Transboundary Water Resources Management: A Review of the River Omo Basin

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Abstract- Transboundary water resources need the cooperation of national governments in the development of policies and strategies for development. A holistic approach on sustainable development with an emphasis on protection of the water basin for the continued use o the resources for all partners is ideal but often hard to achieve. Despite this, there have been 295 water agreements made over the world compared to 327 conflicts. As climate change and anthropogenic activities continues to hold ground as major aspects in water resource management, sustainability is key in ensuring development, peace and adaptation reign. Focusing on the Omo River basin, a DPSIR with qualitative analysis was done on policies and strategies that are will come into effect and are already in place to establish their social, cultural, economic and environmental effects. Based on the current trend, the main focus of both governments seems to be on economic development with an avoidance of any possible negative effects of energy, agricultural and industrial projects.

Index Terms- River Omo Basin, Transboundary Water Resources, DPSIR Framework, Qualitative Analysis. Lake Turkana

I. INTRODUCTION

Transboundary water resources are water sources such as rivers, lakes, aquifer ad river basins that are shared by two or more countries. These resources are important to a vast number of people for their livelihood and life support. There are 300 transboundary aquifers serving 2 billion people that rely on groundwater and 276 transboundary river basins and lakes that cover approximately half of the Earth's surface. [1] As climate change continues to morph the way water is spread out in the world, cooperation is key to providing water to these vulnerable areas. If not avoided, over exploitation of aquifers, rivers, and lakes make water supple unreliable and unsustainable causing international tension and conflict.

Sometimes even the best intensions have negative consequences such one country building a dam as a measure to adapt to climate change which reduces flow downstream into another country. Management of water resources at this scale needs cooperation between countries on strategic plans in heavily water dependent sectors like agriculture, industry, energy, navigation, water supply and sanitation to enable sustainable development. The efficient and cooperative management and development of shared water is very crucial as it benefits all parties improving international trade, climate change mitigation, economic growth, security and governance. A basic Qualitative Document Analysis is discussed in regards to any action plans, strategies, bilateral agreements and interactions between any relevant bodies regarding water recourse management; sustainable development; and potential socio-economic and environmental effects.

II. IDENTIFY, RESEARCH AND COLLECT IDEA

There may have been 37 conflicts over water since 1948 but there have also been around 295 international water agreements that have been negotiated and signed since then. In light of this The Convention on the Protection and Use of Transboundary Watercourses and International Lakes (UNECE Water Convention) was adopted in Helsinki in 1992 and enforced from 1996. It was a legal framework for the transboundary management of water resources in the Pan European area but has been available to the rest of the world since 2003, though it was enforced in 2013 as tool for worldwide cooperation. It aims to facilitate cooperation in the management of transboundary water resources to protect its quality, quantity and sustainable use. All United Nations members can demand the use of the Convention since 2016. However, despite this around two thirds of transboundary resources do not have any cooperative management frameworks. In addition, climate change adaptation has become a major factor in transboundary water resources management as there has been growing evidence on its continued effect on the global landscape. [2] This creates an even bigger need for the integration of sustainability in decision making strategies.

One such way is through assessing the interactions between development and these water resources. When it comes to integrated environmental assessment and reporting, the DPSIR (Driver-Pressure-State-Impact-Response) framework is the most widely adopted mostly due to its proven track record in understanding the creation and progression of environmental problems.

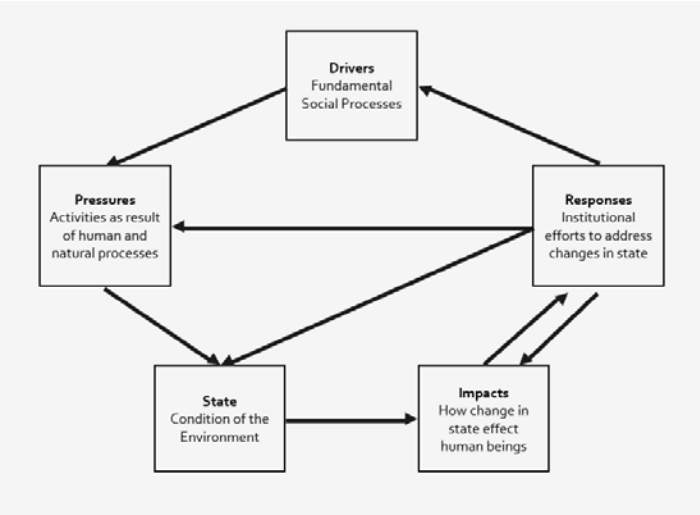

Figure 1: DPSIR Framework Flow Chart

It was developed in 1999 by the European Environmental Agency (EEA) and has been used on both the global and local scale. Its use has further evolved into tackling such issues but not without some critics on how its setup doesn't accommodated local knowledge in the Impact and Response portions and social and cultural factors in the Drivers portion, especially when it is used in the Global South. [3] To mitigate these critics, the assessment of the transboundary water resource will focus on the large scale country level as well as local ones within the watershed through qualitative document analysis.

When it comes to permanent desert lakes, Lake Turkana comes out on the top of that list. The Omo River provides around 80% of the lake's water with it getting the rest from the Turkwel and Kerio Rivers. It covers an area of 7,560 km^2 and has not outlet and only relies on evaporation to get rid of its water. The lake provides potable water for people in the area as well as food in terms of aquatic life from its rich wildlife. It supports over 300 bird species, both indigenous and migratory. The surrounding Sibiloi, Central Island and South Island National Parks are UNESCO World Heritage Sites with one of the last indigenous Nile Crocodiles, some hippopotami and various venomous snakes. [4]

III. WRITE DOWN YOUR STUDIES AND FINDINGS

Drivers

Population.

In 2017, Ethiopia laid the groundwork towards providing electricity to all its citizens by 2025 by launching the 'Light to All Program. [5]This is meant to balance the inequality in electricity access with urban areas and rural areas having 87% and 5% of the population connected to the national grid [6] especially as the population is set to rise to 171.8 million by 2050. [7] This change is more than double the population in 2012 that was 83.7 million which has pushed the government to make policies that can cater to this doubling in population by the half of this century. [8] Biomass is the primary source of energy in Ethiopia accounting for 91% of the energy used with petroleum products and electricity at around 7% and 2% respectively. [9] This has pushed the country to look to hydropower as its saving grace due to its untapped potential. [10]

Case Study: Assessment of Omo River Basin

The Omo River Basin is an endorheic drainage basin that spans the area of 146,000 square kilometres. It comprises of the Shewan Highlands, the Omo River, its tributaries and Lake Turkana. The River Omo starts off at its source 7600 ft high up in the Shewan Highlands, a mountainous plateau in Southern Ethiopia. It also has tributaries that include the Gibe, Gojeb, Denchya, Mui. Usno and Wabi, with Gibe being its most important one. The river continues meandering 760 kilometres south and flows down an elevation of 2000m, finally emptying out into Lake Turkana which is mainly situated in Kenya.

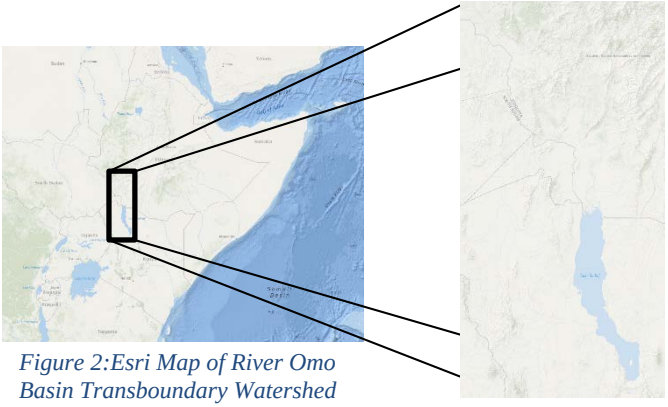

Figure 2:Esri Map of River Omo Basin Transboundary Watershed

Energy Generation

Ethiopia has the potential to produce over 60,000 MW of power from renewable energy sources. This comprises of 45GW hydropower, 10 GW wind energy, 5GW geothermal and 4.5 - 7.5 kWh/m2/day solar irradiation. [11] They have set in place a target for 35,000 MW by 2037 to sustain the country's economic growth. The country currently relies on hydropower, other renewables and thermal energy for 86%, 8% and 6% of its energy which is a capacity of 2261 MW that provides 23% of the country with electricity. To boost production of electricity, Ethiopia is focusing on increasing hydropower by constructing more dams and hydropower stations in the Omo River Basin. [12]

Food Security

With a growing population, comes the need to create new jobs and provide sources of food. Ethiopia has an irrigable land potential of between 3.7 and 4.3 million hectares of which 7 – 10% of this is actually irrigated. This area consists of 55% irrigation schemes that are traditional, 20% modern small-scale schemes and 25% medium to large scale commercial farms. The country is focusing on improving crop production through constructing several dams and reservoirs; and expanding irrigation schemes. Irrigation in the country is heavily reliant on rainfall but the country has plans to change that. [12]

Pressures

Water Abstraction

Hydropower Generation

Ethiopia has three power stations in the Omo River Basin; Gibe I, Gibe II and Gibe III with plans for the future Gibe IV and V. The

Gilgel Gibe I is a 1,700 m long and 40 m tall rock-filled dam on the Gilgel Gibe River that started construction in 1988, commissioned in 2014 with a hydroelectric power plant with an installed capacity of 184 MW. Water from the dam is diverted to the power station and then discharged back to the Gilgel Gibe River. This water is then channelled through a 9.2 km long tunnel to the Gibe II Station that goes through a mountain ridge. Gibe II power station has an installed capacity of 421 MW which consist of four 107 MW generators that are operated by four Pelton turbines which are powered by water from a headrace that runs 26 km under the Fofa Mountain and eventually converts into a penstock with a 500 m drop. The water is then discharged into the Omo River.

Ethiopia is in the process of increasing its hydropower capacity from 2.3 Gw in 2016 to 10 GW in 2018, 17 GW by 2020 and 35 Gw by 2037 to establish the country as a regional renewable energy hub. Gibe III Dam is in the Southern Nations Nationalities and Peoples' Region. It is a 610 m long and 243 m high roller-compacted concrete dam with a reservoir capacity of 14.7 km^3 and a surface area of 201 km^2. Water is fed into the power house Nationalities and Peoples Regional State which is in the Omo River Basin and sets to include tracts of land from the Omo National Park and Mago National Park.1 Four sugar mills and factories are also planned for development in this area.

Cotton is grown in the country on about 80,000 hectares of land which a drop in the ocean compared to the 1,000,000 hectares the government has earmarked for cotton irrigation for 2030. However, Ethiopia is currently the second highest producer of cotton in Africa and looks to improving its foothold in the cotton production sector. A 15 year national cotton development strategy covers the need for an environmentally, economically, socially and industrially beneficial system for producers and the nation alike. This strategy looks to providing stakeholder engagement and promote sustainable production practices while improving textile and garment production, industrialization process, foreign currency earnings, job creation and the country's GDP. [13] It is not clear what part of the country this strategy will focus on for the development of the cotton farms but due to the water irrigation plans in the Southern Nations, Nationalities and Peoples Regional State, the area could see some potential development for this purpose.

State

Looking at the water level changes of Lake Turkana over time, the late 1800 to the mid-1900s saw the water level drop 20m. The level then rose 5- 10 m from the 1970 – 1980 and reduced to current levels of an average of 30.2 m in 1990. [14] These infrastructural projects have various effects on the environment as they take away water from the basin changing the ecology of the water system. One of the objectives of Gibe III is to regulate flow of the Omo River and modify the annual flood regime downstream. [15] During its construction, the project will destroy natural vegetation, whole ecosystems and completely change the geography of the area it is being constructed in. further downstream as the dam is filling up, water flows will reduce leading to loss of aquatic life and effects on ecosystems downstream. At the south end of the basin, Lake Turkana is projected to reduce 20 metres or more through two penstocks that branch into five tunnels for each turbine that operates ten 187 MW generators for a total capacity of 1870 MW. A Memorandum of Understanding to purchase electricity from the dam has been signed by Kenya will transmission lines currently under construction, potentially linking the electricity grids in both countries. Ethiopia is also looking to export electricity to Sudan, Uganda and Djibouti. The Gibe IV and V are proposed to be built further downstream with 1,470 MW and 660 MW capacity respectively. Gibe IV would likely have similar effects on the water system as Gibe III. [12]

Irrigation

The Lower Omo region is set to be Ethiopia's largest irrigation area with 445,000 hectares of land available for agricultural development. One such project in the area under the Ethiopian Construction Works Corporation is the construction of a 41 km long canal, which will supply 125,000 m3 of water for irrigation. Within this region, 200,000 hectares of government run plantation and seven sugar processing factories are planned that would rely on water from this water canal. 100,000 hectares of this irrigation land lies in the Southern Nations,
reducing fish numbers and potentially reducing biodiversity. As inlet water quantity reduces, the salinity of the water would increase contributing to biodiversity loss. [16]

The irrigation project on their own have the potential to cause a lot of harm to the water ecology of the area and downstream. Apart from the destruction of local natural habitats for crop irrigation, cotton and sugar have large water requirements taking away more water than other drought resistant crops would. This water abstraction has negative impacts on aquatic ecosystems downstream. Furthermore, their irrigation can lead to soil salinization as well as freshwater salinization in arid areas such as Ethiopia. Pesticide and fertilizers from cotton and sugarcane irrigation can also be transported into the water system through runoff and have been attributed to biodiversity loss, degradation of water systems and poisoning of wildlife. Sugarcane mills produce runoff rich in organic matter that is known to kill aquatic life and also contains heavy metals, oil, grease, cleaning agents that are poisonous to the ecosystem. [17] As the water upstream continues to be diverted into dams and irrigation schemes, the fish community in the Lake Turkana will be diminish due to their dependency on the flood pulse and the receding areas at the end of the shores for breeding cues. Increased salinity and alkalinity are also a threat to fish populations as the water level reduces. [18] Due to the lack of monitoring of the issue, these could very well be issues that are currently occurring and not a projection into the future state of the dam.

Impacts

As has happened in previous dam projects, the Gibe IV and V are projected to lead to the displacement of people for their constructed as has occurred with the Gibe I, II and II dams. Concerns have also been made on the safely and proposed life expectancy of the Gibe III such as fractures, leaks, mudslides that could potentially fill the dam, and real-life lower efficiency of operation in general. Further downstream as Gibe III fills up, increased competition for water for communities could cause more clashes. Communities that rely on fishing, pastoralism and

agriculture will also be affected by loss of water access, aquatic biodiversity loss and number reduction, as well as regional wildlife like migratory birds that rely on Lake Turkana as a stopover. This will affect the self-sustainability of such communities which would need government assistance to mitigate clashes and provide water and food for the foreseeable future. Residents that rely on the potable water of Lake Turkana would be faced with a future with no reliable drinking water as the lake becomes more saline from the reduction in inlet water. [19]

In the past, a 30,000 hectare palm oil plantation was established in the Omo Valley in 2010 that was forcefully taken by the government from the members of the Suri tribe, which led to few arrests and led to some of the members protests that led to the death of 54 unarmed Suri people ate the hands of the government. Despite this, displacement of people for 300,000 hectares of land in set to happen in South Oromo for proposed sugar and cotton plantations. The past is set to repeat itself if not handled correctly. This will disrupt these people's way of life including their social, economic and cultural connection to the land with around 200,000 indigenous people are heavily reliant on the Omo River for their survival. The emphasis on large sale cash crop farming takes the conversation away from small scale farming which is the basis of livelihood for many communities. The main form of farming in the Omo Delta is through the use of flood retreat cultivation will be threatened by the dam's flood control measures which will affect their cultural and economic way of life. Flood waters that bring down rich silt will no longer be available making farming in the area obsolete.

Responses

There has been some backlash by some organizations such as the Friends of Lake Turkana against the construction of the Gibe III dam and subsequent dams as well as the abstraction of water for the irrigation use. These organizations call for the need for cultural protections of the people's ways of life and historical sights through opening dialogue with the UNESCO World Heritage Committee, pushing the Governments of Kenya and Ethiopia to both take an independent environmental assessment of the effects of the Gibe II dam to shed a light on the potential negative effects of the dam on the ecosystem and the livelihoods of the indigenous people that rely on the basin. Their main basis is an Environmental Impact Assessment by the African Development Bank that pointed to the loss of 85% of annual flow during the filling of Gibe III; the drying up of the Ferguson Bay in Lake Turkana which is an area that communities rely on for fishing; the capture of sediment that would reduce the fertility of flood plains from farming; a change of water quality that could make Lake Turkana saline and no longer a potable water option for communities and wildlife; and the loss of 30% of water downstream from irrigation projects. [17] However, UNESCO rejected the notion to add Lake Turkana as a World Heritage Site in 2012 but has been keen to push for Strategic Environmental Assessments from both governments from 2012 to 2017 despite getting no responses from each side. The last push was made in 2017 where the deadline of February 2018 was set for the submission of both SEAs on the impacts of agricultural and hydropower projects on the Lake Turkana National Parks and the Lower Valley of the Omo. [20] Due to all these factors, the lake has a was added to the List of World Heritage in Danger in 2018 by UNESCO. [21]

IV. CONCLUSION

Despite portions of the lake and lower Omo Delta having been zoned as an international biosphere reserve, the region will continue to face foreseeable threats from a combination of human activities (hydropower dams and irrigation schemes), climate anomalies as well as changes in demography and population. [14] On the other side of the Kenyan border, Ethiopia has the most to benefit from exploiting the water resources in the basin and has plans to do so to improve water security, generate electricity and provide water for crop production under its Growth and Transformation plan. [12] To do so the plan looks at improving agricultural practices of farmers, a shift from low to high value crops and providing water for accelerate and sustainable agricultural growth. This contributes to the country's plan to become a middle-income country by 2025. As it pushes to do, it puts a strain on the water shed.

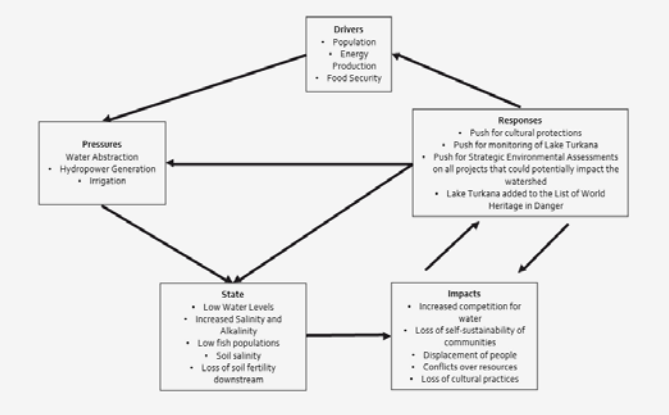

Figure 3: Summary of the DPSIR Framework of the Omo River Basin

The main challenge of this case study is the lack of accurate and updated water information. Its unavailability makes quantitative analysis impossible thus heavily relying on projections from old data and hydrological modelling from secondary sources such as satellite imagery. These tools are able to provide a clear direction on how development could affect the ecosystem but first hand water analysis would be the best option in terms of provide clear fact-based data that can be used to push for the protection of the Omo River Basin transboundary water resource. Despite this a qualitative analysis of the management of the transboundary was possible and thus achieved. The main trend of the cooperation between the two countries was purely on an economic development level with unclear information on cooperative cost sharing and benefit sharing arrangements.

In general, there is a lack of monitoring and evaluation on water based energy, industrial and agricultural projects, the avoidance of the acknowledgment of an Environmental Impacts Assessment from the African Development Bank and the lack of Strategic Environmental Assessments from either countries despite a push from UNESCO due to the possible effects on Lake Turkana National Park – a world heritage site. Despite all these issues, the projects are still underway with a clear lack of sustainability due

to the avoidable future negative impacts on the environment and the lives of the people that rely on the water basin. It's only a matter of time when these issues will create real avoidable repercussions that these two countries will have to deal with.

ACKNOWLEDGMENT

I thank all the researchers who have put their heart, soul and time into quantifying the changes that are occurring to our natural landscapes from which policies and decisions can be based on to protect these resources.

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