Transboundary Water Management: Add Climate Change and Stir

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Abstract

There are many transboundary river basins worldwide. In Africa, international river basins cover 62% of its landmass. Transboundary waters are, in some cases, shared but not managed or governed properly. When coupled with the added pressure of climate change, water management will become even more complicated. In this paper it is argued that in order to have effective and sustainable transboundary water governance, adaptation and mitigation for climate change need to be included in transboundary agreements. The paper focuses primarily on two transboundary river basins in the African continent: the Nile River Basin and the Volta River Basin. The importance of transboundary water management is examined, as well as its associated challenges in light of the Nile and Volta Basins. Their existing and/or planned institutional arrangements are also addressed. Furthermore, this paper provides general knowledge on how climate change will affect transboundary waters while also exploring the hypothesized impacts of climate change on the Nile and the Volta Basins. Finally, SWOT analyses of the Nile Basin Initiative (NBI) and the Volta Convention are presented, assessing the extent of their preparedness to the impacts of climate change and outlining some general recommendations regarding how to approach climate change in the transboundary management context.

Keywords: Nile Basin; Volta Basin; transboundary water management; climate change; conflict; cooperation; Nile Basin Initiative; Volta Convention; colonization

Introduction

In the world there are over 276 cases of transboundary river basins, which include both groundwater and surface water resources (UN-Water, 2013; GWP & INBO, 2009). The continent of Africa is home to many transboundary waters, with international river basins covering 62% of the land mass (Lautze, Giordano & Borghese, 2005). Transboundary water management on its own is a very complex task. The added pressure from climate change will make managing water for countries even more complicated. It is already a difficult task as a result of weather patterns that already have natural variability and unpredictability factors (GWP

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This paper will argue that climate change has the potential to have devastating impacts on transboundary water resources. In order to have effective and sustainable transboundary water governance, adaptation and mitigation for climate change must be included in transboundary agreements.

The objective of this paper is to demonstrate why properly managed transboundary water resources are important. This will be done by examining two transboundary river basins in the continent of Africa: the Nile River Basin and the Volta River Basin. The paper will also aim to assess the preparedness of these river basins for the anticipated impacts of climate change. The first section will provide an overview of transboundary water management and its many challenges. An overview of the two river basins that will be examined will also be provided, specifically their geography, politics, and what challenges are facing them. The second section addresses the existing and/or planned institutional arrangements of the two case studies being examined. In the third section, general knowledge of how climate change will affect transboundary waters is examined, as well as the hypothesized impacts of climate change on the Nile and Volta River Basins. The final section of this paper presents SWOT analyses of the two river basins, assessing the extent of their preparedness for the impacts of climate change and outlining some general recommendations regarding how to approach climate change in the transboundary management context.

Transboundary Water Management

Transboundary river basins connect different countries and their populations to each other through social, economic and hydrological opportunities, such as cooperation, peace, security and economic growth (UN Water, 2008). However, as mentioned in the UN-Water
Thematic Paper (2008), some challenges come to light when there are disparities between the countries that share the waters. These challenges can include:

- Water resource management ability;
- Infrastructure accessible in the riparian countries;
- Political focus;
- Socio-economic development in the countries (UN Water, 2008).

Due to the interconnectedness within transboundary basins this can also create tensions and conflicts. Therefore, proper transboundary water management is vital as it can help resolve issues through cooperation, the creation of legal and institutional systems, and discovering shared benefits (UN Water, 2008).

Another reason having proper management of transboundary water resources is important is due to the variety of uses water resources have, from domestic purposes to industry, tourism and economic purposes (Kliot et al., 2001). Within industry and economic purposes, the creation of dams can be found as a common occurrence. Dams in transboundary waters are known to increase tensions between and among riparian countries. They can have negative impacts on the water basins such as the following issues: the loss of biodiversity and ecosystem, creation of upper and lower riparian country tensions, and altering the hydrological regimes (Vink, 2014; UN Water, 2008; GWP & INBO, 2009).

Much of the literature surrounding transboundary water management has suggested that management should be carried out on a basin level or scale, which includes all stakeholders and riparian countries involved in the basin. Holmatov and Lautze (2016) found in their study of different transboundary water laws and treaties that if management is implemented on smaller
scales there is more opportunity for engagement and cooperation. The article makes four recommendations:

- Making sure that the cooperation and agreements are used for the best suited scale, for example small scale treaties would better suit development-oriented projects where larger scale treaties would be better suited towards broad activities such as policy development;
- An emphasis on the role of smaller scale management and how it will be suitable for the situations where a project may not need basin wide participation but just the involved states;
- The third and fourth recommendations suggest that integrated water management can provide a good balance for all scales, meaning creating smaller scale treaties that will complement the larger scale treaties to enhance cooperation (Holmatov & Lautze, 2016).

In addition to the above recommendations, another good beginning step for riparian countries that are looking for a guideline on what an effective agreement should include is to consider the UN Convention on the Law of the Non-Navigable Uses of International Watercourses, also known as the UN Watercourse Convention that was adopted in 1997 (Matthews, 2013). The Convention contains both substantive commitments, which are involved with accomplishing specific results, and procedural commitments, which are the methods to accomplishing the specific results (Matthews, 2013). The three substantive commitments in the Convention are, “equitable utilization, the duty of "no harm," and the obligation to protect and preserve international watercourses” (Matthews, 2013). The procedural commitments include the responsibility of cooperation, consultation, as well as data and information sharing (Matthews, 2013).

Transboundary Water Management: Overview of the Nile River Basin
The Nile is generally regarded as the longest river in the world and has a drainage area of approximately three million square kilometers of territory in eleven riparian states: Ethiopia, Sudan, South Sudan, Egypt, Rwanda, Tanzania, Uganda, Burundi, DRC, Eritrea, and Kenya (see Map in Appendix A). Its catchment area encompasses 10% of Africa's landmass (United Nations Economic Commission for Africa, 2004).

The Basin climate ranges from tropical in the equatorial region of the Great Lakes area and the Ethiopian highlands, to arid in Sudan and Egypt (Paisley, 2013). The White Nile, Blue Nile, Atbara and Sobat tributaries constitute the bulk of the Nile’s 84 Billion Cubic Meters (BCM) annual flow (as measured at Aswan) (Treffner et al., 2010 and Parkes, 2013), but vary in their individual water contributions (as can be seen in the Table in Appendix B), given their differing topographic and climatic origins (El Zain, 2007). During the dry season in the Ethiopian Highlands, from November to April, the White Nile, which originates in Burundi, contributes between 70 and 90% of the total discharge of the Nile (Di Baldassarre, et al., 2011; Mohamed, 2013). However, the Blue Nile, which originates in Ethiopia, contributes approximately 60-70% of the total annual River Nile discharge. The flow of the Blue Nile varies considerably over its annual cycle and is the main contributor to the large natural variation of the Nile flow (Di Baldassarre, 2011).

The Nile plays a central role in human settlement and in the development of a rich diversity of cultures and livelihoods. It includes world-class environmental assets such as the Sudd in South Sudan (Nile Basin Initiative Secretariat, 2012). Sudd is an Arabic word for ‘barrier’ or ‘blockage’. In its original usage, the Sudd referred to the islands and massive floating mats of vegetation found on the Bahr el Jebel between Malakal and Bor, which occasionally completely sealed off the Nile to navigation. The area at the confluence of the White Nile
tributaries is extremely flat, with an average slope of 10 cm per km. Furthermore, river channels at the confluence are very shallow and annually spill large volumes of water into surrounding lands, leading to extensive flooding and wetland formation. The Sudd wetlands have a permanent and seasonal component, the extent of which varies from year to year following local and regional climatic variation, and the flow regime of the Bahr el Jebel and Sobat Rivers (State of the River Nile Basin, 2012). Sudd outflows show little seasonal variation, providing a fairly constant contribution to the White Nile throughout the year. By buffering peak flows, the swamps have a regulating effect on the downstream river regime (ibid) (see Appendix C).

Wetlands and water bodies in the Nile Basin represent at least four percent of the total area. This relatively small portion of the territory provides a great range of basin-wide benefits. The riparian countries have identified more than 70 major wetlands of relevance for the Nile system, with concentrations in two areas: the Equatorial Lakes region and the Sudd area in South Sudan. Still, in their aggregation many smaller wetlands are crucial for the Nile Basin’s overall resilience. Currently, 17 Nile Basin wetlands are designated as “Ramsar wetlands of international importance”, providing wintering grounds for migratory birds and important biodiversity hot spots (Nile Basin Initiative, 2013).

The Nile is essentially Egypt's only source of water. The vast majority of Egypt's rapidly expanding population lives in the Nile Valley and the agricultural sector, which constitutes a significant portion of the Egyptian economy, is heavily dependent on crops that require extensive irrigation (Paisley, 2013). Egypt has historically enjoyed the largest share of the Nile waters – officially (but rather more than) 55.5 BCM or two thirds (as dictated by the 1959 Treaty) – at the expense of its upstream neighbours (Cascão, 2009 and Parkes, 2013). For years it has successfully thwarted attempts to re-allocate Nile waters equitably (Rahman, 2010), and further
entrenched its position as the basin’s ‘hydro-hegemon’ by means of its dominant power position (Parkes, 2013).

Bulto (2009) identifies three major obstacles that hamper the path to a basin-wide agreement in the Nile Basin: the deficiencies of international law in resolving specific basin-wide water allocation issues (legal paucity), the lingering influence of the notion of “water security” bequeathed by colonial masters, and the doctrinal controversies arising from riparian states’ adherence to contradictory theories of sovereignty. Bulto explains that the striking similarity among all colonial treaties and agreements is that they encouraged unilateralism instead of establishing basin-wide regulatory frameworks (ibid). These agreements tended to inform the post-colonial mindset of riparian states whose behaviour is modeled to some extent on the colonial era approach to the problem. This mindset has continued to hinder fresh negotiations and agreements upon the equitable utilization of the Nile. In most cases, the treaties of the colonial era banned irrigation, power generation, and other uses of the Nile waters without the prior agreement of the Egyptian government in order to ensure the constant and undiminished flow of the waters to Egypt (ibid).

According to Zeitoun et al. (2013), some of the challenges that face transboundary management of the Nile Basin are as follows:

- Socioeconomic and environmental pressures;
- Fast-growing populations;
- Increased irrigation and hydropower demand in all basin states;
- Regional impacts of climate variability and climate change;
- Policy and management, i.e. the Nile pits the national development aspirations of upstream states against established downstream agricultural livelihoods.
Transboundary issues; for example, sediments may reduce hydropower capacity, and they may no longer recharge agricultural areas at the Nile Delta. Also, surface and groundwater in the Nile Equatorial lakes might be polluted, and reduced or altered flows from existing and planned increased use upstream can also exist. Other transboundary issues include highly securitized flows in Ethiopia, Egypt and intermittently politicized/securitized in Uganda, Tanzania, and Kenya.

**Transboundary Water Management: Overview of the Volta Basin**

The Volta Basin, located in West Africa, is the ninth largest basin in Africa (Matthews, 2013). It is shared between six riparian states and occupies a surface area of 400,000 kms squared (IUCN, 2012). Burkina Faso and Ghana hold the largest areas of the basin, Ghana with 42% and Burkina Faso with 43%. The remaining 15% of the basin’s area is occupied by Togo holding 6%, Benin with 4%, Mali with 3%, and the Cote d'Ivoire holding 2% (Matthews, 2013). The basin is drained by the Black Volta, White Volta with the Red Volta as its tributary, Main Volta, Oti, and the Lower Volta (Amisigo, McCluskey & Swanson, 2015) (as seen in Appendix D). Lake Volta, which has a surface area of 8500 kms squared, was formed from the damming of the Main Volta at the Akosombo dam that is used for hydropower production in Ghana (Amisigo, McCluskey & Swanson, 2015). The main sources of water in the basin are rainfall, rivers, lakes, and man-made water storage facilities such as dams and reservoirs (Matthews, 2013). Groundwater is not a significant resource in the Volta Basin due to the low primary porosity of the region’s sediment. The use of shallow aquifers is usually detrimental because they are often contaminated by domestic and agricultural waste (Matthews, 2013).

One of the many challenges to managing the Volta Basin is the basin sharing countries are some of the most impoverished countries in the world (Matthews, 2013). The basin is home...
to people from over 50 different ethnic groups and all six nations have faced different colonial histories and experiences, leaving them with very different post-independence trajectories of development (Lautze, Barry & Youkhana, 2008). The existence of the six basin sharing countries is only due to French and British colonization, when borders were drawn with very little consideration to existing West African political chiefdoms (Lautze, Barry & Youkhana, 2008).

Before colonization, water ownership within the basin was seen as collective and all individuals had the right to use the resource freely (Matthews, 2013). Religion was a very important part of water management, as water from the basin’s rivers was seen as holy and most indigenous groups had strict regulations protecting the integrity of the water resource (Matthews, 2013). Tribal chiefs and priests promoted the utilization practices that were environmentally beneficial and sustainable. The introduction of outside influences during the colonial period changed the way the Volta was viewed and managed (Lautze, Barry & Youkhana, 2008). Once colonization began and colonial borders were drawn, the colonial water management system directly contradicted the indigenous management systems (Matthews, 2013). The new management systems put emphasis on ownership and government controlled water rights (Matthews, 2013). The drawing of borders also changed the communal use of water and after independence the countries that share the basin pursued their own water related agendas, with little concern for the impacts their actions would have on water resources outside their own borders (Lautze, Barry & Youkhana, 2008).

The disregard for other countries in the shared basin brought water disputes. One of the most noteworthy disputes occurred in 1962 with the construction of the Akosombo Dam and its reservoir Lake Volta in Ghana (Matthews, 2013). Thousands of people were forced to relocate due to flooding and livelihoods were lost. The Akosombo Dam is heavily relied on for electricity
generation, producing 90% of the electric energy in Ghana (Kasei & Diekkruger, 2010), yet at the time of construction there were no agreements made to ensure a continued flow from upstream countries (Osusu, Waylen & Qiu, 2008). Past drought have caused low reservoir levels, which in turn have caused conflicts between Ghana and Burkina Faso. Reduced reservoir levels in Lake Volta cause power shortages in Ghana, which then causes Ghana to accuse Burkina Faso of withdrawing too much water upstream (Matthews, 2013). The most disputes occur between Ghana and Burkina Faso, yet they both continue to build dams in order to generate hydroelectric power (Matthews, 2013). The most predominant use of the Volta Basin’s water is for agriculture, leading to a large number of dams being built (Matthews, 2013). Water demands in the Volta are not currently being met due to inadequate infrastructure of water supply systems, misuse of water, flood irrigation practices which cause evaporation and seepage, and overconsumption (Matthews, 2013).

**Overview of Existing/Planned Transboundary Institutional Arrangements**

In the paper by Lautze et al. (2005), the authors analyze how internal and external drivers impact the creation of African transboundary water law. The internal drivers are objectives and goals for the treaty and the external drivers are not clearly stated within the treaties, however they still shape the treaties during development and direction. Some of the drivers found for transboundary management treaties have influenced policies in the two case study basins of the Nile and Volta. These include internal drivers such as irrigation projects that require building a dam and external drivers such as geopolitics (Lautze et al., 2005). The article also discusses the influence that the past colonial history in Africa has had on the creation of treaties and agreements for transboundary water management. Agreements can be motivated by non-water related or water-related matters and in the past the majority of the treaties formed by colonial
powers were over non-water related matters, but more so for land-related matters (Lautze et al., 2005). However, the treaties that involved at least one African state were focused more on the water-related issues. The treaties post-colonial rule in Africa are found to be most commonly driven by goals or internal drivers including joint management of the water resources among the riparian governments, this focus would be uncommon in treaties where colonial powers were involved (Lautze et al., 2005). Another internal driver that the authors found within African water treaties was an increased focus on environmental sustainability in the last couple of decades, which is important for the future for implementing climate change mitigation and adaptation (Lautze et al., 2005).

In terms of the external factors, it was found that they are the ones that have had the most influence on the creation of treaties as well as orientation and realization. The four external drivers that were discussed by the authors that had the most influence on transboundary water regulation were: geostrategic significance, international trends of management and development for water resources, cultural or religious identity of the country, and international attention due to conflict potential (Lautze et al., 2005). The driving influencer that has gained momentum over the other three has been the potential for conflict with transboundary resources; therefore agreements have been influenced to avoid that potential conflict. The majority of the influences, which originate from the external factors mentioned above, are generally connected to circumstances internationally, not within the continent of Africa (Lautze et al., 2005).

Another difficulty with transboundary water law that was found in literature is the lack of representation of vulnerable people within access policies (Vink, 2014). There were two different types of vulnerability explained in the article by Vink (2014), extrinsic and intrinsic vulnerability in terms of water potential. Extrinsic refers to unequal repercussions that are caused by
peripheral circumstances such as unequal power relations, water withholding, and social issues. Intrinsic vulnerability is described on a smaller scale, where equal access will not necessarily contribute to equal potential, as people require different amounts of water depending on their characteristics (Vink, 2014). The new Sustainable Development Goals (SDGs) have focused on leaving no one behind and implemented a goal specifically for universal access to water and sanitation, which allows for vulnerable people to become an important focus and for an increase water potential to occur (Vink, 2014). Vulnerable groups and their access to quality and sufficient water need to be considered early on in the formation of transboundary water agreements as they can help with where the allocation of water is needed in order to fulfill the human rights approach to water rather than just water as a right (Vink, 2014).

One of the more debated aspects of transboundary water laws is equitable and reasonable use, how to define it, on what level, and who gets to decide? A major part of the debate for equitable and reasonable use is what scale the use should be based on, whether country, basin, or household and if use should be divided by types of use. Or should equitable and reasonable use be based on a rights-based approach that looks at capabilities rather than scale and amount of water (Vink, 2014). A common measure of equitable and reasonable use of water is setting a per person daily minimum, which has been calculated to equal 50-100 litres including water needed for daily activities, but does consider that there are variations between individuals. On the contrary, if the minimum limit was to be replaced by a vague term like adequate amount, there is more room for interpretation and some people may use more water than they require or it could mean that populations are limited to even less than the minimum (Vink, 2014). Within transboundary water management agreements, this issue of measurement needs to be addressed.
from the beginning, a specific amount or term needs to be selected and the riparian countries can then move forward using the measurement as a marker for equitable use in future agreements.

**Overview of Existing/Planned Institutional Arrangements: The Nile River Basin**

Molden (2009) explains that agreements and treaties over the Nile basin can be divided into those that were essentially aimed at creating and justifying British claim (and later Egyptian claims) over the Nile and those that were later created to redress some of the inequities embedded in the previous agreements. The former treaties could be called treaties of allocation and the later cooperative treaties. The Nile treaties from 1890 to 1959 that led to division of entire Nile water between Egypt and Sudan to the exclusion of all other riparian countries belong to the first category of treaties aimed at securing complete control over the Nile by Egypt and to some extent by Sudan. The treaties starting from 1977 (Kagera Basin Agreement, Hydromet, Nile Basin Initiative (to be described in greater detail below) and currently Cooperative Framework of Agreement) aim at redressing some of the inequities inherent in the previous water allocation agreements as already stated earlier. These treaties, later in the 1990s, were also focused on benefit sharing – a concept popularized by the World Bank and later taken up by the Nile Basin Initiative (Molden, 2009). Table 2 (see Appendix E) lists the historical agreements and treaties of the Nile River Basin since 1890 to the present day. This table is based on Westman (2009).

Such unfair colonial agreements have been the cause of a long history of unsuccessful negotiations and disputes over allocation and development of Nile water resources (Paisley, 2013). However, after decades of interaction and the involvement of external agents (such as the World Bank and the UNDP), the Nile riparian countries have been able to take at least a first step
toward cooperation by entering into the Nile Basin Initiative (NBI) in 1999. This initiative has been ratified by riparian states as a regional partnership for spurring growth and addressing the critical challenges of the Nile River Basin. It is led by the riparian states of the Nile and is built around a shared belief that countries can achieve better outcomes for all the peoples of the Basin through cooperation rather than competition. Its Shared Vision is “To achieve sustainable socio-economic development through equitable utilization of, and benefit from, the common Nile Basin Water resources” (Nile Basin Initiative Secretariat, 2016). Metawie (2004) notes that the major objectives of the NBI are as follows:

- To develop the water resources of the Nile basin in a sustainable and equitable way to ensure prosperity, security and peace for all its peoples;
- To ensure efficient water management and the optimal use of the resources;
- To ensure co-operation and joint action between the riparian countries, seeking win–win gains;
- To target poverty eradication and promote economic integration;
- To ensure that the programme results in a move from planning to action.

When the NBI was first agreed upon, it represented the only institutional arrangements that involved all basin riparian countries of the Nile Basin. It described itself as “transitional arrangement until a permanent legal and institutional framework is in place” and comprised a Council of Ministers of Water Affairs of the Nile Basin (Nile-COM), a Technical Advisory Committee (Nile-TAC) and a Secretariat (Nile-SEC) (Nicol & Shahin, 2003).

The ultimate objective of the NBI was to conclude a cooperative framework agreement that would incorporate the principles, structures and institutions of the NBI and that would be inclusive of all the Nile riparian states (Paisley, 2013). Work on the Nile Basin Cooperative
Framework Agreement (CFA) started immediately after the NBI was formally established in 1999, and continued for more than 10 years. However, the process ran into some major difficulties as a result of the resurfacing and hardening of the respective positions of the riparians over the colonial treaties, as well as the Egyptian and Sudanese claims to what they see as their acquired uses and rights of the Nile waters (Salman, 2013). Those differences could not be resolved at the negotiations level and were eventually taken to the ministerial meetings that took place in Kinshasa, Alexandria and Sharm El-Sheikh in 2009 and 2010. However, those meetings in turn failed to resolve those differences, and no agreement on the final draft CFA could be reached (Salman, 2013). What those negotiations did was further widen the gap and exacerbate the differences over the allocations of the Nile waters between the Nile’s lower and upper riparians, and over the CFA as a whole (Mekonnen 2010).

**Overview of Existing/Planned Institutional Arrangements: The Volta Basin**

After the colonial period ended and the nations sharing the Volta Basin gained independence in the 1960s, no transboundary water management system existed in the basin until 2008. This is a very significant amount of time to spend without a transboundary agreement. There were, however, a few regional efforts initiated and funded by NGOs (Matthews, 2013). The only two international agreements that involved multiple riparian states that existed in the Volta Basin before the 21st century had no mention or concern for the uses of the basin's water. These agreements existed for the purpose of purchasing electricity generated by the Akosombo Dam (Lautze, Barry & Youkhana, 2008). There was a severe lack of integrated water management and of coordination between various institutions within the basin sharing states (Lautze, Barry & Youkhana, 2008). The water-related institutions would implement projects and programs that had no regard for the goals of other institutions (Lautze, Barry & Youkhana,
2008). Within Ghana, there was three water management institutions: The Volta River Authority, the Ghana Water and Sewerage Corporation, and the Irrigation Development Authority. There was no practical integration between these water management institutions, or with the many institutions that also existed in Burkina Faso (Lautze, Barry & Youkhana, 2008). The water management institutions and authorities that existed in Ghana and Burkina Faso after independence and into the 1990s had no hierarchy. The institutions looked only to fulfil their own goals, even if this impacted the efforts of other institutions (Lautze, Barry & Youkhana, 2008). In the 1990s Burkina Faso and Ghana underwent Integrated Water Resource management-oriented restructuring of their water institutions (Lautze, Barry & Youkhana, 2008).

The first step to transboundary water management took place in 1971 when a joint transboundary commission known as the Permanent Joint Commission for Cooperation Between Ghana and Upper Volta was established. It was created in order to facilitate collaboration for political, economic, and social issues affecting both Ghana and Burkina Faso (Matthews, 2013). After a severe flood in 1994 and an energy shortage in Ghana in 1998 caused by reduced water levels, international interest in establishing a more permanent transboundary water authority between Ghana and Burkina Faso rose significantly and NGOs sponsored many regional initiatives (Lautze, Barry & Youkhana, 2008). The World Bank, the United Nations Development Program, and the Swedish International Development Agency established the Global Water Partnership (GWP) in 1996 in order to promote integrated water resource management around the world, which in turn fostered the formation of the West African Water Partnership in 2002. All six basin sharing nations are partners with the goal of promoting and
implementing regional water management programs that are targeted to improve living conditions and alleviate poverty (Matthews, 2013).

Of the many programs that have been tried in the Volta Basin, one of the most successful programs was initiated by the German Federal Ministry of Education and Research. This program was the Global Change and the Hydraulic Cycle (GLOWA) research program that undertook the GLOWA Volta Project in 2000 in order to assess the sustainable development potential of water resources in the basin (Volta Basin Authority, 2011). This was one of the first projects to contribute to transboundary cooperation within the Volta Basin (Lautze, Barry & Youkhana, 2008). This project ended in 2009 but a follow-up project was done in order to strengthen the human capacity and the research infrastructure, and to promote the dissemination of research results (Volta Basin Authority, 2011). The United Nations Environment Program also sponsored a project called the Addressing Transboundary Concerns in the Volta Basin and its Downstream Coastal Area project in 2002. This project, and the many other projects done by a number of international organizations, set the path for the formation of a regional transboundary water management institution on the Volta Basin (Matthews, 2013).

In 2004, the Ghana-Burkina Joint Declaration was signed by the governments of Ghana and Burkina Faso in order to acknowledge their common environmental and water issues, and the importance of including the other basin sharing nations in a collaborative committee (Lautze, Barry & Youkhana, 2008). All six nations began the process of forming a transboundary water management institution called the Volta Basin Authority (VBA) (Volta Basin Authority, 2011). The Volta Basin Technical Committee (VBTC) was also established in 2004 in order to include all nations in the planning process of forming a Volta Basin transboundary water resource management program (Lautze, Barry & Youkhana, 2008). In 2005, The VBA was created after
the signing of the Memorandum of Understanding by all six states (Volta Basin Authority, 2011). In 2007, the Convention on the Status of the Volta River and the Establishment of the Volta Basin Authority (Volta Convention) was signed by the six basin sharing countries and it came into force in 2009 (Volta Basin Authority, 2011). The three purposes of the Volta Convention are to recognize the Volta River as an International watercourse, create substantive and procedural obligations for the riparian states, and to establish the VBA and its mandate. The Volta Convention states that the mandate of the VBA is to promote permanent consultation tools among the parties for the development of the basin, promote the implementation of integrated water resource management, authorize the development of infrastructure and projects that have the potential to impact the water resources of the basin, develop joint projects, and to contribute to poverty alleviation and sustainable development (Volta Basin Authority, 2011). The Volta Convention gives the VBA jurisdiction over the Volta River, its tributaries and sub-tributaries, the reservoirs and lakes, groundwater and wetlands, as well as the aquatic and land ecosystems linked to the basin (Matthews, 2013). The substantive and procedural obligations for member states are very few and limited in scope. The treaty fails to address all relevant factors in the equitable and reasonable use of water, and due to the broad scope of the treaty there is significant potential for difficulties in interpreting and applying the Volta Convention (Matthews, 2013).

Between the late 19th and early 21st centuries the Volta Basin’s water management institutions and policies experienced a large amount of change (Lautze, Barry & Youkhana, 2008). The success of the Volta Basin is dependent on the six basin sharing nation implementing the obligations of the Volta Convention and ensuring the VBA successfully carries of its mandate. The main concerns regarding the stability of the VBA are the lack of sufficient structures and the high turnover of political leadership (Matthews, 2013). The basing sharing
states do not have the financial resources or institutional capacities to effectively deal with potential natural disasters, making it vitally important to correct the shortcomings of the obligations set out in the Volta Convention to plan for future emergencies (Matthews, 2013). The convention’s principles need to be more specific in order to make the existing obligations implementable. The Volta Convention and its implementation are in their infancy, but the necessary steps in creating a basin wide regime have been taken (Matthews, 2013).

**Climate Change as a Threat Multiplier**

In addition to the many challenges transboundary water management faces, the newest challenge that is increasingly becoming more difficult to manage is climate change. Transboundary water agreements need to take climate change into consideration and begin implementing policies that will help basins with climate change adaptation. There are many projected impacts that climate change is expected to have on transboundary water basins. One of the projected impacts climate change will have on transboundary waters is an increase of water stress, including a reduction in the availability of renewable freshwater (Tir & Stinnett, 2012). Climate change is also expected to increase the rate of severe weather events, such as floods and droughts, therefore increasing the need of adaptation policies within transboundary water management (World Water Council, 2009; GWP & INBO, 2009; UN-WWAP, 2015). The increased amounts of droughts and floods from climate change can have severe impacts on health, the environment, and economic and social activity (UN-WWAP, 2015). The seasonal variability of river runoff and precipitation will also be affected by climate change, which could increase the amount of droughts in some countries and reduce the flow of water in rivers in summer months. These impacts will cause a greater reliance on surface waters for countries that already experience less precipitation in summer (Tir & Stinnett, 2012).
International conflict is also a potential outcome of climate change, as the increased water variability will further impact how countries are affected by decisions made by the other riparian countries. Due to the increased water stress, the riparian countries of transboundary waters will hold more value for the water resources that they have access to, this will include an increase in economic and political value of those resources (Tir & Stinnett, 2012). To counteract the water stress and potential conflict that could arise from the climate change impacts, transboundary treaties are a good way to reduce those tensions and set specific regulations for the waters to help lessen the stress on the water resources. Specifically, if transboundary treaties make use of international institutions, they will be more successful at reducing tensions brought about by climate change between riparian countries (Tir & Stinnett, 2012; UN-WWAP, 2015).

Climate Change as a Threat Multiplier: The Nile Basin

A large number of studies have attempted to examine the potential climate change impacts on water resources in the Nile Basin (see, for example, Di Baldassarre 2011; Conway and Hulme 1996; Elshamy, et al. 2009; Kite and Waititu 1981; Hulme 1990; Gleick 1991; Yates and Strzepek 1998; Strzepek et al. 2001; Kim et al. 2009).

According to the Climate Change Strategy that has been adapted by the Nile Basin Initiative, the Nile Basin is highly vulnerable to the impacts of climate change owing to a multiplicity of factors. This strategy lists a number of climate trends that are likely to occur as a result of climate change in the Nile basin. They are as follows:

- Higher evaporation and consequent increased losses from reservoirs.
- Higher evapotranspiration rates and rising crop water requirements leading to an increase in demand for irrigation water.
The high potential evaporation values in the Nile region – ranging from some 3,000 mm/year in northern Sudan to 1,400 mm/year in the Ethiopian Highlands, and around 1,100 mm/year in the hills in Rwanda and Burundi – make the basin particularly vulnerable to drought events.

Higher frequency and intensity of severe rainstorms that will lead to an increase of flood risk and serious storm damage.

Higher water temperatures in the Equatorial Lakes, which strengthen thermal stratification, increase algal productivity, accelerate microbial mineralization, and reduce oxygen dissolution, among other effects.

Expansion of the range of vector-borne diseases such as malaria to higher altitudes due to warmer temperatures.

Sea-level rise that could threaten the very productive Nile Delta and the cities along the Indian Ocean coast.

It is also worth noting that in recent years, the Nile Basin Initiative has supported research and analysis to better understand the vulnerability of the basin to climate change and evaluate adaptation actions to reduce climate-related risks (Cooley, 2009). The Climate Change Strategy adopted by the Nile Basin Initiative has recommended, as an overall goal, that basin-wide resilience to climate change be strengthened, and that climate compatible water resource management and development be ensured (Nile Basin Initiative, 2013). The Strategy has also recommended five strategic objectives to govern NBI’s climate change strategy. They are as follows:
● Strengthen the knowledge base to enhance common understanding of climate change risk and its impacts on water resources, ecosystems and the socio-economic system of the Nile Basin.

● Strengthen long-term capacities for addressing climate risks and uncertainty in the Nile Basin at national and transboundary levels.

● Support climate resilient planning and implementation addressing climate risks and uncertainty in NBI’s programs.

● Promote scalable low carbon development through enhanced transboundary cooperation in areas such as protection of wetlands as well as clean energy use and development.

● Strengthen basin-wide climate finance access and the capacity for development of feasible projects in the Nile Basin (Nile Basin Initiative, 2013).

The Cooperative Framework Agreement (CFA) also has some provisions to respond to climate uncertainty (Zeitoun, et al. 2013). A Nile Basin decision-support system is being developed now to provide a framework for sharing information, understanding river system dynamics, and evaluating alternative development and management schemes. Although climate change was not explicitly mentioned in the project scoping information, the tool may prove useful in integrating climate change into management of the Nile Basin water resources (Cooley, 2009).

Given that climate projections are uncertain, and that very often demographically- and economically-induced growth in demand for water is expected to outweigh climate-driven changes, adaptation in the water sector should focus on building adaptive capacity and no-regret type activities in response to multiple factors (Goulden et al. 2009).

*Climate Change as a Threat Multiplier: The Volta Basin*
West Africa has been listed as a region of the world that will be most impacted by
droughts due to climate change, which will lead to loss of livelihood (Ndehedehe, Awange,
Corner, Kuhn & Okwuashi, 2016). Several studies have projected that up to a 20% decrease in
rainfall will occur in the Volta Basin by 2080-2099 (Matthews, 2013). The competing demands
for water resources and poor climatic conditions of the Volta Basin are putting the basin’s water
resources under very heavy stress. The current climatic conditions in the Volta Basin regions are
causing high variability in temporal and spatial distribution of rainfall, which is leading to
variability in stream flow (Volta Basin Authority, 2011). The climatic extremes that the Volta
Basin region has already been experiencing on a recurring basis are droughts, dry and dusty
winds, and torrential flooding. The unreliable rainfall patterns also create difficulties in meeting
the food production goals, impacting food security (Kasei & Diekkruger, 2010). Extreme
weather events, such as droughts and floods, are expected to rise in frequency and intensity in the
Volta Basin (Volta Basin Authority, 2011). The cost of mitigating the impacts of climate is a
large obstacle, as the basin sharing countries are impoverished nations (Matthews, 2013).

Since the 1970s the whole of West Africa has been experiencing a period of declining
rainfall that has caused a series of severe droughts (Osusu, Waylen & Qiu, 2008). The
agricultural sector is very vulnerable to the changes in climate because it is mostly rainfed and
irrigation is at a low level of development within the basin. The agricultural sector is very
important to the basin sharing countries and makes up 30% of Ghana’s GDP and employs
approximately 50% of their population (Amisigo, McCluskey & Swanson, 2015). Changing
climate has the potential to greatly inhibit any future progress in the long run of Ghana’s
agricultural sector due to the vulnerable state it is currently in, as well as inhibiting the economic
development of the basin sharing countries (Ndehedehi et al., 2016). The past exploitation of the
water resources in the basin has caused serious environmental problems. The VBA is supposed to avoid and reduce the environmental problems within the basin, although climate change is projected to exacerbate the problem of declining water resources in the Volta Basin (Amisigo, McCluskey & Swanson, 2015).

The declining levels of rain have been led to Ghana not being able to meet industrial demand or meet international commitments of power supply. These power shortages have resulted in accusations of exploitive withdrawals in upstream countries causing reductions in flows to the lower basin, (Kasei & Diekruger, 2010). These accusations are causing tensions and have the potential to lead to conflict. Although these accusations are being made, studies show that water withdrawals upstream in Burkina Faso have very little impact on reservoir levels in Ghana (Osusu, Waylen & Qiu, 2008). The changing rainfall levels are impacting the water levels, and in turn impacting power generation, although this rainfall variability is poorly understood by those making the accusations (Kasei & Diekruger, 2010). The political issues, mismanagement of water resources, and over-reliance on the Akosombo Dam have the potential to work together to lead to the changes in climate becoming increasingly devastating in the Volta Basin (Osusu, Waylen & Qiu, 2008). There is a great need to diversify the sources of energy and have higher cooperation in water sharing issues in order to avoid the increasing potential for conflict and deal with the declining water levels (Osusu, Waylen & Qiu, 2008).

**SWOT Analysis: Preparedness for Climate Change**

**SWOT: Nile Basin**

This section adapts a SWOT analysis technique to summarize the fundamentals of the Nile Basin Initiative. It is based on Belay et al. (2010) as well as the Nile Basin Initiative Secretariat Strategic Plan. First, as far as the strengths of the NBI are concerned, the NBI focuses
on multi-country, multi-sectoral programs of collaborative actions, exchange of experience, and trust and capacity building designed to build a strong foundation for regional cooperation and sustainable management of the Nile water. It was also intrinsically geared towards achieving the Millennium Development Goals and Sustainable Development. Its Shared Vision Objective now is: “To achieve sustainable socio-economic development through the equitable utilization of, and benefit from, the common Nile Basin water resources” (Nile Basin Initiative, 2017).

Furthermore, it has strong donor support from giant institutions like the World Bank, Global Environmental Facility, German Agency for Technical Cooperation, African Development Bank, and Canadian International Development Agency for implementing its projects. The NBI has also set up governance, institutional structures and processes to provide permanent mechanisms for constructive dialogue, planning and development among riparians, focused on the sharing of water and water’s benefits.

The opportunities of the NBI include continued support of the World Bank to the NBI projects. This presents “hope” for achieving the NBI goals in the future. Furthermore, financial and in-kind contribution of member will help sustain NBI functions. Also, establishment of NBI-ISP (Institutional Strengthening Project) is hoped to provide solutions to the challenges facing the NBI. For example, it will allow the NBI to undertake an institutional design processes to prepare the NBI for new challenges in absence or presence of Cooperative Framework of Agreement (CFA). Moreover, since the Nile Basin countries are part of the African Union, NBI project has an opportunity of benefitting from the New Partnership for Africa’s Development (NEPAD), which aims at providing an overarching vision and policy framework for accelerating economic cooperation and integration among African countries. More involvement of NGOs and civil society will also involve the overall effectiveness and efficiency of the implementation of
the NBI projects. Another opportunity is the Climate Change Strategy adopted by the NBI. This Strategy is a good step in the right direction. It is important to put in place robust measures needed to address most, if not all, of the challenges posed by climate variability and change.

It is also worth noting that the Grand Ethiopian Renaissance Dam (GERD) has the potential to foster cooperation by offering regional socio-economic benefits through the coordination and management of hydraulic infrastructure in the basin for an improved water regulatory regime. These improvements in turn may greatly assist in addressing the uncertainties that climate change will bring to the basin. Coordination over the operation of GERD may also prove to be a catalyst for additional benefits ‘beyond water’, such as a greater integration of markets and trade (Sadoff & Grey, 2002).

Regarding the weaknesses, the NBI lacks institutional depth like thin staffing which is insufficient to respond to the increasing and emerging demands placed on the institution in the area of strategic planning, resource mobilization, or responding to basin management issues. It also does not have adequate capacity to develop regional databases and to analyze water resource information. There is also a lack of coordination and linkages with some NBI stakeholders like the Lake Victoria Basin Commission, and the planning of NBI projects did not incorporate the local knowledge of the indigenous people in the Nile Basin countries. Another weakness is failure in regional cooperation among the Nile riparians to ultimately reach basin unity.

Finally, there are threats that face the NBI. These include the Nile Basin Water Treaty of 1929, which limits effective utilization of the Nile-waters. There is also history of tensions and instability in the region, both between countries and within countries. Thus, when one country refuses to cooperate, it can have significant consequences on the NBI goals. Furthermore, increasing population coupled with poverty creates pressure on resources of the Nile. NBI
countries are also in different development stages with six out of the poorest 10 nations of the world and this threatens the initiative’s path towards achieving its goals. Meanwhile, the World Bank policies possess future uncertainty of the NBI projects due to its historical bad record in achieving its goals in the countries under its funds. Finally, climate change and water stress, coupled with lack of trust and genuine cooperation among upstream and downstream basin states have the potential to force the Basin states to act unilaterally without caring about the public interest.

The above SWOT analysis has clearly shown that the NBI is not immune from the challenges, weaknesses, and threats. However, it has also shown that the NBI has some strengths and opportunities, and therefore we recommend that the NBI capitalize on these strengths and opportunities to work out the challenges it faces.

**SWOT Comparison Chart: The Nile vs. Volta Basin**

<table>
<thead>
<tr>
<th></th>
<th>Nile Basin and NBI</th>
<th>Volta Basin</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Strengths</strong></td>
<td>The NBI focuses on multi-country, multi-sectoral programs of collaborative actions, exchange of experience, and trust and capacity building designed to build a strong foundation for regional cooperation and sustainable management of the Nile water. The NBI is intrinsically geared towards achieving the Sustainable Development Goals. Strong donor support from giant institutions like the World Bank, Global Environmental Facility, German Agency for Technical Cooperation, African Development Bank and Canadian International Development Agency for</td>
<td>Positions the basin sharing countries to promote international cooperation for rational and sustainable management of water resources. The existence of the VBA allows for there to be one authority with the sole purpose of sustainable management of water resources. The VBA provides a strong international image of transboundary water management, and with this reputation it has the ability to attract funding in order to help them achieve the goals they have set out. The VBA strengthens the</td>
</tr>
</tbody>
</table>
implementing its projects. The NBI has also set up governance, institutional structures and processes to provide permanent mechanisms for constructive dialogue, planning and development among riparians, focused on the sharing of water and water’s benefits. Coordination of projects between basin sharing countries and can help to provide a direction for the projects to achieve the goals and obligations set out in the Volta Convention. Development of Strategic Plans to guide the sustainable use of resources in the Volta Basin.

<table>
<thead>
<tr>
<th>Weaknesses</th>
<th>Opportunities</th>
</tr>
</thead>
<tbody>
<tr>
<td>The NBI lacks institutional depth like thin staffing which is insufficient to respond to the increasing and emerging demands placed on the institution in the area of strategic planning, resource mobilization, or responding to basin management issues. Inadequate capacity to develop regional databases and to analyze water resource information. Lack of coordination and linkages with some NBI stakeholders like the Lake Victoria Basin Commission, Planning of NBI projects did not incorporate the local knowledge of the indigenous people in the Nile Basin countries. Failure in regional cooperation among the Nile riparians to ultimately reach basin unity.</td>
<td>Continued support of the World Bank to the NBI projects. This presents “hope” for achieving the NBI goals in the future. Financial and in-kind contribution of member will help sustain NBI</td>
</tr>
</tbody>
</table>
functions.

Establishment of NBI-ISP (Institutional Strengthening Project) is hoped to provide solutions to the challenges facing the NBI. For example, it will allow the NBI to undertake an institutional design processes to prepare the NBI for new challenges in absence or presence of Cooperative Framework of Agreement (CFA).

Since the Nile Basin countries are part of the African Union, NBI project has an opportunity of benefiting from the New Partnership for Africa’s Development (NEPAD), which aims at providing an overarching vision and policy framework for accelerating economic cooperation and integration among African countries.

The Grand Ethiopian Renaissance Dam (GERD) has the potential to foster cooperation by offering regional socio-economic benefits through the coordination and management of hydraulic infrastructure in the basin for an improved water regulatory regime. These improvements in turn may greatly assist in addressing the uncertainties that climate change will bring to the basin. Coordination over the operation of GERD may also prove to be a catalyst for additional benefits ‘beyond water’, such as a greater integration of markets and trade (Sadoff & Grey, 2002).

More involvement of NGOs and civil society will also involve the effective partnerships through collaborative projects. There are a large number of NGOs that have been working in the Volta Basin whose expertise can be used, as well as other environmental NGOs that can be collaborated with.

There is opportunity for the VBA to create awareness on use, management, and protection of water resources in the basin in order to ensure sustainability of water use.
<table>
<thead>
<tr>
<th>Threats</th>
<th>Overall effectiveness and efficiency of the implementation of the NBI projects.</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Climate Change Strategy of the NBI.</td>
<td></td>
</tr>
<tr>
<td>Nile Basin Water Treaty of 1929, which limits effective utilization of the Nile waters</td>
<td>Delaying ratifications to the Volta Convention is a major threat. If the Convention is not ratified, countries will continue to have no clear obligations to follow through with.</td>
</tr>
<tr>
<td>Non participation of some countries in the full affairs of the NBI (Regional Co-operation stalls)</td>
<td>There is the threat of too much focus on individual national interest, which would inhibit effective transboundary water management.</td>
</tr>
<tr>
<td>Political instability in the NBI countries</td>
<td>The financial situation of the basin sharing countries is unpredictable. The basin sharing states already lack the financial resources to deal with potential natural disasters, and climate change is expected to increase the frequency of extreme weather events.</td>
</tr>
<tr>
<td>Unfulfilled member country expectations</td>
<td>Unfulfilled member country expectations.</td>
</tr>
<tr>
<td>Failure to achieve financial sustainability, and Member Countries have difficulty meeting financial obligations</td>
<td></td>
</tr>
<tr>
<td>Unsustainable water use practices by some Nile riparians such as the development of new settlements in the desert, the farming of relatively water-intensive crops and the storing water in reservoirs with relatively high evaporation rates (Bailey, 2013).</td>
<td></td>
</tr>
<tr>
<td>Climate change and water stress, coupled with lack of trust and genuine cooperation among upstream and downstream basin states have the potential to force the Basin states to act unilaterally without caring about the public interest.</td>
<td></td>
</tr>
</tbody>
</table>
**SWOT: Volta Basin**

There has been significant progress made in the transboundary management of the Volta Basin in recent years. One of the major strengths of the Volta Convention is that it positions the basin sharing countries to promote international cooperation for rational and sustainable management of water resources. The existence of the VBA allows for the existence of one authority with the sole purpose of sustainable management of water resources (VBA Strategic Plan, 2010). In the past, there were too many authorities between the riparian countries with different goals trying to govern the Volta Basin unsuccessfully (Lautze, Barry & Youkhana, 2008). The VBA provides a strong international image of transboundary water management, and with this reputation it has the ability to attract funding in order to help them achieve the goals they have set out (VBA Strategic Plan, 2010). The VBA also strengthens the coordination of projects between basin sharing countries and can help to provide a direction for the projects to achieve the goals and obligations set out in the Volta Convention (VBA Strategic Plan, 2010).

An important strength of the development of transboundary management in the Volta Basin is the Strategic Plans developed in order to help guide the implementation of the Volta Convention’s obligations.

There are also weaknesses to the Volta Convention. The VBA is a very new authority and is not yet widely utilized or respected by all stakeholders. Stakeholders planning on implementing projects are only supposed to do so with permission from the VBA, though projects are still taking place without their permission (VBA Strategic Plan, 2010). Political will
is a major issue surrounding the transboundary management of the Volta Basin. There is a high turnover in political leadership in the basin sharing countries and there are financial constraints to dealing with climate related disasters (Matthews, 2013). The different colonial histories that the basin sharing countries experienced continue to act as a weakness for effective transboundary management. Inadequate funding also puts constraints on long-term planning, making it even more difficult to commit to the obligations set out in the Volta Convention.

The Volta Convention is still a very new transboundary agreement, so there are many opportunities to make it more effective. Ratifications to the Convention can be made in order to include more concrete obligations in making environmental and climate issues a higher priority. There is also the opportunity for more effective partnerships through collaborative projects. There are a large number of NGOs that have been working in the Volta Basin whose expertise can be used, as well as other environmental NGOs that can be collaborated with (VBA Strategic Plan, 2010). There is opportunity for the VBA to create awareness on use, management, and protection of water resources in the basin in order to ensure sustainability of water use (VBA Strategic Plan, 2010).

Although making ratifications to the Volta Convention presents opportunity for improvement, delaying these ratifications is a major threat. If the Convention is not ratified, countries will continue to have no clear obligations to follow through with (Matthews, 2013). There is also the threat of too much focus on individual national interest, which would inhibit effective transboundary water management (VBA Strategic Plan, 2010). The financial situation of the basin sharing countries is unpredictable (VBA Strategic Plan, 2010). The basin sharing states already lack the financial resources to deal with potential natural disasters, and climate change is expected to increase the frequency of extreme weather events (Matthews, 2013).
Currently, the Volta Basin has not taken the appropriate steps to ensure preparedness to climate change. They are still in the early stages of their transboundary water management agreement, but they are in a positive position to make improvements to the VBA that is their current authority.

**General Recommendations for Climate Change Preparedness**

The United Nations Economic Commission provided lessons learned from the experiences of a few basins that have already begun the adaptation process for climate change in the article for Europe (ECE) and the International Network of Basin Organizations (INBO). A few of these lessons learned would be useful for riparian countries, specifically the case studies examined throughout this paper, to take into consideration with their own implementation of climate change adaptation management. In addition to the lessons learned, following the examination of these cases through SWOT analyses the following general recommendations can be made.

- **Data Collection and Information Sharing:** are needed to achieve more productive and powerful adaptation for climate change (ECE & INBO, 2015).

- **Risk Management Plan:** should be included in climate change adaptation plans in their legal provisions as suggested by the UN World Water Assessment Programme due to a lack of institutional capacity as well as legal capacity for addressing the impacts of severe weather events, such as droughts and floods, on transboundary basins (UN-WWAP, 2015).

  Guidance on Water and Climate Adaptation was developed in 2009 to help guide basins with transboundary management and adaptation for the effects that climate change could have, like severe weather events (World Water Council, 2009). Five measures to assist with adaptation
that were recommended by the Guidance would be beneficial for the examined case studies or any other transboundary water basin to include in policies for climate change adaptation for water resources management are:

- Prevention measures: to prohibit consequences resulting from climate change;
- Measures to improve resilience: used to enhance management capacity for the consequences of climate change;
- Preparation measures: utilized to minimize the impacts of the consequences from climate change;
- Response measures: used following a significant weather event to help reduce the impacts of climate change;
- Recovery measures: used for reconstruction following a significant weather event (World Water Council, 2009).

Political will is also needed in order to achieve any of these measures for adaptation as well as the willingness to share authority with the other riparian countries in the basin (World Water Council, 2009).

**General Recommendations for the Nile and Volta Basins**

In spite of the Nile’s comprehensiveness and complexity it is not immune to weaknesses and threats. The basin is going to have to capitalize on its strengths and opportunities in order to work out the challenges it faces. Similarly, the Volta Basin also needs to capitalize on its strengths and opportunities. It has made significant progress in recent years forming the VBA and Volta Convention, yet it is still necessary to make to the obligations stated in the Convention implementable. It is imperative to develop a strategic, ethical and human approach to the challenges and/or crises facing the NBI and Volta Convention. A paradigm shift is necessary -- a
new way of thinking in order to create innovative tools for constructive dialogue and social communication among the states of the Nile River Basin and Volta River Basin.

Regional cooperation in the Nile River Basin is fragile, and if the various countries do not act quickly to build cooperation and develop a joint plan on how to harness the Nile, the crisis will get worse. A win-win solution to the management of the Nile River Basin will require a change in perspective and will require a willingness to sit down and resolve outstanding issues. In regards to the Volta Basin, a comprehensive strategic plan is also necessary in order to create an effective climate change strategy and continue to develop transboundary management, as it is still new to this basin.

Building on what was just stated, the following general recommendations need to be taken into consideration:

- Adopt a comprehensive human and strategic approach to solving the issues pertaining to the development of the Nile River Basin and Volta River Basin.
- Employ innovative tools for addressing crisis and natural disaster, and come up with appropriate and common solutions for these events.
- Deal with the Nile and Volta as integrated units, which will require the basin sharing states to work together (multilateralism not unilateralism).
- Use moral and ethical principles in dealing with the problems and challenges of regional cooperation and water management.
- Formulate a shared vision to combat poverty and to promote development in all the countries of the Nile River Basin.
- Call for more ‘thinking together’ among the Nile and Volta riparians on all levels and with all stakeholders in order to build trust within transboundary water management.
Due to the fact that population pressure is one of the driving forces leading to environmental degradation in the Nile basin, it is recommended that the NBI should have a separate project focus on population control within the basin states.

- To ensure the obligations of the Volta Convention are implemented, create a more comprehensive strategic plan that includes climate change as a major issue to be addressed.

**Conclusion**

This paper argued that climate change has the potential to have devastating impacts on transboundary water resources. In order to have effective and sustainable transboundary water governance, adaptation and mitigation for climate change must be included in transboundary agreements. The impacts of climate change are already affecting both the Nile and Volta Basins. The SWOT Analyses presented for the Nile and Volta Basins clearly show that these transboundary water basins are not prepared for climate change. There are opportunities to increase the effectiveness of the transboundary management in these two cases, and the recommendations outlined provide advice on how to improve. Although the Nile and Volta Basins have transboundary agreements in place, they need to address the increasing threats that climate change presents in order to be effectively prepared for climate change.
References


Conceptual framework for the management of shared river basins with special reference to the SADC and EU. *Water Policy*, 2, 9–45.


http://www.nilebasin.org/index.php/nbi/who-we-are


Appendix A: Map of The Nile River Basin

Source: The World Bank Group
Appendix B: Table of Riparian share in the Nile's drainage basin

<table>
<thead>
<tr>
<th>River</th>
<th>Area of drainage basin (km²)</th>
<th>Share per country in drainage basin (%)</th>
<th>Mean discharge (BCM)</th>
<th>Mean discharge (annual) (%)</th>
<th>Mean discharge (flood period) (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blue Nile (Khartoum)</td>
<td>324,530</td>
<td>Ethiopia 92, Sudan 8</td>
<td>49.7</td>
<td>55.5</td>
<td>59 (1994) 68 (2002)</td>
</tr>
<tr>
<td>Atbara (mouth)</td>
<td>100,400</td>
<td>Ethiopia 45, Sudan 55</td>
<td>11.7</td>
<td>13.5</td>
<td>13 (1994) 22 (2002)</td>
</tr>
<tr>
<td>Sobat (mouth)</td>
<td>225,000</td>
<td>Ethiopia 40, Sudan 60</td>
<td>13.7</td>
<td>15.5</td>
<td>14 (1994) 5 (2002)</td>
</tr>
<tr>
<td>White Nile (Malakal)</td>
<td>1,332,070</td>
<td>Sudan 64, DRC 2.5, Kenya 4, Rwanda 3.5, Uganda 13, Burundi 3.5, Tanzania 9.5</td>
<td>29.6</td>
<td>33.5</td>
<td>14 (1994) 5 (2002)</td>
</tr>
<tr>
<td>Main Nile (Aswan) (1899-1971)</td>
<td>3,030,700</td>
<td>Sudan 62.7, Ethiopia 12.1, Egypt 9.9, Uganda 7.7, Tanzania 3.8, Kenya 1.8, DRC 0.8, Rwanda 0.7, Burundi 0.5</td>
<td>84-88</td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>

Appendix C: Total Flows of The Nile

Source: Blackmore and Whittington, 2008
Appendix D: Map of the Volta Basin

Source: Ndehedehe et al., 2016
### Appendix E: Table of Nile treaties and agreements from 1890 to the present day

<table>
<thead>
<tr>
<th>Year</th>
<th>Name of the treaty</th>
<th>Signatories</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>1890</td>
<td>Anglo German Treaty</td>
<td>Great Britain and Germany</td>
<td>To legalize that Nile Basin was in the sphere of British influence</td>
</tr>
<tr>
<td>1891</td>
<td>British protocol with Italy</td>
<td>Great Britain and Italy</td>
<td>Italy pledged not to undertake any irrigation work which might significantly affect the flows of the Atbara into the Nile</td>
</tr>
<tr>
<td>1894</td>
<td>Anglo-Congolese agreement</td>
<td>Great Britain and Belgium</td>
<td></td>
</tr>
<tr>
<td>1906</td>
<td>Anglo-Congolese agreement</td>
<td>Great Britain and Belgium</td>
<td></td>
</tr>
<tr>
<td>1906</td>
<td>Anglo-Ethiopian agreement</td>
<td>Great Britain and King Menelik of Ethiopia</td>
<td></td>
</tr>
<tr>
<td>1906</td>
<td>Tripartite agreement</td>
<td>Great Britain, Italy and France</td>
<td></td>
</tr>
<tr>
<td>1919 &amp; 1925</td>
<td>Anglo Italian agreement</td>
<td>Great Britain and Italy</td>
<td>To gain influence over Lake Tana</td>
</tr>
<tr>
<td>Year</td>
<td>Agreement Title</td>
<td>Parties</td>
<td>Description</td>
</tr>
<tr>
<td>------</td>
<td>-----------------------------------------</td>
<td>----------------------------------</td>
<td>------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>1929</td>
<td>Nile Water Agreement</td>
<td>Egypt and Great Britain</td>
<td>Concession to produce cotton in Sudan, Egypt to get 48 km³, Sudan 4 km and rest 32 km³ was unallocated.</td>
</tr>
<tr>
<td>1934</td>
<td>London agreement on Nile</td>
<td>Great Britain and Belgium on behalf of Rwanda and Burundi</td>
<td>No work was permitted on Kagera basin</td>
</tr>
<tr>
<td>1938</td>
<td>The New Anglo-Italian Agreement of 1938</td>
<td>Great Britain and Italy</td>
<td>British interest in Lake Tana, but later annulled in 1949 along with 1902 treaty.</td>
</tr>
<tr>
<td>1949</td>
<td>Own Falls agreement</td>
<td>Egypt and Britain, on behalf of Uganda</td>
<td>To construct Own falls in Uganda and Egypt to monitor flows downstream</td>
</tr>
<tr>
<td>1952</td>
<td>Egypt Sudanese Agreement of 1952</td>
<td>Egypt and Sudan</td>
<td>Sudan got concession to raise water level in Sennar Dam by 1 m</td>
</tr>
<tr>
<td>1959</td>
<td>Nile water apportionment agreement</td>
<td>Egypt and Sudan</td>
<td>To divide water of the Nile between Sudan and Egypt. Construction of Aswan High Dam and Rosaries dam and Jonglei canal.</td>
</tr>
<tr>
<td></td>
<td>Date</td>
<td>Event Description</td>
<td>Participants</td>
</tr>
<tr>
<td>------</td>
<td>------------</td>
<td>----------------------------------------------------------------------------------</td>
<td>---------------------------------------------------</td>
</tr>
<tr>
<td>1967-1992</td>
<td>HYDROMET and UNDUGU</td>
<td>Egypt, Sudan, Kenya, Uganda, Tanzania</td>
<td></td>
</tr>
<tr>
<td>1977</td>
<td>Kagera Basin Agreement</td>
<td>Tanzania, Rwanda and Burundi and Uganda</td>
<td></td>
</tr>
<tr>
<td>1993</td>
<td>Framework Agreement for General Cooperation</td>
<td>Egypt and Ethiopia</td>
<td></td>
</tr>
<tr>
<td>1993</td>
<td>TECCONILE</td>
<td>All countries</td>
<td></td>
</tr>
<tr>
<td>1993</td>
<td>Nile Basin Initiative</td>
<td>All countries except Eritrea which had an observer status</td>
<td></td>
</tr>
<tr>
<td>2010</td>
<td>Cooperative Framework Agreement</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2015</td>
<td>Declaration of Principles</td>
<td>Egypt, Sudan, and Ethiopia</td>
<td>An initial deal to end a long-running dispute over the sharing of Nile waters and the building of Africa's biggest hydroelectric dam, in Ethiopia.</td>
</tr>
</tbody>
</table>