Improved Drinking Water Source

In this study, 65% of the population resided in rural areas which closely parallels to JMP generated estimate of 63% (WHO/UNICEF 2010) for sub-Saharan Africa. The majority of the study population, 66%, had access to an improved drinking water source. This figure is comparable to the most recently reported coverage rate of 60% in sub-Saharan Africa (WHO/UNICEF 2010). This study also produced estimates of the difference in coverage between urban and rural settings that were similar to those generated by the JMP. While the JMP estimates that 83% of the urban sub-Saharan Africa population has access to an improved water source compared to 47% of the rural population (WHO/UNICEF 2010), this study produced estimates of 85.7% and 55.0%, respectively.

Government effectiveness was found to have the most influence on the likelihood of having an improved drinking water source. This may be due to the fact that water, as a utility, is vulnerable to the issues such as lack of capacity and government prioritization (World Bank 2001). With lower levels of government effectiveness, the development and sustainability of such public services are often hindered (World Bank 2004; Marshall and Cole 2009). In Zimbabwe, for example, it was suggested that the 2009 cholera outbreak that spread to Zambia, Botswana, Mozambique, and South Africa was the result of an ineffective and inattentive government (Jung 2009). In 2006, the governing party

relinquished control of the municipal water supply, which at the time was functioning well, to the national authorities in an attempt to bring in revenue to the national government (Jung 2009). Since that time, Jung reports that the water supply system has deteriorated, has not been maintained, and has been contaminated by waste that has collected as result of sporadic waste collection services (Jung 2009). According to Jung (2009), the government is almost entirely to blame for this outbreak “due to the denial of assistance and the downplaying of the problem.”

Stratification of the data showed important disparities in access to improved drinking water sources between urban and rural settings. Urban dwellers were five times more likely to get their water from an improved water source than rural dwellers, and government effectiveness was found to be the independent variable with the strongest association with access. In general, government institutions are thought to be responsible for the lack of safe water available to citizens in developing nations. Facts such as centralized decision making catering to political and business interests, along with and lack of accountability and capacity have led to inefficient and unsustainable water services in developing regions, particularly in the rural and poorest communities (Swatuk and Kgomotso 2007). Decentralization of water utilities is often suggested as a means of providing more efficient service, specifically to rural populations. Proponents of decentralization contest that rural dwellers are especially vulnerable to the shortcomings of weak governments, and would benefit from more localized utilities (World Bank 2004).

GNI was also found to have a positive association with access to an improved

water source, though the relationship established in this study was not found to be as strong as the literature suggests. The WHO states that the richest quintile of the sub-Saharan African population is more than twice as likely as the poorest to use an improved source for drinking water (2010), while the OR estimates in this study range from 1.029-1.424. However this could be due to the limited sampling of only 11 countries in SSA.

Travel Time to Water Source

This study found that 16.7% of the study population had a travel time of more than 30 minutes to their water source. This is similar to the JMP (2008) produced estimate of 18% for the region. In urban areas, 95% of inhabitants have travel times of 30 minutes or less, compared to 77% in rural areas. This differs from JMP estimates which suggest shorter travel times for 45% of urban dwellers and 32% of rural. This likely stems from the fact that the JMP estimates only measures travel times for those using improved water sources or water piped directly to the premises. Still, it is important to note that, according to the JMP, one third of unpiped, improved drinking water sources require travel times of more than 30 minutes (WHO/UNICEF 2010).

GNI and political stability were found to be the variables positively associated with shorter travel times. The JMP (2010) asserts that piped water is a luxury reserved for the wealthy, so it makes sense that higher GNIs are associated with shorter travel times in general. As for political stability, research has shown how instability and conflict can negatively impact water and sanitation infrastructure (O'Hare and Southall 2007; Ugalde et al. 2000; Manoncourt et al. 1992; Martins 2009). Yach (1988) examines the interruption of water and sanitation services in Cape Town, South Africa during an

upsurge of political violence from May to July 1986. Yach's study showed that over 80% of the service interruptions reported during the time of the conflict occurred in the most highly impacted areas (1988). Therefore, it can be deduced that more stable governments are in better position to provide more convenient and reliable water and sanitation services to the public and to maintain them over time.

Household Water Treatment

Household water treatment was alarmingly low within this study population with only 18.9% of respondents indicating the use of some form of treatment. In their study of water treatment practices in low and middle income nations, including African nations, Rosa and Clasen (2010) also found that about 18% of African respondents reported using some form of household water treatment.

All of the independent variables were found to have a positive association with treatment, to varying degrees and in different models. Government effectiveness and GNI were indicated as the variables having the strongest, most consistent positive associations with water treatment. The relationship between income and water treatment is well established in the literature, as cost is often cited as an obstacle to effective in home water treatment (Tumwine 2005; Sobsey 2002). For example, in his discussion of the need for low cost alternative methods for household water treatment, Tumwine (2005) cites the fact that the cost of boiling water, a simple method for water treatment, can actually be quite high in developing nations. According to Tumwine, 1 kilogram of wood is required to boil 1 liter of water – the cost of wood and fuel to boil water may be prohibitive in nations where these resources are not readily available (2005). The

influence of government upon water treatment likely stems from the lack of priority given to public services under weak governments. The promotion of a large-scale household water treatment program would require coordination between various government run and public entities, a feat that would be beyond the scope of an ineffective and inefficient government (World Bank 2004).

Type of Sanitation Facility and Use of a Shared Facility

About 36% of the population in this study had access to an improved sanitation facility; the JMP estimates this proportion to be about 31% for the region (WHO/UNICEF 2010). 23.4% of the rural population in this study used an improved sanitation facility compared to 58.7% of the urban population; the JMP estimates these figures to be about 24% and 44%, respectively. This study's estimate of the urban population with improved sanitation may be overestimated for some nations. For example, the JMP estimate for improved sanitation in Ghana is 13%, which only takes into account improved, unshared facilities (WHO/UNICEF 2010). This is compared to the coverage estimate of 65% produced by this study which considers only the initial improved/unimproved classification, regardless of sharing.

GNI was found to have a consistently positive, strong association with improved sanitation. This finding is in line with current research showing that the richest 20% of the sub-Saharan African population is about five times more likely to use an improved sanitation facility than the poorest 20% (WHO/UNICEF 2010). The poorest 20%, on the other hand, are 16 times more likely than the richest to have no facility at all and practice open defecation (WHO/UNICEF 2010).

Additionally, the generally low sanitation coverage level in this study may be a result of the lack of funding sanitation projects receive worldwide. For example, since 1961, it is estimated that annual World Bank contributions to water projects have exceeded contributions to sanitation projects by about 1.5 billion USD (Fry et al 2008). Fry et al (2008) also examine sanitation coverage in relation to World Bank income group, and find that low income nations generally have the lowest coverage.

Disparities in sanitation between urban and rural settings were clear in this analysis. About 21.3% of the rural population and 47.2% of the urban population used shared facilities. This figure supports the previously established fact that sharing of sanitation facilities is more common in urban areas than in rural. Also, 51.8% of rural respondents had no facility compared to 15% of urban dwellers. The JMP also generated findings with a disparity of similar magnitude, according to the most current report, 38% of rural respondents have no facility versus 8% of urban dwellers.

5.2 Study Limitations

This study demonstrated several important limitations. The first limitation of this study was the recoding of the water and sanitation related variables, particularly access to improved drinking water source and access to improved sanitation facility. While the distinction between improved and unimproved resources is clearly defined by the Joint Monitoring Programme, the coding for source and facility type differed somewhat among DHS surveys. In some instances, personal judgment was required. For example, classifying “pit toilet latrine” as improved or unimproved was challenging without

knowing if a slab (which would make it improved) was present or not. In such cases, the response would be coded as improved or unimproved based on the other options provided in that country's DHS.

The use of world governance indicators as proxies for the political environments of the study nations is also an important study limitation. The computation of these indicators relies upon an unobserved components model, it is not an exact science, and values shift. These scores should not be considered a perfect valuation of the political climate of a nation, but rather a tool to view political climates in relation to each other, and to track changes in stability and government effectiveness over time.

Unweighted data analyses and failure to consider confounding factors should also be considered as study limitations. Furthermore, the data produced by this study should only be considered as a starting point for further research. The interaction between economic and political factors was not explored. In the real world, such factors interact, and should not be considered independently of each other. More complex and sophisticated models are required to fully understand the interaction between economic and political factors and their influence upon the availability of improved water and sanitation resources.

5.3 Recommendations

Further research is required to truly understand the magnitude of the impact of political and economic factors upon access to improved water and sanitation resources in the developing world. However, this study reinforces some common public health

postulates. First, GNI does appear to be associated with access to improved sanitation facilities, as well as shorter travel times to water source. These are two important variables that can greatly impact the health and quality of life for individuals in developing nations, and poverty is widely accepted as a factor that exacerbates health problems and widens health disparities (WHO; Pruss; WHO/UNICEF 2004; Mara 2003).

Government effectiveness appears to have an important impact upon access to improved drinking water sources, which likely stems from lack of capacity and priority given to such matters in nations with less effective governments (World Bank 2001). The associations between the economic/political factors and water treatment and access to private toilet facilities was more difficult to discern, and it is likely that other factors influence these variables. However, the relationship between these variables and economic and political factors is somewhat intuitive. Stable, effective governments are in better position to develop and maintain efficient, reliable public utilities, while ineffective governments may lack the capacity and attention to the problem to do so (World Bank 2001).

Urban or rural residence greatly influenced the interaction of GNI, political stability, and government effectiveness. Stratification by type of residence revealed confounding and effect modification, which suggests that living in an urban or rural environment has an influence upon one's access to improved water and sanitation resources, with rural residents usually being more negatively impacted than urban residents. Decentralization and dispersed ownership of public water and sanitation utilities has been suggested in the literature as a means of alleviating some of the burden

of lack of resources from rural residents, and generally increasing the water and sanitation coverage. Research suggests that the decentralization and privatization of public services, such as water and sanitation, can promote competition and ensure broader access to these resources (World Bank 2004).

In relation to government effectiveness and political stability, further research should explore access to improved water and sanitation among refugee populations in affected nations. Also, it is important to explore the development of these resources in post-conflict nations, which often face significant problems of post-conflict fragility including physical destruction, environmental deterioration, social trauma, severely limited productive capacity and service provision, and general lack of trust, oversight, and accountability (Marshall and Cole 2009).

5.4 Conclusion

Safe water and sanitation resources are vital to maintaining and improving population health. Lack of such resources is a major factor for disease and ill health, particularly in developing nations. In developed nations, improvements in water and sanitation are widely considered among the top public health achievements of the 20th century. However, developing nations have not had the same success in these areas. Political and economic factors must be taken into account when developing water and sanitation related interventions. The economic resources and government capacity of nations are important considerations, and political stability affects the consistency of services and general social climate of a nation. With these factors in mind, successful,

efficient water and sanitation resources can be provided in developing countries, improving the general health and quality of life for the people.

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