Appendix

Rivers, lakes and seas: water Power

"It is as though each Ethiopian carries about 3200 liters of water and delivers them to the Sudan and Egypt every day."

INTRODUCTION

The Creator has endowed Ethiopia with abundant water. It is as if the mountains of Ethiopia carry a water tank from which water is sprinkled essentially through out the year but in different parts of the country. The dominant rainy season over most of the country is the "kiremt", summer monsoon, and the "belg" or "little rains". What is troubling is that one of every five Ethiopians is famished. One wonders why a country endowed with such a bounty by the creator suffers so much. The answer has to with the political environment.

Sufficient reservoirs and dams have not been constructed. Irrigation farming is not developed. Energy such as electricity that could be developed from dams geothermal sources or wind is not harnessed in a sufficient manner. Even in the capital city total blackout is experienced in some nights, which are accompanied by the doubling of the price of diesel generators in the following days. The challenge is real. The solution requires Ethiopians to raise in their imagination the construction of structures that will help them use the natural resources to better meet the needs of the populous. This appendix focuses on issues related to

water. A figure showing the rivers, lakes, and mountains is included on page 205.

The greatest power of water is its incorporation in the photosynthesis reaction that organisms that produce their own food (autotrophs) use to produce **organic molecule (glucose**). The photosynthetic equation is as follows.

$6H2O + 6CO2 + \text{energy} = C6H12O2 + 6O2$

Water and carbon dioxide in the presence of energy (sunlight) are combined to form glucose and oxygen.

Grazers feed on the autotrophs, carnivores feed on the grazers, and omnivores feed on those organisms lower than them in the food chain. Humans feed on other organisms (plants or animals). We seek glucose accumulated by other organisms to derive our energy for survival. Humans starve when water dries up, because water is the medium for the reproduction and growth of organisms, **food**. Clearly, water is very important and we need to review the water resources of Ethiopia beginning with surface water, rivers, lakes and the ocean. This is presented in parts.

Part 1. Rivers, mountains, highlands and valleys of Ethiopia.

Part 2. Rivers of Ethiopia used as boundaries of administrative regions

Part 3. Use of water other than as boundary of regions: Water Power

Part 1. Rivers, mountains, highlands and valleys of Ethiopia.

Ethiopian has highlands (Dega) midlands (Weyan dega) and lowlands (Qola). These topographic and climatic zones resulted from uplift and dissection of Ethiopia by earth moving processes (plate tectonics). Ethiopia was lifted upward into a dome and dissected by the Main Ethiopian Rift Valley into a Northwestern and Southeastern highland regions. The Northwestern sector is larger in area than the Southeastern one. It slopes toward the Sudan. Also, the Northwestern sector receives more rain than does the southeastern sector.

Rivers of the Northwestern sector.
Three rivers in the Sudan, the Sobat, the Blue Nile and the Atbara have several tributaries that drain the western margin of the Ethiopian Rift and the mountains therein, including: Ras Dashen (4620 m) and Mt. Guna (4231 m) of Gonder, Mt. Choke (4100 m) of Gojam, Mt. Abune Yoseph (4190 m) and Mt. Abuye Meda (4000 m) of Welo, Mt. Gurage (3720 m) of Shewa, and Mt. Gugu (4200 m) of Gamo Gofa. The Sobat River joins the White Nile south of Malakal, the Blue Nile joins the White Nile at Khartoum, whilst the Atbara joins the Nile near the town of Atbara in the Sudan.

About 80 % of the surface runoff from Ethiopia is drained toward the Sudan and ultimately to Egypt. In contrast, 20 % of the drainage flows to Somalia in the southeast and within the Ethiopian Rift Valley. Yet, the headwaters and major

tributaries of the rivers that flow down the rift valley to lakes in the rift drain the Northwestern Highland. 85% of the water in Lake Nasar, Egypt, and nearly 100% of the sediments come from the Ethiopian highlands. [URL1] As is well known "Egypt is the gift of the Nile." Because of it Egypt after its independence and its colonial masters before then continually engaged in destabilizing Ethiopia. See Appendix 3 for treaties and efforts used to deal with rivers that drain ultimately to Egypt.

Rivers of the Southeastern sector
Two rivers in Somalia, the Wabe Shebele and Giuba (Juba) have several tributaries as they are traced into Ethiopia. They drain the eastern margin of the Ethiopian Rift boundary and mountains therein, including Gara Muleta (3405 m) of Harerge, Mt. Chilalo (4139 m) and Kaka (4190 m) of Arsi, and Mt. Batu (4307 m) of Bale. The Wabe Shebele River flows southeast to Somalia, and within Somalia it bends south and then southwest parallel to the coast by the Indian Ocean and meets the Giuba River at Gelib, about 200 miles southwest of Mogadishu.

Rivers of the Rift Valley floor.
The Ethiopian Rift floor North of Lake Zeway slopes to the North down which the Awash River, which starts in the mountains of Shewa, flows north and enters Lake Gamari through which it flows to end at lake Abbe near the Djibouti Ethiopian border. South of Zeway the rift floor slopes to the South so that River Bilate drains Mt. Gurage (3721 m) and enters Lake Abaya. The Omo River starts in the mountains of Shewa, flows west of Mt. Gurage of Shewa, and Mt. Gugu (4200) of Gamo Gofa and enters

Lake Turkana. Also the ephemeral River Segan drains Lake Chamo to Chew Bahir.

Part 2. Rivers of Ethiopia used as boundaries of administrative regions

This section describes how the Ethiopian rivers and tributaries serve as boundaries between administrative provinces and awraja (administrative subdivisions of provinces). However, in Eritrea subdivision into nine awraja (Sahel, Akordat, Gash and Setit, Massawa, Keren, Hamasen, Seraye, Akale Guzaye, and Aseb) is made by other means due to paucity of rivers. In the other regions of Ethiopia, ten rivers and their tributaries are used as boundaries of administrative regions.

1. The Mereb River west of Zale Anbesa separates Eritrea from Tigrey. River Mereb flows into the Gash River in Eritrea, and the Gash flows to the sandy plains of Kassala in the Sudan. Both rivers are dry most of the year and do not make it beyond Kassala even when wet.

2. The Atbara River. River Atbara has three tributaries called the Setit in the Sudan and Tekeze in Ethiopia, the Angereb, and the Atbara.

2a. River Tekeze separates Gonder from Eritrea, Tigrey, and Welo. Tributaries of River Tekeze separate Tigray from Welo. Furthermore, within Tigrey, tributaries of River Tekeze separate the Axum Awraja from Shire in the West and Temben in the East. Within Welo, a tributary of River Tekeze separates Wag in the North from Lasta in the South. Within Gonder Province, a tributary of River Tekeze

separates Wegera in the West from Simen in the East. Other tributaries of River Tekeze separate the Libo Aweraja from Simen in the North and Gayint in the South.
2b. River Angereb separates Wegera in the North from Gonder in the South.

2c. River Atbara separates Gonder in the North from Chilga in the South.

3. The Blue Nile of the Sudan has three tributaries the River Rahad, the River Dinder, and the River Abay.

3a. The Rahad River drains the mountains of Chilga in Gonder Province.

3b. River Dinder, to the West of Lake Tana, separates Gonder from Gojam and flows into the Sudan through the town of Omedla.

3c. River Abay separates Gojam from Gonder, Welo, Shewa, and Welega. Its longest tributary is the Didesa River, which drains Kefa, Illubabor, and Welega. Other tributaries include the River Dabus of Welega, the River Bashilo of Welo that rises to the Magdala Mountains, and the River Jema that rises to the mountains of Ankober, Shewa. The Abay almost circles around the bottom of Mt. Choke of Gojam. Several tributaries start from that mountain and separate many awraja including Agew Medir in the North, Mota in the Northeast, Bichena in the East, Debre Markos in the Southeast, and Kola Dega Damot in the South. Another tributary of River Abay separates the largest Awraja of Gojam, Metekel in the West from Kola Dega Damot in the South and Agew Mider to its north.

River Gilgel Abay, which is a feeder river to Lake Tana, separates Agew Medir to the West and Baher Dar to the East. Within Gonder Province, a tributary to River Abay separates Debre Tabor in the West from Gayint in the East.

River Bashilo, a tributary of River Abay, separates Gayint of Gonder in the West from Borena of Welo in the East. Within Welo, River Bashilo separates Wadla Delanta in the North from Borena and Were Himenu to the South. In turn, Were Himenu is separated from Borena by a tributary of River Bashilo. Another tributary of River Abay separates Borena of Welo in the North from Merhabete of Shewa in the South. River Jema, a tributary of Abay, separates Merhabete in the North from Selale in the South. River Muger separates Selale in the East from Jibat and Metcha in the West. River Guder separates Jibat and Mecha of Shewa in the East from Horo Gudru of Welega in the West. River Didesa separates Horo Gudru in the East from Gimbe in the West, and Arjo of Welega and Limu of Kefa from Buno Bedele of Illubabor. Within Welega, a tributary to River Didesa separates Horo Gudru in the North from Arjo in the South. Again within Welega, River Dabus separates Asosa in the West from Gimbe in the East.

4) River Sobat has three tributaries, the Baro, the Gelo, and Akobo.

4a) River Baro separates part of Welega in the North from Illubabor in the South. It then forms a boundary between Ethiopia and the Sudan at the Illubabor panhandle.

4b) River Gelo forms part of the boundary between Illubabor in the North and Kefa in the South.

4c) River Akobo separates Gimira in the West from Maji and Goldiya in the East of Kefa Province, and forms a 250 mile long boundary between Ethiopia and the Sudan.

5) River Omo separates Kefa from Gamo Gofa, Sidamo and Shewa, where the northern reach of the Omo is called River Gibe. Within the Kefa Province, River Gojeb, which is a tributary of the Omo separates Jima in the North from Kulu Konta in the South.

6) River Bilate drains Mt. Gurage (3721 m), and flows due South and enters Lake Abaya. It separates Kembata and Hadiya of Shewa and Welayeta of Sidamo on the West from Haykotch & Butajira of Shewa and Sidama of Sidamo in the East.

7) The ephemeral River Segen connects Chew Bahir to Lake Chamo and separates Gamo Gofa in the West from Sidamo in the East.

8. The Giuba River of Somalia has three tributaries, the Dawa, Genale, and Weyb.

8a) River Dawa, with its northern reach called River Awata, flows within Sidamo, before it forms the boundary between Ethiopia to the North and Kenya and Somalia to the South, between the towns of Melka Mera and Dalo at which it joins the Ganale River before flowing into Somalia.

8b) River Genale drains the southwest and south sector of Mt. Batu and flows southwest to join River Dawa at Dolo.

Within Bale, a tributary of the River Genale separates Delo in the West from Mendoyu in the East. The northwestern mountainous part of Bale west of Mt. Batu is called the Genale Awraja.

8c) River Weyb drains the southeast sector of Mt. Batu and flows southwest to join the Genale River at Weldeya, Bale. The northern part of the River Weyb separates Mendoyu from Wabe. El Kere forms the southeastern half of Bale, but it is not separated from the rest of Bale by a river.

9. Wabe Shebele drains Mt. Batu of Bale from the northern side and Mt. Kaka from the eastern side and Mt. Chilalo from southern side and flows east, collecting tributaries that drain the Harerge Mountains including Gara Muleta before it flows southeast to Somalia. The Wabe Shebele separates Bale from Arsi and Harerge.

Primary and secondary tributaries of Wabe Shebele subdivide Arsi into Ticho in the South and Arba Gugu in the North. Within Hararge, primary and secondary tributaries of Wabe Shebele bound many of the awraja, whilst some are bounded by other criteria. Within Harerge and bounding the Wabe Shebele are the following awraja, from northwest to southeast: Habro, Gara Muleta, Gursum, Degeh Bur, Gode, and Kelafo. Southeast of Degeh Bur are Kebri Daher, and Welewel & Warder, which are not bounded by rivers. West of Degeh Bur, the Fafen River, a secondary tributary of the Wabe Shebele separates Gursum from Jijiga. Another secondary tributary of the Wabe Shebele separates Harbo in the Northwest from Chercher, Adal & Gara Guracha. East of that and separated by River Galeti is Webera. East of that and separated by River

Ramis is Gara Muleta. East of that and separated by River Gobele is Harar Zuriya. East of that and separated by River Erer is Gursum. North of Gursum and Harar Zuriya, but not separated by a river is Dire Dawa, Isa and Gurgura.

10. River Awash partly separates Shewa from Arsi and Harerge. Within Shewa, River Kesem a tributary of River Awash separates Yerer and Kereyu in the Southwest from Tegulet and Bulga in the Northeast. Another tributary of Awash draining Mt. Abuye Meda (4000 m) and beginning at Majete separates Yefat and Tumuga of Shewa from Kalu of Welo. Within Welo, River Mile, tributary of Awash, separates Ambasel in the Southwest from Yeju in the Northeast.

Part 3. Use of water other than as boundary of regions: Water Power

This part focuses on the power of moving water (cold river or ground water, or hot groundwater as in hydrothermal fluids of the Rift Valley), which may be utilized directly for agriculture and aquaculture (growing of fish) purposes or indirectly for generating electricity.

3a) Cold water - direct use.

3a1) River, spring, ground water power - direct use:
Rivers and springs may be dammed, and the water used for irrigation in a variety of ways. Such water also serves towns and cities and the people therein. Likewise, groundwater may be pumped to serve similar purposes.

Building dams from earthen materials (mud and rock) and strengthened by concrete.
Reservoirs accumulate water not only from the runoff of one year but over several years. For example, the inflow of water to the Aswan dam is 84 Km^3 per year, whilst the Aswan dam contains 170 Km^3 of water.

God gave an estimated 110 cubic kilometer of surface water per year to Ethiopia. The figure 110 Km^3 of surface water is arrived at by FAO, the Ethiopian government, and other agencies that estimate water resources. If we know the population of Ethiopia, say 75 million Ethiopians, we can calculate the amount of water each individual Ethiopian is endowed by the Creator from surface runoff. (Let us remind ourselves of some conversions before we perform very simple arithmetical calculations. 1,000,000,000 cubic meters are equal to 1 cubic kilometer. 1,000 liters is equivalent to 1 cubic meter. 1,000,000 individuals are equal to 1 million individuals. A year has 365.25. Now we are ready to make calculations.)

Calculations

(110 KM^3 x 1,000,000,000 m^3 x 1,000 liters) /(75,000,000 individuals) = 1,466,666 liters per person per year (or 1.5 million lppy). 0r (1,466,666 lppy/ 365.25 days) = 4,015 liter per person per day (or about 4,000 lppd). **In terms of surface water, God gave each individual Ethiopian about 4,000 liters per day.**

Then we have the lake waters, and ground water, which I have not included in the gift of fresh water to Ethiopia abundantly provided for by God to Ethiopians.

Unfortunately 80% of the surface water goes to the Sudan and Egypt. This translates to 3,200 liters of water per individual per day is delivered to the Sudan and Egypt. **It is as though each Ethiopian carries about 3200 liters of water and delivers them to the Sudan and Egypt each day.**

Above, an estimate of water that flows to the Sudan and Egypt is provided. Let us now focus on the meaning of reservoirs. A way of looking at reservoirs is to consider the simple calculation of 4,000 liters of surface water per day allotted by God to Ethiopians that is shown above. If each individual were to use 400 liters a day, throw away 600 liters a day to the elements and place 3,000 liters a day in a reservoir, he would have 3, 000 + 5,000 = 8,000 liters of water in the next day. Notice how what saved in one day is added to the total allotment for the next day.

Again, if each individual were to use 400 liters a day, throw away 600 liters a day to the elements from the 8000 liters of the next day in the reservoir, he would save 7, 000 liters**.** If the individual placed his unused part of the water allotment in a reservoir, on the third day he would have 11,000 (i.e., 7,000 + 4,000) liters of water to deal with, out of which he would save 10,000 liters. If dams and reservoirs were not constructed, the allotment would be 4,000 liters each day. Reservoirs are like investment instruments. Water unused I a day will be saved for use in subsequent days.

The idea of constructing dams across rivers and building reservoirs is the way to go. If Ethiopia could build sufficient reservoirs, the dams would contain waters not

only from rivers but also from rainwater and non-channel surface runoff.

Our friends in the Sudan and Egypt, should have no worries, for we can pipe the waters down to them, and save water from being lost by evaporation as the rivers flow through the desert. Furthermore, there will always be water flowing throw existent rivers because of heavy rainfall in Ethiopia, and would carry sediment that way. The dams could over flow, or there could be programmed flow. The possibilities are infinite, the advantages quite profound. However, the idea of damming Ethiopian rivers in Ethiopia or building reservoirs within Ethiopia should in no way be predicated on receiving any agreements from any other country. Ethiopian waters are Ethiopia's, but Ethiopia is a just and good neighbor.

As the coach said: Failure to prepare is preparing for failure. Ethiopians should prepare and build dams and reservoirs.

3a2) Reservoir upkeep

Water reservoirs may be man made or they could be natural (lakes). Since the downfall of the Aksumite Empire, the depth of Lake Gamari to which the Awash flows has been reduced by 1 1/2 meters (Butzer, 1981), and other lakes have been filled with silt. Lake Abaya to which River Bilate flows is accumulating silt, as is Lake Turkana to which River Omo empties. Existing dams and lakes that are used for hydroelectric production or for water reservoir for cities such as the Koka, Fincha, Legedade and Lake

Tana require dredging at regular intervals. Silt is accumulating in lake Tana and Turkana as expressed by Nasa. [URL2] No less attention should be given to the Rift Valley lakes to which perennial or ephemeral rivers carry mud and silt. Lakes from which silt has not been dredged will be not only shallow but also salty due to excessive evaporation, particularly in the rift floor. Thus, reservoir upkeep is extremely important.

No purpose is achieved by building new dams if the existing dams and lakes are not properly maintained. Dams that may be constructed across steep slopes will likely become filled with silt in shorter time because of soil erosion in the rainy season. Yet, countries like Costa Rica, which is mountainous, which is roughly of the same latitude as Ethiopia and which has built hydroelectric stations at two or more sites down much smaller rivers than Ethiopia has, could provide as models that Ethiopia could emulate. I had visited one of the hydroelectric construction sites of Costa Rica a few years back, and I have been impressed that Ethiopia could do likewise.

An interesting observation is that Lake Turkana might have been the prehistoric source of the Nile (Harvey and Grove, 1982). Climate fluctuates over time has raised the height of the water surface in the lake. About 130,000 to 35,000 years before the present, the water level of lake Turkana was 75 to 80 meters above its current level. The water over flowed from Turkana through the Pibor River to the current White Nile. Similar overflow occurred 12,000 to 5000 years before the present.

3a3) River water- indirect use - to generate hydroelectricity:

Generation of electricity by using running water relies on the principle of conservation of energy. That is to say energy is neither destroyed nor created; it may be transformed from one form to another variety. Basically, copper wire is wound around a magnet, which is placed by the shaft of a turbine, so that movement of the turbine and hence the magnet will induce electricity in the copper wire. Fast enough flow of water rotates turbines placed on its path. The movement of magnet induces current in the copper wires, thus converting kinetic energy of moving water to electrical energy in the wires. Fast enough flow of water may be achieved as follows.

1) By damming a river as a means of assuring steady flow and allowing water from the dam to flow to turbines.

2) By redirecting a river to flow through a pipe or aqueduct, and storing the water at a suitable place from which a steady flow of water will be made to turn turbines

3) By pumping water to a suitable water storage facility during off-peak electric usage periods and then allowing a steady flow of water to turn turbines during peak-hour periods (pumped-storage hydroelectric plat).

4) By a combination of 2 and 3.

Here are selected statement from a Canadian hydroelectricity education effort: "Hydroelectric generators direct the flow of water through massive turbine devices

which are much more efficient at extracting the kinetic energy from the moving water and turning it into electricity through the rotation of electrical generators." [URL3]

"Pumped-storage hydroelectric plant, combined pumped-storage hydroelectric plant A specific type of hydroelectric generating facility that produces energy during peak demand periods using water pumped into an elevated reservoir during off-peak periods. When a facility uses both pumped reservoir water and natural current flow, it is referred to as a combined pumped-storage hydroelectric plant." [URL4]

3b) Hot water (geothermal energy)

Hot water in the ground is called geothermal or hydrothermal water, and the energy that may be derived from it is called geothermal energy.

3b1) Hot water - direct use

3b1a) Direct use means that the hot water can be piped to plants (industrial, agricultural, aquaculture) for purposes of facilitating, enhancing, accelerating processes. Hot water temperature ranging from 38°C to 149°C is used for such direct use. [URL5]

Ethiopia has a huge and inexhaustible reservoir of heat in its rift valley. Secondary porosity generated by fracturing of rocks during the rifting process in Ethiopia serve as conduits for rain water to percolate down the fractures. The groundwater that seeps down is heated by proximal magmas beneath the rift floor, and the hot water, or steam, which is buoyant, ascends to the surface or comes very

close to it. Hot water bubbles at various places on the rift floor, steam and volcanoes are more abundant in the Afar depression. The "Filwouha" in Addis is such type of natural hot water. Indeed the hot water baths at "Filwouha" that people take in Addis attest to one of the direct uses of hot water. Such hot water should be piped to the homes of people and industrial plants. There are other direct uses of geothermal water.

3b1b) Geothermal power for green house:
The Carbon dioxide present in natural hot waters ranges from 300 to 1000 ppm. The high concentration of this gas promotes higher rates of photosynthesis, and hence more plant growth. Studies have shown that the rate of plant production (primary productivity) in greenhouses is increased by about 15% when open hot water is circulated in a green house. For obtaining the benefits of the carbon dioxide, hydrogen sulfides, which is often present in natural hot waters, must be remove by purifying apparatus. [URL6]

3B2) Hot water - indirect use.

Geothermal energy can be used to generate electricity by making steam move turbines. Three kinds of power plants may be used depending on the temperature of the hydrothermal water, as described in an education effort by the US Government on indirect use of geothermal energy, which is illustrated by diagrams in URL7:

"Converting Steam and Hot Water to Electricity. Three power plant technologies are being used to convert

hydrothermal fluids to electricity. The type of conversion used depends on the state of the fluid (whether steam or water) and its temperature."

3B2a) " Dry Steam Power Plants. Steam plants use hydrothermal fluids that are primarily steam. The steam goes directly to a turbine, which drives a generator that produces electricity."

3B2b) "Flash Steam Power Plants. Hydrothermal fluids above 400 degrees F (200 degrees C) can be used in flash plants to make electricity. Fluid is sprayed into a tank held at a much lower pressure than the fluid, causing some of the fluid to rapidly vaporize, or "flash," to steam. The steam then drives a turbine, which drives a generator."

3B2c) "Binary-Cycle Power Plants. Most geothermal areas contain moderate-temperature water (below 400 degrees F). Energy is extracted from these fluids in binary-cycle power plants. Hot geothermal fluid and a secondary (hence, "binary") fluid with a much lower boiling point than water pass through a heat exchanger. Heat from the geothermal fluid causes the secondary fluid to flash to steam, which then drives the turbines."

Of course there are other forms of generating electricity including the use of coal-fired boilers, nuclear fuel heated water, solar power, and wind power.

3C) Marine water power

Those Ethiopians who feel that Eritrawi Ethiopians have seceded and that should be final may find the discussion on the maritime power a bit odd. Discussions with some Tigrawi Ethiopians indicate that some others (Tigrawi inhabitants of Hamasen, Seraye, Akal Guzay) prefer to be called Tigrawi "Eritreans" instead of being identified as Tigrawi Ethiopians. Among their grievances is that Menelik cut the hands of (mutilated) Eritrawi soldiers who fought on the side of Italy.

Some Tigrawi "Ethiopians" are highly offended by this condition. TPLF leaders and propagandists blamed Emperor Menelik for what they called the weakening of the Tigrawi Ethiopian clout (see Appendix 4 for an exposition of the historical context that belies it). They assumed that the emperor did not liberate Eritrea from Italy after the battle Adwa because he wanted to weaken the Tigrawi clout.

Emotional condition of this sort is to be expected form feuding brothers and will be settled in time. They ought to be reminded of how Ras Wolde Mikael of Mereb Mellash and Fitawrari Dabbab Araya (son of Ras Aray Dimsu of Tigrey Province and the son brother-in-law of Ras Alula) had conspired with Egypt and Italy against the interests of Ethiopia in the reign of Atse Yohannes IV (Erlich, 1974). Treason has happened before and it shall be overcome in time. Moreover, if they truly blame Menelik for separation, since Menelik is long gone, why do the current crop of TPLF-EPRDF leaders fight to bring about a division of the Tigrawi people and place them in separate countries? However, many other Ethiopians who are ruled by the EPLF, e.g., the Afar Ethiopians have not denied that they

are Ethiopians. Accordingly, to deliver the Afar Ethiopians of the Aseb region to be subjected to Tigrawi "Eritreans" remains unconscionable. Regardless, all Ethiopians will benefit from an education on "water power" of the maritime region.

Ethiopian history makes it evident that the economic wellbeing of the country is assured when Ethiopia retains its maritime territories and properties. Despite the advent of the Moslem religion in AD 6th century and the subsequent establishment of Islamic administrations in parts of Ethiopia, particularly in the coastal areas, Ethiopian emperors still collected tributes from those regions until the fateful revolt by Gragn Mohammed in the 16th century. Atse Libne Dingel (1500- 1533) reigned over Ethiopia when the Ethiopian coast stretched from Swakin (near Port Sudan) past Zeila in Somalia. The Portuguese vessels that came to Ethiopia landed at that time at Ethiopian ports. The revolt by Gragn of Zeila transformed Ethiopia and bestowed "a geography of poverty" to it up to 1952. Most devastating was the role taken by Egypt, whose leaders served as Turkish representatives and claimed many coastal regions of Ethiopia by a bogus reason that their support to Gragn had so empowered them. The bogus Egyptian claim over some of the coastal regions of Ethiopia was inherited by Great Britain, which colonized Egypt as of 1882. After 1885, Britain implemented a pact with Italy, which made the Ethiopian coastal region of Swakin up to Ras Kasare a British domain, while the coastal region from Ras Kasare to the French colonial territory of Djibouti became an Italian domain. Thus, initiated by a bogus claim of Egypt (of the Ottoman Empire), Ethiopia subsequently lost its coastal regions to European expansion into Africa.

By 1952 Ethiopia succeeded in regaining part of its coastal territories and its maritime interests. Unfortunately, misguided Ethiopians brought economic devastation and "a geography of poverty" upon Ethiopia, and the secessionist former Ethiopian province of Ethiopia, Eritrea by 1993. The cost of the secession is tremendous for both the landlocked region of Ethiopia and the coastal region of Ethiopia now called Eritrea. This report, however, will focus merely on marine "water-power."

3C1) Gateway to the world

Despite the political interests that attempt to divide the ocean of the world into sub regions, there is really only one ocean that surrounds the Earth. A coastal region allows a free country to roam from one corner of the ocean to another, to export and import goods without seeking permission from another state. A coastal region is simply a gateway to the world. Hence, possession of marine water offers the unparalleled platform for a nation to freely transact with others.

3C2) Marine resources: aquaculture, mining and resort

A stretch of continental shelf (littoral zone) of about 12 nautical miles in width, which is located adjacent to land and around islands of a country is by international agreement a part of the country or sate which owns the adjacent land. Hence, the Red Sea littoral and the region around the islands, including the Hanish Islands, are the maritime territories of Ethiopia (now the secessionist province of Eritrea). Moreover, about 200 miles of marine region adjacent to the land is the exclusive economic zone (EEZ) of the adjacent state, again by international law of

the sea. Empowered by the EEZ, coastal states regulate fishing mining and scientific research in those waters. Granted that the Red Sea is not that wide a sea. However, the neighboring coastal states could work together and assert their EEZ rights, while permitting "innocent" passage of vessels over their EEZ zones.

3C2a) Marine organism resources: The warm waters of the Red Sea are particularly good regions for catching fish. Corals in the warm waters are habitats the can be exploited four tourist attraction. Even more profitable is fish farming (aquaculture or mariculture) that may be constructed in shallower parts of the littoral zone, and over which different kinds of fish including shrimps, oysters and mussels can be grown in a more protected environment. Oysters may be grown for food and for extracting pearl. Shrimps can be grown in plenty. Such fish farm products can be sold at local and international markets.

3C2b) Mining: The Red sea littoral zone and the islands have thick deposits of salt that could be extracted and sold at profits. Phosphate deposits may be looked for at the shelf break, and extracted for profit. Copper, Zinc and iron sulfides that abound around hydrothermal vents in the depth of the Red Sea have already been exploited by international firms without paying the necessary dues to the owners of the Red Sea. Worse, they have polluted the area at will. Such exploitation should be stopped and the rightful owners should judiciously extract metallic deposits.

3C2c) RESORT: The warm waters of the Red Sea and its natural fishes and reefs can serve as attractions to tourists.

Hotels and restaurants may be built in appropriate places to attract tourists.

3D) Commerce, refineries, shipping lines

An important use of coastal regions is the development of ports that serve commercial activities. Such services and activities will bring employment to many citizens. Port fees by visiting vessels are other ways of extending service to ships and obtaining funds. Oil refineries may be constructed near the ports so that refined oil may be transported to regions that need them. The existent Ethiopia oil refinery at Aseb should be maintained and made operational and at high efficiency. Thus, the country should regulate the cost of refining oil, and working there should employ several citizens. Commercial shipping lines may be housed in the ports to export and import items that are needed in the hinterland or in other areas of the world. Ethiopian exports of coffee and hides, and other agricultural products can be easily and more cheaply exported to other regions.

3E) Naval power

No interest or territory can be said to belong to any country that is unable to defend its interests or territories. Hence, naval power is a very significant component to the defense of a coastal region. Owing to foreign intervention on its coastal regions, Ethiopia has not been strong in the area of naval power since the demise of the Akumite Empire. However, that should not deter it from developing plans and technologies that will protect its interests.

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