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NILE RIVER: LIFELINE AND SOURCE OF CONFLICT FOR NORTHEASTERN AFRICA

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ABSTRACT

Over 238 million people live in the Nile River Basin. For many nations in this region in Eastern Africa, the Nile River is the sole source of freshwater. This has made the Nile one of the most contested rivers in the world. Egypt is the dominating power on the river with over 80 million of its people dependent upon the river. For centuries, Egypt has had a near monopoly over the Nile's resources, which has proved to be a detriment to the hundreds of millions of other people who cannot fully utilize the Nile water within their country's national boundaries. Recently, however, many of the 10 other Nile nations have signed a novel agreement known as the Cooperative Framework Agreement. This agreement is essentially a declaration from the Nile nations stating their right to use the Nile water resources within their national boundaries. The Cooperative Framework Agreement is also a rejection of centuries old Nile Water Agreements signed by European colonial powers, on behalf of their African territories, and Egypt. This thesis analyzes the legality of the current Nile Water Agreements, ways to increase water consumption and decrease water loss, and considerations for a comprehensive new agreement between the 11 Nile states. Related statutes of international law and water law are considered to determine the legality of the current Nile water treaties. Rapidly increasing populations and less stable precipitation patterns have placed strains on water and agricultural resources throughout the region. As tensions are rising, a new Nile Waters Agreement must be created. As ex-Egyptian President Anwar Sadat stated, "The only matter that could take Egypt to war again is water." This thesis strives to propose ways to prevent such a war from occurring by analyzing the entire situation and suggesting tangible solutions.

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Introduction

Over 238 million people live in the Nile River Valley ("Opportunities and Challenges," 2012). Under current laws and treaties, approximately 100 million people have the right to use the Nile River's waters (Carlson, 2013). The Nile River is arguably the longest river from its source in Burundi to its exit point into the Mediterranean Sea out of Egypt. It is comprised of three main branches: the White Nile, Blue Nile, and the Atbara River. These three tributaries, along with the hundreds of others that bring water to the Nile, run through 11 nations (Figure 1).

The Nile River is responsible for providing life-giving services to millions of people. Millions are suffering because they do not have the right to fully utilize the Nile's waters for their own benefit. This is because of treaties created during the 20th century when many of these nations were still under the power of a European nation. The Nile Waters Treaty of 1929 is the primary treaty, which started Egypt's official domination over the Nile's waters (Wolf, 2008). It was promulgated between the newly independent Egyptian government and the United Kingdom—who represented its territories in the upper Nile basin. Those territories are the modern-day nations of Sudan, South Sudan and Uganda (Carlson, 2013). The Nile Waters Treaty of 1959 is the most recent major treaty that governs jurisdiction over the Nile's waters. Egypt and the newly independent Sudan essentially split the Nile's yearly flow between the two nations by allocating 55.5 and 18.5 billion m^3 of the Nile's usable 74 billion m^3 of water respectively (Wolf, 2008). This treaty does not take into account any of the interests of the other upstream nations.

Despite the fact that there are treaties governing the Nile's usage, many of the upstream nations are rebelling against these agreements. They argue that these Nile Water Agreements are unjust and illegitimate, raising many points widely recognized in international law and water law. Nations such as Ethiopia, where 84% of the water that reaches Egypt originates, argue that they were not consulted during the agreements and, therefore, do not need to abide by them (Carlson, 2013). The upstream nations have signed the Cooperative Framework Agreement, which was created to assert their right over some of the Nile's annual flow. The situation has the potential to become disastrous, particularly because 95% of Egypt's population is reliant upon the Nile as their sole freshwater source ("State Information Services," 2009). It is critically important to find solutions to rectify this thorny issue before tensions escalate further, which is why this topic was chosen for this thesis.

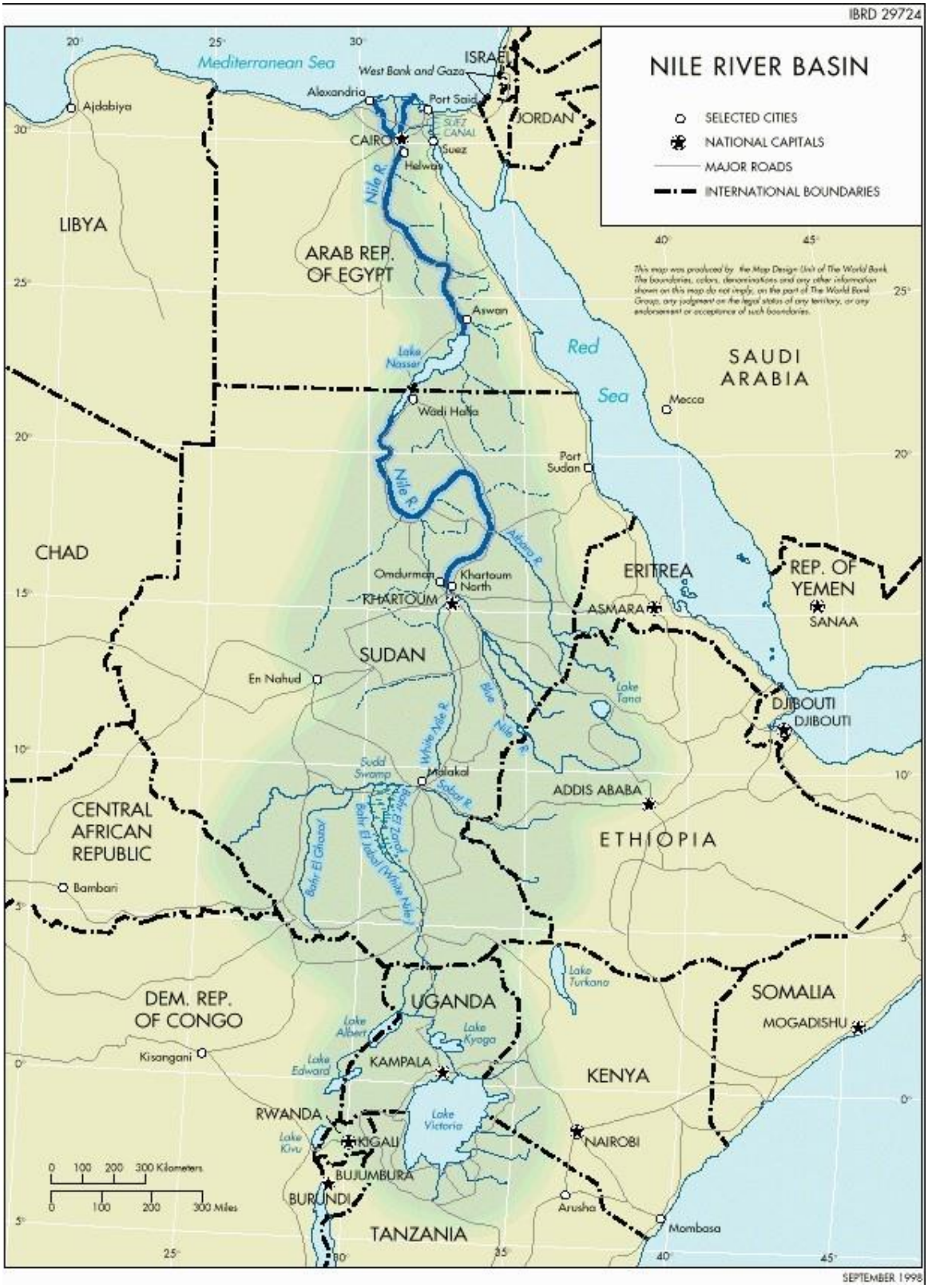
In order to prevent catastrophe from occurring in the region over the Nile, a new binding treaty should be created. This treaty would need to address the legitimate concerns of Egypt, the nation farthest downstream and most dependent user of the Nile, while still allocating appropriate quantities of water to the upstream nations. Here, I discuss relevant background information on economics, geography, law, and potential solutions to better understand and address the Nile water issue.

Geography of the Nile Region

The geography of the Nile River is one of the most diverse of any river systems in the world. Due to the fact that the Nile River is the longest river in the world, it crosses through very diverse climates along its course ("The Water Resources of the Nile Basin," 2012). Beginning in the vicinity of Lake Victoria in Central Africa and the highland region of Ethiopia, this river crosses through 11 countries on its journey to the Mediterranean Sea ("The Water Resources of the Nile Basin," 2012). Approximately 238 million people reside in the Nile River Basin, which is located in Egypt, Sudan, Ethiopia, Eritrea, South Sudan, Democratic Republic of the Congo, Uganda, Kenya, Tanzania, Burundi, and Rwanda ("Opportunities and Challenges," 2012). A map of the Nile River Basin, shown in Figure 1, can be found on the following page.

The Nile can be divided up into three main branches—the White Nile, Blue Nile, and Atbara. The White Nile begins from its sources in Burundi and Rwanda and then drains into Lake Victoria—the largest freshwater lake in Africa. From Lake Victoria, the river continues to flow north crossing the political borders of Uganda, South Sudan, and Sudan until reaching near the Sudanese capital, Khartoum, where the White Nile meets the Blue Nile River. The Blue Nile River begins in the highlands of Ethiopia where excessive rains in the summer months cause the river to swell in size. The convergence of the Blue and White Nile near the city of Khartoum creates a single river often referred to as the "Nile Proper". The Atbara River also forms in the Ethiopian highlands and enters the Nile Proper north of Khartoum near the town of Atbara in Northern Sudan. The Nile Proper flows northward through Egypt where it ends into the Mediterranean Sea. The Nile River is the main, and sometimes the only, true viable drinking water source in many of these nations. The unique geography of the Nile has made it the most valuable natural resource in the region ("Opportunities and Challenges," 2012).

Figure 1. Political Map of the Nile River Basin ("Nile River Basin," 2000)



White Nile

The White Nile is one of the three major tributaries of the Nile River. The source of the White Nile is largely from the small rivers that enter Lake Victoria and the lake itself ("Opportunities and Challenges," 2012). From Lake Victoria, the river flows north through Uganda and a series of lakes before reaching South Sudan. During this portion of the White Nile, seasonal rains and tributaries add to the river's volume ("Opportunities and Challenges," 2012). In South Sudan, the White Nile slowly meanders through the Sudd—a series of massive wetlands that have extensive amounts of evapotranspiration, and hence loss of usable water ("Opportunities and Challenges," 2012). After passing through the Sudd, the White Nile flows north into Sudan where it joins with the Blue Nile River. The amount of water that reaches Egypt from the White Nile is fairly consistent, regardless of the season, and makes up approximately 14% of the water in Lake Nasser. The Sobat River, which combines with the White Nile in northern South Sudan, accounts for an additional 14% of the water in Lake Nasser ("ICE Case Studies," 1997).

Figure 2. Map showing where the White and Blue Nile Rivers meet (Carslon, 2013)

Lake Victoria, situated between Tanzania, Uganda, and Kenya is the second largest freshwater lake in the world with an area of 69,484 km^2. It is situated approximately 1134 m above the sea level on the East African plateau. The lake exists between the West and East Great Rift Valley systems of East Africa in a shallow, continental sag. To the East of the lake lies the Kilimanjaro mountain range, and to the West lies the Rwenzori mountain range. The Northern part of the lake is located on the equator resulting in an extremely hot and tropical climate (Kizza, 2009).

Due to its geographic position and elevation, Lake Victoria experiences an abundance of rainfall. While the lake itself and immediately surrounding areas have a tropical climate, the greater region is highly variable climatically and some areas, especially to the South, have semi-arid climates. Eighty percent of the annual recharge of the lake comes from precipitation. This

makes Lake Victoria extremely susceptible to climate change. Currently, precipitation patterns vary greatly month-to month and year-by-year. Generally, Lake Victoria experiences a long rain season from March to May and a short rain season from October to December. On a yearly basis, according to a recent study conducted by researchers from Makerere University, Uppsala University, and University of Oslo, most of the sites that were measured do not have precipitation trends. Rainfall across the lake is generally variable with only 17% of the records at measuring sites indicating a trend. Two thirds of these trends indicated increased rainfall, mostly concentrated in the North of the Lake by Uganda. The rainfall around Lake Victoria is largely dependent upon the local weather patterns. The local climate is highly dependent upon seasonal changes and climatic events such as global warming (Kizza, 2009).

Water also enters Lake Victoria through many smaller streams coming mostly from the East and West. The largest and significant of these streams is the Kagera River. The Kagera River flows through western Tanzania and begins primarily in Burundi. The largest tributaries of the Kagera River, the Ruvuvu and Nyabarongo flow from Burundi and Rwanda. Other important inlets into Lake Victoria are the many smaller rivers coming from Kenya such as the Migori. The flow of all of these rivers combined is responsible for supplying Lake Victoria with nearly 20% of its annual recharge, making them important components in the Lake Victoria ecosystem, and in turn, the Nile River ecosystem ("Kagera River," 2015).

The White Nile, from the point where it exits Lake Victoria to the point where it crosses into Lake Albert, is generally referred to as the Victoria Nile. This section of the Nile runs through Uganda. After leaving Lake Victoria near Uganda's city of Jinja, the river flows north into Lake Kyoga. Prior to entering Lake Kyoga, the river is bisected by three hydroelectric dams and hydrostations including, the Bujagali, Kiira, Nalubaale power stations. Multiple new

projects are being proposed and construction has already begun on the Isimba power station. The river itself and the lakes that the Nile transects along its North-bound flow are among the most important water sources for Uganda's nearly 36 million people. This section of the river is characterized by swamps and is largely unnavigable ("Uganda," 2014).

The Victoria Nile next enters Lake Kyoga. This lake is in a large basin located in central Uganda and is comprised of many smaller fringe lakes on its outskirts that become wetlands during the rainy season. The main fringe lakes are Lakes Kwania, Kojweri, Nakuwa, and Myaguo. Lake Kyoga is essentially a widening of the Nile that exists in a geological setting, which made the lake's existence possible. The Achwa, Pager, Dopeth-Okok, and Mpologoma are all large rivers that drain into the lake. Lake Kyoga is shallow, usually reaching a maximum depth of nine meters. From Lake Kyoga, the Victoria Nile flows to the northeast into Lake Albert and along the way, the Victoria Nile receives additional volume from the Kafu River. On its path, the river drops in elevation relatively steeply creating rapids and waterfalls. Along this part of the river, Uganda is planning on constructing two additional hydroelectric power stations – the Ayago and Karuma ("Uganda," 2014).

After leaving the Kyoga Lake system, the Nile River enters Lake Albert. Lake Albert exists in the northern-most section of the Albertine Rift, a section of the Great Rift Valley. The western half of the lake is within the Democratic Republic of the Congo, while the Eastern half is in Uganda. On the Western side of the Lake, the Blue Mountains rise steeply forming a natural border that prevents the lake from expanding westward during rainy seasons. No major cities are on the shores of Lake Albert. The lake is fed primarily by two sources, the Victoria Nile and the Semliki River, which connects Lake Albert with Lake Evans and Lake George to the south. All of these lakes and rivers have an impact upon Lake Albert, which in turn, affects the flow rate

and volume of the White Nile River. After leaving Lake Albert, the Nile is known as the Albert Nile and flows due north heading towards South Sudan. The Zano River, serving a large area of northwestern Uganda, is an important tributary that drains into the Albert Nile near the border of South Sudan (Saundry, 2012).

Coursing north from Uganda into South Sudan, the next section of the White Nile is known as the Mountain Nile. The Mountain Nile is characterized by rapids that reach as far north as the capital of South Sudan, Juba. The largest feature of the Mountain Nile is the Sudd. The Sudd is one of the largest wetlands in the world and the largest wetland within the Nile system. The area is characterized by papyrus and aquatic grass covering expansive regions, which are frequented by hippopotami and crocodiles. This unique environment is an important ecosystem for many migratory species and nearly 400 species of birds. The pastoral Nilotic Nuer people have inhabited the region for centuries. These wetlands are highly variable in size and are dependent upon the area's different climate regimes that change with the season ranging from 30,000 km^2 in the dry season in size to 130,000 km^2 in the wet season. The Sudd is very shallow which prevents continuous travel across the White Nile from the South to the North. The Sudd ecosystem serves the local region as an important source of water, fishery, and flood catchment region (Kaushik, 2012).

Despite the benefits of the Sudd, nations like Egypt and Sudan have been trying to divert water away from the wetland for the past century. It is estimated that 55% of the water that enters this massive wetland is lost to evapotranspiration (Suttcliffe, 2010). Egypt and Sudan began a joint venture project, the Jonglei Canal, to divert water away from the Sudd. The idea was first seriously proposed in 1907 and operations began in 1978 (Kaushik, 2012). Due to political instability in Sudan, the canal was never finished, however, although serious talks about

recommencing canal construction are currently underway (Kaushik, 2012). It is estimated that the water brought from the Jonglei Canal could enhance Egypt's water supply by approximately 5-7% (Suttcliffe, 2010). If the canal was successfully constructed, however, the canal would cause irreparable damage to the Sudd ecosystem and may not reap as fruitful benefits as upstream states had anticipated (Kaushik, 2012).

To the North of the impassable Sudd, the Mountain Nile thins back into a single river as it quickens its pace as it continues to move northward through South Sudan and Sudan. At Lake No in northern South Sudan, the Bahr el Ghazal River meets with the Mountain Nile contributing over 11 billion m^3 of water to Nile. The Sobat River enters the White Nile in northern South Sudan and contributes over 13 billion m^3 of water to the river. The amount of water input from the Bahr el Ghazal and Sobat rivers make up the majority of the water that will actually make the journey to Egypt via the White Nile. The Mountain Nile flows north into Sudan where it is the primary water source for millions of people in the country. In the Sudanese capital, Khartoum, the White Nile reaches a confluence with the Blue Nile (Suttcliffe, 2010).

Blue Nile

The Blue Nile River is the second major tributary that forms the Nile River. It forms as the exit point for Lake Tana, a freshwater lake in the Ethiopian Highlands, and flows through Ethiopia and eastern Sudan before meeting with the White Nile near Khartoum, Sudan. The Blue Nile accounts for nearly 59% of the water that reaches Lake Nasser in Egypt—making it an important resource for Ethiopia, Sudan, and Egypt. The volume in the river is highly dependent upon the region's seasonal climate. In the summer months, the river swells in size contributing nearly 70% of the water that reaches Egypt while in the winter months the volume is much smaller ("ICE Case Studies," 1997).

Figure 3. Map showing the source of the Blue Nile River ("Blue Nile Map," 2004)

Lake Tana is the largest source of water for the Blue Nile. Located in the Amhara region of the Ethiopian Highlands, this lake is the largest body of water in Ethiopia. Precipitation and various smaller rivers such as the Lesser Abay, Reb, and Gumara Rivers feed the lake. The lake

has a total drainage area of nearly 15,000 km^2. The average depth is 7.2 m while the maximum depth is 14 m. The Tis Abay I and II hydroelectric plant is located 32 km south of Lake Tana and uses the flow from the Blue Nile to produce electricity for the region. The city of Bahir Dar, located to the south of Lake Tana where the Nile River begins, is one of Ethiopia's major tourist destinations and plays a significant role in the Ethiopian economy (Kebede, 2006).

The region surrounding Lake Tana is an agricultural, and fishing-based economy with approximately 47% of the Lake Tana catchment area covered by farms (Wale, 2008). The main outflow of Lake Tana is the Blue Nile River (Kebede, 2006). The lake exists in a land depression that was formed millions of years ago from volcanic activity (Wale, 2008). The Nile exits Lake Tana at the lake's south end where the elevation rapidly drops causing the river to flow at a fast pace (Kebede, 2006).

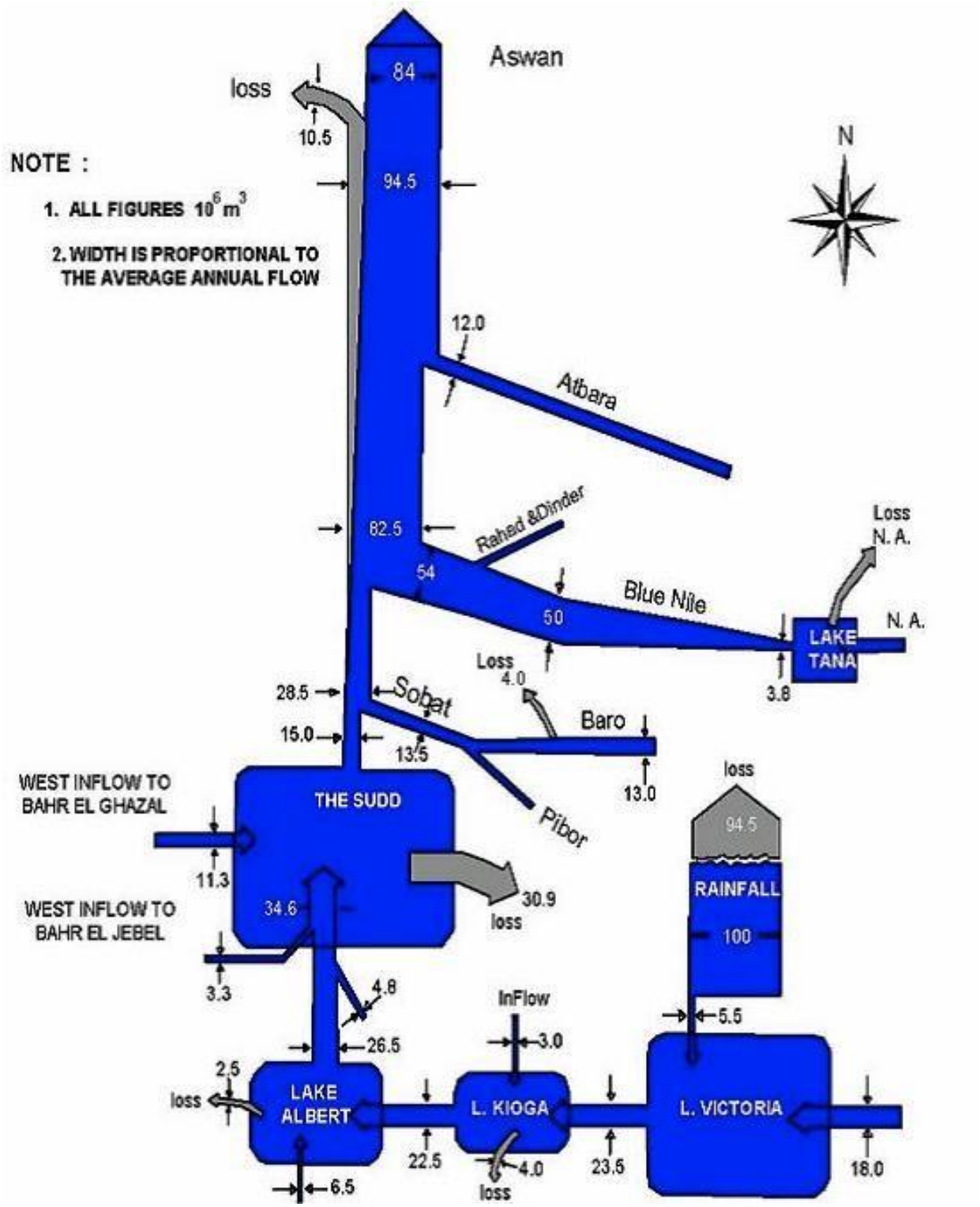
From Lake Tana to Khartoum, the Blue Nile winds its way through the Ethiopian highlands carving deep canyons into the landscape. Large portions of the Blue Nile are unnavigable or extremely dangerous to transverse. The Bashilo, Jamma, Muger, Didesa, and Dabus Rivers are some of the many tributaries that enter the Blue Nile on its way to Sudan. Approximately 1460 km long, the Blue Nile catchment area is a vital source of water particularly to the Sudanese economy. Two dams, the Ruṣayriṣ and Sannar, were constructed on the river to provide irrigation water to nearly 1 million acres of land serving primarily Sudan's cotton and agriculture industries. These dams also provide nearly 80% of the nation's hydroelectric power. In the Ethiopian highland rainy season from June to September, the Blue Nile swells in size to the point that over the course of a year it will provide about 70% of the water that enters the Nile proper. The Blue Nile is a particular point of contention between Ethiopia and downstream Nile nations. Ethiopia is currently constructing a massive dam on the river deemed illegal by the

downstream users because it could threaten their water supply. This topic will be discussed at length in later sections ("Blue Nile River," 2015).

The Atbara River is another large river that begins in the Ethiopian Highlands. Approximately 14% of the water that reaches the Aswan Dam comes from this river ("ICE Case Studies," 1997). The river is formed north of Lake Tana and is the last major tributary reaching the Nile River Proper (Zaghloul, 2007). For large periods of the year, the river is mostly dry and a series of small lakes are created, however, the river swells during the summer months in the rainy season (Zaghloul, 2007). The Khashm El-Girba dam is located on the Atbara River in eastern Sudan and is used to create electricity and to stabilize the intermittent water flow by creating a lake behind the dam that has allowed for consistent flow north of the dam (Zaghloul, 2007).

The Nile Proper is formed at the confluence of the White and Blue Nile Rivers. This part of the river stretches from Khartoum, is joined by the Atbara River further downstream, and eventually exits out of Egypt into the Mediterranean Sea. Egypt and Sudan are the sole users of this portion of the river and are highly dependent upon it for their national water resources. The Merowe Dam and the Aswan High Dam are two of the major infrastructure projects that have been created on this portion of the Nile River. Both of these projects have regulated the flow of the Nile, produced hydropower, and created reservoirs to allow for irrigation of local lands. The Nile proper is the most developed section of the Nile with the highest population density in close proximity to the river in the basin. ("The Water Resources of the Nile Basin," 2012).

Figure 4. This image shows the inlet and outlet sources of the Nile on its way to Egypt ("The Water Resources of the Nile Basin," 2012)



People of the Nile

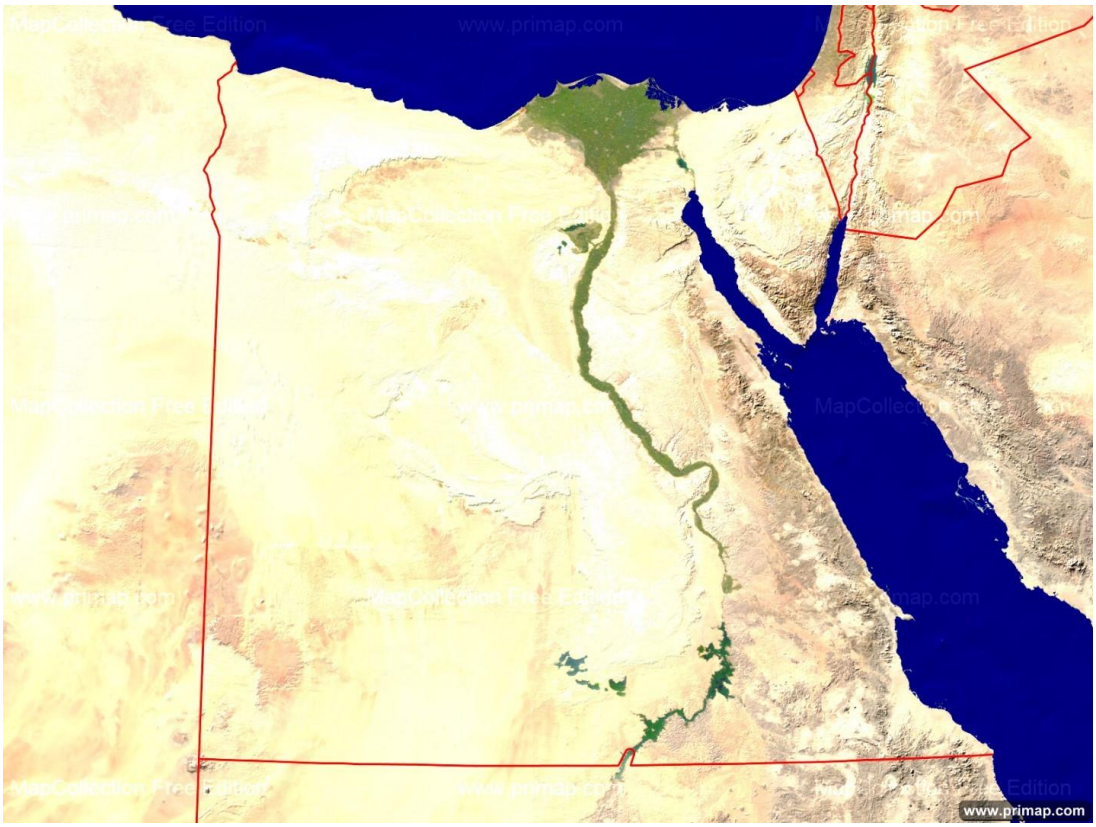
The Nile River, arguably the largest river in the world – it is considered the longest in latitudinal extent but the Amazon has a larger discharge, stretches from central-eastern Africa beginning in Lake Victoria and flows northward all the way to the Mediterranean Sea in Egypt. The Nile River basin is approximately three million km^2 in area, effectively covering 10% of the land area of continental Africa (Kameri-Mbote, 2007). The Nile and its tributaries directly impact eleven nations, including Egypt, Sudan, Ethiopia, South Sudan, Democratic Republic of the Congo, Uganda, Kenya, Tanzania, Rwanda, Burundi, and Eritrea. Approximately 268 million people live in the Nile River Basin, and 437 million people live in the Nile River nations ("Opportunities and Challenges," 2012). Each of these 11 nations has differential economic outlooks, access to water, and usage of their Nile River resources.

Egypt

Egypt is the most populous nation in the Nile River Basin with approximately 87 million people ("Egypt," 2014). The annual population growth rate is 1.8%, which has been decreasing year by year (Karajeh, 2013). Egypt stretches from the Southern Mediterranean down to the border of Sudan (Figure 5). Egypt controls the Sinai Peninsula as well as the Sinai Suez canal, making the nation one of the most important nations in terms of global trade and transportation. Egypt is a regional economic and military powerhouse as well as the most populous Arab nation in the world, allowing Egypt to have significant political power in the region and across the world.

In total, Egypt is 1,004,500 km^2 in area with only 2.87% of the land arable for crop production. However, Egypt has been reclaiming desert lands since the construction of the Aswan dam in 1970, which is steadily increasing the arable land available. As of 2003, there were approximately 34,200 km^2 of irrigated land. Nearly all of the arable land is located around the Nile River from which approximately 95% of Egypt's water comes. The remaining 5% of Egypt's water comes primarily from groundwater resources. Minimal amounts of Egypt's water comes from the 20 – 150 mm of precipitation that falls annually mostly in coastal northwestern Egypt. In total, Egypt uses 69.7 billion m^3 of water annually, where 55.5 billion m^3 comes directly from the Nile River, 4.7 billion m^3 is recycled water from agriculture catchment, and the remaining amounts comes from groundwater or other recycled sources.

Figure 5. Satellite Map of Egypt ("National Maps - Egypt - Satellite," 2014)



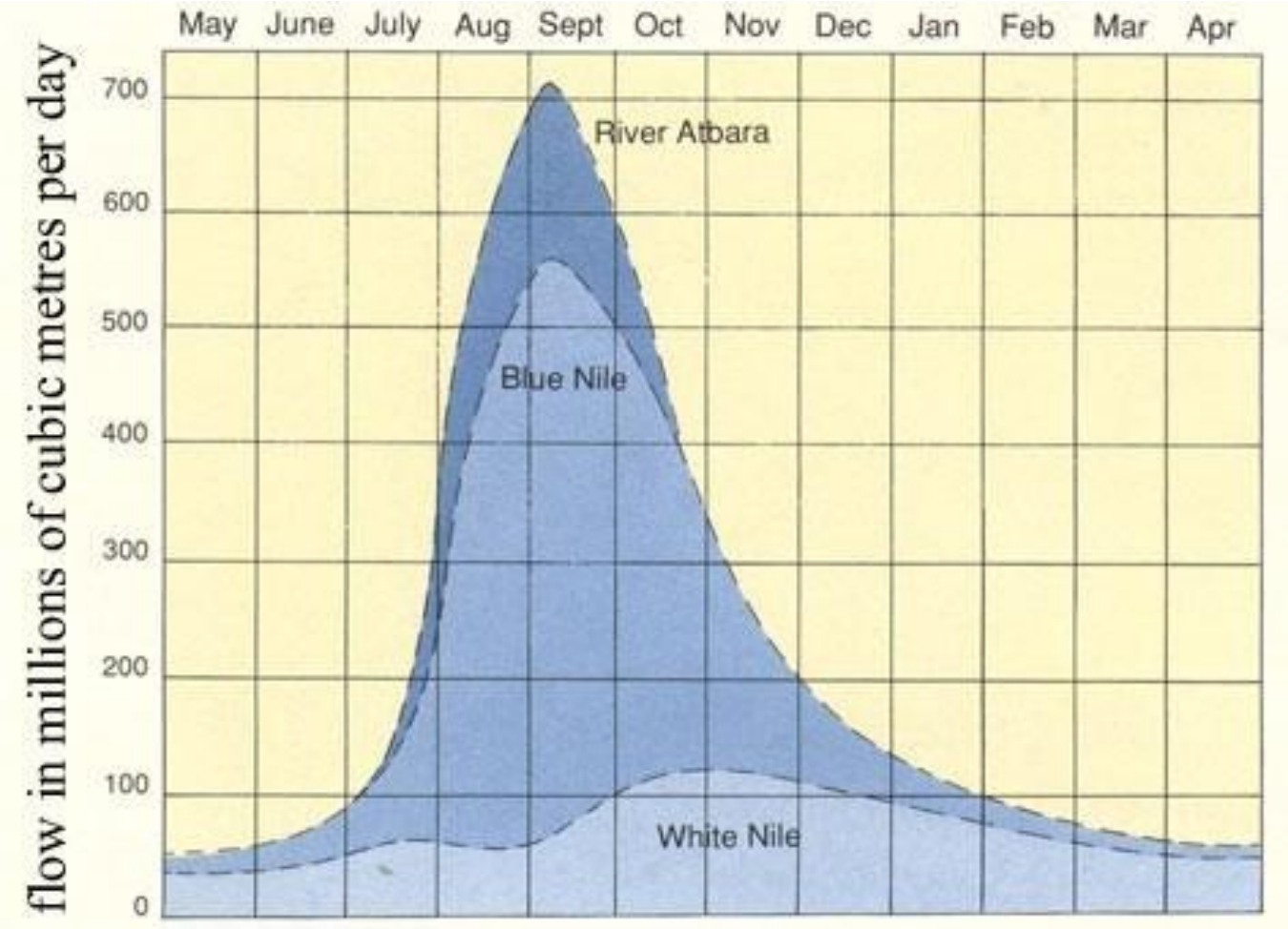
By simply looking at a map of Egypt, as shown in Figure 5, one can see how dependent the nation is on the Nile. Due to the contrast between the nation's arid environment and the arable environment created around the Nile River, it is quite easy to surmise where the Egyptian population lives. All of the green areas on the map correspond to the populated parts of the country. Most of these sections follow along the Nile River, which appears to make the Nile seem larger. The river irrigates even the green areas in the southern part of the country that do not seem to be attached to the Nile. These farmlands are a part of the Toshka projects— a controversial project that diverts thousands of m^3 of water to one of the most arid parts of Egypt ("State Information Services," 2009).

Agriculture accounts for approximately 15% of Egypt's USD 232 billion GDP. In 2012, 55% of the population relied on agriculture for their livelihood and 32% of the nation was employed by the agricultural industry. The percent of people employed in the agricultural industry has been decreasing as more people move to the more urban areas of the nation where there are better economic situations. Egypt has 40,000 km of canals that bring the Nile water to farmed areas on either side of the Nile. An estimated 80 – 85% of all water resources are used by the agricultural industry with the main crops being cotton, rice, corn, and wheat (Karajeh, 2013).

Nearly 99.3% of the population has access to improved drinking water sources. This percentage is slightly higher in urban areas and slightly lower in rural areas ("Egypt," 2014). As of 2010, an estimated 10.4% of Egypt's electricity comes from hydropower sources, mostly from the Aswan Dam ("Egypt," 2014). The Aswan High Dam is Egypt's most important dam and hydroelectric power source. The dam produces approximately 10 billion kwh per year of electricity and is directly responsible for creating Lake Nasser—a massive water reservoir that holds more than

two years' worth of volume of water (169 billion m^3) for the entire Egyptian population (Rosenberg, 2015). The dam is responsible for regulating the flow of the Nile, and thus, has prevented the annual flooding of the Nile since it was constructed in 1970. Egypt is the most downstream nation on the Nile; therefore, the water that reaches Egypt comes from all of the Nile's sources including the White Nile, the Blue Nile, and Atbara Rivers. Figure 6 shows how the volume of the Nile changes on a seasonal basis and shows the source of the water that reaches the Aswan High Dam in Egypt.

Figure 6. Water volumes (million m3/day) of the Nile in Egypt broken down by its primary source ("Future Demands on the Nile," 2007)



Sudan

Sudan borders the Red Sea to its East, Eritrea and Ethiopia to the Southeast, South Sudan to the South, Chad to the West, Libya to the Northwest and Egypt to the North (Figure 7). Most of the nation is very dry and arid due to the presence of the Sahara desert in the western half of the country. Parts of the south and southwest of the nation receive rainfall, particularly the regions closest to the border of Ethiopia. The largest source of freshwater in the nation is the Nile. In Sudan, many tributaries of the Nile converge at different locations to form the Nile Proper, which eventually flows into Egypt. The White Nile, flowing north from South Sudan, encounters the Sobat River flowing from the east, the Blue Nile near Khartoum where the two rivers converge, and the Atbara River from the southeast forming the Nile proper. These four rivers combined bring 84 billion m^3 of measured water annually to the Aswan High Dam in Egypt ("ICE Case Studies," 1997). While the White Nile, Sobat, Blue Nile, and Atbara Rivers converge within Sudan, they are all formed elsewhere. The Sobat, Blue Nile, and Atbara Rivers, which make up 14%, 59%, and 13% of the water reaching Egypt annually, all begin in the Ethiopian Highlands ("ICE Case Studies," 1997). The White Nile, originating from Lake Victoria in Central-East Africa, makes up 14% of the water reaching Egypt ("ICE Case Studies," 1997). Most of Sudan is within the Nile River Basin. Parts of the West and East of the nation are reliant upon groundwater outside of the Nile watershed. In Figure 7, one can see the convergence of the White and Nile rivers. The light blue line on the right side of the river to the North is the Atbara River. Most of the Sudanese population lives somewhere within this watershed.

Figure 7. Political Map of Sudan ("White - Blue Nile," 2014)

Sudan is the sixteenth largest nation in the world by area measuring 1,861,484 km^2. Only 6.76% of the land is arable with most of the arable land is located in close proximity to the Nile River or one of its tributaries ("Sudan," 2014). Sudan has a population over approximately 35.5 million people with an annual population growth rate of 1.78%, which has been increasing year by year ("Sudan," 2014). Around 80 – 85% of the Sudanese rely upon the Nile Basin's waters (Sullivan, 2010). Only 55.5% of the nation has access to clean drinking water with 66% having access in urban areas and 50.2% having access in rural areas ("Sudan," 2014). Sudan is apportioned 18.5 billion m^3 of the Nile's volume annually, giving the nation nearly 22% of the Nile's annual flow.

The Sudanese economy is heavily dependent upon agriculture with approximately 80% of the labor force working in the agricultural industry, which encompasses nearly 40% of the nation's GDP (Sullivan, 2010). The main agricultural products are cotton, peanuts, and sugarcane. Ninety-seven percent of all of the nation's Nile waters are used by the agricultural industry which is heavily reliant upon handmade, inefficient irrigation schemes (Sullivan, 2010). As of 2010, 18,900 km^2 of land are irrigated from the Nile ("Sudan," 2014).

Two thirds of Sudan's electricity is generated from hydropower sources. There are five major dams in Sudan. The Sennar and Roseries dams are on the Blue Nile River. The Khashm el-Girba Dam is located on the Atbara River and the Jebel Aulia Dam is located on the White Nile River. All four of these dams were constructed to provide flood control, irrigation services, and hydropower for the nation. The Merowe dam is a massive dam-reservoir located on the Nile proper in the North the country. It produces 1250 megawatts of energy per year, which nearly doubled Sudan's electricity generation by the time the dam was completed in 2009 ("Merowe Dam," 2015).

Comparison of the Downstream Nations

Egypt and Sudan, generally referred to as the downstream users, are the largest consumers of Nile water. According to the 1959 Nile Waters amendment to the 1929 Nile Waters treaty, Egypt is allocated 55.5 billion m^3 and Sudan 18.5 billion m^3 of the Nile's 84 billion cubic meter annual flow. This means that Egypt, which has a population more than 2.5 times larger than Sudan, is allocated 3 times more Nile water than Sudan. To begin with, the 1929 and 1959 Nile Waters Agreement essentially allows solely Egypt and Sudan to use the Nile

water by allocating 88% to the two nations and assuming the remaining 12% will be evaporated. This is not a sustainable allocation of the Nile's waters, especially because it does not allocate any waters to the other Nile basin nations. This point will be discussed in greater detail in a later section ("ICE Case Studies," 1997).

Table 1. This table is a comparison of Egypt's and Sudan's Nile water use ("Egypt," 2014) and ("Sudan," 2014)

Table 1. Nile Water Use - Egypt vs Sudan	Egypt	Sudan
Allocated Nile Waters (Billion $m^{3)}$	55.5	18.5
Irrigated Land (Km^2)	34220	18900
Km^2 of irrigated land/ Billion m^3	616.58	1021.62

From Table 1, it is evident that Sudan is able to irrigate more land than Egypt with the same amount of Nile water. One possible explanation for this is that parts of southern Sudan receive ample rainfall, especially in the areas irrigated by the Blue Nile closer to the border with Ethiopia, thus reducing Sudan's reliance on Nile water. Egypt receives virtually no rainfall and must rely nearly 100% on irrigation in order to plant crops. If this is the case, it seems that Egypt is more reliant upon the Nile waters and, therefore, makes sense that it will require greater access to the Nile. People in favor of Egypt having greater access to the Nile may argue this point. In truth though, it reveals that many of the water-heavy crops, such as cotton and corn, being planted in Egypt are unsustainable crops for the local environment. More efficient, less water-intensive crops would be better suited in Egypt. This point will be discussed further in a later chapter.

Upstream Nile Nations

The other nine Nile nations are generally considered the upstream Nile nations. These nations are Ethiopia, Eritrea, South Sudan, Democratic Republic of the Congo, Uganda, Tanzania, Kenya, Rwanda, and Burundi. Different tributaries of the Nile are formed or flow through all of these countries. While the Nile is the most important water resource in the downstream nations, increased access to the Nile for upstream nations would greatly enhance their respective economies and improve their citizens' quality of life. Due to this fact, many of the upstream nations are challenging downstream nation's sovereignty of the Nile's waters.

Ethiopia

Ethiopia is landlocked country located in east Africa. It is bordered by Eritrea to the North, Djibouti to the Northeast, Somalia to the East, Kenya to the South, South Sudan to the Southwest, and Sudan to the Northwest (Figure 8). The Sobat, Blue Nile, and Atbara Rivers constitute approximately 86% of the water that will eventually reach the Nile in Egypt. All three of these rivers form in the Ethiopian Highlands. These rivers become fast-moving, large volume rivers during the summer months, which can create extensive flooding in the region. In the dry season, the Blue Nile volume is greatly reduced causing the size of the Atbara and Sobat Rivers to reduce to the point where they become small, separated lakes rather than flowing rivers. ("ICE Case Studies," 1997).

The Ethiopian highlands are a region in western Ethiopia characterized by high rainfall in the summer months. Most of the people in this region are subsistence farmers who live on small plots of land. The success and prosperity of these farms, which constitute most of the work

force, are highly susceptible to drought and flooding. Famine is a regular occurrence in Ethiopia due to the fact that 85% of the workforce is involved in the agriculture industry and heavily reliant upon rain for crop production. Rainfall has become more inconsistent in recent years ("Ethiopia," 2014).

Figure 8. This figure shows Ethiopia's major river basins. The Tekeze, Abbay, and Baro-Akobo are all a part of the Nile River basin ("River Basins of Ethiopia," 2010)

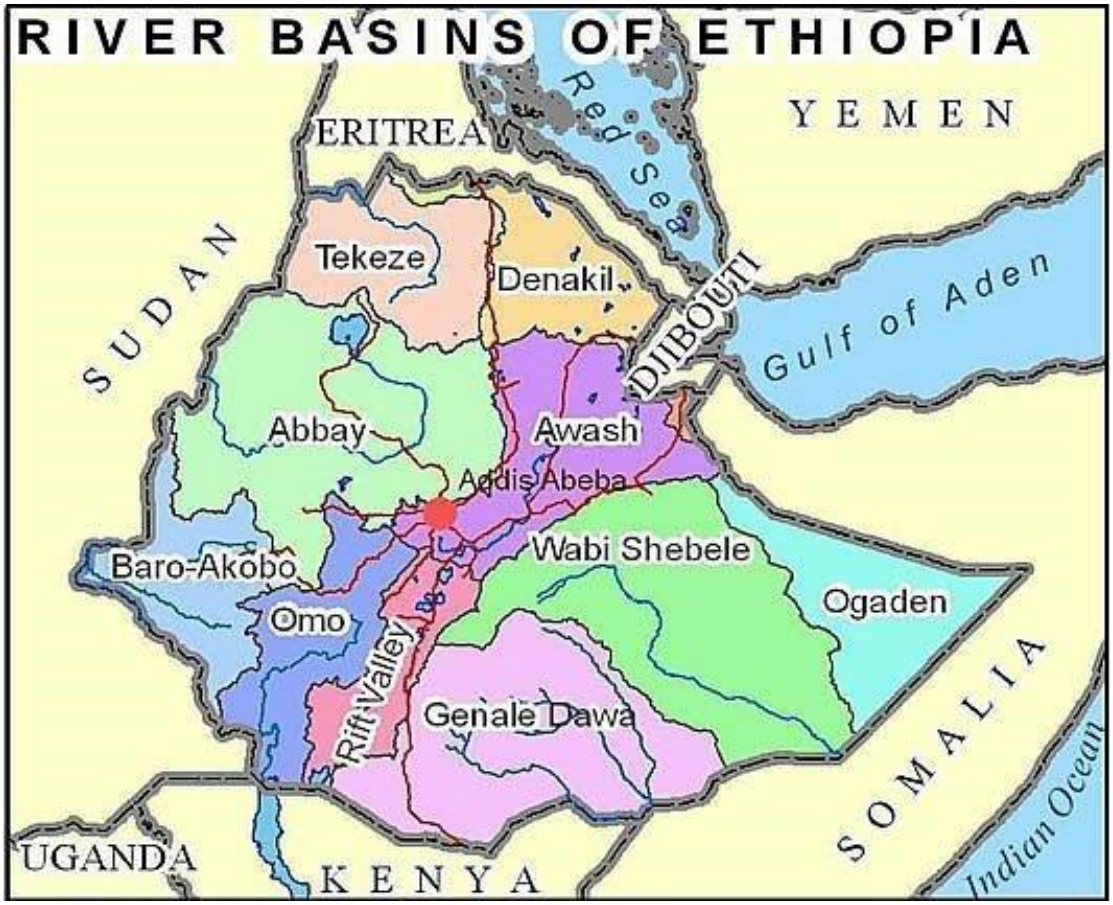


Figure 8 shows the various major river basins within Ethiopia. The Tekeze river basin is the largest basin in the Tigray and northern Amhara administrative regions in Ethiopia. The Tigray River is the largest tributary of the Atbara River and plays an integral role in Northern Ethiopia. Within the Tigray river basin, it is estimated that approximately 5-10 million people are dependent upon the basin for their livelihoods ("Opportunities and Challenges," 2012). The

Tekeze dam is a massive hydroelectric dam that was built on the Tekeze River and finished in 2009. It supplies 300MW of power to the local region, specifically to the Tigray capital Mek'ele. It was constructed and financed largely by the Chinese companies Sinohydro, China Gezhouba Water and Power Group and the Ethiopian company, SUR Construction. While the dam has provided power to thousands of people in the region, most of the electricity is generated in the large urban areas or has been sold to industrialized neighbors. The vast majority of rural, impoverished farmers are still not receiving electricity from this hydroelectric dam. Construction of this dam was controversial because it was in direct confrontation with the 1959 Nile Waters Agreement. By constructing the dam and enlisting foreign investment to finance the construction, Ethiopia placed itself in direct opposition to the interests of Sudan and Egypt (Pottinger, 2008).

Figure 9. Ethnic-political map of Ethiopia ("Administrative Regions," 2000)

The Abbay watershed is the most populated of the three Ethiopian watersheds that encompass the Nile River. This river system is also known as the Blue Nile. Most of the Amhara, Beneshangul-Gumuz, and parts of northeastern Oromiya are found within this river

system. Approximately 15-20 million people live in the Abbay watershed where agriculture is the economic mainstay ("Amhara People," 2015). Small towns are constructed on the tops of hills to avoid floods and crops are planted on the sides of hills where they can retain larger volumes of water ("Amhara People," 2015). On the Blue Nile south of Lake Tana, there are two smaller dams, the Tis Abay I and the Tis Abay II which produce 12 and 73 MW respectively (Tesfaye, 2000). Currently, there is a major dam on the Beles River, a tributary of the Blue Nile which is producing 460 MW of electricity and is providing irrigation to over 1416 km^2 of land in the Lake Tana vicinity ("Beles Multipurpose Project", 2013). Construction of this dam was done largely without the permission of Egypt, which claims it essentially has jurisdiction over any significant activities on any part of the Nile River. The Grand Renaissance Gorge Dam is currently being constructed on the Blue Nile close to Ethiopia's border with Sudan. This dam is expected to produce nearly 6000 MW of power, which would make Ethiopia the largest electricity producer on the continent (Veilleux, 2013).

The Baro-Akobo watershed consists of two rivers, the Baro and Akobo, which eventually become a part of the Sobat River. The Baro River is the primary river in this system and produces 83% of the Sobat River's volume. Most of the people living in this watershed live in the Northeastern Oromiya and Gambella parts of Ethiopia. Approximately 1 to 2 million people live in this watershed with the vast majority living agricultural lifestyles. There are not currently any significant dams in the region; however, Ethiopia has recently approved the Tams hydropower project on the Baro River which will produce 1,060 MW of power as well as two large irrigation projects for the region. (Yewondwessen, 2013)

Ethiopia has approximately 96 million people living within its borders, of which nearly a third live in the Nile watershed. While 96.8% of people in urban areas have access to clean

water, only 42.1% of the people in rural areas have access. This means that only 51.5% of people have access to clean water in the whole country. 85% of the workforce is employed by the agriculture industry, which makes up 47% of the national GDP. The main agricultural products are coffee, corn, various oil seeds, and livestock. Ethiopia is the source of 86% of the water that eventually reaches Egypt, yet it currently controls a meager amount. Only 5% of the irrigable land in the Blue Nile basin has been used for food production due to inconsistencies in precipitation. In a land continually ravaged by floods and drought, and where 29% of children are underweight and 39% of the population is below the poverty line, Ethiopian authorities are trying to invest in hydroelectric dams to lift their nation to higher economic lifestyles ("Ethiopia," 2014).

South Sudan

South Sudan is the youngest state in Africa after declaring independence from Sudan in 2011 ("South Sudan," 2014). The nation is bordered by Sudan, Ethiopia, Kenya, Uganda, Democratic Republic of the Congo, and Central African Republic (Figure 10). Over 11.5 million people live within the nation ("South Sudan," 2014). The South Sudanese economy is heavily focused on exporting petroleum; however, the vast majority of people work in the agricultural sector ("South Sudan," 2014). South Sudan is known to have some of the most fertile soils in Africa and has abundant rainfall making the nation highly suitable for agriculture ("South Sudan," 2014). Currently about 4% of all the land in South Sudan is under cultivation. Only 3% of this cultivated land is irrigated, meaning that the other 97% of the crops are watered from rain ("Agriculture, Food Security, and Livelihoods," 2014). Most of the cultivation occurs in the

flood plains of the many tributaries of the Nile which are suitable for both irrigation and rain-fed agriculture (Agriculture, Food Security, and Livelihoods," 2014).

Figure 10 is a political map of South Sudan that also shows the main rivers within the country. Nearly all of the populated areas of the country lie near or on the banks of one of these many tributaries. Approximately 99% of South Sudan lies within the Nile watershed, meaning that the Nile is imperative to the survival of South Sudan (Agriculture, Food Security, and Livelihoods," 2014). One of the major Nile features in South Sudan is the Sudd wetlands. These wetlands make up 15% of South Sudan's land area and are responsible for evaporating an estimated 55% of the White Nile every year ("The Environmental Resources of the Nile Basin," 2014).

Figure 10. Political Map of South Sudan ("Map of States of South Sudan," 2012)

South Sudan does not have significant potential to produce hydroelectricity due to the mainly slow moving waters within the Sudd where there is minimal elevation change. South Sudan's only possible location for hydroelectric potential on the Nile is located south of the capital, Juba, where the steep changes in elevation makes the area suitable for a power station.

Due to political instability, South Sudan is still an economically poor nation with 50.6% of the population living below the poverty line ("South Sudan," 2014). There are significant political tensions, divided among ethnic lines, which have effectively thrown the nation into civil war ("South Sudan," 2014). The instability has prevented significant foreign investment in the nation ("South Sudan," 2014). If and when stability eventually returns to the nation, South Sudan could play an integral role in creating a more equitable solution for the Nile by serving as the breadbasket of East Africa ("The Environmental Resources of the Nile Basin," 2012). South Sudan's fertile soil and abundant rainfall would make this nation the ideal location for increased agricultural production. The more arid downstream nations could make trade deals or lease land in South Sudan in order to plant crops in this region where less Nile water is required to grow crops. This would allow downstream nations to reduce their Nile water usage and would also increase water efficiency in the region. Additionally, South Sudan could become the location of massive canal projects that would circumvent the Sudd in order to increase the amount of water that reaches downstream nations. The Jongeli Canal was constructed for this purpose, and while significant progress was made, operations ceased when fighting began between Sudan and South Sudan during Sudan's civil war (Sugiyama, 2012). This canal would increase the amount of water that reached the Aswan dam by an estimated 4 billion m^3 annually (Sugiyama, 2012). In later sections, the possibility of diverting some of the water from the Congo River to the Nile River will be discussed. If this endeavor is ever realized, water would most likely be brought

into the Nile water shed by pumping it down to the Bahr-al-Ghazal River, a tributary of the White Nile River, in western South Sudan near the border of the Democratic Republic of the Congo (Hussein, 2013). South Sudan's location in the Nile Basin will make it a key player in future Nile negotiations.

Eritrea

Eritrea is located in northeastern Africa and bordered by Djibouti to the southeast, Ethiopia to the south and southeast, Sudan to the West, and the Red Sea to the North and East (Figure 11). This nation of over 6.4 million people has a geography consisting of hot, dry coastal climates in locations bordering the Red Sea and cooler, generally wetter climates in the central highland regions of the country where most of the larger cities and towns are located. The central highland climate is very similar to the Ethiopian highland climate with a rainy season in the summer months. Most of the agriculture within the country is heavily reliant on rainfall with only 5.87% of the land arable and only 216 km^2 of land irrigated. While the economy, in terms of GDP, is mostly dependent upon the service industry and industrial activities, 11.7% is dependent upon agriculture. Despite this, approximately 80% of the nation's workforce is in the agriculture industry ("Eritrea," 2014).

Figure 11. Political map of Eritrea ("Eritrea," 2006)

Eritrea is currently experiencing one of the most debilitating droughts in the nation's existence since separating from Ethiopia in 1991 ("Eritrea," 2014). This drought is causing local water tables to drop and destroying large percentages of the crops that the nation produces. The lack of rainfall is completely decimating the nation's agricultural industry, thus causing food shortages and limiting the incomes of millions of Eritreans. Increasing the amount of land that is irrigated is one possible solution to this problem. The three main dams in the nation are the Toker, Mai Hefni, and Mai Surwa dams, which are all used to irrigate lands and to supply water to the nation's capital and largest metropolitan, Asmara ("Eritrea," 2014). Most of the populated areas in Eritrea are located in the central highlands in the western half of the country. This area is dependent upon precipitation and groundwater as water sources; however, much of this region is technically apart of the Nile Watershed. An estimated 38% of Eritreans live in the Nile Watershed ("Opportunities and Challenges," 2012). Much of the water in Eritrea within the watershed rarely reaches the Nile Proper due to evaporation, becoming stored in aquifers, and

agricultural usage ("Eritrea," 2014). In times of intense flooding, the Gash River stemming from southern Eritrea, will flow into the Atbara River ("Eritrea," 2014). Eritrea's border with Ethiopia is along the Tekeze River, known as the Setit River in Eritrea, which supplies most of the water to the Atbara River. This region is sparsely populated and there is very little infrastructure on the Eritrean side of the river, nevertheless, a few of the Tekeze's tributaries, such as the Adama River, begin in Eritrea ("Eritrea," 2014). Because most of the water within the Nile basin in Eritrea does not play a large impact upon the Nile's volume, Eritrea is not a major player in the Nile dilemma.

Eritrea, along with the Democratic Republic of the Congo, are the two upstream nations that are not fighting against Egypt and Sudan to gain greater control of the Nile. Eritrea, an observer in the Nile Basin Initiative, often aligns with downstream nations with respect to changing water agreements. This alliance is partially the result of past Nile politics involving Ethiopia and Egypt. Many historians believe that the emperor of Ethiopia in 1959, Emperor Haile Selassie, was frustrated by the Nile Waters Agreement amendment between Egypt and Sudan because it gave no allocation to Ethiopia over any of its Nile River resources and also because Ethiopia was not consulted by either government. As a result of the mistrust between the two nations, the emperor initiated a separation of the Ethiopian Orthodox Church from the Egyptian Orthodox Church located in Alexandria. By doing this, Egypt's power of choosing religious figures within Ethiopia ended. This ended 1,600 years of a joint institution between these two churches. Additionally, Ethiopia began to plan for the construction of dams on the Blue Nile, and Tekeze Rivers. The prospect of dams along sources of the Nile threatened Egypt's Nile water resources. The Egyptian, President Nasser, encouraged the largely Muslim part of Ethiopia, the former Eritrea, to secede from Ethiopia. President Nasser also encouraged

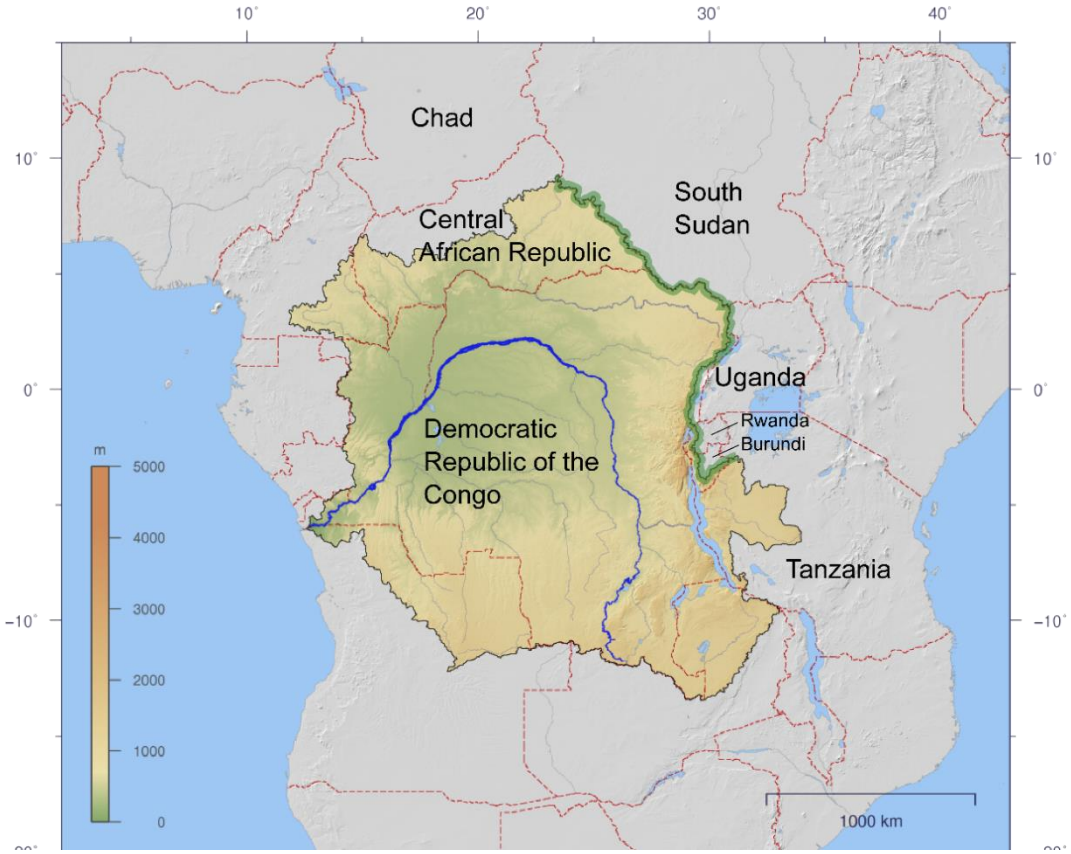
Muslims in the Ogaden region in Eastern Ethiopia to secede. The goal of Egypt was to destabilize Ethiopia to prevent them from building dams in the Nile River Valley. Eritrea eventually separated from Ethiopia in 1991. Due to these religious and political reasons, Eritrea has taken a position favorable to downstream nations over the Nile and against the positions of Ethiopia in particular (Carlson, 2013).

Democratic Republic of the Congo (DRC)

The Democratic Republic of the Congo is home to over 77.4 million people and borders Zambia, Angola, Republic of the Congo, Central African Republic, South Sudan, Uganda, Burundi, Rwanda, and Tanzania (Figure 12). The nation is very diverse and over 200 distinct ethnic groups live within the nation's borders. The economy is mostly dependent upon natural resource ores, and agriculture—particularly products such as copper, gold, diamonds, coffee, and sugar ("Congo," 2014).

Figure 12 shows the Congo basin, which makes up the vast majority of the Democratic Republic of the Congo. The bright green line on the right side of the image is the dividing line between the Nile and Congo basins.

Figure 12. Map of the Congo River watershed. The dark green line is the border between the Congo and Nile watersheds ("Congo-Nile Divide," 2013)



Only a small portion of the DRC is in the Nile Basin. Provinces partially within the Nile River Watershed are Orientale, North Kivu and South Kivu (Figure 12). Large population centers in the DRC within the Nile Basin include Goma, Butembo and Bumia. Approximately 2.6 million people from the DRC live in the Nile Basin with the overwhelming majority of the residents working in the agriculture industry, specifically growing tea and coffee crops. This region is characterized by high rainfall making crop irrigation unnecessary. Precipitation and tributaries formed in the DRC are some of the major inlet sources for Lake Albert and Lake Edward, which are both a part of the White Nile catchment region ("Opportunities and Challenges," 2012).

The Democratic Republic of the Congo, along with Eritrea, is the one of the two upstream nations who have not expressed an intention to develop the Nile watershed within their borders for their own use. Neither of these two nations have expressed the will to join the Nile Basin Cooperative Framework Agreement. The Nile Basin Cooperative Framework agreement is an assertion, and possibly a future treaty, amongst upstream Nile nations stating that they have the right to develop their own Nile resources for irrigation and energy purposes without the consent of Egypt ("State Information Services," 2011).

The DRC may also be the unique source of a possible solution to the Nile problem. The discharge rate of the Congo into the Nile River is approximately 100 billion m^3. On average, 84.5 billion m^3 of water is annually measured at the Aswan High Dam. This means that over 14 times more unutilized freshwater is entering the Atlantic Ocean from the Congo River than the entire volumetric flow of the Nile. There have been discussions between the DRC and the Egyptian government over diverting some of the Congo's flow into South Sudan. Such a project, if it could overcome legal and economic roadblocks, would effectively solve the Nile water crisis (Hussein, 2013).

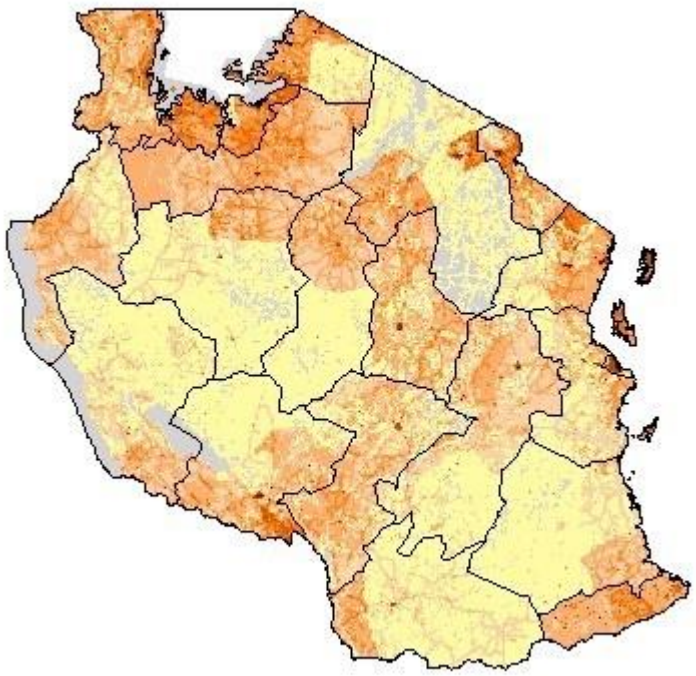
Tanzania

Tanzania borders Mozambique, Malawi, Zambia, Lake Tanganyika, Burundi, Rwanda, Uganda, Lake Victoria, Kenya and the Indian Ocean (Figure 15). A tropical climate with ample rain exists along the coast while temperate climates dominate the rest of the country. Highland regions exist in the northern and southern halves of the nation while a central plateau region covers the central portion of the nation. The economy of Tanzania is heavily reliant upon

agriculture, which is dependent upon water resources. In total, 80% of the workforce works in the agriculture industry while the remaining 20% works in industries such as gold mining and manufacturing ("Tanzania," 2014). The percentage of people working in the agricultural industry is much higher in the northern part of the nation, which is a part of the Lake Victoria watershed ("Tanzania," 2014).

There are approximately 50 million people living in Tanzania. Approximately 21%, or 11.5 million people live in the Lake Victoria watershed (Opportunities and Challenges, 2012). These northern sections of the nation are among the most densely populated in the nation as illustrated in Figure 15.

Figure 13. Map of population density in Tanzania ("Coastal Habitats," 2011)



Nearly all of the water used in Tanzania's agricultural sector comes from rain or groundwater sources. Crops grown in the northern part of the country mostly consist of coffee,

tea, and staple crops which all require large quantities of water to grow ("Tanzania," 2014). In total, Tanzania has 5893 km^2 of irrigated land out of an estimated 294,000 ha of land that could be irrigated (Makoye, 2013). This amounts to only 0.02% of the total irrigated land in the Nile watershed ("Opportunities and Challenges", 2012). Much of this unirrigated land is in the highly populated north of the country in the Lake Victoria watershed. Tanzania has recently passed the National Irrigation Act of 2013, which will provide infrastructure and capital to produce irrigation systems throughout the nation (Makoye, 2013). Tanzania is one of the leading members of the Nile Basin Cooperative Framework Agreement and desires to use more of the Lake Victoria watershed to irrigate crops in the Northern part of the nation (Carlson, 2013).

Uganda

Uganda is located in central Africa and is bordered by South Sudan, Kenya, Tanzania, Burundi, and the Democratic Republic of the Congo (Figure 13). Uganda is 241,038 km^2 in area making it about the size of the state of Oregon in the U.S. About 28% of Uganda's land area is arable making this nation one of the most fertile countries in Africa. Small lakes and wetlands dominate the landscape of Uganda. Lake Victoria, the largest lake in Africa, makes up the southeastern portion of the country. This lake plays an immense role for Uganda's economy with respect to transportation, fishing, tourism, and agriculture. Lake Victoria also plays an important role in stabilizing the climate in the local area and is one of the major sources of the Nile River. In addition to Lake Victoria, other major lakes in Uganda such as Lake Kyoga, Lake Edward, and Lake Albert are a part of the Nile River Basin ("Uganda," 2012).

Figure 14. Political Map of Uganda ("Map of Uganda," 2014)

Approximately 36 million people live in Uganda ("Uganda," 2014). About one quarter of the national GDP is derived from agriculture, while 82% of the workforce is involved with agriculture ("Uganda," 2014). While most Ugandans still live rural lifestyles or in smaller towns, Kampala, the Ugandan capital, is the fifth largest city in the Nile River watershed with a population of over 1.5 million (Opportunities and Challenges, 2012).

Water security is one of the largest problems in Uganda. Many of the farms within the nation are planted on dewatered wetlands ("Uganda," 2014). This practice, while allowing farmers to plant on fertile soil, makes farms more susceptible to flooding. There is abundant rainfall in Uganda, however, many farms rely solely on rainfall to water their crops, which can prove to be disastrous during times of drought ("Uganda," 2014). The economy of Uganda would greatly benefit from increasing the amount of land irrigated throughout the country however, many of Uganda's water resources are technically under Egypt's jurisdiction due to the

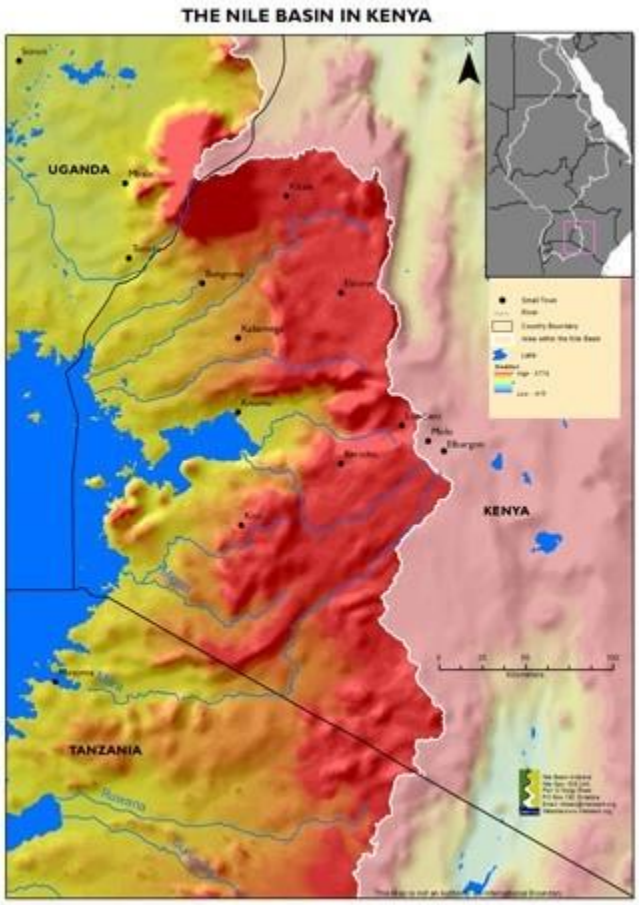
Nile Waters Treaty of 1959. This means that Egypt has the power to veto any projects that could disrupt the flow of Nile on the Victoria Nile, Lake Kyoya, Lake Albert, the Albert Nile, and technically any other tributaries that add significant volumes of water to the Nile (Carlson, 2013). Since 99% of Uganda falls within the Nile River basin, the Nile Waters Treaty has given Egypt substantial amounts of power over Uganda ("The Environmental Resources of the Nile Basin," 2014). This is the primary reason why Uganda is one of the leading nations fighting to circumvent the current Nile waters treaties (Carlson, 2013). Uganda has signed the Nile Basin Cooperative Framework Agreement and is expected to be one of the nations to implement it in the coming years (Carlson, 2013). The main implication of the Nile Basin Cooperative Framework implementation is that the signatories would no longer adhere to Egypt's directives over the Nile.

Uganda has numerous dams and hydroelectric power stations located throughout the country. The four largest that supply the greatest amount of electricity to the nation are the Owens Falls, Kiira, Nalubaale, and Bujagali dams ("Bujagali," 2014). All four of these dams are located along the Victoria Nile section of the White Nile shortly after it exits Lake Victoria. While these dams produce a large percentage of Uganda's electricity generation, they have been suspected of slowly shrinking Lake Victoria's volume over time ("Bujagali," 2014). It is thought that these dams are actually allowing more water to flow North than would naturally occur which is removing more water from Lake Victoria than in previous years ("Bujagali," 2014). Uganda is currently planning to construct more hydroelectric power stations and dams along the Nile in order to produce hydroelectric power and to increase the nation's irrigation capacity. Currently only 144 km^2 of land is irrigated within the country ("Uganda," 2014).

Kenya

Kenya is located in East Africa and borders Lake Victoria, Uganda, Ethiopia, Somalia, Tanzania and the Indian Ocean (Figure 14). The geography of Kenya is diverse with a tropical climate existing along the coast, an arid interior, and a fertile climate in the West characterized by the rift valley lakes. Kenya is over 580 million km^2 in area and nearly 10% of that land is arable. Kenya has five major water basins including the Lake Victoria Drainage System, Lake Valley Inland Drainage System, Athi Drainage System, Tana Drainage System, and the Ewaso-Ng'iro Drainage System. The Lake Victoria Drainage system is the least developed basin in the nation. While approximately 9% of Lake Victoria is owned by Kenya, the Lake Victoria Basin provides nearly 52% of the nation's freshwater. Most of this water in the western part of the country is used by the agriculture industry ("Kenya," 2014).

Figure 15. Nile Basin in Kenya ("Kenya Map," 2015)



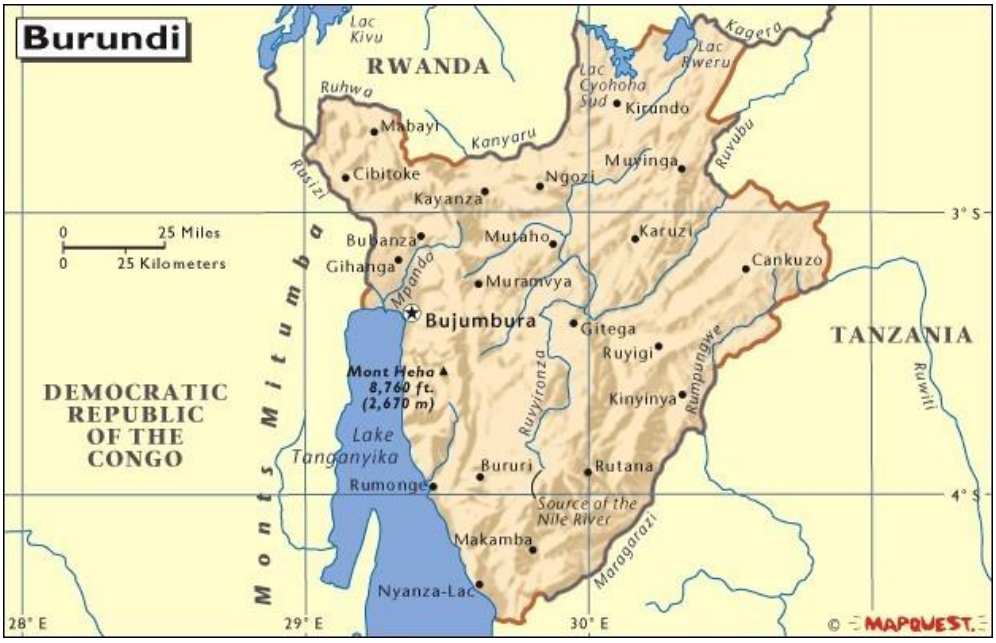
Over 45 million people live throughout the country while nearly 40% of the population, or 18 million people, live in the Lake Victoria watershed ("Opportunities and Challenges," 2012). Approximately 61.7% of the population has access to safe drinking water while only 29.6% of the nation has access to improved sanitation ("Kenya," 2014). About 30% of the GDP comes from agriculture while nearly 75% of the workforce is involved in the agriculture industry ("Kenya," 2014). An even higher percent of the workforce in the Lake Victoria drainage basin works in agriculture.

Kenya is one of the lead nations in the Nile Basin Cooperative Framework Agreement. Kenya wants to assert its right to increase its irrigation projects in the Lake Victoria Basin. These irrigation projects would improve the economy of western Kenya and provide increased stability in a region that predominantly relies upon precipitation and groundwater (Carlson, 2013).

Burundi

Burundi is located in central Africa and is bordered by Tanzania, Lake Tanganyika, the Democratic of the Congo, and Rwanda (Figure 16). The Kagera River, the most distant source of the Nile, begins in Burundi ("Burundi," 2014). This small, mountainous nation is very densely populated with nearly 10.4 million people living in the 27,830 km^2 area ("Burundi," 2014). Approximately 59% of the population, or 6.2 million people, live in the Nile watershed ("Opportunities and Challenges," 2012). Nearly 91.5% of the urban population has access to clean drinking water while 75.3% of the population in total has access to clean drinking water ("Burundi," 2014). An overwhelming 93.6% of the workforce works in the agriculture industry ("Burundi," 2014). Burundi receives significant rainfall and most farms are rain fed; however, about 214 km^2 of land is irrigated ("Burundi," 2014). Like many other upstream nations, Burundi is in favor of having greater access to the Nile River Basin and is a signatory the Nile Basin Cooperative Framework Agreement.

Figure 16. Political map of Burundi ("Burundi," 2014)



Rwanda

Rwanda is located in central Africa in a very mountainous region bordered by the Democratic Republic of the Congo, Lake Kivu, Uganda, Tanzania, and Burundi (Figure 17). Tributaries of the Kagera River begin in Rwanda and the Kagera River makes up part of the nation's border with Burundi ("Rwanda," 2014). About 83%, or 9.3 million people of Rwanda's 11.3 million people live within the Nile River Basin ("Opportunities and Challenges", 2012). The total area of the nation is 26,338 km^2 and approximately 96 km^2 of land is currently irrigated ("Rwanda," 2014). About 46% of the land is arable which makes the nation an ideal location for agriculture production. Similar to Burundi's climate, Rwanda has a tropical climate with ample rainfall ("Rwanda," 2014). Most of the farming is rain-fed. Ninety percent of the workforce works in agriculture, which makes up 32% of the national GDP ("Rwanda," 2014).

About 80% of the urban population has access to clean drinking water while 68.3% the rural population has access ("Rwanda," 2014). Rwanda is also seeking to access more of its Nile Basin resources and is a signatory of the Nile Basin Cooperative Framework Agreement.

Figure 17. Political map of Rwanda ("Rwanda," 2014)

Summary of the Nile's Importance to basin countries

The 11 Nile nations have very diverse climates, lifestyles, and cultures. However, one thing that they have in common is a connection to the Nile. The river plays an important role for the survival of all of these nations. Some nations, such as Egypt and Sudan, are more dependent upon the river than others like the Democratic Republic of the Congo or Eritrea. The nations in the Lake Victoria Basin and Ethiopia have a lot to gain by being able to access greater amounts of the Nile's resources. Large numbers of people in the region need stable water sources for drinking water and agricultural purposes. The hydroelectric potential in some of the nations could lift millions of citizens out of poverty and improve millions of more lives. What must be

remembered, however, is that any new actions on the Nile must be conducted under the framework of international law and without harming Egypt, whose 84 million people could not live without the Nile.

Are Waters of the Nile Egypt's Inherent Right?

Egypt is a unique country. It has been well known for centuries as being one of the most fertile places in the world thanks to the annual inundations of the Nile that brought fertile soil down from the Ethiopian Highlands during the rainy season (Carlson, 2013). This fertile land was home to approximately 2 – 5 million people for centuries (Carlson, 2013). The population of the region would fluctuate with the productivity of the land, and over the centuries, steadily increased. After remaining in the low millions for centuries, by 1800 the population had reached about 20 million people and by 1960, 28 million people ("Egypt Population," 2015). The population increase was the result of building thousands of irrigation canals that were erected by the governing Ottoman and then British authorities to increase the arability of the watershed. The growing population exemplifies the technological advances of the time, the improvements in agricultural resources, and better management over the Nile (Carlson, 2013).

As the twentieth century progressed, Egypt worked to further control the Nile. In 1970, Egypt completed the Aswan High Dam over the Nile Proper in southern Egypt. The dam regulated the Nile's flow. No longer did Egypt have to contend with the flooding and droughts that resulted from a change in the Nile's volume ("Aswan High Dam," 2010). A massive 169-km^3 reservoir, Lake Nasser formed behind the dam ("Lake Nasser," 2015). The reservoir allowed for agricultural production to increase as more land could be irrigated (Carlson, 2013). Nearly one billion kWh or 15% of the nation's electricity demands became satisfied by the Aswan High Dam ("Aswan High Dam," 2010). The tourism industry boomed, the economy soared, and the population increased from 28 million in 1960 to today's 82 million ("Egypt

Population," 2015). Egypt's control over the Nile has transformed the nation into an economic powerhouse with one of the largest economies in the region and the largest population in the Arab world. (Carlson, 2013).

That said, Egypt's economic strength in 2015 is faltering. With such rapid development and total control over the Nile River, Egyptians have blinded themselves to some of the consequences over the management of the river. Every year, millions of dollars' worth of fertilizer needs to be imported to enrich the soil in order to reach agricultural demand (Carlson, 2013). These fertilizers pollute the Nile River downstream making the water dangerous to consume and are responsible for the massive drop in fish populations (Carlson, 2013). Egypt has expanded to its limits under current water treaties. Despite being permitted to use nearly 75% of the available Nile water, the nation will soon face a massive water shortage. Egypt's unsustainable lifestyle is affecting all Nile users. Most of the inhabitants in the other Nile nations are already living in water scarce conditions. An increase in Nile water consumption by any of the nations would have a harmful impact upon the others. If these other governments were able to have a more equitable share of the Nile's resources, millions of lives in the other nations could be saved or greatly improved. Nevertheless, Egypt has fought tooth and nail over the last decade to control and enhance its own allocated proportion. The former Egyptian President Anwar Sadat even famously said, "The only matter that could take Egypt to war again is water," (Kameri-Mbote, 2007). Being the most downstream nation, how has Egypt been allowed to use such large quantities of the river's water? How has this sense of entitlement over the river progressed into its current form? How has Egypt forgotten that it is the "Gift of the Nile" and adopted the opposing thought that the Nile is Egypt's gift?

Ancient Egypt

One of the primary reasons Egypt feels so entitled to such a large percentage of the Nile's water resources is because of how Egyptian culture has developed wholly around the Nile. For thousands of years Egypt developed a total reliance on the Nile without having any need to share the river's resources with any other group of people. Until relatively recently, reliance on the Nile existed in sustainable terms due to smaller population sizes. Ancient Egypt developed into one of the world's most successful civilizations because of its use of the Nile.

Pre-historic Egyptian civilization was largely a hunter-gatherer existence with small, mobile populations living in the vicinity of the Nile. These ancient communities existed sustainably in the Nile vicinity with movements and daily activities based upon the Nile's flow and behavior. These mobile communities lasted in the region for thousands of years. They became dependent upon the consistency of the Nile's fluctuating seasonal changes and viewed the Nile as sacred. Agriculture took a long time to become well-established in Egypt. In the nearby Mesopotamia region, farming communities have been discovered thriving as early as 9000 BCE. In comparison, early farming settlements in Egypt date to around 5000 BCE. Early Egyptian agrarian communities would have planted native vegetation, like wheat, flax, and papyrus in the fertile soils closer to the Nile in the vast floodplain. The settlements were located uphill away from the river in order to avoid the dangerous effects of the river's floods. These populations retained their hunter-gatherer livelihoods for about eight months of the year and planted their crops during the months when the Nile River was at a stable level. The small towns gradually grew into larger communities capable of supporting larger populations, principally due to the increase in agriculture—and their reliance on the Nile (Butzel, 1976).

These pre-dynastic Egyptian communities depended upon the Nile's seasonal cycle to plant their crops and grow prosperous. The Nile River usually behaved in a predictable, timely manner during this time period (Butzel, 1976). The Nile would flow very slowly for most of the year with the water flowing from the White Nile further upstream (Butzel, 1976). The "miracle of the Nile" was the yearly flood that resulted from monsoon rains in the Ethiopian highlands (Postel, 1999). These rains caused the Blue Nile's waters to massively increase. In southern Egypt, the Nile began to rise as early as July and reached the delta region four to six weeks later. The Nile levels started to recede in October, and around November, the Nile sank back to its low-lying, normal level (Postel, 1999). The annual flooding brought nutrient-rich silt from the Egyptian highlands to Egypt and water to the fields. The planting season occurred during the months between the annual floods. When there were periods of stable yearly rains, Egyptians prospered, and when the rains were irregular, floods or droughts occurred causing widespread misery for the population. This yearly occurrence was responsible for creating the fertile soils that allowed such an arid part of the world to support considerable populations. The inundation process was stopped with the construction of the Aswan High Dam ("Aswan High Dam," 2010).

As Egyptian communities transitioned further to become more agrarian and sedentary, local populations increased in size (Butzel, 1976). These communities relied more upon agriculture and less upon hunting for their food sources. Becoming heavily reliant upon agriculture forced ancient Egyptian communities to become even more dependent on the Nile—the primary water source in this arid region. Pre-dynastic Egyptian communities faced a difficult transition from mostly hunter-gatherer to agrarian-based economies. Agrarian communities were forced to live closer to the Nile in order to protect and work their multitude of crop fields (Butzel, 1976). Living closer to the Nile destroyed many of the precious animal habitats, which

decimated native species, such as gazelle populations, upon which local communities were once dependent for protein (Butzel, 1976). Increased reliance upon the Nile caused inconsistencies in the Nile flooding cycle, such as floods and droughts, to have a much more severe impact on Egyptians (Postel, 1999). Communities began to spread throughout the Nile watershed as populations in the region increased. The Nile delta region in Northern Egypt was a dense, largely uninhabitable jungle region (Butzel, 1976). It, however, possessed some of the most fertile soils in the region and during this pre-dynastic period, many communities expanded into the area (Butzel, 1976). Life was difficult during these times, yet populations continued to grow. In order to survive, these communities had to work together to expand agriculture production and to make the delta more suitable for settlement. Many scholars believe this is the reason why Egypt developed into such a complex and sophisticated civilization – because of the need to control the Nile (Butzel, 1976).

Enormous irrigation and expansion projects required capital, manpower, and leadership. Powerful pharaohs were eventually created to fill the role of this power vacuum. Egypt's rich civilization developed to wrest control of the Nile. The pharaoh-based system ultimately developed as the leaders of powerful communities consolidated their control over other towns and expanded their rule. Pharaohs eventually became designated as the omnipotent rulers of ancient Egypt. With their power, ancient pharaohs constructed enormous irrigation projects to make agriculture more stable within the region. These leaders had the resources and power to plan large irrigation projects between towns and away from the Nile to expand arable land. Over time, Egyptian communities were largely divided up under the power of two different kingdoms. Lower Egypt stretched from the Nile Delta to the modern day Faiyum area while Upper Egypt began along the Nile near Faiyum down to modern Aswan Dam. The first recorded union

between the two main kingdoms in Egypt, the Upper and Lower Kingdoms, occurred around 3000 BCE under the Scorpion King. With his newfound consolidated power, the first king of a unified Egypt constructed dikes all along the Nile. These dikes were used to divert the flooding Nile to water fields even farther away from the River (Baines, 2011).

Not only did ancient Egypt's political structure, food sources, and water sources depend upon the inundations of the Nile—nearly all other aspects of ancient Egyptian lifestyles were also closely associated with it. Ancient Egypt's calendar was based on the three, four-month cycles of the Nile. Known as Akhet, Peret, and Shemu, these three calendar cycles represented the time of the Nile floods, the planting season, and the harvesting season, respectively. The rich soils brought down from the Nile allowed ancient Egypt to plant a surplus of important stable products like wheat. Kingdoms in surrounding areas such as Mesopotamia and Arabia traded extensively with Egypt for its crop surplus, giving Egypt economic and political stability during strong harvest seasons. Crops like papyrus were used not only as a source of food, but also to create sandals, river boats, and paper. The Nile also served as a means of transporting goods and people via boat in a time frame of days. Having such a fast means of transportation across an entire kingdom was a rarity in ancient times and allowed dynasties to rule more effectively with greater organization and control (Baines, 2011).

Perhaps the most telling element of how the Nile impacted Egyptian culture is how the river affected Egyptian theology. The Nile represents the bridge between life and death according to ancient Egyptian religion. This is why the sun, believed to be the giver of life according to ancient Egyptian mythology, rises every day in the East, and sets every day in the West. The Nile river runs South to North, so from the perspective of the ancient Egyptians, it appeared that the Nile truly separated the cycle between the rising and the setting of the sun.

Interestingly, all Egyptian tombs are built to the West of the Nile so that the dead could continue from death into the underworld. According to Egyptian mythology, the annual inundations of the Nile occurred because of a god, Hapi, who would pour water from a massive pot to begin the floods and tie together papyrus to stop the river flow. Hapi was viewed as a fertility god and it was widely believed that one of the primary gods, Ra, emerged from the Nile on the first day of the Earth's creation. This would make Hapi the father of the God of the Sun and, therefore, the father of all life forms. Ancient Egyptians would pray to Hapi during the inundations of the Nile and leave statues of him outside of their doorstep. Despite all of this, Hapi was not one of the primary Egyptian Gods and although the Nile was so pervasive to human life, the Nile itself was not extensively prayed to and there are no records of any temples built to honor Hapi or the Nile. This insight is very important because it shows how ancient Egyptians may have felt about the Nile ("Hapi," 2010).

Scholars believe that ancient Egyptians often took the Nile for granted despite realizing how important it was for their civilization. Ancient Egyptians believed that the Nile existed even before life, and that it would always exist. This mindset that the Nile River is a part of the very fabric of Egypt and that it is necessary for Egyptian survival is still pervasive in modern times. This mentality that the Nile is the source of life, the barrier from death, and the very essence of Egypt is still strongly felt by Egyptians and is why the nation believes it needs to control all aspects of the Nile (Baines, 2011).

Ancient civilizations in Northern Sudan based in the Nile Basin also had a similar outlook on the river. The Nubian empire, though distinctively different from the ancient Egyptian kingdoms, had many similarities in terms of politics and economics and religious beliefs. Northern Sudan was ruled by Egypt many times over the course of its history, and

ancient Nubia ruled over Egypt for 60 years. Both regions live in similar climates and have had a lot of contact with one another. This has led many Sudanese to have similar viewpoints as Egyptians over the Nile and possess a deeply ingrained sense of ownership over the river as well (Smith).

Upstream nations have not had extensive dependency over the Nile river resources over their respective histories. The Nile river basin contains nine other countries. These nations generally experienced much more rain than arid Egypt or North Sudan, so reliance primarily on the river's resources in these upstream nations was always sustainable. The Nile River's volume was never truly impacted by the small-scale water use by the upstream peoples. With populations increasing in upstream nations and preparations being made for expected instability in rainfall, these upstream nations now wish to use more of their Nile resources.

The history of the people of the Nile River valley has seen many rulers and civilizations, many who levied their power to control the Nile. From Egypt, Ethiopia, to European colonizers, dominant powers have used their supremacy to control, or threaten to control, the Nile River and its tributaries. These occurrences have made a vital impact on the perceptions that these people have of one another and the current division of the Nile water resources.

Supremacy of the Nile

The Nile River has always been relied upon by civilizations throughout East Africa. Upstream nations along the White Nile have always used their water resources for their personal benefit. African peoples relied upon Lake Victoria and the White Nile as a freshwater resource for drinking water supplies, subsistence agriculture, fishing, and a means of transportation. High

precipitation rates allowed upstream users to be less reliant on the Nile than downstream users. Due to the geography of the vast Sudd wetlands, there had been minimal conflict and interaction between upstream Nile users and downstream Nile users prior to European colonization (Carlson, 2013).

The case with Ethiopia is very different. Over hundreds of years, the people of Egypt and Ethiopia have developed a unique relationship that has been both cooperative and distrustful at times. Discord in these nations' relationship stems from issues dealing with religion and control of the Nile. In terms of religion, since 330 CE when the Axumite emperor in Ethiopia converted to Christianity, the Ethiopian church was a part of the Coptic Church, based in Alexandria, Egypt. The Coptic Church diminished in power and adherents as Islam spread across Northern Africa. In the 7th century, Islam became heavily enshrined in Egypt. Muslim rulers exerted influence over the Coptic Church who appointed bishops and adopted policies for its adherents. Thus, Egyptian authorities exercised influence over Ethiopia, a nation where the vast majority of the population was Coptic Christian due to their influence in choosing the region's bishop. During the time of the crusades, the Ethiopian emperor - Lalibela, acted upon Ethiopia's resentment towards Egypt. In retribution for the Muslim occupation of Jerusalem, the emperor threatened to divert the Tekeze River away from the Nile. The Tekeze River, which becomes the Atbara River as it crosses into Sudan, accounts for nearly 14% of the water that reaches Egypt (Carlson, 2013).

Differences between religion and water resources have resulted in past conflicts. These conflicts were often instigated by Egypt with the dual purpose of trying weaken Ethiopia's hold over the Nile and to empower Muslim communities within Ethiopia. Throughout the centuries numerous small uprisings by Muslim communities in Ethiopia with Egyptian support were put

down. Egypt and Ethiopia went to war in the late 19th century. The Khedive government of Egypt attempted to invade Ethiopia in order to spread its power throughout the Nile basin. Egypt invaded from coastal regions to the North and was decimated by the Ethiopian army in 1875 and 1876. The Battle of Gura in modern day Eritrea ended the war. Tensions in the 20th century led to Egypt supporting Muslim groups in Eritrea and Somalia. Egypt funded these communities, who wanted independence, in order to distract Ethiopia from following through with its plans to create dams on the Nile and to weaken Ethiopia's army. This internal struggle in Ethiopia ensued for 30 years and resulted in the creation of the Ethiopian break-away state, Eritrea (Carlson, 2013).

This mutual distrust over religion and the Nile still plays a role in more modern times. In 1959, Egypt and Sudan renegotiated part of the 1929 Nile Waters Agreement and created the 1959 Waters Agreement. Implications of this treaty will be discussed later in the following chapter in greater detail, but the agreement essentially divided up all of the available yearly volume of the Nile. Ethiopia, where 84% of the water that reaches Egypt comes from, was not consulted in these discussions (Carlson, 2013). The Ethiopian emperor responded to this treaty by publicly announcing Ethiopia's plan to construct a series of massive dams on the Nile— an act directly in confrontation to the 1959 Nile Waters Agreement (Carlson, 2013). Additionally, the emperor encouraged an end to the union between the Ethiopian Orthodoxy and the Coptic Church, which ironically occurred the same year as the Nile Waters Agreement – 1959. This separation ended the unity that existed for over 1600 years (Carlson, 2013). In current times, religion and control of the Nile are still intertwined. Recently, the Patriarch of the Ethiopian Orthodox Church visited Egypt in discussions with the Patriarch of the Coptic Church (Hussein, 2015). These meetings were planned in advance in order to improve the ties between the

Egyptian and Ethiopian churches and to celebrate Christmas in 2014 (Hussein, 2015). During this meeting the Coptic Patriarch was quoted as saying, "We do not expect the Ethiopian people to inflict damage on Egyptians, because it violates religious principles and all humanitarian values," with respect to the possibility that the Renaissance Gorge Dam could negatively impact Egypt's water resources (Hussein, 2015). This shows how Egypt is taking a different approach to preventing the dam from being completed. Despite the fact that the Coptic and Ethiopian Orthodox church are no longer one denomination, the disapproving words of the Coptic Patriarch are likely to strike a chord with a significant portion of the Ethiopian population. By deeming that the dam is essentially removing the only source of water from Egypt, the Patriarch is proclaiming that Ethiopia should not follow through with the plans to construct the dam if studies find the dam will be detrimental to Egypt.

Egypt's River

Based upon an analysis of Egypt's past and the geography of the nation, it is relatively simple to understand why the nation has become so dependent upon the river. Egypt developed from a people of hunter-gathers into one of the economic powerhouses of the Middle East by learning to control and use the Nile's resources. As history has shown, Egypt's prosperity has been directly linked with its ability to maintain control over the Nile. Egypt's population has increased in recent decades with the creation of the Aswan High Dam, which has steadied the Nile's flow, allowing for a more consistent water supply in Egypt and greater irrigation potential.

With a population of 87 million people, 95% of whom directly rely upon the Nile River for water resources, Egypt has a lot to lose if other nations start to access greater proportions of

the Nile ("State Information Services," 2009). "Egypt's leaders are prepared to countenance their neighbors building hydroelectric dams that hold back water, provided that water ultimately returns to the river to flow on downstream. But they are not prepared to allow countries to take water out of the river for consumptive uses like agriculture," (Pearce, 2010). Egypt is recognizing the inevitability of other nations using the Nile for their own prosperity, however, Egypt must ensure that Nile nation's usage of the water does not impact the volume of water reaching Egypt.

Allowing other nations to control their own water resources, if done properly, could improve the regional economy by allowing the region to become a hub for hydroelectric power ("Hydropower Potential," 2012). The hydroelectric potential of the Nile River Basin is larger than 20 GW per year and currently only 26% of this energy is being produced—mostly in Egypt and Sudan ("State of the Nile", 2009). Reaching such a large capacity would improve regional economies, however, there is a significant risk for Egypt in allowing these dams to be built. If these dams are built, particularly in places such as Ethiopia, which has the largest hydroelectric potential in the region, Egypt will be even more reliant upon upstream nations (Pearce, 2010). These massive dams could easily be used as obstructions to prevent the river from flowing to Egypt (Pearce, 2010). If there was a significant political row, an act of terrorism, or a war in the region, Egypt's Nile supply, on which it is completely dependent upon for survival, would be in jeopardy. In addition, the creation of man-made lakes on the upside of the dam would allow for lands to be irrigated more easily which would reduce the amount of water flowing to Egypt. This lack of stability is something that no nation would voluntarily allow to happen.

Egypt is facing the most massive challenge that the nation has ever encountered. Nile populations throughout the region are rapidly increasing and have a greater demand to access

their Nile resources. Egypt's traditional hegemony over the river appears to be coming to an end. A plan must be devised to allow Nile nations greater access to the Nile, while following the parameters of international law. In order for water resources to be reallocated, it will be necessary to engineer methods to increase the annual volume, improve technology in the region to reduce water consumption, and to create an unbiased body to oversee and mediate all potential infrastructure and issues in the region. The Egyptian psyche of ownership of the Nile is justified based upon its historical relationship and reliance on the river. As African populations have shifted and grown over time, however, this mindset of ownership over the river needs to be altered for the benefit of the region.

Nile Imperialism

In the late 19th century, European powers were creating worldwide empires across multiple continents. The breakup of Africa occurred throughout the 19th and 20th centuries with different European powers exerting different spheres of influence. The imperial conquests of the United Kingdom, France, Germany, Italy, and Belgium all influenced the current situation in the Nile River basin. Endeavors by European powers are directly responsible for the creation of numerous treaties over the Nile River. The most significant of these treaties is the Nile Waters Agreement of 1929. This treaty was reviewed and changed resulting in the Nile Waters Agreement of 1959. The 1959 agreement is used by Egypt and Sudan as justification for their control over the Nile.

Historical Context

Beginning in the 1870s, European powers increased their influence throughout Africa and established varying degrees of control over their African colonies. Prior to this period, European nations had small garrisons or controlled small areas of land throughout the continent. The demands of industrialism, economics, political pride, and the desire to spread their culture resulted in Africa becoming divided up amongst colonial powers. In 1884, the Treaty of Berlin was held and one of its primary purposes was to officially coordinate the distribution of African territories amongst European powers. European powers divided up Africa under different regions of influence.

Figure 18. Map of European possessions in Africa in 1914 (Iweriebor, 2011)

The 1880s and 1890s were a period of massive invasion by European powers on Africa, which ultimately resulted in 90% of the continent being under European rule after just sixteen years of colonization. In Figure 18, the United Kingdom, represented by the red, and France, represented by blue, controlled the largest territories on the continent. The British controlled most of the Nile River Basin. British domination of Egypt was imperative to maintain the United Kingdom's global supremacy over trade and to administer effective rule over all of its Asian and Pacific possessions. Egypt is strategically located adjacent to both the Mediterranean and Red Sea. This location and the geography of a thin stretch of land separating these two seas from each other made Egypt the ideal location to build a canal to connect these two bodies of

water. This canal, the Suez Canal, was built largely by the French earlier in 1869. Control of this canal was a necessity for Britain to maintain its massive empire, particularly its lucrative Indian possessions. Hence, control of Egypt was a point of national interest for the United Kingdom (Lee, 2011).

Interestingly enough, Egyptian policy to protect Egypt began with providing funds and support to the Ottoman Empire. During the 19th century, France and Russia had formed an informal alliance, which was seen as a threat to the British Empire's dominance. The United Kingdom feared that Russia, coming down from the North across the Middle East, and France, moving in from the West across Africa, could have severely affected the United Kingdom's access to Eastern parts of the empire if the two nations were able to reach and conquer Egypt. The Ottoman Empire already had an established government in Egypt and the defense of the Ottoman homeland in Anatolia was of great interest for the United Kingdom in order to prevent Russia from expanding further south. Investing in the Ottoman Empire was the British Empire's way of prohibiting Russia's expansion into the Middle East. This policy of investment in the Ottoman Empire was successful in deterring Russian expansion southwards until 1876 when the Khedive government in Egypt and the Sultan in Istanbul both declared bankruptcy. From 1879–1882 Egyptian soldiers rebelled against the Khedive government as a part of the Urabi Revolt. The Khedive government in Egypt was supportive of British interests concerning the Suez Canal so preserving their authority became a priority for British foreign policy. British troops invaded Egypt and established a de-facto protectorate state in order to defend its national interests. Further revolts flared up throughout the Sudan region around this time. Prior in the 19th century, the Khedivan Egyptian government had taken control of Sudan. Mahdist Sudanese rebel groups were able to take over most of Sudan during this time, including the capital Khartoum. The

United Kingdom, who had inherited Sudan after invading Egypt, did not send troops in time to protect Sudan from the rebel groups. British policymakers decided that refinancing and running an administration in Sudan would not yield benefits worth the expensive cost. Additionally, British policymakers were not threatened by the Mahdist rebels who did not have the technology, expertise, or military to invade Egypt or disrupt the Nile's flow to Egypt. With this idea in mind, Great Britain decided to allow the Mahdist rebel groups to continue their rule in Sudan. Many European powers, however, particularly Italy and France, viewed Mahdist rule effectively as a power gap and moved in to make their claim on the land. As the 19th century came to a close, British policy over Sudan reversed. They believed if other European powers established control in Sudan or other parts of the Nile Basin, they could impede the Nile's flow to Egypt. In order to maintain stability in Egypt, the United Kingdom also made control of the Nile River basin a national priority. Most of the treaties regarding the Nile that still exist today were created during this time period of European colonialism in Africa. The majority of the treaties were signed by the United Kingdom and another colonial power in order to protect Egypt's Nile interests (Lee, 2011).

Nile River Water Agreements amongst European Nations

Many agreements were signed between European colonial powers over governance of the Nile River. European colonial powers signed treaties with one another over the Nile for various reasons. Some of the European powers exchanged treaties over the Nile in order to secure their other interests in Africa. Other treaties were signed in order to strengthen ties between the two colonial powers in order to strengthen their positions on some dispute in an entirely different

section of the world. Whatever the reason for the various colonial Nile water treaties, they served the interests of the European power and not necessarily the African people who lived in the region (Okoth-Owiro, 2004).

The United Kingdom, acting to protect its global trading empire, drafted numerous treaties with other colonial powers in order to secure stability over the Nile River Basin for Egypt—where the Suez Canal is located. One of the earliest agreements was signed on April 15, 1881 between the United Kingdom and Italy (Okoth-Owiro, 2004). Italy was the colonial power of present-day Eritrea and parts of northern Ethiopia where the upper Atbara River is located. After the Mahdist rebels removed Egyptian rule in Sudan, Italy vied for control of the region (Lee, 2011). In this treaty Italy stated that it would not construct any irrigation or other structures that might inhibit the flow of the Atbara River (Okoth-Owiro, 2004).

The United Kingdom signed the treaty of Heligoland-Zanzibar Treaty to further establish British rule in Uganda and for further recognition of British interests in East Africa on July 1, 1890. This treaty shows how the United Kingdom desired to have full control of the Nile River Basin by strengthening its control over Uganda where, at that time, the source of the Nile was believed to have originated (Okoth-Owiro, 2004).

During the period of instability in Sudan, France and Ethiopia worked to establish closer ties. France supplied weapons and blocked Italy in its activities in the Ethiopian vicinity and Ethiopia offered its support of French ambitions in the Nile basin. The British were able to regain control of Sudan and diplomatically ward off the French from further conquests in the Nile basin by further recognizing the French's authority in West Africa (Okoth-Owiro, 2004).

The United Kingdom signed a treaty with France and Italy on April 3, 1906 essentially stating that all three nations would respect the rights of the British possessions of Sudan and

Egypt. Also in 1906, the UK signed a treaty with the Belgian Free State in the Congo to redefine the nation's sphere of influence in the Nile basin. This treaty ensured that the Belgian Free State would not construct on the Semliki and Isango rivers in order to prevent the volume of water in Lake Albert from diminishing (Okoth-Owiro, 2004).

By the 20th century, as European powers had already laid claim to their African territories for decades, the nature of treaties between European powers changed. The Nile delta was seen as a part of the United Kingdom's sphere of influence and the treaties of this century dealt with securing the Nile for Egypt in areas outside of British control. In December 1925, a very important treaty was signed between the United Kingdom and Italy. This treaty reaffirmed that Italy recognized the water rights of Egypt and Sudan over the Sobat and Blue Nile rivers headwaters and additionally stated that Italy would not take any actions that would reduce the water flowing into the Nile Proper. Numerous other treaties were signed between European powers to secure the Nile for Egypt. These treaties set a precedent of overlooking the needs of other parts of the Nile Basin in order to ensure Egyptian security. The most prominent of these treaties, and still frequently referred to in Nile disputes, is the Nile Waters Agreement of 1929 (Okoth-Owiro, 2004).

Nile Waters Agreement of 1929

The Nile Waters Agreement of 1929 is easily the most profound and far reaching Nile basin treaty. Despite being nearly 100 years old and signed under colonial auspices, this treaty is still argued by some Nile nations to be a legitimate contract amongst Nile states. "It is the

dominating feature of legal relationships concerning the distribution and utilization of the Nile waters today," (Okoth-Owiro, 2004).

The Nile Waters Agreement of 1929 was signed between the United Kingdom, representing its colonies in the Nile Basin, and Egypt, which achieved independence in 1922. The purpose of the agreement was to secure Egypt's right over all aspects of the Nile's volume of water, including areas outside of its immediate jurisdiction. This allowed Egypt to have a legal basis to increase its allocation of Nile water by having the power to construct projects in other Nile nations to its own benefit and to prevent potentially harmful projects to Egypt's supply from coming into fruition. The first paragraph of the Nile Waters Agreement of 1929 concisely describes the drive behind the agreement: *"For the purpose of examining and proposing the basis on which irrigation can be carried out with full consideration of the interests of Egypt and without detriment to her natural and historic rights."* (Okoth-Owiro, 2004).

This treaty basically ensured that Egypt had a strong role in the decision-making process over any activity, which could be deemed to pose any threat upon Egypt's water supply. The treaty has given Egypt an authoritative role in any dam, irrigation project, or any other water-intensive infrastructure project on the Nile.

Below are two significant excerpts from the agreement: *"To propose a basis for irrigation in which full consideration should be given to the rights and interests of Egypt. Future development in Egypt may require the construction of works in the Sudan and neighbouring territories, such as Uganda, Kenya and Tanganyika, and it feels that Egypt should be able to count on receiving all assistance from, the administrative authorities in the Sudan in respect of schemes undertaken in the Sudan, as well as from the British Government in any questions concerning the neighbouring territories."*

These two excerpts are symbolic of the nature of the report – that the entire Nile River has historically been Egypt's and that the river's usage should be at Egypt's discretion in the future (Okoth-Owiro, 2004). The purpose of the agreement was to facilitate this idea.

"Save with the previous agreement of the Egyptian Government, no irrigation or power works, or measures are to be constructed or taken on the River Nile or its branches, or on the lakes from which it flows in the Sudan or in countries under British administration, which would, in such a manner as to entail prejudice to the interests of Egypt, either reduce the quantities of water arriving in Egypt or modify the date of its arrival, or lower its level."

This leading statement is one of the key points under analysis and disputed amongst Nile states. It essentially gave Egypt total control over all water activities affecting the Nile (Okoth-Owiro, 2004). Its legitimacy was meant to ensure a stable flow into Egypt. Additionally, the treaty specifically allocated Egypt 48 billion m^3 and Sudan 4 billion m^3 of water per year (Wolf, 2004). The flow of the Nile during the dry season would be reserved exclusively for Egypt. Egypt and Sudan agreed that the combined needs of other basin states would not exceed 1,000-2,000 MCM/yr., and that any claims would be met with one unified Egyptian-Sudanese position (Wolf, 2004).

The construction of the Owens Fall Dam in Uganda solidified the legitimacy of the Nile Waters Agreement of 1929. This dam was constructed in Uganda at the mouth of the Nile just North of where the Nile exits Lake Victoria. Construction of the dam, including planning, construction, and even administrative phases, was conducted by the United Kingdom, but at the behest of Egypt (Okoth-Owiro, 2004). A summarizing excerpt from this last colonial Nile river treaty is below:

"The interests of Egypt will, during the period of construction, be represented at the site by the Egyptian resident engineer of suitable rank and his staff stationed there by the Royal Egyptian Government to whom all facilities will be given for the accomplishment of their duties. Furthermore, the two governments have agreed that although the dam when constructed will be administered and maintained by the Uganda Electricity Board, the latter will regulate the discharges to be passed through the dam on the instructions of the Egyptian Government for this purpose in accordance with arrangements to be agreed upon between the Egyptian Ministry of Public Works and the a pursuant to the provisions of agreement to be concluded between the two Governments."

The construction of this dam validated the 1929 Nile Waters Agreement. Despite the fact that Uganda had control over maintaining the dam, Egypt was in charge of dictating the water discharge rate (Okoth-Owiro, 2004). There is no mention of any compensation from Egypt towards Uganda for using Uganda's water resources. In fact, the wording of this contract solidified the idea that any activities on the river needed to be governed by Egyptian prerogatives. This act basically bestows ownership of the Nile to Egypt. Other nations in the Nile River basin are treated as though they are leasing part of the river and therefore need to adhere to Egyptian dictations. It is this point upon which downstream and upstream nations fundamentally differ. A more recent adaptation of the Nile Waters Agreement of 1929 is the Nile Waters Agreement of 1959. This agreement has been the law over the Nile and only until now has there been significant opposition to its right to rule.

The Nile Waters Agreement of 1959

The Nile Waters Agreement of 1959 is essentially the governing document over the Nile today. This treaty was negotiated between Egypt and a newly independent Sudan. Both nations collectively calculated the annual flow of the Nile to be 84 billion m^3 and divided up all of the river's resources amongst themselves. Out of the 84 billion m^3 of water that was measured in Egypt, Sudan was allocated 18.5 billion m^3 of water annually and Egypt was allocated 55.5 billion m^3. After taking into account the nearly 10 billion m^3 of water that evaporates annually from Lake Nasser, virtually none of the Nile's water resources were allocated to the other Nile Basin states (Wolf, 2004).

The Nile Waters Agreement of 1959 came about largely to assuage investor fears over the safety of the proposed Aswan High Dam in southern Egypt. Egypt desired to create a massive reservoir within its own borders to have a backup water supply during vicarious times of drought, to increase the amount of land it could irrigate, and to produce hydroelectric power. Many locations in Sudan and Uganda were proposed to be the site of this massive infrastructure project by the United Kingdom. In the end, Egypt decided the best location for its own security would be within its own borders and so the location of the current Aswan High Dam was chosen. In 1952, plans to construct the Aswan High Dam were created. The Aswan High Dam cost over one billion dollars to construct. Such a costly endeavor required large loans from investors who needed to be sure that conflict would not ensue between Egypt and Sudan over the dam ("Aswan High Dam," 2010). As a result, Egypt negotiated with Sudan over the latter's Nile waters rights.

The 1959 Nile Waters Agreement was created in order to redefine the water rights of Egypt and Sudan (Wolf, 2004). Below is a table showing what each side originally proposed during negotiations.

Table 2. This table shows the goals that Sudan and Egypt aimed to receive from the Nile Waters Agreement of 1959 and the actual agreement (Wolf, 2004)

Table 2. Nile Waters Treaty of 1959 negotiations		
Position	Egypt (billion m^3/year)	Sudan (billion m^3/year)
Egyptian	62	8
Sudanese	59	15
Nile Waters Treaty (1959)	55.5	18.5

What is different about this compromise is that Egypt appeared to have given Sudan even greater quantities of water then Sudan originally proposed. A breakdown of the Nile distribution shows why the water was allocated this way. Both countries agreed that the volume of water reaching Egypt annually was 84 billion m^3. Ten billion m^3 were subtracted from the total volume due to evaporation off of the proposed Lake Nasser leaving 74 billion m^3 to dispense between the two nations. The fact that the 10 billion m^3 was subtracted from the total volume of the water and not solely from Egypt's share of the water is very significant, considering that the location of the dam is in Egypt. By not dictating that Egypt would bear all the tax from the evaporative effects of Lake Nasser, Sudan's support of the treaty expressed its own backing and commitment to the dam. The total volume of the Nile to be distributed was reduced which essentially meant that Sudan was equally responsible for Lake Nasser's Nile evaporation. By allowing Egypt this victory, Sudan was reaffirming the idea of Egypt's historic rights over the Nile. The dam could have been much more efficient in other, less arid locations in the basin, however, Sudan's acquiesce to Egypt's wishes showed that despite the idea of splitting the Nile, Egypt was still in control of the river. The Nile Waters treaty of 1959 automatically allocated Egypt 48 billion m^3 and Sudan 4 billion m^3 of the Nile due to "historical rights", alluding to the 1929 agreement. The remaining 22 billion m^3 were divided between Egypt and Sudan who would receive 7.5 billion m^3 and 14.5 billion m^3, respectively. Any additional volume that

would be added to the Nile in the future naturally or through man-made projects would be divided evenly amongst Egypt and Sudan. Additionally, the treaty gave Egypt the right to buy Sudan's shares of the Nile if Sudan did not require them (Wolf, 2004).

The implications of this treaty were far-reaching. Egypt was able to retain a massive hold on the Nile and create a dam that would hold years' worth of water for Egypt. At the same time, Sudan was able to increase its allocation of the Nile more than four-fold. This treaty benefitted both nations greatly, created a stable political atmosphere between the two nations, and most importantly, created a strong partnership between the two nations over the Nile (Okoth-Owaro, 2004). Egypt and Sudan have been supportive of one another's Nile endeavors and equally condemning on the claims of the other Nile state's rights over a part of the Nile. This alliance has allowed the Nile hegemony to persist until the present.

The Nile Waters Treaty of 1959 was decided between Egypt and Sudan over water resources that do not even exist in their own nations. It does not seem like a very plausible agreement considering that none of the upstream nations were consulted during any of the negotiations. Many different statutes of international law were not followed in the creation and implementation of this Nile Waters treaty.

Legality of the Nile Waters Agreements of 1929 and 1959

The Nile Waters Agreement of 1959 is the primary, most recent, treaty that governs Nile water usage today (Okoth-Owiro, 2004). This treaty is often disputed by upstream nations who claim that they were either not engaged in the treaty process or that they were under the rule of a foreign nation at the time of the treaty's signing (Wolf, 2004). In the latter case, these countries argue that as successor states of imperial governments led by foreign nations, these African nations were not being represented by their own people, rather European governments, and thus, are not required to follow the agreement. Additionally, there are legitimate concerns over whether principles of international water law are being adhered to. Further analysis of international law reveals the legality of the Nile Waters Agreement of 1959.

Principles of International Law

The first main argument against the Nile Waters Agreements legality deals with state succession. A widely practiced legal argument regarding the creation of new states are the principles of the Clean Slate Doctrine of State Succession. This policy states that successor nations are not required to adhere to agreements that are unadvantageous to the state that were erected during the rule of the predecessor nation. The argument is that the previous ruling power is no longer in charge of the nation, therefore, previous decisions lack legal authority without the consent of the current ruling government (McKenzie, 2012).

This principle is followed in treaties throughout the world and has been argued by Egypt and Sudan in previous Nile disputes (McKenzie, 2012). Egypt maintained this argument after its

independence as a way to create a treaty with the United Kingdom who controlled upstream Nile nations at that time. Egypt desired a contract between the two ruling powers that was created with the Egyptian government's consent. This desire led to the creation of the Nile Waters Agreement of 1929 (Okoth-Owiro, 2004). Interestingly, Sudan also used the same argument against Egypt after it gained its own independence 1956. After years of uncertainty and the potential for war striking between the two nations, discussions began to create a Nile compromise. Sudan claimed the 1929 Niles Water treaty lacked legitimacy and that it had no right to govern over Sudan's Nile claims. As a result, Sudan raised the Sennar dam in 1925 over the White Nile without the consent of the Egyptian government (McKenzie, 2012). This act was directly confrontational towards Egypt and a blatant disregard for the Nile Waters Treaty of 1929. As a result of the discourse, the potential for Sudan to negatively impact Egypt's access to the Nile, and to assuage the fears of Aswan High Dam investors, Egypt struck a deal with Sudan (McKenzie, 2012).

Currently, Egypt claims that the Nile Waters Agreements of 1929 and 1959 are legal and must be adhered to by upstream Nile nations. Egypt is essentially ignoring the principles of the Clean Slate Doctrine of State Succession, which it advocated early in the 20th century when it benefitted its own position over the Nile. Today, Egypt champions the principle of Universal Succession in which successor nations are bound to the agreements decided by predecessor states (McKenzie, 2012). This policy is a direct contradiction of Egypt's previous position.

The Clean Slate Doctrine of State Succession is a principle that has been recognized and used for much of the past century. While there is not a single cohesive international law that regulates state succession, the Vienna Convention on Succession of States provides a useful framework (McKenzie, 2012). Articles 9 and 10 are directly related to the Nile dispute with

respect to whether African nations are obliged to follow the treaties signed by their European colonizers and Egypt.

"Obligations or rights under treaties in force in respect of a territory at the date of a succession of States do not become the obligations or rights of the successor State or of other States Parties to those treaties by reason only of the fact that the successor State has made a unilateral declaration providing for the continuance in force of the treaties in respect of its territory." ("Vienna Convention," 1978*).*

The Vienna Convention clearly states that the upstream Nile nations are not obligated to follow the previous treaties simply on the basis that their predecessor governments, under European occupation, agreed to the 1929 and 1959 Nile Waters Agreement.

The international law principle of "*clausula rebus sic stantibus"* is also being violated by the Nile Waters Treaty assertion over upstream nations. This principle states that an agreement is void, *"*if the circumstances under which the treaty was drafted or envisioned underwent a substantial change," (Wolf, 2004). The circumstances of these treaties were in a colonial context when it benefitted the United Kingdom to agree to these treaties. Ensuring Egypt's longevity was a primary priority for the United Kingdom in order to protect the interests of its empire. In the present, these nations are independent from European colonialism and are governed by native populations. This has changed the situation dramatically by allowing these nations to have the authority to adopt policies in their own best interests. The massive change in the political scene is a perfect example of "*clausula rebus sic stantibus*", thus invalidating the right of the Nile Waters Treaty of 1929, and in turn the Nile Waters Treaty of 1959, from having any power over upstream users.

Water Law

In addition to internationally accepted polices being ignored by implementing the Nile Water Treaties of 1929 and 1959, laws regarding the governance of shared bodies of water are also being violated. The Helsinki Agreement, although technically non-binding, is the primary agreement that is consulted when issues arise over international bodies of water. The Helsinki principles have been directly applied to create treaties in disputed water areas, such as the Mekong River Delta region of Southeast Asia. Careful analysis of the Helsinki Agreement shows several problems with the current Nile Waters Agreement of 1959 (Okoth-Owiro, 2004).

One of the related applicable sections of the Helsinki Agreement states that each nation is "*entitled, within its territory, to a reasonable and equitable share in the beneficial uses of the waters of an international drainage basin*," ("The Helsinki Agreement," 2003). This statement is clear in purpose, yet vague in defining parameters. The Helsinki Agreement is stating that nations are only allowed to use the water resources within their own political boundaries. Additionally, it is stating that a nation's consumption should be proportional to its actual needs without negatively impacting the rest of the drainage basin. This statement is a point of contention between the downstream and upstream nations. The definitions of "reasonable" and "equitable" remain undefined.

Downstream nations interpret the Helsinki Agreement in a way that supports maintaining the status quo over the Nile River's allocation. These nations have claimed that they have a greater need for the Nile's waters. Looking closer at Egypt's water resources, the Nile is nearly the sole source of water for 95% of Egyptians ("State Information Services", 2009). Egypt has the largest, and the population most reliant upon the river, and therefore should be allocated the largest percent of the Nile's annual volume. Egypt receives minimal rainfall and the most

heavily populated regions along the Nile receive virtually no rainfall ("State Information Services", 2009). Other nations, such as Ethiopia, Uganda, and other upstream Nile nations receive plentiful rainfall. Most of the farmland in these upstream nations, where the agrarian industry is the largest consumer of water, is watered by rainfall, rather than through irrigation from the Nile. With these facts in mind, downstream nations choose to view upstream nations as needing minimal amounts of Nile water, and thus it would be unreasonable for the downstream nations to be allocated larger percentages.

Upstream nations have taken a very different interpretation of the "reasonable" and "equitable" clauses. Rainfall has become more erratic in the Nile River Basin in recent decades and populations in upstream nations have greatly stretched their resources as their populations rapidly increased. In order to provide stability for upstream nations, irrigation should increase to account for the instability and chaos that occurs during times of drought or inconsistent rainfall. Nations such as Ethiopia and Uganda also desire to construct dams along the river to produce hydropower. If these dams do not ultimately impact the Nile's annual flow, it would make sense to allow for these dams to be constructed, without Egypt's approval. Reasonably, upstream nations should have increased rights over the Nile river basin in their lands. Allowing Egypt and Sudan to have a monopoly over the river, particularly when the sources of the river do not commence in these downstream nations is clearly not fair, but also inefficient. Projects such as the Aswan Dam, which causes an annual 10 billion m^3 of water to annually evaporate is not a fair usage of Nile waters. By building larger dams in less arid parts of the basin, less water would be lost to evaporation, effectively increasing the Nile's annual volume. Additionally, because nations like Egypt have minimal international regulations on their usage of the Nile, they use their water resources inefficiently. Currently, Egypt sends 10% of the volume of Lake

Nasser to irrigate farms as a part of the Toshka project. Large percentages of this water are evaporated on its journey to the farmland located in the desert of southern Egypt. In 2012, the Ethiopian Prime Minister Meles Zenawi exclaimed, "While Egypt is taking the Nile water to transform the Sahara Desert into something green, we in Ethiopia—who are the source of 85% of that water—are denied the possibility of using it to feed ourselves,". Many of these arguing points that upstream nations are likely to champion seem to be valid concerns (Carlson, 2013).

Recent developments in international law have focused upon basin wide management (McKenzie, 2012). This sort of management would require collective coordination of the Nile by all of the Basin states. By managing the river with one international body, rather than 11 different governments all vying to create the best deal for themselves, the Nile will be managed the most effectively. One entity controlling Nile policy would allow for the free flow of data on all aspects of the Nile and applicable technology—such as water-conserving agrarian techniques. This type of management would revolutionize the economy of the region and allow Nile resources to be more efficiently used.

Analysis of international law has shown that the Nile Water Treaties of 1929 and 1959 are no longer acceptable laws to govern the Nile. The principles of State of Succession and "*clausula rebus sic stantibus*" are clear indications that the upstream nations have been exploited for years. Under the state of succession principle, upstream nations have no obligation to abide by laws created by the United Kingdom on its behalf. The "*clausula rebus sic stantibus*" principle also shows that the treaties no longer have to be followed because of the changing dynamics of the regions governance. The reasonable and equitable clause of the Helsinki Water Agreements can be interpreted in a magnitude of different ways by any nation. One thing seems quite clear, however. This clause is designed to allocate waters amongst nations on an as-needed

basis where the nations with the largest need for the Nile receive the highest proportion of the resource. This would certainly mean that Egypt and Sudan deserve the largest share of the Nile, but a share that reflects upstream nation's needs must also be considered. Projects that do not disrupt the volume of water reaching the downstream nations also should be allowed to be constructed. A basin-wide management system also needs to be implemented to increase cooperation and the efficiency of Nile projects. This sort of approach will give all of the nation's access to all of the projects being proposed on the Nile and promote camaraderie rather than fuel rivalries.

Changing Nile Dynamics

As the political and economic situations in Nile Basin countries have drastically changed over the past century, the governing of the Nile has also changed. Egypt's "historical right" and European colonialism created an atmosphere where downstream nations dominated the Nile. As Nile Basin nations gained their independence, they began to assert their right over the Nile. Upstream nation's persistence over their water rights has led to instances of cooperation and discourse between Nile nations.

Nile Basin Initiative

In the spirit of cooperation, the Nile Basin Initiative (NBI) was created in 1999 ("Introduction," 2012). All of the Nile River Basin nations are official members of the NBI, aside from Eritrea which participates under an observer status ("Introduction," 2012). The NBI was created in order to oversee development of the Nile in a cooperative manner and to promote trust amongst member states. It is primarily funded by the World Bank, African Development Bank, Swedish International Development Cooperation Agency, Germany's Society for International Cooperation (GIZ), and member fees ("Cooperation on the Nile", 2013). The NBI is the first organization that has included all of the basin nations. Previously, there was a sense of mistrust between most of the nations over their usage of the water. Prior to the NBI, Dr. Callist Tindimugayaa – a former Uganda water minister said, "*At the beginning, we would be in a room and we wouldn't talk to each other – we saw each other as enemies. No one would talk in meetings because of the suspicion*," ("Cooperation on the Nile," 2013). However, within the

confines of the organization, cooperation and dialogue have been conducted in a constructive manner, which has diminished ill feelings a majority of the nations.

There have been significant successes instituted by the NBI. The decision making body of the NBI is comprised of the most senior water ministers of each member state. This has allowed the NBI to become a means of directly communicating concerns regarding the Nile to other nations, thus promoting constructive dialogue. On a more technical side, basin-wide studies have been conducted in order to obtain better information and data on the Nile's resources. Individual nations that once lacked the expertise and capital to assess water or meteorological resources were given the opportunity from the NBI. Cooperation between nations has allowed international projects to be created within the basin. The NBI played an integral role in implementing power-line projects between Sudan-Ethiopia and also in the Lake Victoria region. The Rusumo Falls Hydroelectric project in the Lake Victoria region was also administered by the NBI. An additional NBI-affiliated project, the Eastern Nile Watershed Management is a more recent project between Egypt, Sudan, and Ethiopia. This management system, where 80 million dollars was invested by all three participant nations for short-term development within the region, is a prime example of how the Nile Basin Initiative has warmed relations between Nile adversaries ("Cooperation on the Nile," 2013).

One of the largest societal changes that the NBI initiated was altering perceptions over Nile management. Beginning with mostly a downstream-based management approach, the NBI encouraged a basin-wide approach that took more of the needs of upstream nations into account. The perception that Egypt owned the Nile has been greatly reduced and Nile management is gradually shifting from competition to cooperation amongst states. Ultimately, the NBI initiated the shift from Egyptian management to joint management of the basin.

This institution was essentially created to promote collaboration amongst basin states in order to effectively develop the Nile and manage its resources. It was not meant to be a permanent solution to the Nile issue and was planned to be decommissioned once a permanent body was created to manage the Nile ("Cooperation on the Nile," 2013). This permanent body, known as the Cooperative Framework Agreement (CFA) officially came into force in 2011. A majority of the NBI members adopted the CFA; however, Egypt, Sudan, the DRC, South Sudan, and Eritrea were not signatories.

Cooperative Framework Agreement

The Nile Basin Cooperative Framework Agreement is a Nile waters treaty. This agreement is meant to be the primary document governing the Nile Basin. Ratified by Kenya, Uganda, Ethiopia, Tanzania, Rwanda and Burundi, this agreement came into force in 2011 once Burundi adopted the policy – the sixth nation to do so. This agreement was created over recent decades and was started by upstream nations who were discontent with the colonial-era agreements championed by the downstream nations. The contents of the Nile Waters Agreements of 1929 and 1959 excluded the upstream nations from utilizing the Nile River resources within their countries and the Cooperative Framework Agreement was erected in direct opposition to these colonial era treaties. At the time of this paper's completion, the downstream nations who currently control access over the Nile, Egypt and Sudan, have not signed the agreement. Despite this, the former Egyptian Minister of Water Resources and Irrigation, Mahmoud Abu-Zeid said, "During the last ten years, we have been working on a framework and everybody agreed to more than 95 percent of the articles," (Abedje, 2011).

The true, and really crucial, issue preventing the downstream nations from signing the agreement is section 14b of the document. Section 14b deals with water security and reallocating water rights over the Nile. The disparity between the upstream and downstream nations is also concerned with whether a new treaty would supersede older treaties. It is evident that the downstream nations are reluctant to give up their upper-hand over the Nile.

The Cooperative Framework Agreement came into force once a majority of the Nile Basin Initiative members accepted it. Essentially, this means that the upstream nations are abiding by the agreement while the downstream nations are not bound to it. Upstream nations, according to the Cooperative Framework Agreement, are now able to construct hydroelectric and irrigation projects without Egypt's previous consent. This is a potentially dangerous scenario and could lead to conflict (Abedje, 2011).

In order to secure the greatest level of stability and to protect the longevity of the Nile, all of the Nile Basin countries should be a part of the Cooperative Framework Agreement. In order for this to happen, section 14b needs to be adjusted in order to recognize the importance of the Nile for all of the basin states. Currently, section 14b says, "not to significantly affect the water security of any other Nile Basin States" while Egypt and Sudan desire it to state, "not to adversely affect the water security and current uses and rights of any other Nile Basin State" ("Agreement on the Nile River Basin Cooperative Framework," 2012). A compromise needs to be made on this section. The downstream nation's version respecting current uses and rights is essentially saying that the colonial water agreements will remain valid, allowing the downstream nations to retain nearly all of the Nile's annual flow. The upstream nation's version, on the other hand, is vague by using the word "significant". If the upstream version of section 14b defined the word "significant" by setting specific parameters related to the measured need of a nation, it

is more likely that the downstream nations would be more inclined to accept the agreement. In order for the Cooperative Framework Agreement to be successful, all of the Nile Basin states need to be involved.

Unity among the Upstream Nations

In recent years, upstream nations have wrestled greater autonomy over the Nile from downstream nations. These nations believe that colonial era agreements that have governed Nile usage over the 20th century are illegal and biased towards downstream nations. Upstream nations claim that they require greater access to the Nile river resources within their own borders for the survival of their people as population pressures and changing environments place extreme pressure on these nation's resources. Nations such as Ethiopia have already outlined their own agendas regarding their independent use of the Nile.

Recent studies commissioned by the Nile Basin Initiative show clear proof that many Nile nations will face a larger need for Nile resources in the future. Figure 19 depicts how Nile Basin populations are estimated to change from 2010 to 2030 ("Opportunities and Challenges," 2012).

Figure 19. This image shows how Nile Basin populations are expected to grow ("Opportunities and Challenges," 2012)

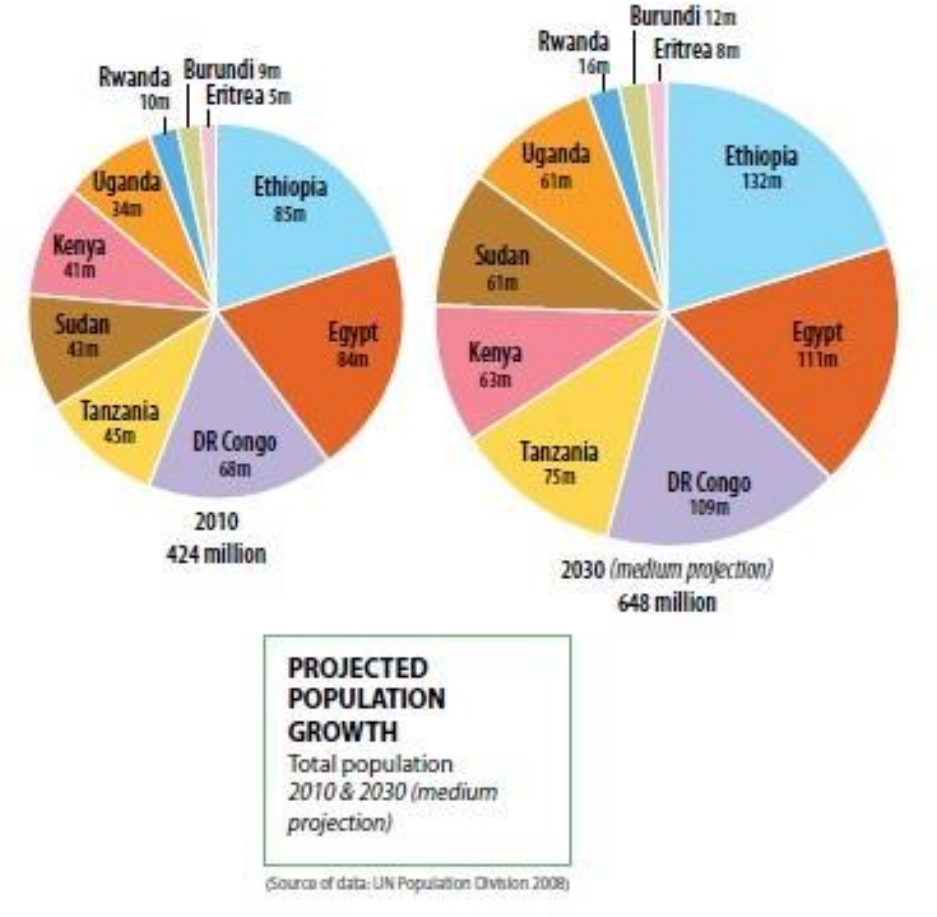
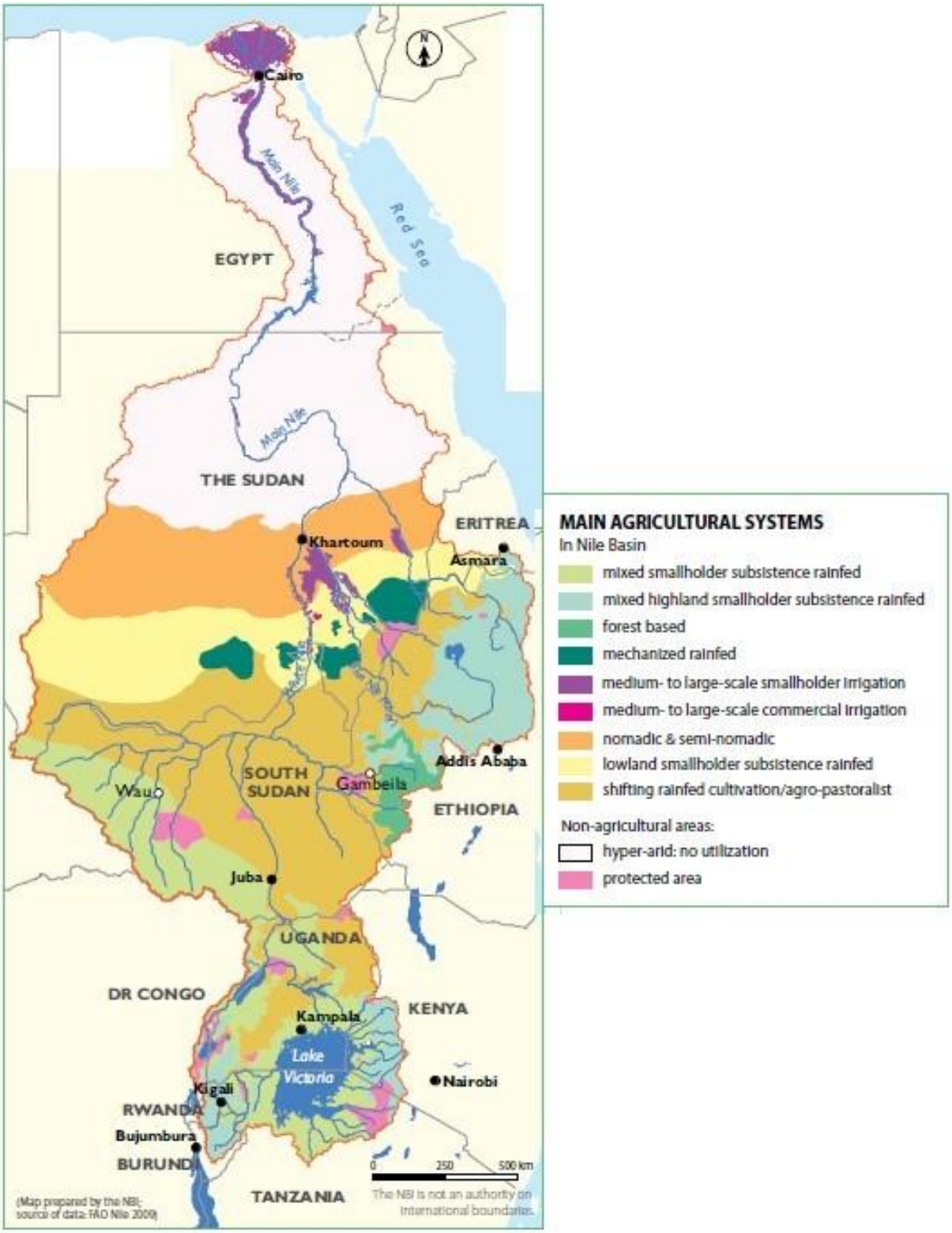


Figure 19 shows that the population of Egypt, Sudan, and Uganda will increase by approximately 27 million, 17 million, and 27 million respectively. All of these people will rely almost entirely upon the Nile for their water resources. The populations of all of the other Nile basin states are all also expected to increase, however, not all of these people will reside in the Nile basin region of their nation. As is evident, all of the Nile Basin populations are expected to continue to increase into the future. While this will certainly put a greater strain on the Nile for downstream nations who completely rely upon the river, changing climatic and precipitation patterns are requiring upstream nations, who previously relied upon precipitation, to rely more upon the Nile for irrigation purposes ("Opportunities and Challenges," 2012).

About 78% of all of the water measured at Aswan High Dam is used in irrigation schemes, of which 97% take place in Egypt and Sudan. Other upstream nations have always relied upon consistent rainfall to water their crops. In recent times, however, inconsistent rainfall and increasing average temperatures have led to widespread drought and increased evaporation rates. Inconsistent rainfall has made upstream nations protest stronger against downstream dominance over the Nile as they claim they will need to expand the amount of area irrigated to replace the change in precipitation. Figure 20 depicts agricultural systems in the Nile Basin. Western Ethiopia, Western Tanzania, Northern Kenya, and Uganda are regions that are particularly vulnerable to changing precipitation patterns. Irrigation will need to be employed in these areas in order to continue agricultural production ("Agriculture, Food Security, and Livelihood," 2012).

Figure 20. Nile agricultural systems map detailing conditions for farming throughout the Nile Basin ("Agriculture, Food Security, and Livelihood," 2012)



Ethiopia in particular is planning on increasing the amount of land that it irrigates. The Ethiopian Highlands region has been populated by small-scale subsistence farmers who have relied upon rain for their crops. This region traditionally receives large quantities of seasonal rain. Lately, climate change has severely impacted the region with devastating droughts occurring every couple years. In order to bring stability to agriculture and to increase livelihoods in Ethiopia, the government has created ambitious plans to make itself the hydroelectric powerhouse of Africa. Ethiopia is well positioned to construct massive dams across many of its rivers, which could supply enough electricity to support its own population and create a massive surplus to sell to other nations in the region. These dams would also serve another purpose by creating vast reservoirs, which could be used to expand irrigation in many parts of the nation. Ethiopia's most ambitious dam is the Grand Renaissance Dam ("Agriculture, Food Security, and Livelihood," 2012).

This massive dam, planned to cost nearly $4.8 billion, is currently being constructed on the Blue Nile River in western Ethiopia. Once completed, it will produce a reservoir twice the volume of Lake Tana, or nearly the annual flow of the Blue Nile, capable of producing 6000 MW of power and irrigating thousands of hectares of land around the Blue Nile Region. This ambitious project is being financed largely by the Ethiopian government and its population. Ethiopia claims the construction of the dam will help lift thousands of Ethiopians out of poverty and improve the lives of millions of people by bringing water security and electricity to the region (Veilleux, 2013).

Egypt, on the other hand, essentially sees this dam as a way for Ethiopia to control the flow of the Blue Nile River – the source of 59 % of the water that reaches Egypt ("ICE Case Studies," 1997). Egypt took part in a panel of experts to gauge the impact the dam would have

upon the region. One member of the panel of experts was quoted as saying "Egypt faces a 6% reduction in the High Aswan Dam's electricity-generating capacity and no water loss if the reservoir is filled during years of average or high rainfall. If the reservoir is filled in a dry year it would 'significantly impact on water supply to Egypt and cause the loss of power generation at High Aswan Dam for extended periods.'" The Grand Renaissance Dam is symbolic of the current struggle between the upstream and downstream nations over the Nile. Both nations claim that the opposing side is violating their water rights. Additionally, both sides have evidence that support their claims. In the case of the Grand Renaissance Dam, construction commenced in secrecy. The panel of experts recommended that construction should stop until a comprehensive feasibility study is conducted. Until the impacts and consequences of the dam are fully understood, construction of the dam should cease (Veilleux, 2013).

In this case, it seems as though Egypt should oppose construction of the dam. Nevertheless, this is only one of many projects, which Egypt will naturally oppose. There are many dams, depending on their size and location, which could actually increase the overall flow of the Nile. Egypt may still oppose the construction of these dams because the dam will inadvertently give the upstream user control over the flow of the Nile. If the dams are used responsibly, however, the upstream users should be able utilize their share of the Nile without impacting Egypt's share. This is a reality that Egypt must accept in the future. Additionally, there are measures that Egypt and Sudan should take to increase their water security and reduce their Nile footprint.

Egyptian Options

As upstream nations push their own Nile agendas forward, Egypt must adapt to the situation in order to protect its own interests. Previous techniques that have been used to repel upstream nations' desires to access the Nile are no longer proving to be effective. Egypt's threat of war with any nation which defies Egypt's water rights, outlined in the Nile Waters Treaty of 1929 and 1959, had always deterred upstream nations from pursuing projects on the Nile. Egypt has the most powerful army in the region and has always threatened to use its manpower to remove any perceived threats that could inhibit the flow of the Nile. Leaked documents from WikiLeaks show that Egypt has already constructed a base in southeastern Sudan that would be used as a launching facility for any potential attack on the Grand Renaissance Dam should the need arise in the future (McGrath, 2014).

Despite the fact that Egypt has flexed its muscles in the past and still has a very capable army, it is highly unlikely Egypt would actually ever go to war with another Nile state. The costs, both monetary and political, associated with invading another nation would be enormous and unwise. The Egyptian economy would suffer from such an invasion and the desired outcome would be extraordinarily difficult to achieve. Even if Egypt were able to invade a Nile nation in the name of protecting its water rights, this course of action would prove to be futile in the long run. Egypt would be globally condemned for its actions by the United Nations and even its closest allies would be forced to isolate it. Fighting in another nation's home turf is also a major disadvantage because the invaded populace have a greater knowledge of the region and a stronger resolve to fight. Upstream nations have reached the point where they have realized Egypt's threat of invading is a bluff. That is not to say that Egypt would hesitate at taking

individual measures to destroy select targets that could considered a threat to Egypt's welfare, however, all-out war is highly unlikely (Milas, 2012 pg 15-32).

In the case with the Grand Renaissance Dam, former Egyptian President Mohamed Morsi specifically mentioned that airstrikes were a plausible option if the dam was determined to be an indisputable threat (McGrath, 2014). Nevertheless, even airstrikes could bring international condemnation and destroy any chance of positive future relationships between Egypt and the upstream nations. Egypt's best bet at protecting its own access to the Nile River is to work to form strong diplomatic relations with upstream nations, which will benefit the entire Nile Basin

Another tactic Egypt has previously used to prevent the construction of upstream Nile infrastructure was to dissuade donors from investing in the projects. Egypt holds considerable influence with the Western world as one of its powerful Middle Eastern allies. The Western world values its strategic partnership with Egypt for political, geographic, and economic reasons and would not jeopardize this mutually beneficial relationship by destabilizing the Nile Basin by investing in upstream Nile projects. Most Arab nations have also been highly supportive of the Egyptian viewpoint and have withheld aid to upstream nations. Additionally, international aid agencies have been wary of investing in upstream Nile infrastructure because of the threat of an Egyptian invasion, which could destabilize the entire region. In recent years, however, upstream nations have become more politically stable, making them more attractive investment opportunities. China has also played a key role by investing in African infrastructure and by becoming the source of capital for many upstream projects. China's investments have proven to be a game-changer in Egypt's investment blockade. Due to Egypt's weakening political position, and the reality that a joint basin management system would actually benefit all of the Nile basin states, Egypt must make adaptations to its own water infrastructure. Egypt needs to

become a more water efficient nation and decrease its reliance on the Nile in order to adapt to the future where it likely will have a smaller Nile water allocation (Pflanz, 2010).

In order to adapt to a future where they will have to accept upstream usage of the Nile, Egyptians must adopt more water efficient policies. Egypt uses nearly 85%, or nearly 48 billion m^3, of all of its water resources to irrigate crops. Large quantities of this water never actually reaches the crops and is lost through leaky pipeline systems or is evaporated. Out of the 15% of the remaining water resources not used for agriculture, an additional 3 billion m^3 is absorbed by plant life growing around the river. This remaining 15% is, often times, so heavily polluted from pesticides that it cannot be consumed without being heavily treated. Egypt's inefficient water usage is severely hurting all Nile water users and is preventing people throughout the basin from safely using the Nile (Sabry, 2012).

To top it off, Egypt's water supply is expected to naturally decrease in the coming years due to climate change. The United Nations Environment Program has listed Egypt as highly vulnerable to changes in its water supply due to expected decreases in the future volume of the Nile River. Estimates on how the Nile's volume will be altered by climate change vary from 10-90% reduction by 2095. Climate change is also expected to result in rising sea levels worldwide. Egypt is expected to experience coastal damage in the delta region from rising sea levels. This would have the negative effect of degrading soil fertility while increasing the soil salinity of some of the most arable regions in Egypt. Expected temperature increases will put stress on crop water requirements, due to increased evaporation levels. It is clear that whether Egypt loses water to upstream nations or to the woes of climate change, Egypt's water supply is all but certain to be reduced in the future. In order to use water more efficiently and to reduce its

dependence upon the Nile River, Egypt must decrease it reliance on the Nile, build resilience in its agricultural sector, and update its internal water policies (Elsaeed, 2012).

One of the first systems that needs to be updated is Egypt's irrigation practices. Currently, irrigation ditches bring Nile water to agricultural regions and pipelines will then bring the water to individual farms. This system is extremely inefficient because many of the earthen ditches allow water to percolate downwards through the ground while also allowing large amounts the surface waters to evaporate. Water is then indiscriminately used to irrigate all of the crops. This has led to a system where farmers will use all of the immediately available water to irrigate their crops, resulting in times when crops are overwatered and times when they are under-watered. It is estimated that implementing a water-trading scheme would result in farmers using water more efficiently. This program would work by farmers having the right to temporarily sell a proportion of their water rights back to the market during times with a surplus of water. This would allow farmers with a water deficit to be allotted more water. This sort of program will require vigilant government oversight in order to ensure that the water is pumped to the correct household at the right time. Studies have shown that this system is a plausible option to reduce water usage and could bring down agricultural water usage by 10% (Gobar, 2011).

Irrigation ditches and pipelines need to be reconstructed in order to reduce the amount of water lost every year. It is difficult to estimate how much water will be saved by updating piping systems, however, it will likely save several billion m^3 of water annually. Updating every single water pipe and ditch in Egypt is a daunting, expensive challenge that would take years to realize and a massive input of capital. Fixing every leaky pipeline in Egypt would be an insurmountable task, however, creating stricter laws and regulations guiding new pipe and irrigation channel construction would be a great way of reducing future water losses. An effective policy to

combat the leaky pipe situation would be to encourage individuals to indicate the location of leaks in their local area and on private property to local government officials. Local government authorities would determine the authenticity of the most detrimental claims, and at the locations of the largest leaks, the area would receive federal funding to fix the pipe. This sort of system would immensely reduce the amount of water lost annually from leaky pipes.

Adopting green economic policies would also reduce Egypt's annual water consumption. Many of the crops that are currently planted in Egypt, such as cotton, rice, and sugar cane, require large quantities of water to survive ("Thirsty Crops," 1986). Plants that are less water intensive should be subsidized by the government and be encouraged. Table 3 shows the average amount of water required to plant a kilogram of some of the most water-intensive crops during a growing season. Table 4 shows techniques that can be used reduce the amount of water needed to grow water-intensive crops. By employing some of these water saving techniques or by subsidizing less water-reliant plants, Egypt will reduce its water consumption.

Table 3: Water Requirements for Common Crops ("Thirsty Crops," 1986)

Table 3. Water Intensive Crops	
This table shows the average amount of water needed to grow some water-intensive crops. These crops are among the most common agricultural products.	
Crop	Typical Water Requirements (liters/kg of crop)
Cotton	7,000 - 29,000
Rice	3,000 - 5,000
Sugar Cane	1,500 - 3,000
Soya	2,000
Wheat	900
Potatoes	500

Table 4. This table shows techniques that could be used to reduce the amount of water needed to produce the most common crops ("Thirsty Crops," 1986)

Table 4. Water Saving Policies	
This table shows come techniques that could be used to reduce the amount of water needed to grow these four common crops	
Crop	Selected water saving practices
Rice	Shorter land preparation period Direct or dry seeding Laser levelling Switch to aerobic rice varieties
Sugar	Drip, sprinkler, and alternate furrow irrigation Water deficit during crop elongation Replanting crop die-off each year
Cotton	Knowledge about cotton growth models Water deficit during early crop development and before harvest Shallow soil cultivation Drip, sprinkler, and alternate furrow irrigation
Wheat	Broad bed cultivation Drip, sprinkler, and alternate furrow irrigation Zero tillage and laser levelling Water deficit in non-critical growth periods Crop varieties that grow under sub-optimal water availability

Egypt can also reduce its water consumption by using more water efficient farming techniques. Drip irrigation is a specific technique that would immensely reduce Egypt's water usage. Drip irrigation conserves water by releasing small amounts of water directly to the soil around the crop, which minimizes the amount of water wasted According to a report by the United Nations Environment Program (2015), Egypt has the potential to save 23 billion m^3 of water annually by switching from flood irrigation to drip irrigation. This enormous quantity of water would make it feasible for Egypt to face a future where the Nile brings less water to the nation.

There are numerous other methods and paths Egypt could take to reduce its reliance upon the Nile. One of the primary issues with all of these water-reduction techniques, however, is that

they all require large amounts of money and foresight for implementation. The Egyptian government would struggle to find the billions of dollars needed to completely revamp its agricultural sector on its own. International aid agencies, foreign allies, and the UN should be shouldering part of the cost. Any nation that desires to prevent war from occurring in the Nile region should be focused upon reducing Egypt's reliance upon the Nile. One of the primary reasons that international aid agencies have withheld funds from upstream Nile infrastructure for the past century was to prevent conflict in the region. While the likelihood that war will occur has been greatly reduced, Egypt's stability needs to be a primary focus for the region' stability. Upstream nations deserve to have greater access to the Nile resources within the boundaries, however, at this point in time, Egypt is wholly reliant upon its Nile allocation. Constructing dams and pumping systems upstream is not the appropriate course of action while Egypt remains entirely dependent upon the Nile. One could even argue that constructing such infrastructure now is illegal under international law because it could potentially reduce Egypt's only water supply. Upstream nations should have part of the Nile's annual flow allocated towards their own usage, however, their allocation would inevitably come from Egypt's proportion. The key to allowing upstream nations the right to using the Nile is by weaning Egypt off of the river. There are additional ways to increase Egypt's water supply.

In addition to decreasing its water consumption, Egypt should also invest in projects that will increase the Nile's measured volume and develop alternative water sources. One of the greatest causes of water loss across the Nile is evaporation. Evaporation is especially prevalent in the Sudd region, Lake Victoria, and the dam-generated reservoirs created by dams in Egypt and Sudan. In order to circumvent the Sudd, Egypt supported and financed the Jongeli Canal with Sudan in the latter half of the 1970s (Sugiyama, 2012). This canal would have connected

the White Nile south of the Sudd with the portion of the White Nile north of the Sudd. Construction halted because of instability caused by the Sudanese civil war (Sugiyama, 2012). The location, now in South Sudan, is still unstable due to rebel unrest throughout the country. Despite the unrest, there is considerable interest in recommencing construction. If the canal is built, it will increase the flow that reaches Egypt by an estimated 4 billion m^3 (Sugiyama, 2012). This canal, however, would cause irreparable damage to the Sudd ecosystem, which plays a very important role in the regional climate. The Sudd plays an important ecological role by acting as a filter to control water quality and flow. It also plays a key economic role for local people by serving as an important water source for cattle and for fishing (Ramsar, 2006). The Jongeli Canal will reduce the water flowing into the wetland by 10% in the dry season and 20% in the wet season (Ramsar, 2006). What effect this reduction will actually have upon the local region has yet to be determined, therefore, construction of the canal should not continue until its potential consequences upon the local region are known and understood.

Evaporation can also be reduced in the future by implementing a basin-wide management system that will strategically build dams in cooler regions. It is estimated that Lake Nasser, located in the arid Nubian desert of southern Egypt, loses 10 billion m^3 of water every year (Rosenberg, 2015). This enormous quantity of water is lost annually because the planners of the Aswan dam decided that having full control over the dam, by placing it within Egypt's borders, was more important than the water that could have been conserved had the dam been built in a less arid part of the basin. Regions situated at higher altitudes, where lower average temperatures persist, naturally have lower evaporation rates and are better locations for future dams (Veilleux, 2013). Through a basin-wide management system, dams can be built at a location that will generate the maximum benefit for all of the basin states.

A less conventional approach to increase the Nile's volume would be to link the Nile with a tributary of the Congo. The Congo River releases 1000 billion m^3 of water annually into the Atlantic Ocean. The proposal is that by constructing a series of canals, Egypt could divert some of this unused water to the Nile River. A recent study by the Egyptian Minerals Resource Authority concluded that connecting the rivers was plausible through transporting the water a distance of 600 km and at an altitude gradient of 200 m by using four pumping systems. The Congo and Nile rivers flow at different altitudes and would require a dam in addition to the canals to raise the water to the necessary height. This system would generate large quantities of hydroelectric power and create infrastructure that could finally connect the entire continent – northern Africa to southern Africa. Part of the Congo River in the eastern part of the Democratic Republic of the Congo would be attached to the White Nile in Sudan via the canal stretching through South Sudan. In total, it is estimated that such a system could bring an additional 39.5 billion m^3 a year of water to Egypt. The estimated price tag is $1.6 billion. This price would be enough to construct the series of canals, the dam and the required pump stations. According to a prominent Egyptian investor Ibrahim al-Fayoumi, "'An Arab and international financing group offered to partake in financing the project and dig a canal connecting both rivers, with the Congolese welcoming the initiative,'" (Hussein, 2013).

Despite the many positives associated with connecting the two rivers, there are two massive obstacles that have prevented the project's construction. The first is the swampy terrain of South Sudan. This type of environment is incompatible with the conditions needed to support a canal. Many people in the Egyptian water ministry believe that the cost of the project would become prohibitively expensive because of this terrain. The second major obstacle deals with the legality of connecting two rivers from separate water basins. According to international

riverine law, it is illegal to connect the water from one river basin to another. Connecting two different water basins could change the direction and volume of the river's flow, which could have a drastic impact on all surrounding regions. There are, however, different interpretations of the international river law governing the river basins. According to Fayoumi who has hired a team to determine the legality of the situation, because the Democratic Republic of the Congo is in both the Congo and Nile River basins, it is legally allowed to adjoin the two rivers within its own nation. This interpretation, however, is not shared by most Egyptian politicians. The linking of the Congo River to the Nile, while there are many obstacles in the way of its construction, could be a viable option to increase the Nile's volume (Hussein, 2013).

Additional methods to increase Egypt's water supply involve systems other than the Nile River. Desalination technology could be utilized to convert seawater to freshwater. This technique is prohibitively expensive, however, seawater is a completely renewable resource that is actually expected to increase in the future as a result of climate change ("Launch of Egypt's Green Economy", 2015). Use of solar power from this region of high solar radiation could reduce the energy footprint of desalination. Recycled wastewater could be used for industrial and agricultural use (Berhane, 2013). In water scarce nations such as Israel, water recycling technology has allowed 83% of wastewater to be recycled and reused mostly for agriculture, thus reducing its total water consumption (Berhane, 2013). Another viable option for Egypt would be to tap into the deep water reserves under the western part of the country. The Nubian Sandstone Aquifer System, the largest fossil groundwater aquifer in the world, is approximately two million km^2 in area ("Chad," 2013). This aquifer is jointly managed by Egypt, Libya, Sudan, and Chad ("Chad," 2013). Libya has spent over 20 billion dollars to create its system pumping and transporting groundwater from southern Libya to the populated North of the nation hundreds of

miles away (Watkins, 2006). This system, affectionately known as the Great Man-Made River Project, has solved Libya's water crisis of the 1960s and has made the nation a leader in hydrological engineering technology (Watkins, 2006). There are potential dangers in "mining" an aquifer, particularly in arid regions where replenishment from surface precipitation is unlikely given recent changes in the region's climate. Still, such a system could potentially be created in Egypt with Libyan guidance.

Conclusion

Questions about managing the waters of the Nile River Basin should be addressed immediately to prevent conflict from erupting in Africa. Egypt and Sudan, the downstream nations, have had a virtual monopoly over the Nile for much of the past century. Under the Nile Waters Treaty of 1959, Egypt and Sudan are allocated 55.5 and 18.5 billion m^3 of water annually, respectively (Wolf, 2004). Accounting for evaporation, this allocation leaves essentially no water from the Nile for the use of the other Nile Basin states. Additionally, the treaty requires approval by Egypt for any new infrastructure over the Nile that could potentially disrupt its flow to Egypt—in all of upstream nations (Wolf, 2004). Recently, there has been significant pushback from upstream nations. Due to rapidly increasing population sizes, threats from environmental change, or for the economic benefits, upstream nations are fighting for the right to use part of the Nile River ("Agriculture, Food Security, and Livelihoods," 2012). The upstream nations of Uganda, Rwanda, Burundi, Kenya, Tanzania, and Ethiopia have all signed the Nile Basin Cooperative Framework Agreement, which asserts their right to safely pursue their individual Nile agenda (Abedje, 2011). This is a pivotal moment in the timeline of Nile politics. The Nile is Egypt's only true, dependable source of water, accounting for nearly 95% of all of Egypt's water usage ("State Information Services," 2011). Egypt will certainly not just allow upstream nations to indiscriminately use the Nile if it places Egypt's supply in danger. At the same time, based on Egypt's actions and statements over the past decade, it appears Egypt recognizes that upstream nations will begin to use the Nile's resources. Egypt needs to ensure that it can adapt in time to the change in its Nile allocation.

A basin-wide management approach needs to be implemented over the entire Nile. This means that all of the Nile nations need to come together and collectively made decisions that will

protect all Nile resources and ensure water security for the people who live in the Nile Basin. Basin-wide studies need to be conducted to determine the ideal locations for new dams based upon the greatest hydroelectric potential, lowest evaporation rates, and ability to control flooding. Nations need to work together in an open and free manner regarding their prospective Nile projects in order to promote a trusting, productive working atmosphere. Nile Basin governments should view one another as partners working towards a common goal rather than rivals.

For a basin-wide management approach to be effective, all of the Nile Basin nations must be involved. The Cooperative Framework Agreement is the future of Nile. The only real point of contention with the agreement is the section that deals with water security (Abedje, 2011). The wording of the downstream nation's version of the section in contention, which protects "current uses and rights of any other Nile Basin State", is something that would continue the management system of the past—catering the needs of solely downstream nations ("Agreement on the Nile River Basin Cooperative Framework," 2012). The upstream version, which reads "not to significantly affect the water security of any other Nile Basin States" needs to be more specifically defined ("Agreement on the Nile River Basin Cooperative Framework," 2012). In particular, the word "significant" needs to be defined. Specific allocations based upon current and short-term needs should be determined for each nation. Over the next few years, comprehensive field analyses and studies need to be conducted by third parties to determine immediate and short-term Nile water needs. This portion of the Cooperative Framework Agreement should be revised in an increment of appropriate years to redistribute the water to the basin nations by the appropriate amounts based upon third party validation of each nation's requested allocation.

The goal is that over time, downstream nations—specifically Egypt, will be able to increase their water efficiency, and thus, decrease their need for large quantities of Nile water allocation. For this plan to become a reality, however, the change needs to start by aiding Egypt in its quest to decrease its Nile dependence. International aid agencies, donor nations, and individuals who desire to improve the lives of all of the 240 million Nile Basin citizens need to work to first ensure the water security of the 80 million Egyptians who entirely depend upon the Nile ("Opportunities and Challenges," 2012). Egypt needs to first have its irrigation practices completely revamped. By switching to drip irrigation from flood irrigation, Egypt can remove an estimated 23 billion m^3 of water out of its annual water demand ("Launch of Egypt's Green Economy", 2015). As Egypt gradually becomes more water efficient, upstream nations can use the water that Egypt no longer requires for their own irrigation purposes. If the Nile is truly meant to be managed on a basin-wide approach, then ensuring Egypt's security first is the safest way to ensure effective cooperation and the water security of all of the basin states. A tentative timeline would need to be created that outlines the locations and acres of land that have switched to drip irrigation in Egypt.

An oversight body should be created by the cooperative framework agreement that will facilitate a basin wide management style. All decisions would require the approval of the representatives of all of the nations, rather than a simple majority. Representatives should be technocrats that have specialties or a background in engineering, economics, or another related profession. Politicians should not be the primary representatives under a basin-wide management system because they will naturally act excessively to protect the interests of solely their nation, which will undermine the joint management system and the spirit of cooperation. If disputes arise, third party professional organizations—such as the UN, should be consulted.

The Nile issue does not have to turn into a war. Instead it can be used to show how nations, with very different cultures and outlooks, were able to come together to support and to cooperate with one another—for the mutual benefit of all. The future of the Nile should not be based up historical rights or colonial agreements; it should be based upon the needs of the people who presently live in the Nile basin. Upstream nations need to have greater access to the Nile in order to prepare for decreased precipitation patterns and population increases. Upstream allocation of the Nile, however, cannot come at the expense of Egypt. A plan needs to be put into place to fast track Egypt to reduce its water consumption so that upstream nations can be given greater Nile allocations in earnest. Through a spirit of cooperation and mutual respect, a crisis over the Nile can be averted.

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Academic Vita: Jason Pollack

The Pennsylvania State University **Graduation: May 2015**
Schreyer Honors College

Bachelor of Science in Environmental Systems Engineering
Minor in Energy, Business, and Finance

WORK AND LEADERSHIP EXPERIENCE:

Chevron **Questa, New Mexico**
Environmental Intern May 2014 – August 2014

- Wrote the first wildlife management plan for the Questa mine property
- Tracked the expanding subsidence zone through using GPS data and by physically monitoring the region
- Created wildlife safety pamphlets for distribution to new employees
- Aided in ion-exchange plant inspection, cleanup, and maintenance activities
- Commenced mine certification documentation and planning for the Wildlife Habitat Council

Research Assistant **Department of Energy and Mineral Engineering**
Professor Klima September 2013 -- Present

- Experimented on coal ash to determine the effectiveness of products in absorbing pollutants, such as aluminum, zinc and copper, to prevent these pollutants from entering streams and damaging local ecosystems

Earth Engineering Inc. **East Norriton, Pennsylvania**
Intern/ Inspector May 2013 – August 2013

- Obtained and conducted concrete samples to test for the viability of buildings according to ASTM standards
- Determined the risk of groundwater contamination and the water table at construction sites
- Conducted experiments on soil samples from construction sites to deduce the soil's ability to hold water

Robbins Park Environmental Education Center **Ambler, Pennsylvania**
Intern May 2011 - June 2011

- Collected and organized solar panel data for the environmental center and the township
- Learned how to manage environmental centers and environmental parklands
- Discussed habitat problems related to the park and generated solutions with environmental engineers

Twin Spring Farm Day Camp **Ambler, Pennsylvania**
Rock Wall Counselor Summers 2008 - 2012

- Generated new activities to improve camper experience
- Developed a novel system of belaying the children down the rock wall which greatly improved their safety

ACTIVITIES:

- **Relay for Life Penn State Merchandise Captain** – Responsible for creating, ordering, selling and marketing Penn State Relay for Life merchandise
- **THON** – Served on the Rules and Regulations and the Hospitality committees in order to help make the largest student-run philanthropy event a success
- **Society of Environmental Systems Engineers –** Participated actively in my major's society in order to learn more about job opportunities and to help younger members with their career goals and course scheduling

SKILLS/CERTIFICATION

- Proficiency in Microsoft Office Programs
- RCRA Hazardous Waste Generation Training Certified