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Underwater timber harvesting on the Volta Lake : implications for the environment and transportation

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UNDERWATER TIMBER HARVESTING ON THE VOLTA LAKE: IMPLICATIONS FOR THE ENVIRONMENT AND TRANSPORTATION

By

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DECLARATION

I certify that all the material in this dissertation that is not my own has been identified, and that no material is included for which a degree has previously been conferred on me.

The contents of this dissertation reflect my own personal views, and are not necessarily endorsed by the University.

Signature : 

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ABSTRACT

Title of Dissertation: **Underwater Timber harvest on the Volta Lake: Implications for the Environment and Transportation.**

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This dissertation is a study of the ramifications of underwater timber harvest for the environment and marine transport safety. The study is focused on the Volta Lake, located in Ghana.

The work begins with a brief account of underwater timber harvesting in other parts of the world. Particular attention is paid to the modus operandi employed in the harvest and the effects for the country or region where this is taking place. A summary of the benefits and problems of underwater timber harvest is noted, following the selected global account. The dissertation then narrates the history of how timber came to populate the Volta Lake. The reasons that necessitate the timber harvest on the lake are explored. A detailed account of the phases of the harvest on the Volta Lake is presented. Furthermore, the technique to be used in harvesting the timber from the lake is examined.

The final chapters of the work critically investigates the effect of the underwater timber harvest on the environment and marine transportation, with special emphasis on the latter. Other factors affecting marine transportation on the lake are explored. Finally, recommendations are made concerning mitigating environmental effects and making marine transportation on the lake safer.

KEYWORDS: *Environment, Examine, Investigate, Marine, Transportation, Underwater, Volta Lake*

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List of Abbreviations

AQCI	Aquatic Cellulose International Corporation
ATH	Aquatic Timber Harvester
BC	British Columbia
CSRD	Clark Sustainable Resources Development
ESIA	Environmental and Social Impact Assessment
FAO	Food and Agriculture Organization
GMA	Ghana Maritime Authority
GMS	Ghana Meteorological Services
GNA	Ghana News Agency
GPS	Global Position System
IMO	International Maritime Organization
NGO	Non Governmental Organization
STCW	Standards of Training, Certification and Watchkeeping
URMS	Underwater Remote Manipulation System
VLCT	Volta Lake Company Limited
VRA	Volta River Authority

Introduction

Background to the study

The Volta Lake is an 8,600 square-kilometre reservoir that was created as a result of a hydroelectric project. The Government of Ghana dammed the Volta river in 1964 to flood the forest, creating a massive hydroelectric generator that today supplies electricity to the entire country and neighbouring ones as well.

The construction of the resultant Akosombo Dam culminated in the submergence of large tracts of forest, and forced the relocation of some 80,000 people to 52 newly created towns on the Lake's higher banks (Kwablah, 2009). The lake is a relatively new aquatic system (48 years old) and is also a major transportation corridor for the communities that live along its banks. It also serves as a source of fish and water-related wildlife, as well as providing irrigation for farmers.

According to Fitzgerald (2008), Ghana alone has submerged over 14 million cubic meters of rot-resistant hardwoods such as wawa, odum and ebony trees when they created the Volta Lake, the largest man-made lake in Africa. Owing to the lack of oxygen under water, the trees typically do not deteriorate, keeping their outstanding, often old-growth, character and physical properties.

In February 2006, the Government of Ghana and the Volta River Authority (VRA) signed an agreement with Clark Sustainable Resources (CSR) Developments, a Canadian firm (Ablordeppey, 2009). The said agreement granted a concession to CSR Developments to harvest trees from the submerged forests in the Volta Lake. This is to be done in two Phases, a Preparatory Phase and a Commercial Phase. It is estimated that the Lake is home to timber resources worth 2.8 billion dollars (Ghana News Agency, 2011).

Statement of the problem

Although the prospects of this project seem encouraging, concerns have being raised in certain quarters. According to Kwablah (2009), the project would affect the breeding patterns of fish in the lake. Fishing is the major industry for the communities along the banks of the Volta Lake. The lake is home to ninety per cent (90%) of Ghana's inland fishery with about 80,000 fishermen depending on it for their livelihood (Klingbeil, 2011). The project is thus likely to negatively impact 80,000 people and their dependents through the direct loss of income. The concomitant shortage in the supply of fish is likely to affect an even larger number of people.

There are also many environmental concerns. In underwater harvesting, some dirt does get into streams and disturbs aquatic life. Underwater logging could also pose an environmental hazard if silt on the drowned logs is distributed into the water. The practice of yanking standing trees from lake beds can pollute the water with sediment, blocking the light needed by aquatic plants (Tenebaum, 2004). Thus, underwater harvesting threatens the life of aquatic organisms and other water-related or water-dependent organisms.

Transportation on the Volta Lake is also likely to be affected by the project. Ghana's non-existent North-South road network makes inland water transportation very important. The Volta Lake stretch from the north to the south of the country makes it the most prominent water body for inland transportation. Cargo such as bulk oil movement, lint cotton, cotton seeds and sheanuts are shipped from the agricultural north to the industrial south for export or for local markets. Also, industrial products and general cargo are shipped from the South to the North. The lake is also expected to serve as a convenient means of transportation between Ghana and its landlocked neighbours – Burkina Faso, Mali and Niger.

Vessels to be found on the Volta Lake range from boats, ferries and pontoons to simple canoes. These vessels do not only transport cargoes and tourists but are also a major means of transport for the communities living along the lake. The most

dominant vessel used is the canoe due to accessibility and cost. However, for decades, passengers and goods have been lost on the lake due to accidents. A significant number of these accidents have been imputed to the presence of so many trees and stumps in the lake. The tree stumps disrupt free-flow of marine traffic on the lake, making navigation difficult, especially small vessels. The stumps punch holes into these vessels, causing them to sink. Many of them lurk just below the water surface where they snag the nets of fishermen and are a collision peril for the long wooden kayaks and other boats that transport goods and people on the Volta Lake (Field, 2007). Therefore, the underwater timber harvesting project is likely to have an impact on transportation.

Aims of the study

This study seeks to:

1. Investigate the practice of underwater harvesting and the technique involved.
2. Assess the impact of this project on the Volta Lake, with special emphasis on the environment and transportation.
3. Make appropriate recommendations based on findings of the study.

CHAPTER ONE

Underwater Timber Harvesting: International Experiences

1.1 Introduction

This chapter examines the basis for underwater timber harvesting. It also discusses selected experiences of this venture across the world, the merits of underwater timber harvesting and the problems associated with it.

In the last century, many states of the world have flooded vast areas of land in a bid to generate hydroelectric power from the large dams created. In many of these situations, entire forests are flooded beneath the new lakes. According to Lucas (2007), the time required to plan and build a dam (between two to five years) is relatively shorter than the time required in harvesting the timber from these forests (between ten to twenty years). This explains why many forests were flooded without fully harvesting the timber, (See Figure 1).

Dead waste or green resource?

Figure 1 A stand of semi-submerged tropical hardwood trees in the Volta Lake Ghana. (Source: Clarke Sustainable Resources Development, 2011)

In many instances, the technology needed to harvest the timber in time was unavailable. In other instances, the authorities considered the forest species undesirable and thus considered the loss as acceptable (Lucas, 2007). Some state authorities also considered the cost of removing these trees as being too high. However, with the current demand for lumber for various purposes, there are hardly any undesirable species.

The International Commission on Large Dams estimates that there are 45,000 large reservoirs worldwide, many of which hold submerged forests. The United States of America alone is reported to have more than 6,500 dams (Lucas, 2007). These submerged forests are reported to be home to 300 million trees, with an approximate value of $50 billion.

Clearly, underwater timber harvesting has the potential to unearth vast wealth without imparting the freestanding forests of today.

1.2 Selected Regional Experiences

The potential of the underwater timber industry has been recognized by a number of states across the world. Consequently, some of them have already begun exploiting this resource. This section discusses the experiences of four countries: Canada, Suriname, Brazil and Malaysia.

1.2.1 Canada

According to Greenemeier (2005), Canada's interest in logging reservoirs is particularly keen. This is because the country has found it difficult to compete with countries like Chile, Russia, Brazil and even the United States in the lumber market. This is due to the cheaper labour rates enjoyed by the timber industry in these countries.

The focus of underwater timber harvesting in Canada has been the British Columbia province. British Columbia is home to a number of large hydro reservoirs. These reservoirs have vast submerged plains full of Douglas fir, lodgepole pine, hemlock and

other high quality timber (National Post, 2007). British Columbia (BC) reservoirs are estimated to hold about 20 million trees underwater (Tenebaum, 2004). This raw material is estimated at $1.5 billion and represents only 5% of the global inventory (Williams, 2007).

In the interior of the province of British Columbia lies the Nechako Reservoir. Members of the Cheslatta Carrier Nation have been reclaiming timber from here since the Reservoir was created. In 1996, British Columbia's Ministry of Forests granted the Cheslatta Carrier Nation a 10-year license to harvest underwater timber. This was after the Ministry had checked for factors like disturbance to the lake bed, the right of the Nation to the wood and willingness to employ local workers. The Ministry considers such licenses beneficial since it helps clean up the reservoir, increasing its tourism value (Greenemeier, 2005). Thus, underwater timber harvesting is not particularly new to the British Columbia province.

The Ministry of Forests in British Columbia continues to play a critical role in limiting the effect of underwater harvesting. The Ministry monitors the water quality and equipment. It has prohibited the use of petroleum-based oil for equipment other than boat motors. In addition, since underwater harvesting activities began affecting animals such as the osprey a kind of fish eating bird who have built huge nests on tree crowns emerging from the shallow end of the water, the Ministry has reacted by building new nests to replace those that break. Research has shown that there has been no harm to the water quality or fish habitat in the Nechako River (Greenemeier, 2005).

The last decade has been more influential in establishing the British Columbia area as the hub of underwater timber harvesting. This is due to emergence of companies backed by entrepreneurs interested in this venture. Aquatic Cellulose was the earliest company from British Columbia to venture into underwater timber harvesting. Their harvest site, however, was located outside Canada. They were harvesting from Brazil's Tucurui Dam. Aquatic Cellulose however went bankrupt in 2003 ("Harvesting Profits," 2012).

Tritton Logging Incorporated, which was established in 2000, is the primary reason why British Columbia has become the leader in underwater timber harvesting. This is due to the introduction of the Sawfish Underwater Harvester; a remote controlled vehicle fitted with eight video cameras, global position system, sonar and seven thrusters, and powered by a 75 HP electric motor (Williams, 2007). The Sawfish goes under the water, identifies the tree, grabs it with 4-foot grapples, attaches an airbag and then cuts the tree. The airbag allows the tree to float on top of the water. The harvest team then collects the trees and transports them to the processing site.

Tritton Logging currently operates at Lake Ootsa and Lois Lake. The trees at Ootsa were flooded in 1954 when the Kenny Dam was built while those at Lois were flooded in the 1930s (William, 2007). At Ootsa Lake, the species harvested are mainly lodgepole pine and spruce while western red cedar, Douglas fir, white pine, hemlock and spruce are harvested at Lake Lois. Tritton Logging Incorporated expects to harvest 45,000 trees annually from the British Columbia region (Behar, 2007).

1.2.2 Suriname

Suriname is a country located in northern South America. The country's underwater timber project is centred on the Brokopondo Lake which was created in 1965 to provide hydroelectric power for the country. The lake is reported to be approximately 1,000,000 acres ("Suriname underwater", 2009). International Hardwood Import (2009) also reports that there are over thirty valuable tropical hardwood species standing in the lake with the exclusive harvesting rights awarded to Vista Enterprises Incorporated.

Timber harvesting on this lake began in 2004. The mode of operation is markedly different from that observed in British Columbia. A specially trained team of divers are responsible for harvesting timber from the lake. These dive teams work together on each tree. They use oxygen-powered saws which are useful both below and above water. Underneath the lake, the trunk of the tree is cut and then sectioned into smaller

segments. Since this wood would not float, they are winched to a boat and then transported to a collection barge. There is further transportation from this barge to the processing site ("Suriname underwater", 2009).

1.2.3 Brazil

Constructed in 1984, the Tucurui Dam is located in the State of Para, Brazil ("Aquatic Cellulose Complete Buyout", 2002). The dam was built for hydroelectric power production and navigation. The forest so submerged as a result of the creation of the dam is reported to contain Brazilian mahogany, walnut, teak, redwood, cherry and over 30 other species of both hardwood and softwood ("Aquatic Cellulose Complete Buyout", 2002).

In January 2002, Aquatic Cellulose International Corporation (AQCI) secured the right to harvest these underwater timbers from the Tucurui Dam. AQCI uses the Aquatic Timber Harvester (ATH), a patented-robotic system to locate, cut and retrieve submerged timber. At the heart of the ATH is the Underwater Remote Manipulator System (URMS). The URMS is a remote controlled device with nine degrees of freedom. It is comprised of five segments that are connected by joints. Two hand controllers are used to work the URMS. The system's software receives commanded inputs and then determines which joint to move, at what speed and in which direction. Meanwhile, the system's control system continues to provide a continuous display of the movements and displays these to the operator via monitors. In this way, the ATH is able to harvest the timber underwater without the need for men to accompany it under the water (TigerLynk, 2009).

The Brazilian government's interest in the project stems from expectations that the project would create jobs and spin-off economic activities for the local people. The project is also expected to make hydroelectric generation efficient and palliate the pressure on land-based forests ("Aquatic Cellulose Completes Buyout", 2002).

1.2.4 Malaysia

Malaysia is a country located in Southeast Asia. Underwater timber harvesting here is concentrated in the Kenyir Lake, an artificial lake in the state of Terengganu in north-

east Malaysia (Kenyir Lake, 2012). The lake was created as a result of the damming of the Kenyir River in 1985 to create the Sultan Mahmoud Power Station (Kenyir Lake, 2012).

The creation of the lake resulted in the flooding of a vast forest. It is estimated that there are 300 million trees underneath the lake (Katayama, 2009). These include species such as Balau, Chengal and Merbau. According to Loke, Tee and Tan (1998), efforts to harvest these underwater trees began in 1991. Underwater divers dove as deep as 100 meters to harvest trees from the lake.

Underwater timber harvesting in the Kenyir Lake has, however, suffered from accidental accidents. Loke et al. (1998) reported cases of decompression illness associated with underwater timber harvesting. There were at least six cases recorded from March 1994 to August 1996. The victims were reported to suffer from cardio-respiratory and neurological disturbances. According to the report, one of the divers died at the hospital while another died at the recompression chamber. The remaining three divers were treated with recompression and made significant improvements.

Clearly, there are dangers associated with underwater timber harvesting, especially when divers are employed to undertake this project. Loke et al. (1998) advises that recompression facilities be sited near the lakes to facilitate the management of such accidents as this would help save the lives of the divers.

1.3 Benefits of Underwater Logging

1.3.1 Environmental Benefit

Underwater timber harvesting has enjoyed widespread approval from environmentalists. This is because concentration on the timber underneath the lakes and rivers of the world would save the forests on the surface of the earth. According to Johnson (2008), approximately one-fifth of the world's rainforest was destroyed within four decades, from 1960 to 1990 and about 13 million hectares of forest are lost globally every year. This has heightened deforestation, with its concomitant effects.

Deforestation has had a significant deleterious effect on biodiversity. According to Vandermeer and Perfecto (1995, cited in Trucksess 2003), a fallen tree leaves a space in the forest that eventually affects biodiversity. While the tree stood in that space it conserved a dark area of land within the forest. With this shade gone, light streams in and causes plants that thrive in brighter light to force out low light plants that needed the shade to survive. The extinction of these low light plants leads to a decline in biodiversity. Deforestation can also lead to a loss in biodiversity when animal species that lived on or below the fallen tree lose their habitat and cannot relocate. This may eventually lead to these animals becoming extinct. Thus, the more trees that are removed from the surface of the earth, the more biodiversity is likely to be lost.

Deforestation has also been a major contributor to global warming, accounting for almost 25% of man-made emissions of carbon dioxide (Johnson, 2008). Underwater trees that are harvested are already dead, thus they do not aggravate this situation when cut down. The situation is however different with trees felled on the surface of the earth. During photosynthesis, trees absorb carbon dioxide into their cells and store it. A tree is comprised of about 50 percent carbon dioxide, although some of the carbon is released during respiration (Johnson, 2009).

Forests, thus, store enormous amounts of carbon dioxide. However, when forests are logged, this carbon is released into the atmosphere. This increases the amount of carbon dioxide and other greenhouse gases in the atmosphere and thereby reduces the ozone layer. The net effect is global warming. The effect of deforestation on climate change can be observed from the infamous status enjoyed by Indonesia and Brazil as the third and fourth largest emitters of carbon dioxide on the planet, respectively. Almost 75 percent of Brazil's carbon emissions come solely from deforestation (Greenpeace, n.d).

With the advent of underwater timber harvesting, these negative and catastrophic effects associated with deforestation would be consequently reduced significantly. With a potential 300 million trees available underwater to be harvested, underwater timber harvesting would certainly reduce the reliance on land based forests as a source

of timber and thus reduce the alarming rate at which forests are disappearing globally (Lucas, 2007). This is especially so considering that these 300 million trees make up 30 percent to the Earth's forests (Wallis, 2006). In other words, they add 30 percent more forest to the current global reserve.

1.3.2 Safer Transportation

The majority of the water bodies from which underwater timber harvesting is being carried out serve transportation purposes as well. The presence of underwater trees however does not bode well for transportation. Trees protruding out of the water, especially at the shallow ends make marine navigation quite cumbersome and can be a threat to boaters. Lucas (2007) reports that in April, 2006 more than one hundred passengers on an overloaded ferry boat on the Volta Lake (the largest man-made lake in the world) in Ghana lost their lives when the boat struck a submerged tree. This threat to transportation and safety is why underwater timber harvesting is being encouraged, since it would rid water bodies of these protruding trees and consequently ensure that such needless accidents are minimized.

1.3.3 Quality of Wood

The quality of wood obtained underwater is another reason why this venture has enjoyed approval from many timber industry experts. Underwater wood is preserved by oxygen-free water, and thus protected from rot and decay. It is also protected from pest infestation (Greenemeier, 2005). The result of these is high quality timber with very high demand, especially by craftsmen.

According to Canada's National Wood Research Institute, trees harvested underwater perform better than land-based ones in the areas of 'machinability', bend, shear and strength (Lucas, 2007). Another desirable trait possessed by underwater timber is their tighter grain. This is as a result of the several decades they had spent undisturbed in their anaerobic environment (Lucas, 2007). Also, the fact that these wood is coming out of a process that intends to help save the environment makes it particularly

appealing to some people. This ‘eco-wood’ tag increases its marketability, attracting environmentalists the world over (“Water may hold timber”,2007).

1.4 Problems with underwater logging

1.4.1 Safety

The modus operandi for underwater timber harvesting seems to vary. While in some places the work is carried out by a robotic device such as the Sawfish, in other places the work is achieved by uprooting the trees with a chain. The third method involves recruiting a team of divers who swim down to the trees and harvest them with a saw. This method provides the greatest cause for concern because of the safety concerns and danger associated with it.

As mentioned earlier, Loke et al. (1998) reported that there were six incidences of decompression illness associated with underwater timber harvesting on the Kenyir Lake in Malaysia from 1994 to 1996. Two of these incidents resulted in death while in the other four cases, the victims had to battle with ill health. With the exception of the British Columbia province in Canada, the other areas of the world with underwater timber harvesting activities seem to rely on divers. The safety of the men and women carrying out this activity is at risk. There is thus the need to have medical teams on site at these places in order to avert any form of fatality to these divers.

1.4.2 Environmental Concerns

While environmentalists focused on happenings on the Earth’s surface may be toasting to underwater timber harvesting, those who focused on happenings beneath the sea do have a reason to be concerned. According to Tenebaum (2004), uprooting trees from underneath the watershed mucks up the water and disrupts the aquatic

ecosystem. The sediments that are released as a result of this process may be inimical to organisms in the lake.

Carrels (2007) also points out that the trees submerged under water provide habitat for fish and wildlife in the watershed. Thus, uprooting trees from under the watershed would equally amount to a decline in biodiversity in the watershed.

However, recognizing that such man-made watersheds are relatively new aquatic environments, it will be difficult to measure the overall impact of the underwater timber harvest.

1.5 Conclusion – International Experiences

This chapter has established the potential for underwater timber harvesting as being indeed very huge; 300 million trees valued at $50 billion. The practice is also not new, although the invention of the Sawfish has maximized the harvest potential and thus thrust the venture into the limelight within the last decade. Furthermore, countries in North and South America, as well as Northeast Asia have experienced underwater timber harvesting and have thus provided valuable lessons for future ventures.

Underwater timber harvesting seems to have both environmental benefits and problems as noted earlier in this chapter. However, with regard to the problem, the use of the sawfish for example does not stir the bottom of the sea and it is therefore unlikely to muck up the water. Additionally, just as the British Columbia authorities have done with regard to the osprey issue, it is possible to anticipate environmental impacts and prepare for them. Thus, by and large, the problems with the environment seem manageable and mitigatable. Furthermore, the potential of underwater logging to make transportation safer on lakes by removing tree stumps makes this type of venture more palatable to the public.

However, there is the need to make underwater timber harvesting as safe as possible. With regard to the issue of safety raised, it is worthy of note that this problem can be

completely eliminated with the adoption of the sawfish technology. This technology also has the advantage of harvesting more trees within a period of time.

Although the international experiences so far seem to overwhelmingly identify underwater timber harvesting as a benign industry, there is the need for countries that wish to undertake this venture to conduct their own environmental impact assessment. This is because, particularly with regard to environmental and social issues, the concerns vary from one region to another.

CHAPTER 2

Underwater Timber Harvesting on the Volta Lake

This chapter presents a brief history of the Volta Lake and describes the attributes of the Lake. It also describes in detail the proposed harvest project and procedures to be used in harvesting the trees and the resulting economic prospects for Ghana.

2.1 The Volta Lake

The Volta Lake, the largest artificial lake in the world, was created as a result of the damming of the Volta River at the Akosombo gorge in 1966. The lake has a dendritic shape, with an average length of 400 kilometres and an average width of 25 kilometres (International Lake Environment Committee, 1999). The lake has a surface area of 8,502 km^2 with a volume of 148 km^3 and a catchment area of 385,180 km^2 (International Lake Environment Committee, 1999). The average depth of the lake is 18.8 metres, with the maximum depth being 75 metres. The lake borders six of Ghana's ten regions - Volta, Central, Ashanti, Eastern, Northern and Greater Accra Regions (Lake Lubbers, 2007). Overall, the lake (see Figure 1) plays a major influence on much of the economy of southeast Ghana.

The Volta Lake was purposely created to generate hydro-electricity for the country. Further it was expected to improve inland water transportation, be a source of fishing and also ensure the availability of water for irrigation. The project was started in 1961 and was completed in 1966 at the cost of £70 million (Volta River Authority, 2006). The creation of the dam led to the relocation of about 78,000 people, being the residents of communities that were affected by the construction. It also led to a vast forestland being submerged under the lake.

The Volta Lake has become home to a variety of living organisms, particularly freshwater fish. The creation of the lake meant that the fish were trapped in the newly formed lake ecosystem. According to Obeng (1977), more than sixty species of fish are to be found inside the lake. Since fish are the main source of protein for majority

of Ghanaians, the lake has provided an opportunity for local communities alongside the lake and beyond to meet dietary needs. Fishing is also the major economic activity of the communities that have developed along the banks of the lake. Thus, the lake is a real source of livelihood for a significant number of communities.

The Volta Lake also serves as a transportation corridor for the numerous communities that live along the lake. The expanse of the lake covers both the southern and northern parts of the country, which has attracted a lot of people to use the lake as a means of transportation. The most common vessels to be found on the lake are barges, canoes and ferries. These vessels are used for the transportation of goods, as well as passengers. Cargo such as bulk oil movement, lint cotton, cotton seeds and sheanuts are shipped from the agricultural north to the industrial south for export or for local markets. The produce of the villages along the lake, such as yam, cocoyam, cassava and other food produce are also sent to the market centres via the lake (Lake Lubbers, 2007). Moreover, almost all the twenty villages along the lake are market centres. Traders access these market centres utilizing transport vessels on the lake to buy and sell.

The Volta Lake is also a preferred tourist destination. The town of Akosombo in particular has attracted a lot of private developers who have put up remarkable facilities and tour packages for tourists. Fishing excursions and water sports have become available through the vacation resorts and lodgings that have been put in place in the area. The particular fish species of interest are Volta perch, African tiger fish, Nile tilapia and several varieties of catfish (Lake Lubbers, 2007). Some tourists also just enjoy the vessel cruises on the lake.

However, navigation on the lake has increasingly become difficult. This is due to the presence of tree stumps on the lake. The Volta Lake is full of submerged hardwood trees such as mahogany, ebony, wawa, odum and teak. These trees are estimated to number around 14 million (Fitzgerald, 2008).The tree stumps disrupt free-flow of traffic on the lake, making navigation difficult, especially for small vessels. The stumps punch holes into the vessels, causing them to sink. Many of them lurk just

below the water surface where they snag the nets of fishermen and are a collision peril for the long wooden kayaks and other boats that transport goods and people on the Volta Lake (Field, 2007).

There have been many accidents on the Volta Lake, owing to the presence of trees and stumps on the lake. In September 2011, the Ghanaian Chronicle newspaper reported the death of nearly seventy people on the Volta Lake as a result of their boat capsizing ("Oh These Lake Disasters", 2011). Tree stumps on the lake were reported to have punched holes in the canoe, causing water to enter the vessel. At this point the vessel began to sink. Sadly, there were not enough life jackets on the boat, leading to the loss of lives. This unfortunate incident has been a recurrent ritual since 1964 (GNA, 2011).

Clearly, the presence of the stumps has become a nuisance for maritime activity. There is the need, therefore, to rid the lake of the stumps in order to improve the safety of transportation on the Volta Lake. A stump-free Volta Lake would be a major boost for passengers and traders who use the lake as a means of transport. It would also promote the burgeoning tourism industry around the lake.

In February 2006, the Government of Ghana and the Volta River Authority (VRA) signed an agreement with Clark Sustainable Resources (CSR) Developments, a Canadian firm (Ablordeppey, 2009). The agreement was ratified by Ghana's Parliament on July 28, 2006. The said agreement granted a concession to CSR Developments to harvest the trees from the submerged forests in the Volta Lake. The lake's timber resources are valued at 2.8 billion US dollars (Ablordeppey, 2009).

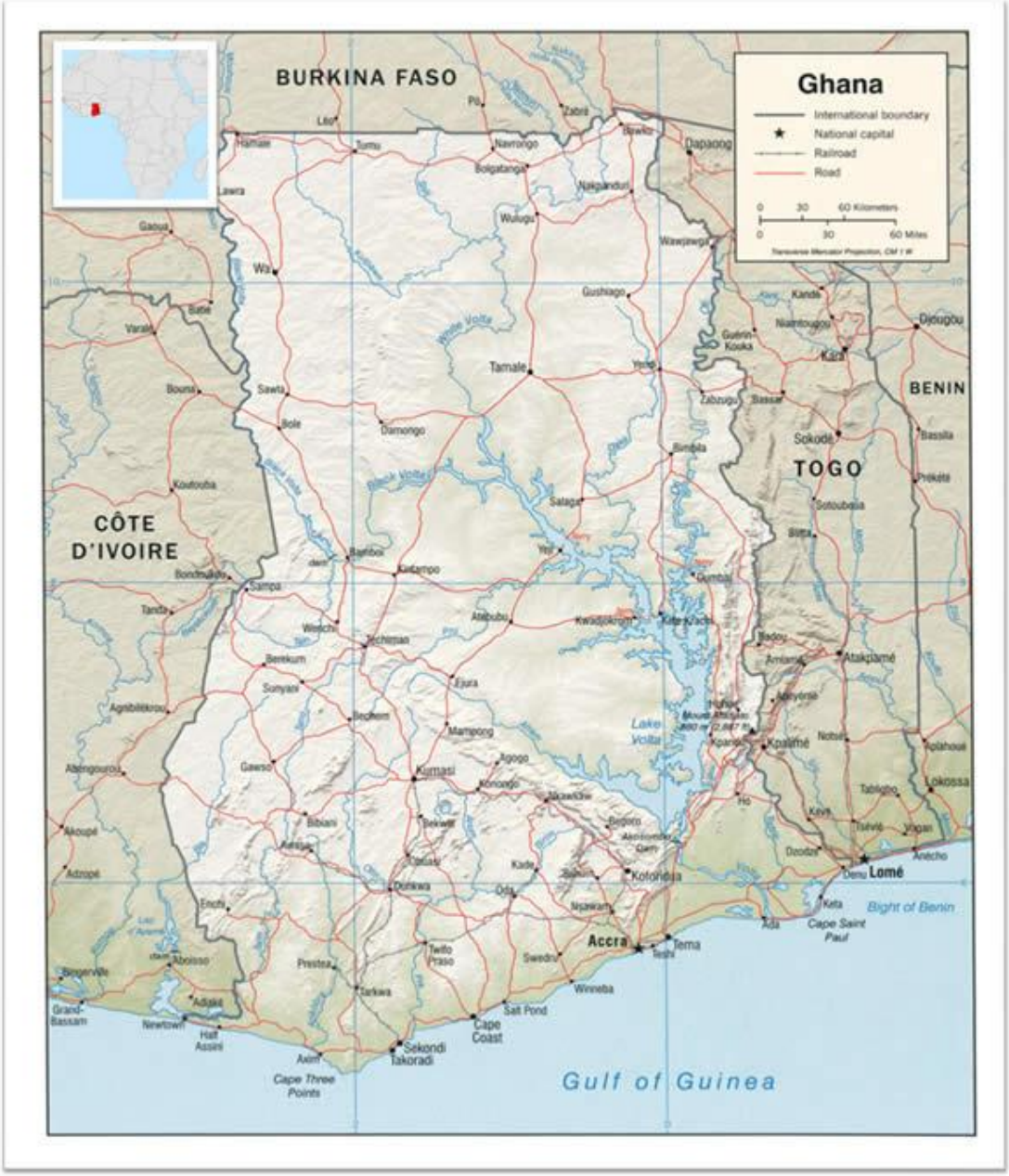

Figure 2: Map of Ghana, showing the Volta Lake (center right)
(Source: Clark Sustainable Resources Development, 2011)

2.2 The Timber Harvesting Project

It must be stressed that the Government of Ghana did realize the need to remove tree stumps from the lake quite some time ago. The challenge the government faced, however, was the lack of capital and technology needed to undertake the project. The agreement the Government of Ghana signed with Clark Sustainable Resources Developments (CSRD) gives the latter the right to harvest underwater tress located in the Volta Lake for fifteen years, renewable for a further ten years (GNA, 2011). CRSD holds the exclusive right to harvest, process and market timber recovered from the Volta Lake. The area of operation is 350,000 hectares in size (GNA, 2011).

As can be seen in Figure 3 Ghana's agreement with CRSD designated two phases of the project: the preparatory phase and the commercial phase (Kwablah, 2009). The preparatory phase was carried out in 2006 soon after the agreement for the project was signed. The preparations for the commercial only began in 2011.

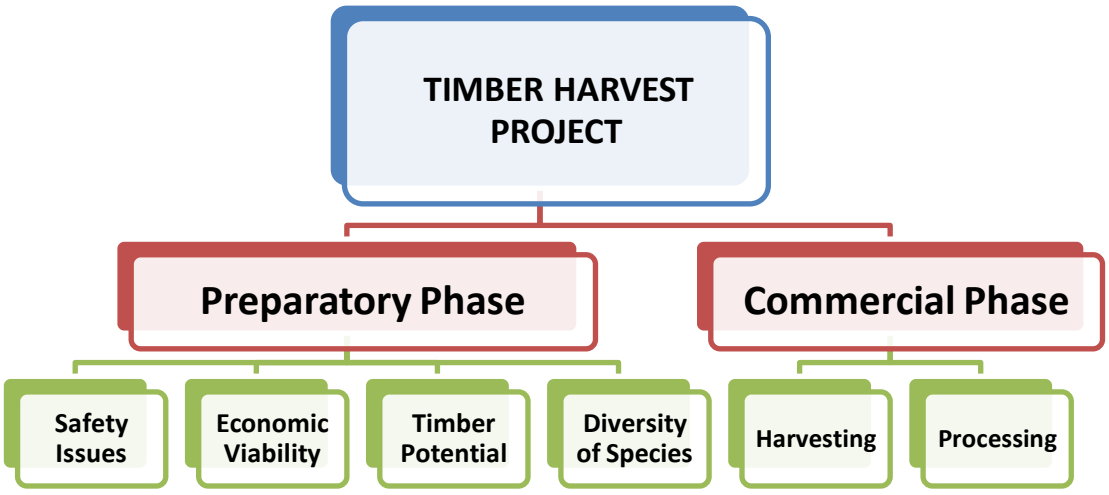

Figure 3: Phases of the Volta Lake Timber Harvest Project (Boateng, 2012)

The preparatory phase involved feasibility studies to ascertain the viability of the project. This included an assessment of the timber potential of the Volta Lake, including the number and diversity of timber species, the economic viability of extraction, processing, marketing and opportunities for adding value to the timber (Ghana News Agency, 2011). The feasibility study also concerned itself with transportation and safety issues. CSRD later reported that it conducted a comprehensive Environmental and Social Impact Assessment (ESIA), valued at US17 million (Kwablah, 2009).

However, the reluctance of both CSRD and the Government of Ghana to release the report to the general public has necessitated this current study. Ghana has yet to enact its Right to Information Bill, thus, it is almost impossible for the public to access this report. Moreover, the fact that all the parties concerned in this assessment cannot be said to be disinterested makes it essential that a neutral party investigate the potential environmental and social impact of this project.

The commercial phase involves the actual process of harvesting the trees from the lake and the subsequent processing needed to make the timber available for market consumption. The details of this phase will be further explored in this chapter.

2.3 The Commercial Phase

2.3.1 Harvesting

Clark Sustainable Resources Development (CSRD) was able to commit the Government of Ghana to agree to its underwater timber harvesting proposal because of one major factor – technology. The equipment designed by Tritton Logging Company, CSRD's partner, is an innovative technology to harvest timber below sea level. The technology being used employs barges, boats, sonar equipment, and most importantly, the SHARC Harvester and the Sawfish. The SHARC Harvester and the Sawfish are the two unique pieces of harvest equipments used for the extraction of sunken trees (Hayhurst, 2011).

The SHARC Harvester is designed for shallow water operations. As seen in Figure 4, it is capable of reaching a depth of 36.5 metres. The SHARC uses a customized barge and excavator, as well as thrusters and DPS (Dynamic Positioning System) which is basically a computer controlled unit which seeks to keep a vessels position quite stable by harnessing the effect of its thrusters and propellers to navigate (Hayhurst, 2010). With the help of video and sonar equipment, the SHARC can manoeuvre around boats and anchors in search of its prey – submerged trees. Its telescoping arm and cutting head allows it to find, cut and retrieve trees. The SHARC is certainly safer, quicker and able to reach greater depths when compared to other diver-based logging mechanisms (Hayhurst, 2011).

Figure 4: The above sea level components of the SHARC (Source: Hayhurst, 2010)

The Sawfish, on the other, hand is designed for deeper water operations. It is able to go beyond 100 metres (Crockford, 2008). The Sawfish is a remote controlled vehicle that looks like a minivan. The equipment is fitted with eight video cameras, sonar and GPS (Hayhurst, 2010). The Sawfish has seven thrusters and is powered by a 75 HP electric motor (Williams, 2007). The mouth of the sawfish consists of huge pincers

and a 140-centimetre chainsaw. The equipment is also filled with fifty airbags (Crockford, 2008).

The sawfish uses its sonar device to navigate underwater as illustrated in Figure 5. The eight video cameras provide a live video feed to a pilot sitting in a barge on the surface of the water. The Sawfish locates a tree, grabs the tree with its four-foot grapples, drills airbags into the wood, slices the tree off at the trunk with the chainsaw and then sends the log floating to the surface of the lake, by means of the airbag (Crockford, 2008). The floating team collects the floating logs and places them in floating bunks or on barges for transport to the milling sites.

Figure 5: The Sawfish at work (Source: Hayhurst, 2010)

2.3.2 Processing

Clark Sustainable Resources Development has reported that their operation on the Volta Lake has led to recovery of timbers with promising size, great quality and desirable species (Hayhurst, 2011). These species include Odum, Ebony and Mahogany.

Processing of the timber recovered from the Volta Lake is done in two stages. The first stage is the use of a small mill located at Akosombo, the site of the salvage effort. After recovery of the submerged timber, they are transported to this mill. They are sawn, sorted into the appropriate grade specifications and made ready for shipment from this facility (CSRD, 2011).

The larger mill is not yet complete. It is expected to have a manufacturing line for value-added products namely, window and door parts, flooring and trim. There would also be a sliced veneer plant that will process logs into decorative veneer for furniture, mouldings and cabinetwork. A kiln-drying capacity is also expected to be installed for the utilization of the wood inventory. Additionally, a co-generation plant would be built to utilize the mill's waste. This plant will generate its own power from wood biomass for the lumber and veneer dryers, as well as the operation's generator (CSRD, 2011).

2.3.4 Marketing

The marketing of the salvaged timber is to be solely carried out by Tritton Logging's sales team. The roundwood from the Volta Lake has been specifically marked for local consumption. There would be no exportation of roundwood from Ghana to other countries. All other timber is expected to be exported to the markets of Europe, Asia and the United States of America (EUWID, 2011).

2.4 Prospects of the underwater timber harvest

The underwater timber harvesting project being carried out by Clark Sustainable Resources Development holds many prospects for Ghana. The project is currently being totally financed with private foreign capital, thus bringing direct foreign investment into the country. It is estimated that a total of US $100 million would be invested into Ghana as a result of this project. In addition, the Government of Ghana has a 20% commercial interest in the net value of the timber harvested. Furthermore, the Government would also earn a substantial amount of revenue from the corporate taxes CSRD is liable to pay (CRSD, 2011).

The project is also expected to create employment opportunities for Ghanaian citizens. Almost forty Ghanaians are currently being trained and are assisting with the harvesting of the timber from the Volta Lake. However, the biggest opportunity is yet to come with the completion of the larger mill. This mill is expected to employ about 300 Ghanaians on site. Also, when the salvaging operation reaches its peak, about 100 more Ghanaians would be employed in these operations (CSRD, 2011).

However, the greatest benefit expected from the harvest project lies in the area of improved and safer transportation. For decades, transportation on the Volta Lake has been deadly, with fatal accidents occurring quite frequently. The major cause of these accidents has been identified as the tree stumps on the lake. The timber harvesting project however would rid the lake of these stumps, making navigation easier. This would prevent the fatal accidents on the Volta Lake, and thus preserve life and property.

CHAPTER THREE

Underwater logging on the Volta – Implications for the Environment

This chapter will examine and assess the environmental issues associated with the underwater timber harvesting being carried out under the Volta Lake. The chapter would consider both negative and positive environmental implications of the timber harvest, as well as their concomitant effects.

3.1 Environmental benefits

This section of the chapter discusses the environmental pay-offs of the timber harvesting project for Ghana.

According to Fitzgerald (2008), Ghana alone has submerged over 14 million cubic meters of rot-resistant hardwoods such as wawa, odum and ebony trees when they created the Volta Lake. Due to the lack of oxygen under water, the trees typically do not deteriorate, keeping their outstanding, often old-growth, character. The concession granted by the Government of Ghana to Clark Sustainable Resource Development (CSRD) is expected to last twenty five years with the possibility of a renewal (Kwablah, 2009). This means that at least for the next twenty five years, most of Ghana's timber will be produced from the lake beds of the Volta Lake, providing some respite for the forests above sea level.

This is particularly positive news for Ghana, considering that the country is currently facing deforestation at an alarming rate. Ghana's deforestation rate is one of the highest in the world. Ghana lost 135,000 hectares of forest annually from 1990 to 2000, representing an annual deforestation rate of 2% per annum (UNEP, 2008). Ghana's forest decreased further by 115,000 hectares from 2000 to 2005, thus by an average of 2% annually. In fifteen years, between 1990 and 2005, Ghana lost 1,931,000 hectares of forest cover, accounting for 26% of its total forest cover (UNEP, 2008). Ghana's 8 million hectare forest cover at the beginning of the century has been reduced to 1.2 million hectares (Daily Guide, 2011). At this rate, Ghana may not have any old growth forest in the next thirty years. Ghana is already feeling the impact of

this forest loss. The country has initiated plans to start importing timber from Cameroun due to its inability to meet even domestic demand ("Deforestation Leads To Ghana Importing Wood," 2011) . For a country that relied on timber as its largest export to the international market, this turn of events is really significant. Timber was Ghana's third largest export commodity for many years. For such a country to consider importing timber is thus testament to the rate of depletion.

The rapid loss of Ghana's forest reserve has concomitant effects. Deforestation is known to lead to the emission of greenhouse gases, and thus ultimately leading to global warming. According to Conservation International (2012), deforestation releases more greenhouse gases than any other known emitter of greenhouse gas.

Deforestation has been a major contributor to global warming, accounting for almost 25% of man-made emissions of carbon dioxide (Johnson, 2008). Underwater trees that are harvested are already dead, thus they do not aggravate the global warming problem when harvested. The situation is however different when trees are felled on the surface of the earth. During photosynthesis, trees absorb carbon dioxide into their cells and store it. A tree comprises of about 50 percent carbon dioxide, although some of the carbon is released during respiration (Johnson, 2009).

Forests, thus, store enormous amounts of carbon dioxide. However, when forests are logged, this carbon is released into the atmosphere. This increases the amount of carbon dioxide and other greenhouse gases in the atmosphere and thereby reducing the ozone layer. The net effect is global warming.

The environmental effect of deforestation is not limited only to the issue of global warming. Deforestation also leads to the loss of biodiversity. According to Vandermeer and Perfecto (1995, cited in Trucksess, 2003), a fallen tree leaves a space in the forest that eventually affects biodiversity. While the tree stood in that space it conserved a dark area of land within the forest. With this shade gone, light streams in and causes plants that thrive in brighter light to force out low light plants that needed the shade to survive. The extinction of these low light plants leads to a decline in

biodiversity. Deforestation can also lead to a loss in biodiversity when animal species that lived on the fallen tree lose their habitat and cannot relocate. This may eventually lead to these animals becoming extinct. Therefore, the more trees that are harvested from the surface of the earth, the more biodiversity is likely to be lost.

The rate of deforestation in Ghana puts many trees at risk of extinction. It has been estimated that Ghanaian timber species like Mahogany, Odum and Afromosia would be totally lost within the next ten years (Beheton & Ibrahim, 1997). These commercial species are not the only tree species affected by rapid deforestation in Ghana. Medicinal plants are also facing the threat of extinction. Patronage of herbal medicine in Ghana has been on the ascendency since the last decade. At Ghana's Centre for Scientific Research in Plant Medicine, doctors are confident that diabetes and other illnesses could be cured with herbal extracts. The Centre has catalogued over 250 indigenous trees and plants with healing properties. However, there is fear that at the rate of forest loss, species with medicinal properties may be lost before the Centre's team has the chance to catalogue them (Beheton & Ibrahim, 1997).

In addition, deforestation has an effect on soil quality. According to FAO soil experts, when deprived of their natural protection, the soils increase in salt content and are worn away by air and water erosion (Beheton & Ibrahim, 1997). When the soil has excess salts, plant growth is affected. Plants begin to grow a lot more slowly and in certain cases, growth is completely insignificant. Deforestation also leaves the soil bare. This exposes it to rain and wind. These two forces of nature then begin to wash more and more layers of soil off the surface of the land. Considering the fact that the Sahara desert just above Ghana's neighbours continue to expand in all directions, it is important that Ghana does not create conditions for desertification of the country.

According to Beheton and Ibrahim (1997), "Deforestation is changing the habitats of disease-carrying insects and creating conditions that may help to spread malaria, river blindness and other devastating illnesses." For example, the worms that "cause river blindness or onchocercosis, are transmitted mostly by cytoforms of a blackfly (Simulium damnosum) found in savannah regions. These cytoforms are beginning to

spread into areas of cleared forest in Ghana" (Beheton &Ibrahim, 1997). This means that as more forest areas are cleared, diseases that are associated with savannah conditions are indirectly transferred into these areas.

Thus, the pay-offs of the underwater timber harvesting project in the Volta Lake can be rather significant for Ghana. The environmental, human health, and concomitant effects analyzed thus far are likely to be avoided while Ghana utilizes the forest under the Volta Lake (both domestically and for export) for at least the next twenty-five years. This period would allow the projects and programmes initiated by the Government of Ghana and other conservationist NGOs towards sustaining the country's forest reserves to mature and yield significant outcomes.

Figure 6 captures the environmental effects of deforestation that have been discussed earlier in this chapter and the following sections relating to potential Volta Lake ecosystem impacts.

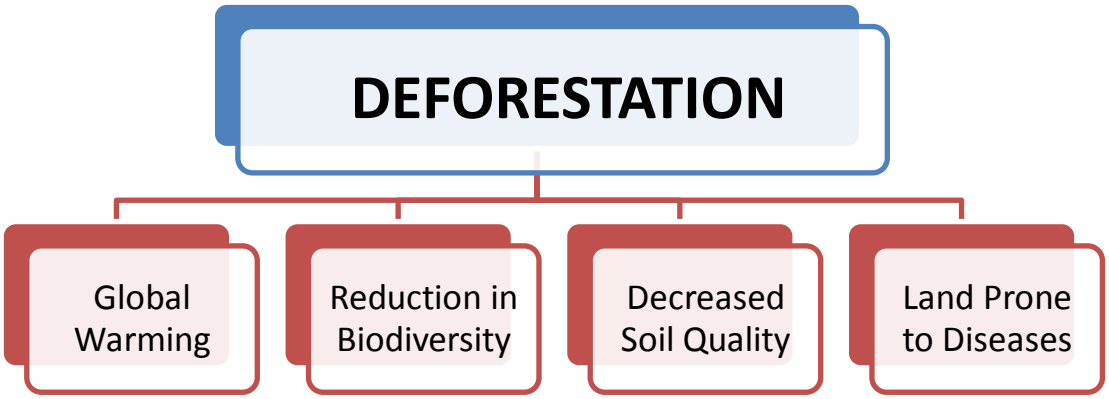

Figure 6: Concomitant Effects of Deforestation (Boateng, 2012)

3.2 Threats to the Environment

This section of the chapter discusses the negative environmental effects that the timber harvest in the Volta Lake is likely to produce. These effects occur mainly in the lake itself.

3.2.1 The Volta Lake Ecosystem

The Volta Lake covers almost one-third of Ghana's total area. The lake contains about 121 species of fish fauna. These come from 28 families and 73 genera (Ministry of Science and Technology, 2002). Almost 81 of the species are economically important, mainly for consumption as food. There are also species of cultural importance, such as: *Heterotis niloticus (Osteoglossidae) Clarias gariepinus, Heterobranchus longifilis (Claridae), Chrysichthys nigrodigitatus (Clarioteidae), Oreochromis niloticus (Chichlidae) and Lates nilolticus (Centropomidae)*. Some of these species have also been labelled as endangered due to their restricted distribution or a degradation of their habitat (Ministry of Science and Technology, 2002). These include: *Brycinus nurxe, B. macrolepidotux, Eleotris senegalensis,* the bivalve, the Volta clam, *(Egeria radiate),* the shrimp, *Macrobrachium spp.*, the West African manatee, *Trichechus senegalensis,* among others (Ofori-Danson & Agbogah, 1995 cited in Ministry of Science and Technology 2002).

Apart from the submerged hardwood trees such as mahogany, ebony, wawa, odum and teak that are plentiful in the Volta Lake, the lake flora is full of other species. These species belong to different categories. There are those floating on the surface, such as *Pistia stratiotes, Azolla africana* and *Ricciocarpus natans*. There are those floating below the surface: *Ceratophyllum dermersum, Utricularia inflexa* and *Aldrovanda vesiculosa*. Species such as *Nympaea lotus*, *Eichhornia natans* and *Sagittaria guyanensis* float on the surface of the lake and are rooted. Other species such as *Najas meiklei, Nitella mucronata* and *Ottelia ulvifolia* float below the surface and are rooted. There are also weeds such as *Mimosa pigra*, *Eclipta alba* and *Enydra fluctuans.* The

weed cover on the surface of the Volta Lake is estimated to be between one percent and ten percent (Volta Basin Research Project, 1999).

3.2.2 Loss of Flora and its Concomitant Effects

The timber harvest project in the Volta Lake is expected to rid the lake of the trees (plants) therein. However, the flora found in water bodies plays certain vital roles. Two particular groups of flora are important in this regard: submerged plants and emergent/floating plants. Submerged plants reduce erosion by reducing flow rate and trapping sediment. Further, they add dissolved oxygen, act as food, serve as habitat for both flora and fauna, and help maintain habitat diversity.

Emergent or floating plants also stabilize streams and lake banks, act as food and harbour fauna, habitat for organisms that improve water quality, reduce evaporation, and reduce turbidity through slowing down flow and sedimentation (Volta Basin Research Project, 1999). The loss of some of these plants through the timber harvest project effectively means that some of these beneficial functions are being lost as well. The ecosystem of the Volta Lake would thus be adversely affected.

According to Smokorowski, Withers and Kelso (1999), even in deep water plants can be beneficial to the ecosystem. The argument had been made that since there is little or no fish at such depths, it is environmentally safe to remove trees from this depth. However, logs in deep water still "provide structural diversity and are potentially important to the ecosystem", especially those that have been submerged for a very long time (Smokorowski, Withers & Kelso, 1999).

Among all the effects, the most outstanding and most documented are the ones relating to fish. According to Tenebaum (2004), uprooting trees from underneath the sea mucks up the water and disrupts the aquatic ecosystem. The sediments that would be thrown into the sea as a result of this process may be inimical to organisms in the sea, particularly fish. When this sediment settles on fish spawning beds, it affects the emerging fry. The sediment could reduce the flow of water in a spawning bed,

consequently decreasing the amount of oxygen available to eggs. Sediments could also impede the movement of emerging fry (Smokorowski et al, 1999).

Furthermore, research in lotic environments, that is water sources that move, show that suspended sediment has the ability to affect fish health and behavior. Suspended sediment concentrations could infect the wounds of fish and increase abrasion to the gills from sediment particles. When exposed to suspended sediment, fish behavior tends to change, particularly territorial, gill-flaring and feeding behavior. These changes in behavior could affect the health of the fish (Smokorowski et al, 1999).

Suspended sediments have also been found to affect fish mobility. Different species of fish and age-classes within particular species react to sediments differently, in terms of mobility. However, the danger lies in the fact that this induced mobility could lead to certain fish having to move from safe areas to more open areas, exposing them to predators. The need to move could arise from the desire to find more oxygenated water since sediments tend to affect the oxygen concentration in a particular area by reducing it. According to Breitberg (1992, cited in Smokorowski et al 1999), the "energy expended to move to more oxygenated areas, or the inability to move far enough, may result in mortality".

Sediment-induced disturbance that decreases water transparency for a long time could affect the temperature of the water. This in turn would affect the ability of temperature-sensitive organisms in the water body to survive. This could in the long term affect the species composition of the water body.

By the account of Poff (1992), disturbance of the water in varied forms always produces an ecological effect. Schlindler (1978) also stated that the levels of phosphorus had an effect on how abundant phytoplankton would be, since the phosphorus acted as an agent limiting the amount of nutrient content in freshwater.

Smokorowski et al. (1999) have also offered a detailed explanation as to how sediment disturbance affects the level of oxygen in water and its consequential effects. Dissolved oxygen is crucial for the metabolism of aerobic aquatic organisms.

Therefore, changes in the amount of oxygen available in an aquatic system may have implications for these organisms. Sediment disturbance leads to the loading of organic matter to the hypolimnion, which is the dense layer of water in a lake that is thermally stratified and sediments, leading to the consumption of dissolved oxygen. Figure 7 depicts the sediment disturbance in water bodies. This leads to water at the sediment interface becoming anoxic. The net effect is reduced oxygen in the aquatic environment, making it difficult for organisms that thrive on oxygen to survive.

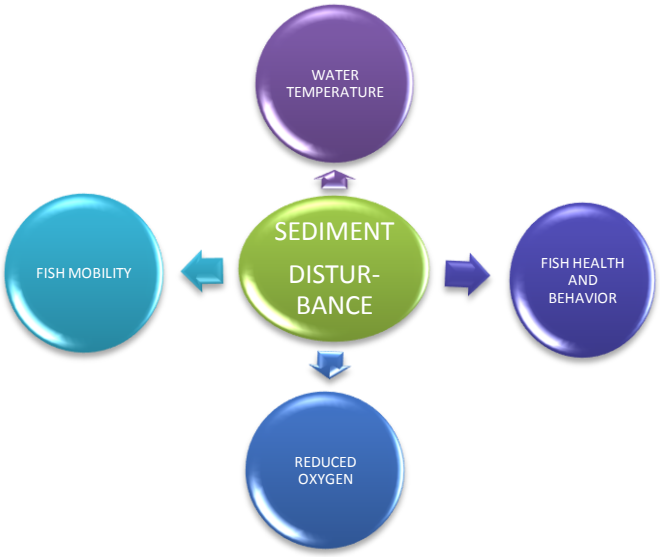

Figure 7: Effects of sediment disturbance in water bodies (Boateng, 2012)

Although both the SHARC Harvester and the Sawfish, the two implements used in the Volta Lake timber harvest project, cut the target trees instead of uprooting them and thus are less likely to cause sediment disturbance, they have been known to malfunction. Kellner (2005) reported a logging on Ootsa Lake in Canada where the airbags of the Sawfish failed. This meant that the tree was cut could not float to the surface of the lake. Rather it plunged down, hitting the lake floor and causing sediments to suspend in the water. Such malfunctions in the Volta Lake project could lead to environmental threats discussed above.

3.3 Conclusion

As has been said by Bilby and Ward (1989) sediments that are stable initially are swept downstream due to the removal of debris of wood from streams and river channels. Structural habitat for fish is lost as a consequence of removal of logs which have remained submerged over a time period.

With regard to the Volta Lake underwater timber harvest project, it looks like the negative environmental impacts are less likely to occur. This is as a result of the technology employed for the project. The SHARC harvester and the Sawfish have by their means of operation quite avoided the most significant threat to underwater timber harvesting – sediment disturbance, and its accompanying detrimental effects.

The environmental pay-offs of the project, therefore, need to be highlighted. Every acre of forest harvested under the Volta Lake is an acre of forest preserved in Ghanaian forests. Considering the horrifying rate of depletion of the country's forests, this project is certainly environmentally friendly. The environmental positive effects of the project are further highlighted by the accompanying effects of deforestation – global warming, loss of biodiversity, decreased soil quality - that would have certainly being severe in Ghana in the next twenty years, had this project not taken off.

Therefore, it is safe to conclude that the underwater timber harvest project in Ghana promises more environmental benefits than threats.

CHAPTER FOUR

Underwater Logging on the Volta – Implications for Transportation

The decision of the Government of Ghana to allow Clark Sustainable Resources Development (CSRD) to harvest trees from under the Volta Lake promises to bring revenues to the government in the form of employment, royalties and taxes. The sale of timber alone is expected to generate about 2.8 billion US dollars for Ghana (GNA , 2011). However, the government's justification of the project has lain in its potential to make vessel transportation on the Volta Lake safer and more efficient. This chapter thus examines the implications of the project for vessel transportation on the Volta Lake.

4.1 The Volta Lake Transportation System

When the Volta River was dammed, its resultant effect was the creation of a man-made lake with a rather dendritic shape averaging about 400 kilometres in length and having approximately a width of 25 kilometres (International Lake Environment Committee (ILCE), 1999). The Volta Lake was purposely created to generate hydro-electricity for Ghana but it was further expected to improve inland water transportation, be a source of fishing and additionally, ensure the availability of water for irrigation. The lake currently serves all four purposes, but besides the issue of electric power, the lake's usefulness in the area of transport stands out.

The lake covers a total of sixteen districts and borders six out of Ghana's ten regions - Volta, Central, Ashanti, Eastern, Northern and Greater Accra Regions (Lake Lubbers, 2007). The communities settling by the Volta Lake have populations that range from 400 to 3,000 people. These communities include Dambai, Dzemeni, Kete-Krachi, Kpando-Torkor, Tapa Abotoasi, Buja, Buipe and Yeji. Communication mediums are almost non-existent within these communities. Their main link with the outside world is via vessel transportation on the Volta Lake.

The Volta Lake thus serves as a transportation corridor for the numerous communities that live along the lake. The expanse of the lake covers almost one-third of the entire country, linking the southern and northern parts of the country. This has attracted a lot of people to use the lake as a means of transportation, especially since there are very few roads linking the northern part of Ghana to the southern half. The few existing roads are not high quality highways, thus, it takes many hours to travel from northern Ghana to the south.

The most common vessels to be found on the lake are barges, canoes and ferries. These vessels are used for the transportation of goods, as well as passengers. Cargo such as bulk oil movement, lint cotton, cotton seeds and sheanuts are shipped from the agricultural north to the industrial south for export or to local markets. The produce of the villages along the lake, such as yam, cocoyam, cassava and other food produce are also sent to the market centres via the lake (Lake Lubbers, 2007). Moreover, almost all the twenty villages along the lake are market centres. Traders access these centres using the vessels that ply the Volta Lake.

Figure 8: Map of Ghana showing the Volta Lake and its tributaries
Source: (FAO, n.d)

The Volta Lake Company Limited (VLCT) is the official transportation facility operating on the Volta Lake. The company operates mainly barges and ferries. Their services are highly patronized since these vessels are able to transport the heavy merchandise that is typically transported on the Volta Lake. However, the majority of

the transportation on the lake is carried out by vessels belonging to individuals. These are mostly wooden boats, powered by outboard motors. It is also not uncommon to encounter small canoes on the lake. This form of transportation is the preferred choice of fishermen living in the many communities along the lake.

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4.2 SAFETY ISSUES ON THE VOLTA LAKE

Unfortunately, the story of maritime transportation on the Volta Lake is marred by many accidents. Annually, lives and properties are lost on the Volta Lake due to accidents involving the vessels on the lake, mostly the wooden boats operated commercially by individuals in the various communities. The causes of these accidents are numerous, ranging from natural to human factors.

The human factors include overloading, thus going beyond the maximum load line on the vessels and the failure to maintain out-board motors and use recommended charts for navigation. In Figure 9 the potential causes of accidents on the Volta Lake are noticed. Natural factors include violent winds that blow vessels away, tree stumps that damage the vessels, particularly wooden vessels and the difficulty of navigation after sunset due to darkness.

Figure 9: Potential Causes of Accident on Lake Volta.

(Source: Curtis, 1995)

4.2.1 The Human Factors

Overloading

As already stated, the main means of transportation for the over twenty communities that populate the lake banks is water transportation. The most popular vessels are the wooden boats commercially operated by individuals living in these communities. However, these boats, and the cost of buying and fitting them with two out-board motors is so expensive that very few people own such vessels. The result of this shortfall is that there are always more passengers and goods than vessels to carry them to their destinations. Consequently, this high demand for transport leads to overloading of the boats as seen in Figure 10.

Figure 10: Passengers scrambling in a boat during a market day at Yeji.
(Source: Modey & Kwawukume, 2011)

Although the Volta Lake authorities have put marks on the boats to signify a crude form of load line and indicate the maximum loading capacity, the boat operators constantly flout this rule despite the presence of a naval force that is tasked with enforcing safety rules. Figure 11 illustrates GMA surveyors marking a boat. The boats are loaded so heavily that the only place left for human passengers is the edge of the vessel. Needless to say, human lives are lost when the boat encounters the slightest mishap such as collision with a tree stump since by sitting on the edge of the boat, they are the first to be tipped into the lake. Figure 12 depicts the unavailability of space for passengers due to over loading of goods.

Figure 11: GMA surveyors marking boats with loadlines
(Source: Ghana Maritime Authority, 2010)

Figure 12: A boat showing the amount of merchandise normally transported. Passengers would be sitting at the edge of the boat. (Source: Amanhyia, n.d)

Lack of Maintenance

This problem is mostly experienced with the operators of wooden boats at the embarkation and landing sites on Volta Lake. As a result of the availability of passengers and the lucrative nature of the boat business, most boat owners and operators are reluctant to take days off for the much needed purpose of maintenance.

Most of the boats operating on the Volta Lake are wooden boats, made from inferior species. This environment makes it necessary for regular maintenance since these boats need regular maintenance on account of their inferior wood source. Further, the out-board motors used to operate these boats need to be maintained and checked regularly to ensure that they are in good operating condition for voyages in the lake. However, the current environment at these inland ports is a horrifying culture of lack of maintenance. Boat owners and operators perpetually postpone maintenance dates as the desire to profit from their business minimizes safety concerns. Sadly, the lack of effective inspection and the presence of corrupt officials who ignore safety standards and procedures serve to preserve this non-maintenance culture. There is thus the need to motivate the personnel (especially financial motivation) tasked with ensuring safety standards in order to make them less susceptible to corruption and thus ensuring that they enforce the safety rules to the letter.

Disregard for navigation charts

The nature of the Volta Lake, particularly the prevalence of tree stumps, means that not every part of the lake is ideal for navigation purposes. Years of experience have allowed the lake authorities to draw navigation charts for users of the lake waterways. These routes are communicated to the vessel operators through workshops and meetings although aids such as buoys and markers might have been more effective. However, these approved routes are sometimes longer since certain areas have to be avoided. Some boat operators choose to disregard these navigation routes for other routes that might be shorter. This is done in a bid to save fuel and time. However, these shorter routes are normally dangerous and are potential causes of vessel accidents.

4.2.2 Natural Factors

Violent Winds

The Volta Lake is prone to some rather violent winds. This may be due to the disappearance of the forests that once bordered the entire lake. The presence of such winds poses a threat to particularly smaller wooden boats since it has the ability to blow them of course and even capsize them. Although boat operators have long realized the danger of setting sail when it is very windy on the lake, these winds could be quite unpredictable. This means that the violent winds may start during a period of calm when the vessels are already on the lake, threatening the safety of goods a passengers. The early warning weather system communicated to vessel operators from the Ghana Meteorological Services (GMS) has been unreliable in the past years. It is not unusual to have violent winds without any warning from the GMS.

Darkness

The use of the Volta Lake for transportation purposes after dusk could be quite dangerous. When it is dark, it becomes more difficult for boat operators to recognize their normal routes. They thus run the risk of navigating through less safer portions of the lake. Travelling on the Volta Lake at night is also dangerous due to the risk of being unable to identify tree stumps on the surface of the lake. As mentioned several times in this chapter, collisions with tree stumps could easily lead to an accident.

It is important to point out that accidents on the Volta Lake could be a result of any of the above factors or even a combination of them.Table 1 provides a record of Volta Lake vessel accidents over the last two decades.

Table 1: Volta Lake Casualties - 1990 to 2011

Month and Year of Accident	Type of Boat	Location of Accident	Death Toll	Cause (s) of Accident
April, 1990	Wooden (open)	Accra-Town	46	Overloading
November, 1992	Wooden (open)	Kpando - Torkor	17	Overloading, Tree Stumps, Strong winds
March, 1994	Wooden (open)	Buipe	11	Tree Stumps, Strong winds
April, 1995	Wooden (open)	Amankwa-Torno	100	Tree Stumps, Overloading
May, 1997	Wooden (open)	Dambai	23	Overloading, Darkness
July, 1998	Wooden (open)	Dzemeni	15	Outboard motor failure
June, 1999	Wooden (open)	Dzatake	70	Tree Stumps, Darkness
April, 2002	Wooden (open)	Amevlovikope	50	Overloading, Tree Stumps
August, 2006	Wooden (open)	Yeji	27	Tree Stumps,
September, 2011*	Wooden (open)	Tata Bator	54	Overloading

(Source: Ghana Maritime Authority, 2007) and Ghana News Agency (2011)*

As could be seen from Table 1 above, vessel accidents on the Volta Lake have become annually higher over the recorded period (1990 – 2011). The two decades of accidents on the Volta Lake has claimed a total of 413 lives and numerous properties. With regard to the causes of these accidents, the causes highlighted in Figure 13 are instructive. Tree stumps are more responsible for vessel accidents on the Volta Lake than any other factor – 38%. This is closely followed by vessel overloading (31%), strong winds (13%), darkness (13%) and outboard motor failure (6%).

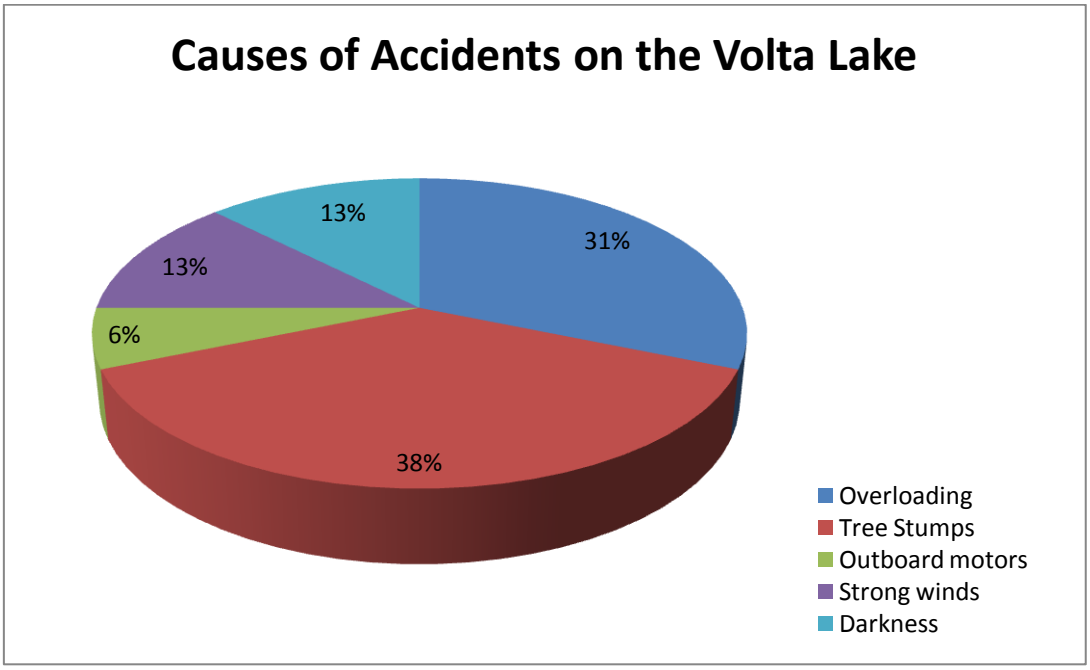

Figure 13: Causes of Accidents on the Volta Lake (1990 -2011)
Source: Ghana Maritime Authority (2007) and Ghana News Agency (2011)

It could thus be concluded that tree stumps are the major cause of accidents on the Volta Lake. The underwater timber harvesting project is thus expected to lead to safer transport on the Volta Lake. Once the tree stumps are removed, the major cause of accidents on the Volta Lake will also be eliminated. The remaining factors relating to weather, darkness and motor failure also require further government intervention to improve the safety environment on the lake.

In recent years, this issue of vessel accidents on the lake has received considerable attention from the government of Ghana. In February, 2010 the Ghana Maritime Authority (GMA) in collaboration with the Ministry of Transport and the Ghana Navy deployed a Naval Task Force, made up of Ghana Navy personnel, in six boat landing and embarkation stations, namely, Tapa Abotoase; Keta Krachi, Dambai, Yeji, Dzemeni and Kpando Torkor. These centres are the major centres for accessing transportation across the Volta Lake. The Task Force checks overloading, improper landing, drunkenness and bad behaviour among boat operators, and also prevents boat sailing in bad weather and sailing when it is dark (See Figure 14).

According to the Director General of the GMA, the Naval Task Force is to be replaced by a permanent Lake Traffic Unit. This Unit would have more personnel and logistics – such as speedboats and high standard binoculars - to enforce inland maritime rules (Ghana Maritime Authority, 2010). In addition, boat safety education programmes are held as depicted in Figure 15 for boat owners and operators to sensitize them on safety procedures and rules.

Figure 14: A Naval Task Force Personnel enforcing safety rules during loading.
Source (Ghana Maritime Authority, 2010)

Figure 15: Boat operators receiving educational training on safety procedures
Source (Ghana Maritime Authority, 2010)

According to the Chief of Tapa Abotoase (one of the communities along the Lake), Baffour Okoforobour Kwame Asante II, there is also the need to address another major threat to safe transportation on the lake if vessel accidents are to be avoided. He identified this threat as the tree stumps that are prevalent on the Volta Lake (Ghana Maritime Authority, 2010). This issue will be further investigated in this chapter.

4.3 The threat of tree stumps to transportation on the lake

The construction of the resultant Akosombo Dam resulted in the submergence of large tracts of forest (Kwablah, 2009). In the depths of the Volta Lake lay over 14 million cubic meters of rot-resistant hardwoods such as wawa, odum and ebony trees (Fitzgerald, 2008). Most of these trees have pushed all the way to the surface of the water. The tree stumps disrupt free-flow of traffic on the lake, making navigation difficult, especially for small vessels. The stumps punch holes into the vessels, causing them to sink. Many of them lurk just below the water surface where they snag the nets of fishermen and are a collision peril for the long wooden kayaks and other boats that transport goods and people on the Volta Lake (Field, 2007). In the case of wooden

boats, considering that most of the passengers sit on the edges of the boat (with goods lying in the interior); these tree stumps are particularly precarious. This is because any major bump into a tree could throw off some passengers into the lake.

Figure 16: Problem of navigation caused by dead trees on the Volta Lake.
Source (Amusing Planet, 2010)

These tree stumps have been responsible for many accidents on the Volta Lake. The presence of tree stumps and overloading of commercial boats are the two major causes of vessel accidents on the lake. Furthermore, fishermen who fish amongst the exposed trees also risk being accidentally thrown overboard or damage to their fishing gear and boats (See Figure 16).

In September, 2011; nearly seventy people travelling on the Volta Lake perished as a result of their boat capsizing ("Oh These Volta Lake Disasters," 2011).Tree stumps on the Lake were reported to have punched holes in the canoe, causing water to enter the boat. At this point the vessel began to sink. Sadly, there were not enough life jackets on the boat to rescue all the passengers. Accidents caused by tree stumps have turned into a perennial tragedy since 1964 (Ghana News Agency, 2011a).

It is as a result of this natural danger that lurks on the surface of the water that the proposal by Clark Sustainable Resources Development (CSRD) to harvest the

submerged trees of the Volta Lake was enthusiastically endorsed by the Government of Ghana. The project is being touted as a future relief for transport on the Volta Lake since a stump-free Volta Lake would ensure safer transportation on the lake.

4.4 Implication for transportation on Volta Lake

Clearly, the removal of the trees standing in the Volta Lake augurs well for transportation on the lake. Without the stumps, navigation for instance would be easier and faster. The current situation has boat operators and other vessel operators on the lake relying on the Ghana Maritime Authority and other regulatory bodies of the lake to chart routes for them. This is necessary to avoid sections of the lake that are riddled with the tree stumps and are thus likely to cause accidents. Tourists who rent boats for pleasure riding on the lake would be particularly be relieved since an inexperienced operator would no longer be needed to take the wheel.

The removal of tree stumps and its concomitant reduction of the risk of vessel accidents is also likely to lead to faster transportation on the lake. Presently, boat operators have to move slowly and cautiously on the lake since they risk running into tree stumps. However, with the stumps gone, and thus the risk eliminated, they certainly could afford to travel considerably faster on the lake. Needless to point out, faster travel on the lake would save time for passengers as well as saving fuel and time for the boat operators.

Another advantage of a stump-free Volta Lake is a reprieve for transportation equipment. Even when they do not encounter accidents, most boats on the lake suffer damage as a result of knocking against tree stumps. This is particularly true for wooden boats, which incidentally also happen to be the modal vessel on the lake. The out-board motors fitted to most boats that ply on the lake suffer damage occasionally as a result of knocks against tree stumps. This presents an even greater problem for boat operators since these motors are very expensive, especially in the light of the impoverished nature of these communities.

In an interview with Mr Ezekiel Kpodo (personal communication, June 7, 2012), a fisherman based at Kpando Torkor, confirmed that although their boats are made from very strong wood, the constant knocks against tree stumps tend to scrape the boats and thus reduce the life span of the boats. According to him, it is not possible to navigate away from all the stumps no matter how skilled and experienced the operator is. This is due to the fact that some of the stumps are hidden just under the water and are therefore not visible on the surface. However, as soon as one passes by, the boat bumps against them. He further explained that this occurs because some parts of the boat are also below the surface. Mr Kpodo also lamented that as a result of the tree stumps, fishermen have to chart courses that are longer in order to avoid stump-infested sections of the water. This prolongs the journey and means more fuel is needed to successfully arrive at a particular destination.

4.5 Implications for Safety

It appears from the preceding section that removal of tree stumps from the Volta Lake would lead to safety for both humans and goods. With the trees stumps gone, there would likely be fewer accidents on the lake. This implies safer travel on the lake, provided other causes of accidents such as overloading of both passengers and goods and other safety protocols are adhered to.

However, not everybody shares this enthusiasm. Mr. Kudjo Anyigbanya (personal communication, June 9, 2012), a boat operator at Dzemeni for the last twenty-three (23) years, stated that the trees stumps do have their use. According to him, God put them in the Lake for a purpose. He narrated how on a number of occasions the stumps saved the lives of his passengers. When storms threaten to blow the boat off course, the stumps become anchors or moorings which travellers hold unto until the water becomes calm again. He also narrated an occasion when his out-board motors malfunctioned all of a sudden and his spare motor was also not operational. As the boat began to sink under the weight of passengers and goods, he quickly navigated it towards the stumps where most of the passengers were able to hold on to these stumps to avoid drowning until another vessel appeared to take them out of danger. According

to him, at least eighty lives could have been lost that day, had it not been for the tree stumps.

Mr Anyigbanya is not alone in arguing for the presence of the tree stumps in the lake. The management of Challenging Heights, a Child's Right non-governmental organisation (NGO), has also expressed concern about the removal of the tree stumps from the Volta Lake. According to Mr. James Kofi Annan, Executive Director of Challenging Heights, apart from the fact that removal of stumps would lead to less breeding sites for fish and thus affect fishermen economically, there are also safety issues to be considered. He mentioned that the lake gets agitated at the slightest wind. Thus, "fishermen used the stumps as their anchor in the event of storms to tie their canoes for safety" (GNA, 2011b). Mr Annan is also of the view that "because women and children are those who have less swimming abilities, they are 10 times more likely to die than men in the event of any disaster on the lake" (GNA, 2011c). According to Mr Annan, the absence of the stumps would always inflate the volumes of the waves of the lake and get it more agitated in the events of storms.

4.6 Conclusion

Tree stumps are not the only cause of accidents on the Volta Lake. However, they have been identified as a major threat to safety and transportation on the lake. With regard to the latter, it is obvious that the removal of the tree stumps would eliminate impediments in the way of vessels plying the lake, make navigation easier and eventually improve transportation.

The case for safety, however, is not entirely one-sided. While the tree stumps present potential danger to the vessels that travel on the Volta and their occupants, they could also be life-savers under certain conditions. During storms and in windy situations, the stumps become a source of anchor or mooring for both passengers and vessels alike.

CHAPTER FIVE

Conclusion and Recommendations

5.1 Conclusion

This study sought to:

1. Investigate the practice of underwater harvesting and the techniques involved.
2. Assess the impact of this project on the Volta Lake, with special emphasis on the environment and transportation safety.
3. Make appropriate recommendations based on findings of the study.

The practice of underwater harvesting is not exactly novel. Countries that have had large forests drowned by lakes have taken to rescuing the sunken wood underneath. As forests on the surface of the earth continue to disappear due to excessive exploitation of trees, timber discovered underwater is being harvested in order to supplement the ever growing demand for timber globally. In addition, underwater trees have been found to be superior in terms of quality when compared to those found on the earth's surface. Furthermore, the devastating effects associated with deforestation have made underwater timber harvesting more acceptable and appealing. The practice has already taken root in countries such as Malaysia, Suriname, Brazil and particularly, Canada.

Underwater tree harvesting was traditionally done by divers. These men and women go underwater and cut the trees. Needless to say, their harvest is limited by the amount of depth they can reach underwater. There are also health-risks associated with this method of underwater harvesting. In Kenyir Lake, Malaysia, there have been reports of divers dying from decompression illness.

In contemporary times, underwater timber harvesting has become a lot more popular due to advances in the technology employed in harvesting underwater timber.

The use of robotic equipment underwater has made recovery of sunken timber a lot safer and more efficient. The SHARC Harvester and the Sawfish, two underwater

timber harvesting equipment designed by Triton Logging Company, are the most popular equipment in the field.

Incidentally, these are the two types of equipment that have been engaged in harvesting trees under the Volta Lake in Ghana. The Volta Lake contains a significant supply of timber since a large forest had to be drowned in creating the lake. The SHARC Harvester is designed for shallow water operations and it is capable of reaching a depth of 36.5 metres. The SHARC uses a customized barge and excavator, as well as thrusters and DPS (Dynamic Positioning System) to navigate to the trees underwater. With the help of video and sonar equipment, the SHARC can manoeuvre inside water. Its telescoping arm and cutting head allows it to find, cut and retrieve trees. The SHARC is thus being currently employed to harvest the trees from the Volta Lake shallow waters.

The Sawfish is being used to cut the trees in the deeper waters of the Volta Lake. It is able to go beyond 100 metres. The Sawfish is a remote controlled vehicle has seven thrusters and is powered by a 75 HP electric motor. The equipment is fitted with eight video cameras, sonar and GPS. The mouth of the sawfish consists of huge pincers and a 140-centimetre chainsaw. The equipment is also filled with airbags.

The Sawfish uses its sonar device to navigate underwater. The eight video cameras provide a live video feed to a pilot sitting in a barge on the surface of the water. The Sawfish locates a tree, grabs the tree with its four-foot grapples, drills airbags into the wood, slices the tree off at the trunk with the chainsaw and then sends the log floating to the surface of the lake, by means of the airbag. The floating team collects the floating logs and places them in floating bunks or on barges for transport to the milling sites.

The impact of the underwater harvesting project has been examined with regards to the environment and transportation. Considering the former, Ghana's current deforestation rate of 2% per annum, which has resulted in a reduction of the country's forest cover from 8 million hectares to 1.5 million hectares within half a century,

makes the underwater timber harvest quite significant. This is because, with most of the country's timber needs – both for local consumption and for export- coming from the Volta Lake, the forests on the surface would be spared for a considerable number of years. Furthermore, this environmental pay-off is evident in the concomitant effects that would have resulted from the lost of forests, particularly, global warming.

With regard to the Volta Lake ecosystem, the underwater timber harvest does pose a threat to the flora and fauna of the lake. The harvest of trees underwater could lead to sediment disturbance which affects the level of oxygen in the water. Dissolved oxygen is crucial for the metabolism of aerobic aquatic organisms. Therefore, changes in the amount of oxygen available in an aquatic system may have implications for these organisms. However, both the SHARC Harvester and the Sawfish, the two implements used in the Volta Lake timber harvest project, cut the target trees instead of uprooting them and thus are less likely to cause sediment disturbance. In addition, the Volta Lake is a relatively new man-made ecosystem that could further adjust to the loss of tree stumps.

Maritime transportation on the Volta Lake has over the years been disturbed by vessel accidents. Although these accidents are due to a number of natural and human factors, one particular factor stands out – tree stumps. Some of the submerged trees in the Volta Lake protrude to the surface of the lake. These trees impede the flow of traffic on the lake. The stumps punch holes into the vessels, causing them to sink. Many of them lurk just below the water surface where they snag the nets of fishermen and are a collision peril for the vessels that transport goods and people on the Volta Lake. The stumps have made transportation on the lake unsafe. Their presence has made navigation quite difficult as vessels have to operate carefully in order to avoid them. This cautious approach has made transportation on the lake also quite slow. In many instances, vessel operators have to resort to longer navigation routes simply to avoid these trees.

5.2 Recommendations

5.2.1 Environment

The environmental impacts of the Volta Lake underwater timber harvest are rather positive, as shown in the preceding pages. This has been made possible by the method of the harvest. The only threat is the possibility of the equipment malfunctioning, thus either the SHARC Harvester or the Sawfish. Should this equipment malfunction while in operation, particularly if the airbags attached to the equipment fail to inflate and float a cut log, then the log might drown and hit the bottom of the lake. Under such a circumstance, it is likely that the sunken log would cause sediment disturbance with accompanying deleterious effects for both the fauna and flora. It must be reminded that this is a relatively new man- made lake ecosystem which will further adjust to the loss of these trees and support the thriving of juvenile fish.

In order to avoid this, the equipment operators - Clark Sustainable Resources Development and their partners – ought to regularly maintain the harvesters and ensure that they are they maintained in perfect working condition. It also behoves the appropriate state institutions to regularly monitor harvesting operations to ensure that these machines are being maintained and operated safely and efficiently.

5.2.2 Safety

With regard to transportation and safety on the lake, the harvesting of the tree stumps is likely to improve both. The implications for safety are particularly heart-warming. The number of vessel accidents on the Volta Lake and the accompanying casualty has made the timber harvest quite timely. Removal of the tree stumps would certainly lead to less vessel accidents on the lake. However, in order to ensure total safety on the Volta Lake, there is a need to address the other causes of vessel accidents on the Volta Lake – overloading, lack of maintenance, disregard for navigation charts, to mention but a few.

It is evident from the author's research that many of the vessel accidents on the Volta Lake would have been avoided had the country strictly abided by the International Maritime Organization's (IMO) Model Safety Regulations for Inland Waterways Vessels and Non-Convention Craft, including Fishing Vessels, operating in Africa. Ghana is a signatory to this document. However, from the account of vessel accidents on the Volta Lake, it is apparent that the regulations in this document are not being effectively implemented and enforced.

Most of the commercial vessels operating on the Volta Lake have no life-saving equipment on board, an unpardonable violation of the General Requirements section of Chapter Eight – Lifesaving Arrangements and Appliances- of the Model Safety Regulations. This section calls for the provision of life-saving jackets and lifebuoys on all vessels. When the vessels on the lake hit tree stumps, are damaged and begin to sink, either lifejackets or lifebuoys on board would have saved passengers from drowning. However, neglect both on the side of boat operators to ensure they have them on board and on the part of the Ghana Maritime Authority to enforce these provisions with vessel owners has led to the drowning of many passengers over the years.

With the exception of the tree stumps on the Volta Lake, the major cause of vessel accidents on the lake has been overloading of the vessels. Chapter Four (Freeboard and Stability) of the IMO Model Safety Regulations requires that all vessels have loading marks on them and that the vessels should not carry goods beyond these loading marks. Although the Ghana Maritime Authority has placed such load marks on the vessels plying the lake, enforcement has been lacking. Vessel operators continue to load their vessels beyond this mark, while officials ignore enforcement or take bribes from vessel operators and allow them to sail.

Another area in where the Ghana Maritime Authority needs to assert its authority has to do with its dealings with boat operators. It is not enough for the GMA to organize seminars for the operators on safety procedures. In order to guarantee safety, it is imperative that boat operators be armed with the highest level of training with regards

to handling their vessels. Although an international convention, it would really help if vessel operators on the Volta Lake are given training as prescribed by the International Convention on Standards of Training, Certification and Watchkeeping for Fishing Vessel Personnel, 1995 (STCW-F 1995), which is set to enter into force on 29 September 2012. The GMA really ought to seriously consider upgrading even inland vessel operators on the Volta Lake up to this standard. Such level of training would prevent vessel operators from considering sailing in darkness, amidst other such high risk practices.

In brief, strict enforcement of the International Maritime Organization's (IMO) Model Safety Regulations for Inland Waterways Vessels and Non-Convention Craft, including Fishing Vessels, operating in Africa would certainly make the Volta Lake safer. Removing the tree stumps from Volta Lake would also make transportation on the lake much safer, especially if considering the percentage of accidents that are due to the presence of the stumps.

5.2.3 Economic benefits

As mentioned earlier in this work, the estimated revenue to the Government of Ghana from the underwater timber harvest is 2.8 billion dollars (Ghana News Agency, 2011). This estimate is based on the concession cost and taxes. In a relatively small economy like Ghana's, this amount is able to usher in quite significant development. However, the economic benefits go beyond monetary gains.

One key area of benefit is the employment avenues that the underwater timber harvest project is going to generate for the people of Ghana. Since the gamut of logging activities, from rescuing the logs beneath the Volta Lake to milling them for export would be conducted in Ghana, there is a lot of employment avenues that come with the project.

With regard to transportation on the lake itself, there would be economic rewards for vessel operators. The demise of the tree stumps means that they no longer have to avoid navigating through certain portions of the lake and thus end up using longer

routes. They could use the shortest route possible on the lake to get to their destinations. This reduces the amount of fuel spent on the out-board motors that power the vessels, thereby reducing cost and time of voyages.

The government of Ghana in granting concessions to Clark Sustainable Resource Developments to undertake underwater timber harvesting on the Volta was solely considering the economic benefits of the project. The economic benefits so far explored justify the project.

However, as this research has shown, there are environmental and safety (transportation) benefits as well. With regard to these same areas – transportation and safety – there are likely detrimental effects arising from the timber harvest project. However, the latter effects are not very significant and some of them are indeed preventable. The government should endeavour to use the proceeds from the harvest to supply the logistics needed to fully implement the IMO Model Regulations outlined earlier in this work. The issue of corrupt officials for example is easily solved by motivating these officials with bigger pay-checks. This would reduce the temptation to succumb to bribes. The revenue could also be used to purchase speed boats and other items needed by the Ghana Maritime Authority to increase their efficiency with regard to monitoring inland water transport

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APPENDICES

Appendix A

Transcript of interview with Mr Ezekiel Kpodo, a fisherman at Kpando Torkor – a fishing community by the Volta Lake - on June 7, 2012.

- Interview conducted by Mr. Bright Sowu, Research Assistant

Interviewer: I would like to ask you a few questions about your fishing activities on the Volta Lake.

Mr Kpodo: Sure, what would you like to know?

Interviewer: Have you noticed the tree stumps on the lake?

Mr. Kpodo: Yes, they are such a nuisance!!

Interviewer: Why do you say that?

Mr. Kpodo: There are so many of them on the lake we (fishermen) [parenthesis mine] are unable to navigate around all of them. As a result, our vessels continue to knock against them. This destroys the vessels. Also, the stumps tear through the fishing nets we cast into the lake and thus affect the amount of fish we are able to catch.

Interviewer: How does this destroy the vessel?

Mr Kpodo: Since our boats are made of wood, the constant knock against the trees tends to scrape the boats. You may think the quality of wood used for our boats makes it resistant to such scrapes, but the truth is that some of this knocks do chew off the vessel. The net effect is that the vessels no longer are able to last as long as they should.

Interviewer: Is this why you consider them a nuisance – because they destroy your vessels?

Mr Kpodo: The vessel destruction part is just the tip of the iceberg. The tree stumps have led to several accidents on the Volta Lake. Although none of the fishermen from here (Kpando Torkor) [parenthesis mine] have ever been involved in a serious accident on the lake, our colleagues from other fishing communities have on several occasions been victims to accidents caused by the tree stumps.

Interviewer: How do the stumps cause these accidents?

Mr Kpodo: When the vessel collides with the stumps, especially when the vessel is really speeding, the impact could capsize the vessel. This throws the fishermen into the lake. In the case of the commercial vessels that carry people across the lake, hundreds of lives and valuable properties have been lost this way.

Interviewer: How come neither the fishermen nor the vessel operators see the tree stumps? They are quite visible, aren't they?

Mr Kpodo: The problem is not with the trees that you can see on the lake; those ones are quite avoidable. However, there are some of them which lurk just at the surface of the water. These ones are not visible on the water. They are the ones that collide with the vessel and capsize it.

Interviewer: So, would you be better off without the stumps on the lake?

Mr. Kpodo: Certainly! Most certainly!!

Interviewer: Have you heard of any efforts to get rid of the stumps on the lake?

Mr Kpodo: No. But we have been appealing to the Authorities to do something about the tree stumps. There are just too many of them, and they are causing havoc.

Interviewer: Does this mean you would welcome efforts to cut the trees on the lake?

Mr Kpodo: Most definitely!! In fact, I would not mind volunteering on this task. If the trees stumps are removed from the lake, it would become safer to use.

Interviewer: Apart from safety, which other way would it help if the stumps are removed from the lake?

Mr Kpodo: The demise of the stumps would also make transportation on the lake easier. As it stands, fishermen and other vessel operators have to be on the look-out for the tree stumps when they are sailing. This means that we cannot travel as fast as we would love to. Also, in a bid to avoid areas that have too many stumps, we resort to longer routes. This has implications for the time spent making a trip and the fuel consumed by the motor as well.

Interviewer: Well, thank you very much for your time. I really appreciate how much you have enlightened me on the issues.

Mr Kpodo: You are most welcome!!