Danakil-Depression and Red Sea Solution to the Ecological, Political and Economical Challenges among Nile River Basin Countries

Hossana Solomon

***Abstract*—**The paper explores a feasibility concept of the Danakil-Depression which is situated only a few kilometers inland and about 125 meters below sea level along the western coast of Red Sea. The Danakil Depression covers about 9700 square km along the Red Sea coast of Eritrea and stretches into Ethiopia. The Red Sea can be used as a Natural Dam for hydroelectric power source, a cheap source of energy and water, to help uplift the people from vicious cycles of poverty. It can also mitigate the controversies over Ethiopia's Grand Ethiopian Renaissance Dam (GERD) and diminish the cloud of war hovering in the region and avoid a permanent ecological disaster. A few kilometers of access canal from the Red Sea would be needed to generate hydro electric power and to desalinate water for the region. The Danakil-Red Sea Project could dissipate the cloud of war in the Nile River Basin.

***Keywords*—** Danakil-Depression, Egypt, Ethiopia, Nile-Basin, Red Sea-Basin

I. Introduction

ACCESS to water is one of the most critical aspects of human survival. According to a report by the World Water Council in 2006, about one third of the total population in Africa lack access to water. As a result, many riparian countries surrounding the Nile river basin have expressed direct stake in the water resources that was flowing the Mediterranean Sea through Sudan and Egypt since the beginning of time. In the past when life was booming, and when population pressure was less acute, riparian countries made no mention of inequity in water resources. However, with the emergence of the global water crisis due to global warming and population growth, these riparian countries began to contest the access to the naturally declining water resource of the Nile [1].

The two groups fighting over the right of Nile waters are as follows: the first group consists of downstream countries Egypt and Sudan. The other group is the upstream countries which includes Ethiopia, Kenya, Uganda, Congo, Burundi, Tanzania, Southern Sudan, Rwanda and Eritrea Fig 1. Most of the upstream countries traditionally depended on rain fed agriculture, but due to climatic changes and unreliable rain patterns in the region, they have been pushed towards irrigated agriculture for their food security and also to harness electrical energy from their water resources. The region has experienced drought and famines for several decades due to the erratic and unreliable rain patterns [2].

Egypt depends on the Nile River for 95% of its water needs for drinking, agriculture and electricity generation and the growing Egyptian population is increasingly dependent on Nile water. Egypt claims it has historical rights to the Nile waters under the Nile Water Agreement signed with Britain in 1929 which gave Egypt the right to veto any project in upstream countries affecting Egypt's share of water flowing to its territory. Egypt also codified this legal status in an agreement with Sudan in 1959 on the eve of Sudan's independence from Anglo-Egyptian colonization. The agreement gave Egypt 55.5 billion cubic meters of water (or 66% of the total water flow), which would go to the Aswan Dam, and Sudan received 18.5 billion cubic meters (22%). The remainder, 12%, is lost to evaporation. Those agreements, first signed in 1929 and 1959 took no account of the nine other nations along the 6,700-kilometer (4,160-mile) river and its basin, which have been requesting for a decade for a more equitable accord. The upstream countries argue that they were not a party to the Nile Water Agreement signed with Great Britain and Egypt in 1929, because they were colonies of Britain at the time, and therefore they do not recognize the legitimacy of the past treaties that locked them out of using the Nile water. These excluded nations want to modify the water-sharing agreement and keep more of the water by building dams, which will directly affect the water share of the downstream states, Egypt and Sudan. The problem is compounded by the projected large population increase in the Nile basin. The UN projects that the population in the 11 basin states will reach 860 million people by 2050. This is pressuring the upstream and downstream groups to try to improve their positions in the sharing of the limited quantity of the Nile waters. A Nile Basin Initiative (NBI), a partnership of all the riparian countries, was initiated in 1999 to mitigate the problem of a long history of disputes, insecurities, and the rapidly growing populations' demand for water, by addressing the ownership and fair use of the common resource. The NBI was led by the riparian states to look for solutions and develop the river in a cooperative manner, to promote regional peace and security. The NBI started with a participatory process of dialogue among the riparian countries that resulted in an agreement on a shared vision to achieve sustainable

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This work was supported in part by the University of the Virgin Islands Faculty Professional Development Fund. The Author also acknowledges the contributions of Dr. Yegin Habtes at UVI and Miss Sofia Solomon who read the draft and provided valuable insight to the paper.

socioeconomic development through the equitable utilization of, and benefit from, the common Nile Basin water resources

Fig 1 Nile Basin Map
Source Wikipedia

II. Cloud Of War Over A Declining Water Resource

In May 2010, Ethiopia drafted the Entebbe Agreement to modify the historical and legal basis for the sharing of water. Six African countries signed a new treaty on the equitable sharing of the Nile waters, despite strong opposition from Egypt and Sudan who have the major share and stake of the river waters. Most upstream countries supported the agreement but Egypt and Sudan refused it.

A year later in April 2011, after Ethiopia, Uganda, Rwanda, Tanzania, Kenya and Burundi signed the Entebbe agreement, in order to reverse a colonial-era treaty seeking equitable water utilization, Ethiopia unilaterally launched the construction of a mega dam, Grand Ethiopian Renaissance Dam (GERD), costing $4.7-billion, about 40 km (25 miles) from Ethiopia's border with Sudan Fig 2. Egypt has been warning upper stream countries against construction of any dams on the Nile River saying it is a life or death issue and any attempts would be considered as threat to its national security. The possible downstream effects of the $4.7-billion Grand Ethiopian Renaissance Dam have been disputed and full details are unclear. Although Ethiopia is a source of 85% of the Nile's water, Egypt and Sudan benefit over 90% of the total water resources under the colonial-era agreement. Ethiopia's decision challenges a colonial-era agreement that had given downstream Egypt and Sudan rights to the Nile water. Although letting water through such dams to generate electrical power may not reduce its flow greatly, the filling of the reservoir behind any new dam means cutting the river's flow for a time. Evaporation from reservoirs and underground seepage can also permanently reduce water flowing downstream. If Ethiopia attempts to continue filling its reservoir during periods of drought, the impact on Egypt's ability to generate electricity and irrigate agricultural lands could be devastating [4].

Sudan, which borders Egypt and Ethiopia, also gets much of its water from the Nile, and it opposed the dam initially, but later changed its stand and supported the project. The new dam on the Blue Nile will eventually have capacity of 6,000 megawatts and is central to Ethiopia's plans to become Africa's leading exporter of power. A 10-member panel was set up that included two members from each of the three riparian countries (Egypt, Ethiopia and Sudan), plus four international experts that were agreed upon by the governments to address the concern of the three countries. The International Panel of Experts (IPoE) issued its final report on GERD in May 31, 2013. The report documents numerous problems with existing analysis on a number of critical issues. Based on the leaked final report, the panel recommends further investigation into the dam's hydrological impacts, including on downstream countries' water supplies and power generation; risks from climate change and geotechnical issues. The panel recommends a full trans-boundary environmental and social impact assessment conducted jointly by the three countries [5].

Fig 2 Rendition of Grand Ethiopian Renaissance Dam
Source: Wikipedia

The Egyptian and Ethiopian governments continue their war of words. The Ethiopian government reported that the panel's report that the Dam offers high benefit for all the three countries and would not cause significant harm on both the lower riparian countries, while Egypt has repeatedly said the report calls for more analysis of downstream impacts and Ethiopia should stop construction of the dam. Ethiopia refused, and continued with dam construction. Concerns swelled in Egypt after Ethiopia diverted the course of the Nile River. Following the Egyptian high profile meeting – which Egypt's State TV accidently aired live – tensions between Cairo and Addis Ababa further escalated. Egypt claims the Ethiopian dam project could diminish its share of Nile River waters.

In a closed door meeting with former-President Mohamed Mursi, Egyptian politicians from different political parties suggested a number of sabotage proposals including military attacks as a means to stop the dam's construction. They also suggested backing Ethiopian rebels as a means to destroy the 4.8 billion dollar project, using Egypt's intelligence service to destroy the dam. Now deposed President Mohamed Mursi told a crowd of cheering supporters that Egypt is ready to sacrifice blood to ensure that "not one drop" is lost. Talaat Mosallam, a retired major general in Egypt's army, noted that if Diplomacy

fails Egyptian military commanders may decide that "it is better to die in battle than to die in thirst." Egyptian leaders are not clear what action they will seek except declaring "all options are open" in protecting the river. Ex-President Mohamed Mursi told a crowd of cheering supporters that Egypt is ready to sacrifice blood to ensure that "not one drop" is lost.

In response to such threats Ethiopia stressed that no force could stop the construction of its massive Grand Ethiopian Renaissance Dam (GERD) being built near to its border with Sudan. According to an AP report, the Ethiopian government is set to increase defense spending by more than 15 percent, a rise that comes amid tensions with Egypt over the building of a new dam on the Nile River. Ethiopians look at the dam as a national project with pride, which will lift their country from the cycle of poverty. Their country will be a major exporter of electrical power to the region. Some political observers predict that in the coming years, Egypt and Ethiopia may be forced to fight a "water war" because Ethiopia's ambitions contradict Egypt's historical and legal rights in the Nile waters. Egypt's new President al-Sisi said he would not allow Ethiopia's multibillion-dollar hydroelectric dam to damage Egypt's relations with Ethiopia or other African countries; he went on to say "If the dam symbolizes Ethiopia's right to development, the Nile symbolizes Egypt's right to life." This may be a conciliatory remark that came from Egypt leader since the crisis started. Both countries may be thinking they are fighting for survival of their nation, but the bottom line is that there are not enough water resources in the Nile for the immediate or for foreseeable future given the declining water supply and increasing demand. The tug-of-war over the Nile River between the upstream and downstream countries is a zero-sum game, with a mentality that will hurt both groups, where no one will emerge a winner but rather both sides losing in the long run. A water war between these two groups could be a vortex that will suck Black Africa and Arab nations, which could last for generations.

III. Avoiding Zero-Sum War-Game And Search For A Win-Win Solution

These African Nile River riparian countries could look to the sea, in order to augment the water and energy supply from surrounding seas, the Red Sea and the Mediterranean. A lesson can be learned from the Jordanian-Israeli-Palestinian people's approach to resolve their shared problem of water, where these Middle Eastern countries agreed to utilize the Red Sea by building a canal that extends 112 miles (180 km) from the Gulf of Aqaba in the Red Sea to the Dead Sea. It would take about 10-30 years to build and cost at least $5 billion. The plan calls for electricity generation and a large seawater desalination plan that would produce as much as 850 million cubic meters [2,788 million cubic feet] of potable water for people in the West Bank and restoring the water level in the Dead Sea. Project proponents aim to utilize the transfer of water from the Red Sea, which is at an altitude 400 meters above that of the Dead Sea, to generate hydroelectric power and boost water supplies to the riparian countries. The transferred water will undergo a desalination process on its way from the Red Sea in order to extract drinking water for use by populations in Jordan, Israel and Palestine. The study is financed through a multi-donor trust fund, and the project itself could cost as much as $5 billion and take up to 20 years to complete [6].

There are three particular sites in Africa that allow for the possibility of high capacity hydroelectric generation capacities operating between the sea and a depression that is below sea level: the Qattara depression in Egypt, the Danakil depression in Eritrea, Ethiopia and at Lake Assal, and the surrounding Afar depression area in Djibouti. The large size of the Qattara Depression and the fact that it falls to a depth of 133 m below mean sea level has led to several proposals to create a massive hydroelectric project in northern Egypt rivaling the Aswan High Dam. This project is known as the Qattara Depression Project. The proposals call for a large canal or tunnel being excavated from the Qattara due north of 55 to 80 kilometers (34 to 50 mi) to the Mediterranean Sea to bring seawater into the area. Water would flow into a series of hydro-electric penstocks which would generate electricity by releasing the water at 60 m below sea level. Because the Qattara Depression is in a very hot dry region with very little cloud cover, the water released at the 70 meters (229.7 ft) level would spread out from the release point across the basin and evaporate from solar influx. Because of the evaporation, more water can flow into the depression thus forming a constant source of energy. Eventually this would result in a hyper-saline lake or a salt pan as the water evaporates and leaves the salt it contains behind. At the time when the project was proposed, scientists explored the viability of such a project, as a key to resolving economic, population, and ecological stresses in the area. However, the project has never been undertaken. Now given the risk of war between Egypt and Ethiopia, it may be wise for Egypt to initiate it and it may be much more economical, expanding Egypt's ability to diversify its water and energy resource rather than depending only on its historical but dwindling water from the Nile [7].

IV. The Red Sea-Danakil-Depression Solution

The lowest cost of any of these sea water-based projects to develop would be the Danakil land depression, which covers some 9700 square km along the Red Sea coast of Eritrea and stretches into Ethiopia; only about a 20-km access canal from the Red Sea would be needed to access this region. It is far easier to build access canals to Danakil than is the case at Qattara which has more mountains to cross Fig 3.

The land depression at Danakil is as much as 125 meters below sea level. Roger Faulkner used a rough estimation of flooding the Danakil Depression at 50% level to indicate an enormous potential energy storage capacity of Danakil-Depression as high as 6000 GW-hours [8].

With the Danakil Depression situated only a few kilometers inland and about 125 meters below sea level, Eritrea and Ethiopia could develop a hydroelectric and potable water generation capacity from the Red Sea. The two countries can be self sufficient in a short period with a renewable and environmentally friendly efficient energy source from the Red Sea Fig. 3. The coast line on the Red Sea, from Marsa Fatima to Tio, which covers about 90 kilometers distance along the coast of Red Sea, is a flat land, without hills or ridges. Fig.4

Sea water can be channeled inland to the Danakil Depression, with little difficulty. The topography of the land between the Red Sea coast and the depression is mostly flat without hills making it unnecessary to excavate tunnels to build a channel. Only a few kilometers of access canals from the Red Sea would be needed to access this region seawater and use it for hydroelectric project.

Fig 3 Red-Sea Coast near the Danakil Depression Eritrea
Source Hossana .Solomon

Traveling westward inland from the sea coast to the Danakil Depression, the elevation gradually slopes downward from the sea level to 125M below sea. By developing this resource, they can boost their agriculture, forestry, and infrastructures, like roads, micro dams, airports, housing etc, which could lead to rapid industrial development, economic freedom and higher standards of living for their people Fig 4.

Fig. 4 Danakil Depression Landscape and people Eritrea
Source: H. Solomon

They could even be exporters of clean cheap energy to the Horn of Africa and beyond. The question is how much potential energy is stored on the Red Sea and if it is economically feasible and practical to exploit it. If it is feasible, then seawater from the Red Sea can be channeled or piped through gravity to series of electric generator plants that can convert the kinetic energy of the flow of water to electrical energy using the elevation difference from the Red Sea all the way to the lowest elevation along the Danakil Depression, thus rendering Eritrea and Ethiopia with cheap, clean, renewable and sustainable electrical energy for the immediate and foreseeable future. Various literature sources indicate that the Red Sea's high evaporation rate lowers its elevation than the Gulf of Aden in the Indian Ocean and it is replenished continuously from the Indian Ocean through Babel Mandeb Fig 7. It is reported that the evaporation rate is so high at the Red Sea that it is sufficient to lower the sea level by over 2 m (6.6 ft) per year. No permanent rivers flow into the sea, and there is very little rainfall. As a result, there is a net inflow of water from the Gulf of Aden to compensate for evaporative losses. The amount of Energy that can be generated will be as wide and as deep of all the oceans of our planet combined. Therefore, theoretically we can assume that the region has access to an infinite amount of energy stored in all of the oceans of this planet. The land is barren and sparsely populated with very little environmental or social impacts, if any development is undertaken in the region. The Danakil Depression is also the hottest area in world, temperatures reaching above 50 degree Centigrade. Because of its desert climate, it is sparsely populated and there are very few wildlife or vegetation cover. Using the Red Sea as a natural dam has an advantage over man-made dams along a river that may have a limited life span, due to silt accumulation behind the dam. Man-made dams often require a large tract of land be flooded behind the dam, creating adverse ecological problems in the short and long run to the surrounding climate affecting wildlife and vegetation. The GERD would flood 1800 KM^2 surface area with 63 billion cubic meter volume of water. Also artificial or man-made like GERD dams are subject to climatic changes and weather conditions such as prolonged drought and rainy seasons, causing fluctuation of the electrical generating capacities. There is very little risk that the Red Sea will not run out of water. The evidence so far from global warming is that oceans and seas are rising. Unless there are some natural phenomena such as massive earthquakes and/or volcanic eruption that could alter the physical condition of the Red Sea and its surroundings drastically, it will remain a natural dam. If it is feasible, the project also will have other secondary benefits of generating potable water for domestic and agricultural uses through desalination processes using the same seawater used to generate electrical energy. The brine which is the byproduct of the desalination process can also be converted to salt with sun's heat energy by natural evaporation process. Thus the region could be the lowest cost industrial salt production in the world [9].

Fig 5 Danakil Depression Access to Red Sea
Source: Hossana Solomon

Harry Valentine, in an article he published in the online magazine Energy central, claims that the evaporation could increase some 10% to 20% per unit area, adding some 18% to 30% more moisture to the band of wind that blows inland from the Red Sea and over part of the northern Ethiopian Highlands. It may be possible to operate technology in this region that may produce some winter rainfall over the watershed area of the Blue Nile. If this can be proved, it can potentially augment the water resource capacity of the Blue Nile region to extend the duration of water flow over the year [10].

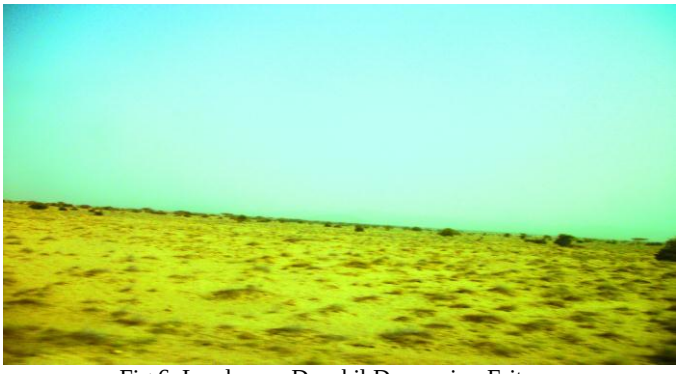

Fig 6: Landscape Danakil Depression Eritrea
Source: Hossana Solomon

Fig.7 MODIS Satellite Image Red Sea and Danakil Depression in Eretria and Ethiopia, Horn of Africa
Sopurce Wikipidia

V. Conclusion

The Danakil Depression in Eritrea and Ethiopia which is located adjacent he Red Sea, can be alternative sources of water to the Red Sea and the Nile Basin countries. The Nile River, even though it is the longest river in the world, has very limited quantities of water compared to other rivers in the world. Competing to the limited quantity of water is an upward battle among people and countries that must depend on its flow. Given the history and propensity of violence in the region, it is better to look for an alternative source of water for future development of the region. It is unwise to disrupt the flow of a river that has been flowing for millenniums of year. The upstream countries should be allowed to use their water resources from the Nile taking into consideration their downstream neighbors need. In the meantime they can jointly explore the alternative of using the Red Sea and the Danakil Depression as a source of energy and water for the foreseeable future, which entails for Ethiopia and Eritrea to have a permanent peace settlement, because Eritrea is the gateway to the Red Sea water resource. If Eritrea and Ethiopia would do this, it will solve their water and energy problems and be a good example for other nations on how to use regional resources for mutual benefits.

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