

Vulnerability of Mangochi's Fishing Industry to Impacts of Prospective Petroleum Exploration in Lake Malawi

ISAAC CHIWAULA

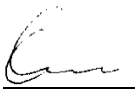
Thyolo, Malawi

Dissertation submitted to Ndata School of Climate and Earth Sciences of the Malawi University of Science and Technology in partial fulfilment of the requirements for the Bachelor of Science degree in Petroleum Geosciences (Oil and Gas)

April, 2023

DECLARATION

I **Isaac Chiwaula** declare that this research project represents my own work and that it has never been submitted to this institution or any other institution for any academic purpose. All sources of information have been appropriately acknowledged.

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ABSTRACT

The fishing industry in Malawi is crucial to both its people and its economy. For many individuals, it is a source of affordable proteins, forex, and jobs. Notwithstanding the advantages of petroleum exploration, prospective petroleum exploitation on Lake Malawi poses a danger to this reliable fishing sector. This study's primary goal is to determine how susceptible the fishing business is to potential oil development on Lake Malawi. The majority of the fishing is done in Mangochi, where this study was conducted.

According to research, over 84% of the residents of Mangochi rely on agriculture and fishing for a living. This study has confirmed that the reason why the population relies on the lake for survival is probably due to low literacy rates. Mangochi has more fish because of the area's shallow waters. Nonetheless, the study made note of the fact that Mangochi's shallow waters put fish at danger of heightened toxicity in the event of any unintentional or deliberate discharge of oil into the lake during exploratory drilling. It has also been determined that more than half of Mangochi's waters are used for significant fishing operations, and that any alteration to this area will result in fishermen losing access to their fishing grounds to petroleum exploration. Also, it has been determined that if the fishing industry has been harmed by the exploratory activities, more than 563,000 jobs will be lost.

In order to reduce the likelihood of oil leaks and sea grabbing by the petroleum sector, it is advised that the government implement rigorous rules when it comes to petroleum exploration. This will guarantee that the resources in Lake Malawi are used to the benefit of both the fishing business and the petroleum industry.

ACKNOWLEDGEMENTS

I want to start by giving thanks to Jehovah for keeping me well throughout my study. I would like to extend my sincere gratitude to Mr. F. Josiya, who is also my research supervisor, for his patient mentoring, encouraging and helpful criticism of my work. Additionally, I want to thank Mr. Tchongwe for helping me maintain my work as scientific as possible.

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ACRONYMS/ABBREVIATIONS

GDP	Gross Domestic Product
PAH	Polycyclic Aromatic Hydrocarbons
GSD	Geological Survey Department
GPS	Geographic Positioning System
GIS	Geographic Information System
NSO	National Statistics Office

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CHAPTER 1: INTRODUCTION

3.4. Background

The Malawi fishing industry is a very important source of employment, money, and nutrition for the people. Lake Malawi is where most fishing is done because it contains more than 800 endemic fish species (Whaley, 2017). On the other hand, Lake Malawi has long been considered the most likely place to find hydrocarbons in Malawi which is expected to result in significant economic opportunities for the country.

The fishing industry and offshore upstream petroleum activities interact heavily throughout regular operations due to their shared dependence on the marine environment. As a result of the dependence of many people on fishing and fish-related industries in Malawi, prospective offshore petroleum exploration threatens their ability to support themselves through fishing.

3.5. Problem Statement

Petroleum exploration on Lake Malawi has been a contentious issue in recent years, with some stakeholders arguing that it could have negative impacts on the lake's ecosystem and the livelihoods of those who depend on it. There is a considerable possibility that petroleum activities on Lake Malawi would diverge from normal operation as a result of an accident at an oil and gas installation, harming fishing activities and having a substantial impact on fishing stocks. Furthermore, fishermen in Malawi are at risk of losing access to their fishing grounds to oil and gas exploration activities due to the 'no go' zones that are usually demarcated around oil and gas installations where fishing around these zones is strictly forbidden. Consequently, the resulting low fish catches would have negative socio-economic impacts and would decrease the annual GDP contribution of the fishing industry.

3.6. Research Objectives

3.6.0. Main Objective

To assess how Mangochi's fishing industry is vulnerable to impacts of prospective offshore petroleum exploration on Lake Malawi

3.6.1. Specific Objectives

The research's specific objectives are:

- To identify the number of people, villages and the size of fishing grounds at risk of being directly affected by offshore petroleum exploration in Mangochi
- To determine environmental and social factors that would intensify the potential impacts of petroleum exploration in Mangochi
- To determine potential negative social-economic effects of oil exploration on Lake Malawi to the people in Mangochi

3.7. Research Questions

This study seeks to find answers to the following questions:

- What is the population of people and the size of fishing grounds at risk of being impacted by offshore petroleum exploration in Mangochi?
- What factors would worsen the potential effects of petroleum exploration in Mangochi?
- What are negative social-economic impacts of petroleum exploration on Lake Malawi in Mangochi?

3.8. Significance of Study

Since exploratory drilling and oil production have not yet begun in Malawi, there has not been any research on the potential fishing areas where effects of the oil and gas industry can arise. Activists and journalists are concerned that prospective petroleum exploration on Lake Malawi has potential of affecting the fishing industry and compromising livelihoods of many people living on its shores but the factors that would intensify these effects haven't been identified. This study was carried out in an effort to close some of these gaps.

This research will be valuable to petroleum project designers, policymakers, NGOs, scholars, and fishermen. The scope of the evaluated consequences will help the oil

exploration and production companies take precautions to ensure that their operations do not negatively impact the dependable fishing industry in Mangochi.

CHAPTER 2: LITERATURE REVIEW

2.1. Geological Evidence for Potential Oil Accumulation in Lake Malawi

Lake Malawi is located in the East African Rift System and is surrounded by sedimentary basins that have the potential to contain oil and gas deposits (Mattick, 1984). However, to determine whether the lake has potential for hydrocarbon deposits, geologists must rely on several lines of evidence, including geological and geophysical data.

One piece of geological evidence that suggests the potential for hydrocarbons in Lake Malawi is the presence of source rocks, which are rocks that contain organic matter that can generate hydrocarbons under certain conditions. Studies have shown that the sedimentary rocks in the surrounding basins, such as the Karoo Supergroup, contain organic-rich shales that have the potential to generate oil and gas (Jacobs, Newman, Winkler, Newman, & Deino, 2005).

Another line of evidence comes from the presence of reservoir rocks, which are porous and permeable rocks that can store and transmit hydrocarbons. Sedimentary rocks, such as sandstones and carbonates, have been identified in the Lake Malawi basin and surrounding areas, suggesting that suitable reservoir rocks may be present (Malunga G. , 2017).

Geophysical data, such as seismic surveys and gravity measurements, have also been used to investigate the subsurface structure of the Lake Malawi basin. These data have revealed the presence of structural traps, which are geological features that can trap hydrocarbons and prevent them from migrating to the surface (Malunga, 2015).

2.2. Impacts of Petroleum exploration on Fish

Aquatic ecosystems are made up of intricate interactions between various plant and animal species and their physical surroundings. (Rout & Sharma, 2013) supports that when there is damage to the physical environment, one or more

species in a food chain may frequently suffer, which may cause damage to other species higher on the food chain.

In order to evaluate the potential impacts of oil and gas industry on the surrounding aquatic environment, (Amoasah, 2010) divided the impacts into first-order and second-order. The first order of impacts in oil and gas industry comprised the activities with immediate effects or consequences on the surrounding environment such as noise, spillage and discharges. These impacts with time, give rise to the second and third orders of impacts which are socio-economic in nature.

2.2.0. Noise

The offshore petroleum industry has a variety of underwater noise sources, such as seismic surveys, drilling activities, and support boats. Fish may occasionally temporarily redistribute because of high frequency noise used in seismic surveys conducted during exploration. Several studies have examined how noise affects fish and mammals. According to their findings, fish spawning success may be negatively impacted by seismic activity (McCauley, 2003).

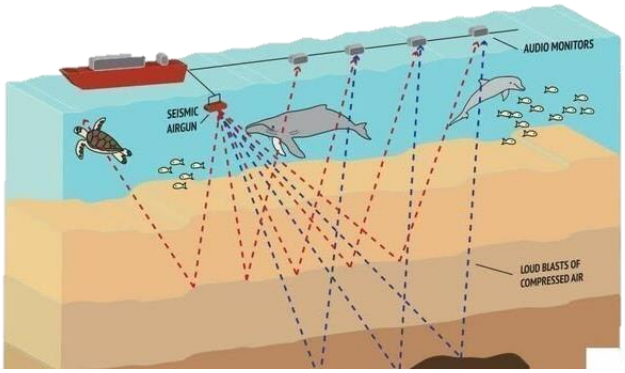


Figure 1: Effects of seismic activity on fish spawning success

Many marine animals rely on the soundscape for auditory information about the locations of predators and prey, communication, and habitat selection due to the great distance that sounds can travel through water. Certain sounds have been demonstrated to have detrimental impacts on marine organisms, resulting in communication breakdowns and unbalanced interactions between predators and prey (Cox, et al., 2016).

2.2.1. Efferent Discharges

Oil, gas and chemical discharge from offshore oil and gas installations or from transport vessels is prohibited by law and is only permitted in limited situations and often in small quantities. Legal discharge is only permitted for compounds with low levels of pollution (Gómez & Green, 2013). Accidental releases from offshore sites, however, may happen as a result of human mistake or equipment malfunction, during operations such as the transfer of fuel from supply vessels, the overfilling of tanks, or well operations.

A study by (Overton, Miles, & Hsieh, 2016) proved that water-based cuttings have least damage to sediment system, only depressing Eh levels during first months of exposure while oil-based cuttings on top of depressing Eh levels increased sulfide concentration. consequently, sediments with heavy oil-based cuttings become anaerobic which leads to loss of biodiversity through a decrease in amphipod population that is important in food chain (Beeby, 1993).

2.2.2. Oil spills

Oil well drilling in the upstream industry may result into petroleum hydrocarbon pollution of the environment (Oberdorster & Cheek, 2001). Oil spills are more likely to affect the aquatic ecosystem (Cairns & Buikema, 1984). A report by (Rout & Sharma, 2013), confirmed that oil spills can result from a variety of factors, including negligence, intentional dumping and tanker accidents such explosions, hull failure, going aground, and collisions.

Gravity often pulls heavy spilled petroleum hydrocarbons into the soil until they reach an impervious horizon, such as bedrock, watertight clay, or an aquifer. However, according to (Onwurah, Ochonogor, Ogugua, & Olawale, 2007), it is noted that lack of miscibility of crude oil causes accumulation of free oil on the surface of water, which spreads laterally over a great distance and contaminate other zones quite far from the point of discharge. While certain oils weather quickly and significantly alter over time in their physio-chemical properties, others hold true over extended periods of time.

Crude oil is very toxic to fish and could affect the survival and metabolism of aquatic animals including fish (Gbadebo, Taiwo, & Ola, 2009). Oil mixes with water as it spreads and becomes sticky, clinging to defenceless marine life that can't flee its lethal pursuit (Rout & Sharma, 2013). *Lymphocytic hyperplasia, haemorrhagic septicaemia*, and *epidermal hyperplasia* are among the fish diseases with short-term toxicity.

Shallow waters can have a significant impact on the toxicity of oil spills in lakes. When oil spills occur in shallow water, they can spread quickly and cover a large area, creating a more concentrated layer of oil on the surface of the water (Prince, 2015). This can result in increased toxicity levels, as the oil can more easily come into contact with aquatic organisms and their habitats.

Furthermore, shallow water ecosystems tend to be more sensitive to pollution than deeper waters, as the water temperature and oxygen levels can fluctuate more rapidly in shallow water environments (Incardona, et al., 2014). As a result, even a relatively small amount of oil can have a significant impact on the health and well-being of aquatic life in shallow water ecosystems.



Figure 2: Impacts of oil spills on fish

In addition to the inherent toxicity of oil spilt in the ocean, increased toxicity has been linked to ultraviolet (U.V.) radiation in a condition called photo enhanced toxicity (Barron, Vivian, Yee, & Diamond, 2008). Fish and aquatic invertebrates' photo-enhanced toxicity appears to be caused by the activation of chemical residues like PAHs (Overton, Miles, & Hsieh, 2016).

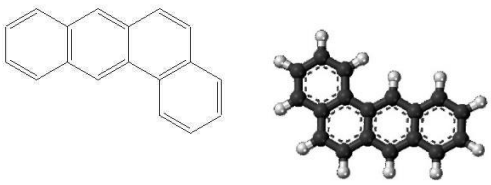


Figure 3: Benzo[a] anthracene molecule and ball-and-stick model

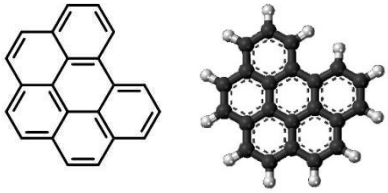


Figure 4: Benzo[ghi] pyrene molecule and ball-and-stick model

PAHs can bioaccumulate in food chains where they interfere with the biochemical or physiological processes of several organisms, leading to the carcinogenesis of various organs, mutation of the genetic code, reduction in reproductive ability, and/or causing haemorrhage in exposed population (Onwurah, Ochonogor, Ogugua, & Olawale, 2007).

A study by (Pelletier, Burgess, Ho, & Kuhn, 1997), proved that un-weathered Prudhoe Bay crude oil seemed to be 100 times more hazardous to embryos following exposure to ultraviolet light. Due to the presence of three-ringed PAH families, crude oil impairs aquatic species' ability to develop their immunity, reproduce, grow, and survive (Brown, Norcross, & Short, 2011).

According to a study by (Laurel, et al., 2019), normal jaw patterning of feed fish for fish was altered by transitory oil exposures of 300 μg/litre or more in the

middle of organogenesis which resulted in lower juvenile growth and marine survival. This study has been summarized as below;

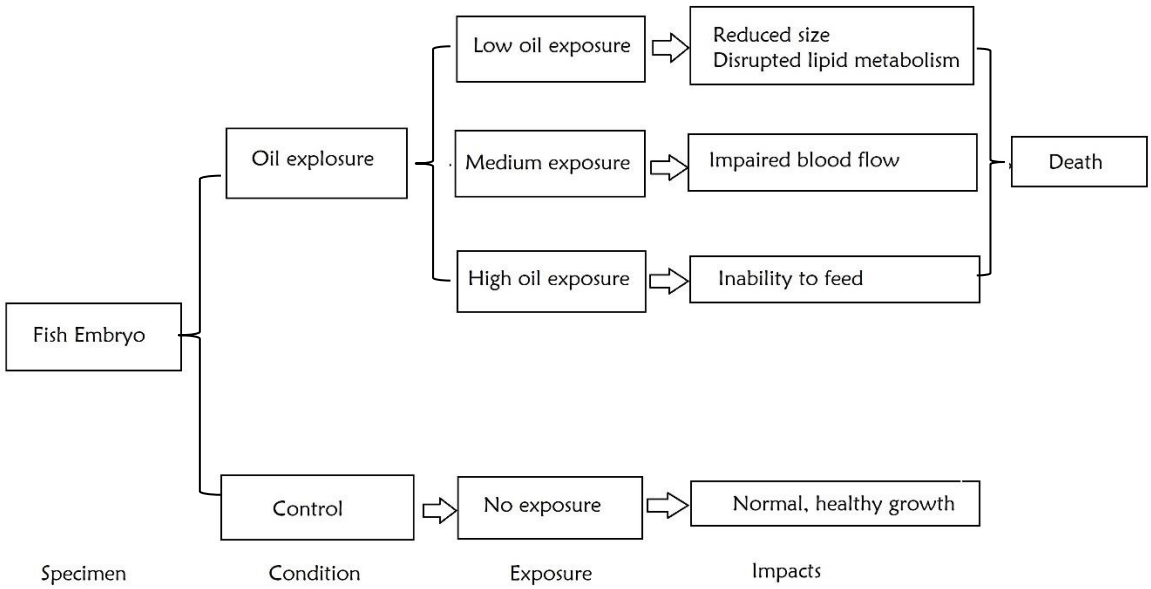


Figure 5: Mortality of fish embryo following levels of oil exposure

2.3. Socio-economic Impacts of Petroleum Exploration

In addition to the direct effects on fish, oil and gas exploration can also impact the humans that depend on it for food and money. Oil and gas exploration and production may have positive as well as negative impacts on changes in fishing communities' economies, societies, environments, and cultures (Edjekumhene, Owusu-Agyemang, & Edze, 2010). The opportunities however need to be balanced with oil-related socio-economic concerns emerging in the local discourse.

Through the indiscriminate disposal of oil-contaminated drilling muds, cuttings, and oil spills, petroleum hydrocarbon and petroleum residue (spent oil) continue to be the principal contaminants to the fish communities in various aquatic settings (Gbadebo, Taiwo, & Ola, 2009). According to research, people who live close to waterbodies consume fish more frequently than those who don't since it's more readily available and costs less than meat (Kaimila, et al., 2019). Therefore, decrease in catch rates of fish brought on by oil and gas exploration tends to result in unrest and poverty brought on by the collapse of the fishing business in many countries (Amoasah, 2010).

2.4. Contribution of the Fishing Industry to the Country

Reports show that fishing contributes much to the economy and health for people in Malawi. Furthermore, the fishing industry employs over half a million people as shown in the table below;

Direct Jobs	63,023
Post-harvest Jobs	Over 500,000
Value Chain	US$454 Million
Overall Protein Supply	40%
Diet Animal Protein	70%

Table 1 Contribution of the fishing Industry to the economy of Malawi



Figure 6: Small-scale fishing in Malawi

CHAPTER 3: METHODOLOGY

3.4. Research Design

Despite the study's focus on the relationship between the prospective offshore petroleum activities on lake Malawi and Mangochi fish industry, literature review information on the effects of crude on marine ecosystems and fish stocks is international. Using key phrases on authorised web services, international secondary data has been gathered by broadening the search using results from relevant research. Additionally, secondary quantitative data was obtained in government offices and has been processed and analysed using statistical, spatial analysis and risk assessment methods to produce results.

3.5. Materials

Local secondary data was gathered from various government offices and scientific studies. The key sources of national data used to conduct the study are given below;

- Geological Survey Department
- Fisheries Department Research Centre (Mangochi)
- Mines and Minerals Department
- National Statistics Office

3.5.0. Geological Survey Data

Geological survey data includes shapefiles used in this study and location of all six Petroleum exploration blocks in Malawi.

3.5.1. Fisheries Department and NSO Data

GIS data of fishing vessel tracks was provided by Fisheries department which were used to provide a clear view of fishing waypoints in months of July to December 2022 for fishermen in Mangochi. Originally, this data was generated by the department who mounted GPS receivers on small-scale fishing vessels to monitor who are fishing in no fishing zones. However, in this study, this data has been

used because it gives clues that identify major areas on lake Malawi where fishers in Mangochi these fisherfolk prefer to fish.

Demographic data includes the number of fishermen and fishing villages in Mangochi (South-eastern arm of Lake Malawi, upper shire and Lake Malombe). This data is used for comparison between the three waterbodies in order to identify where most fishing activities in Mangochi are concentrated.

3.5.2. Mines Department Data

In collaboration with GSD, the data provided by the mines department are maps of petroleum exploration blocks in Malawi and the mining cadastre that was useful when creating my own maps of petroleum exploration blocks. These maps were used to determine how much surface area in the Mangochi waterbodies is expected to be covered by petroleum exploration.

3.5.3. National Statistics Office Data

The data collected at national statistics office includes economic reports of the fishing industry's contribution to the local economy. This data helps to determine how much the fishing in Mangochi alone promotes socio-economic development and the country's GDP.

3.5.4. Software used

QGIS and ARCGIS applications were used to make spatial analysis of the data from fisheries and Geological survey and mines departments. Maps were created and the waypoints were incorporated to display the major fishing ground in Mangochi.

3.6. Methods

3.6.0. Geoprocessing Methods

Methods used in this stage of the research include geoprocessing techniques such as intersection and clipping to identify areas where the petroleum exploration blocks overlaps with Mangochi district. Again, the same techniques have been used to view only the area where petroleum blocks in Mangochi intersects with Lake

Malawi. This results in displaying only the south-eastern arm of Lake Malawi. The resulting image is combined with the GIS data of fishing waypoints in order to produce a map showing a polygon representing the area left for the fishing industry and Petroleum exploration to share.

3.6.1. Geometric probability

A polygon representing an area of a fishing grounds (shaded circle, A_F) in a waterbody A_W within the exploration block has been created. This has been expressed in a model below;

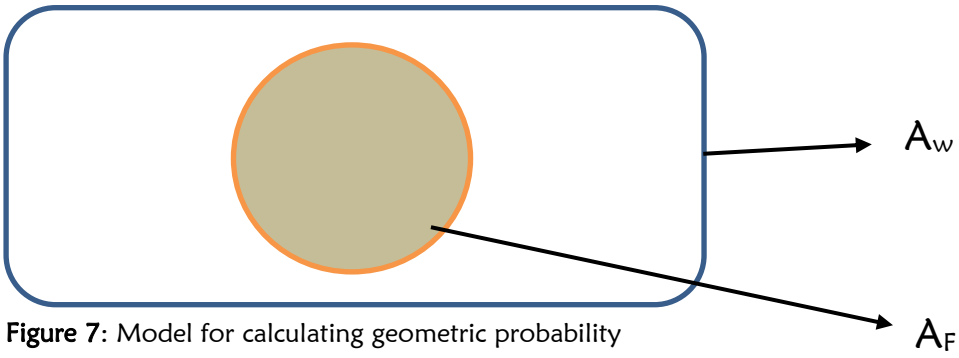


Figure 7: Model for calculating geometric probability

Using both the area of circle representing fishing grounds and the total area of water covered by a petroleum exploration block, likelihood of an upstream activity to occur within a fishing ground within an exploration area has been calculated as a proportion of two-dimension area using the formula;

$$P \text{ (Shaded area)} = \frac{\sum_{i=1}^{n} A_F}{A_W} \qquad \text{..... equation 1}$$

where P = Probability that petroleum exploration activity is equally likely to occur within the shaded regions (A_F)

A_F = Area of fishing ground (Shaded area)

n = number of polygons (fishing grounds)

A_W = Total area of water within a petroleum exploration block

3.7. Study Area

The study was conducted in Mangochi district which is located in southern region of Malawi. According to population and housing census, Mangochi district contributes 6.5 percent of the population of Malawi (1,148,611 persons). Lake Malawi, located in the eastern part of the district, is the third-largest freshwater lake in Africa and is home to over 1,000 species of fish, many of which are unique to the lake.

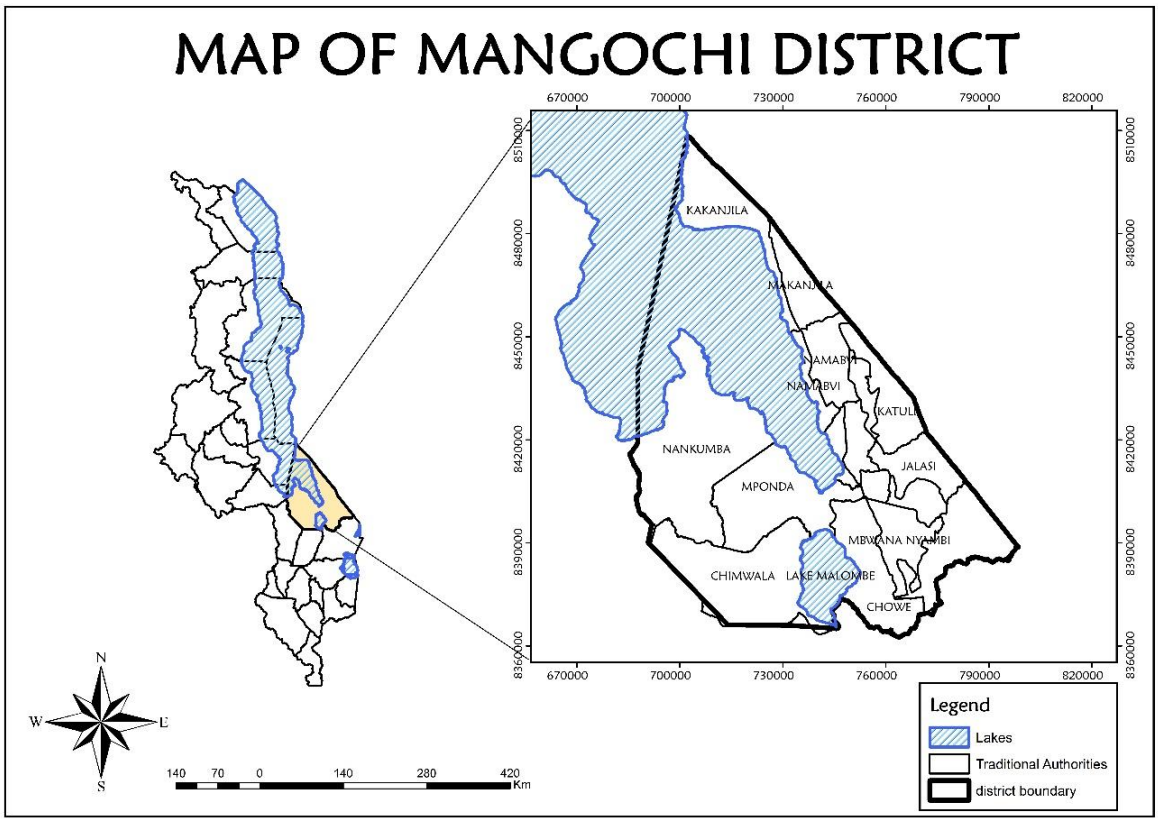


Figure 8: Map of Mangochi district

3.7.0. The Fishing Industry in Mangochi

Mangochi's fishing industry is one of the main sources of livelihood for the local population. Since the lake is shallow, a lot of cichlids are collected there because of it's fantastic breeding environment (Phiri, Kakota, & Hara, 2013). Utaka (*Haplochromic spp.*), Chambo, Usipa (*Engraulicypris sardella*) and Mlamba (*Clarias spp.*) are the most common species captured in this area (Government of Malawi, 2007). According to fisheries department, there are 2,170 gear owners and 19,127 fishing crew in Mangochi living in 181 beaches along the shores.



Figure 9: Common fish species in Mangochi

3.7.1. Mangochi's Potential for Petroleum Exploration

Mangochi covers the south-eastern arm of Lake Malawi which is located in the East African Rift System. This rift basin has thick sedimentary sequences, which contain organic-rich source rocks that have the potential to generate oil and gas. To confirm the presence and extent of hydrocarbon deposits in the lake, further exploration and drilling would be required. Thus, six petroleum exploration blocks were demarcated in Malawi where block 4 covers Mangochi district's portion of Lake Malawi.

Initially, RAK Gas company was awarded a licence to explore for hydrocarbons in block 4 which contains the Lake Malawi south-eastern arm (Whaley, 2017). Prior to the relinquishment of their license, RAK GAS petroleum exploration company finished conducting prospecting surveying in Mangochi in order to identify promising geological formations for petroleum accumulation such as faults and anticlines. Finally, additional exploration activities such as seismic survey and exploratory drilling are yet to follow to confirm the presence of hydrocarbons on the lake.

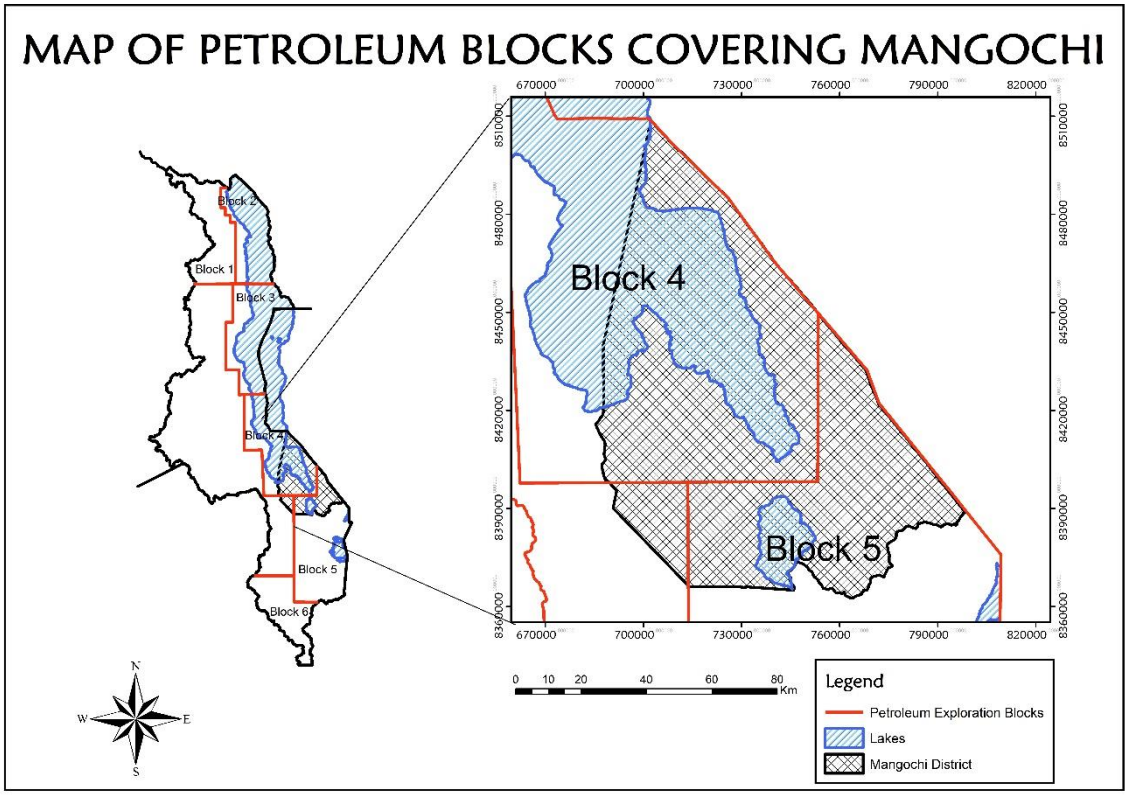


Figure 10: Petroleum exploration blocks in Mangochi

CHAPTER 4: RESULTS

The names and number of all villages, beaches, village heads and traditional authorities that fish in the three waterbodies in Mangochi has been attached in the **appendix**. The table below shows a summary of this data.

Waterbody	Total Beaches	Total Fishing Villages	Total Village heads	Traditional authorities
Lake Malombe	28	28	19	3
Upper shire river	15	15	11	2
Lake Malawi	138	138	106	6

Table 2 Fishing villages and TAs in Mangochi

The aim is to confirm if Lake Malawi supports the most of the fishing in Mangochi district of the three waterbodies. This will also help to have an overview of how many villages and beaches would directly suffer the impacts of oil and gas exploration on Lake Malawi in case of accidents during exploration. Analysis of the above data has concluded that Lake Malawi supports approximately 76% of the fishing villages in Mangochi district as Shown in the graph below.

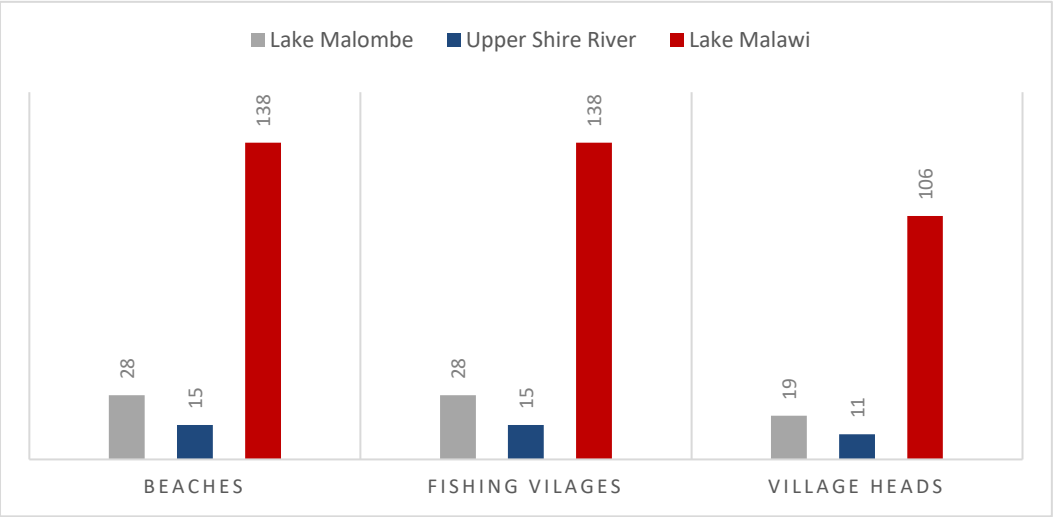


Table 3 Number of fishing villages in three waterbodies in Mangochi

Adding the waypoint data of 15 fishing vessels in Mangochi's portion of Lake Malawi, has displayed a pattern and grounds where most registered small-scale fishers go to fish.

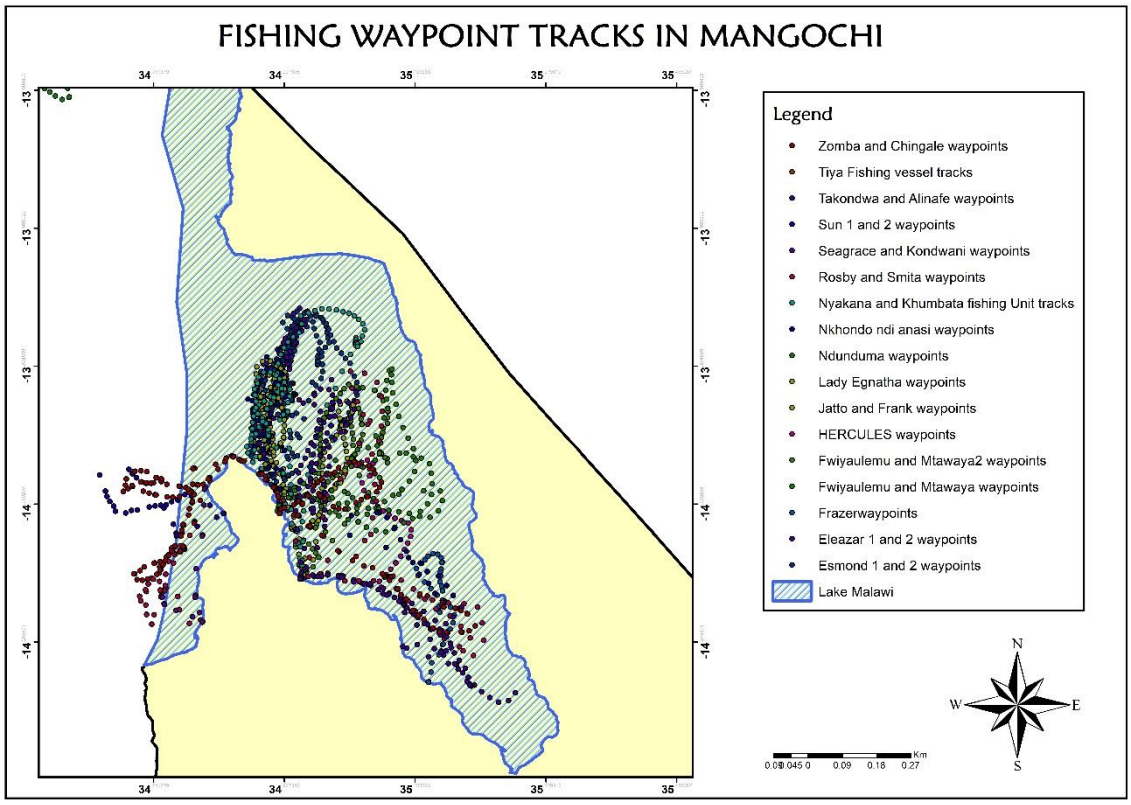


Figure 11: Fishing unit tracks

Using geoprocessing methods, a polygon representing a fishing ground where most fishers sail to catch fish has been created.

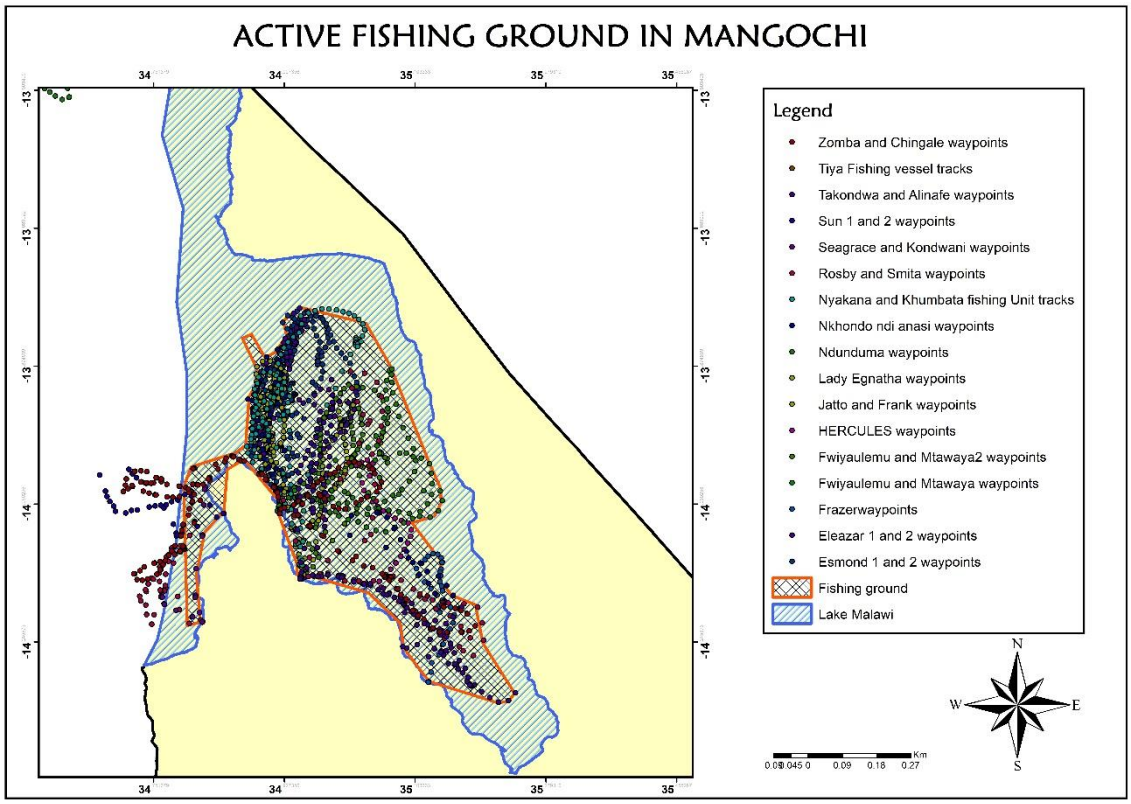


Figure 12: Major Fishing ground in Mangochi

Equation 1 has been used to calculate the probability that petroleum exploratory drilling and other exploratory activities would directly occur within the polygon representing a fishing ground in Mangochi and hinder normal fishing activities. The calculation reveals that for the total area of 2000 Km covered by Lake Malawi in Mangochi, approximately 1080 Km is where more fishing activities are done as represented in the chart below;

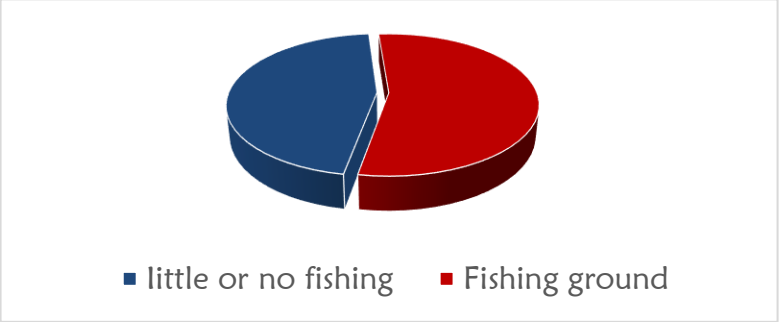


Figure 13: Geometric probability of Exploration occuring in a fishing zone

This means that there is approximately 0.54 probability that offshore petroleum exploration will occur within this zone that actively supports fishing in Mangochi.

To understand the potential social-economic impacts of petroleum exploration on the people of Mangochi, economic activity status of people in Mangochi has been analysed and displayed as below;

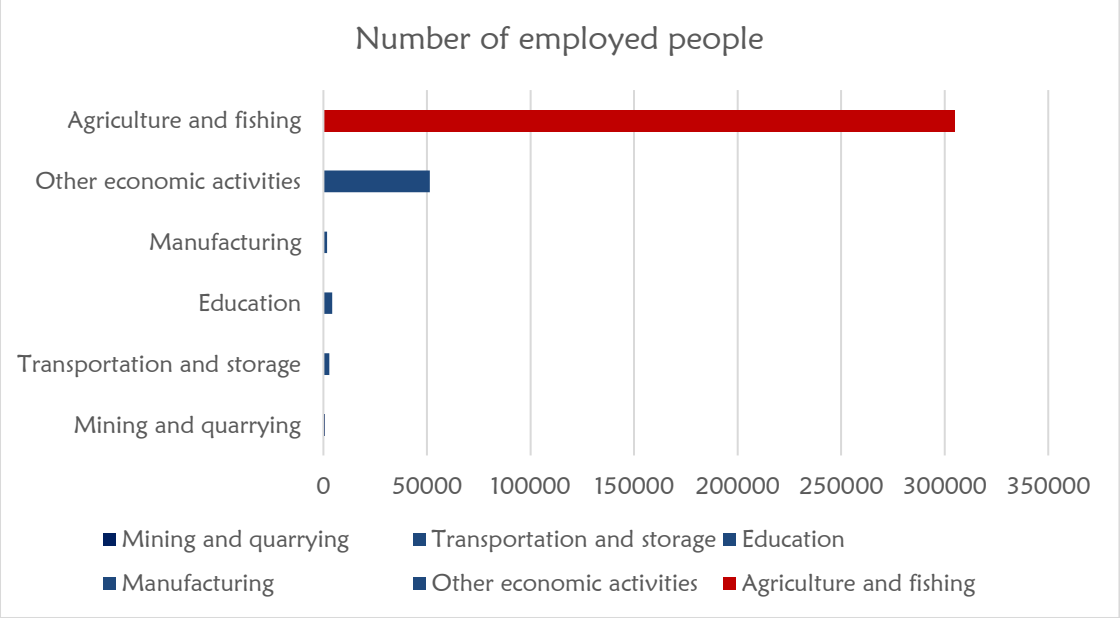


Table 4 Economic activity status for Mangochi

This data reveals that fishing plays a very important role in supporting the population in Mangochi because the majority of the economically active population in Mangochi are employed in agriculture forestry and fishing sector (83.4 percent). Out of 365,914 working people in Mangochi, 305,135 are employed in the agriculture forestry and fishing industry (National Statistical Office, 2018).

Literacy rate of people in Mangochi has been displayed in the graph below;

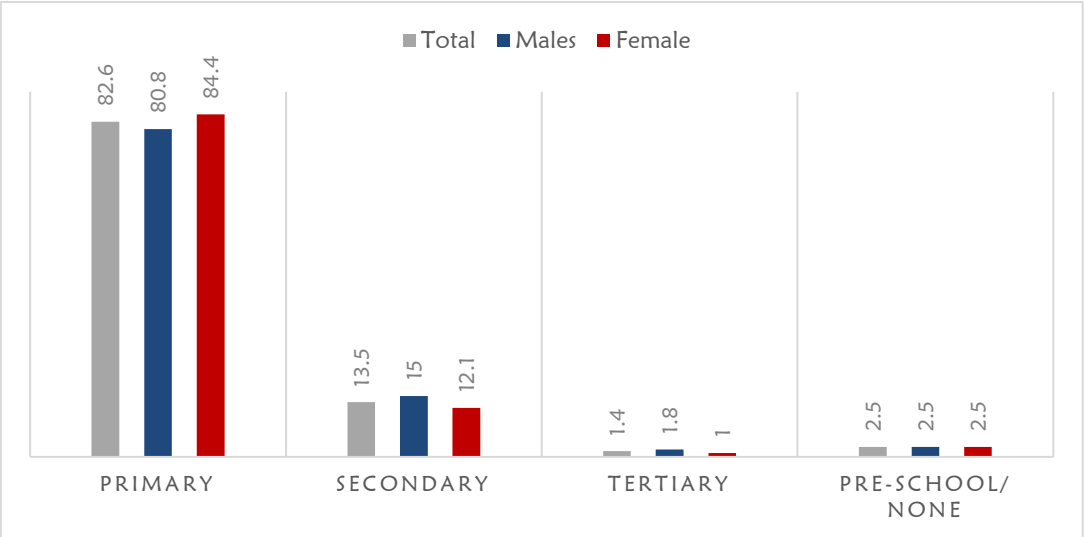


Table 5 Literacy Rate for Mangochi

The majority of the population in Mangochi has primary school as their highest level of education. This justifies why many people in Mangochi rely on the available waters to fish for their survival because they hardly get employed in other industries.

CHAPTER 5: DISCUSSION AND CONCLUSION

The analysis of the results supports that most fishing in Mangochi is done on Lake Malawi compared to the other waterbodies in the district and implies that in Mangochi, Lake Malawi has a large size of a fishing ground with potential to be affected by petroleum upstream activities. There is a 54 percent chance that petroleum drilling in Mangochi would occur within this important fishing area, costing the local fisherman their fishing grounds.

Also, it has been determined that the shallow waters of Lake Malawi could pose a significant threat to fish in the UV zone of the water column such as Chambo, Mlamba, utaka and usipa due to enhanced toxicity in the event of an oil spill because oil can spread quickly and cover a large area. It has also been concluded that the ecosystem in Mangochi is more sensitive to pollution than deeper waters, as the water temperature and oxygen levels can fluctuate more rapidly in such shallow water environments. As a result, even a relatively small amount of oil, drilling mud and cuttings can have a significant impact on the health and well-being of the cichlids that live and feed in these shallow water ecosystems.

Due to the extremely low literacy rates and the fact that fishing is the main source of income in Mangochi, the negative impacts of prospective petroleum exploration would render roughly over 50% of the district's employed population jobless. Data on economic activity status has proved that fishing makes up the largest portion of the Mangochi economy than any other economic activity, and that any disruption to this sector would seriously harm the district's economy.

The economy of the nation benefits significantly from fishing. Fishing supports over 63,000 employment directly, and over 500,000 jobs indirectly through post-harvest work in the boat and engine repair, marketing, and fish processing industries. Fish also contributes greatly to the heath and economy in the country. In light of this, the fishing sector in Malawi deserves to be protected from impacts of petroleum exploration.

Due to this, it is advised that petroleum development be concentrated in Lake Malawi's northern, deeper regions, unless the government enacts very severe legal restrictions and increases oversight of each exploration phase to prevent accidents that could lead to oil spills and other accidents at an exploration site. To lessen the impact that petroleum exploration would have on the fishing sector, it is also necessary to find measures to make it possible to conduct petroleum exploration in lake Malawi's less-fished areas.

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Appendix

Waterbody	Minor Stratum	Beach Name	Village	Group Village Head	Traditional Authority
Lake Malombe	Chimwala	Kausi	Kausi	Mtambo	Chimwala
Lake Malombe	Chimwala	Mtambo	Mtambo	Mtambo	Chimwala
Lake Malombe	Chimwala	Kapyekapye	Kapyekapye	Ukalanga	Chimwala
Lake Malombe	Chimwala	Likala	Likala	Chimwala	Chimwala
Lake Malombe	Chimwala	Chiwaula	Chiwaula	Chiwaula	Chimwala
Lake Malombe	Chimwala	Changamire	Changamire	Changamire	Chimwala
Lake Malombe	Chimwala	Lundu	Lundu	Chimwala	Chimwala
Lake Malombe	Chimwala	Mtenje	Mtenje	Chimwala	Chimwala
Lake Malombe	Chimwala	Mwalija	Mwalija	Chimwala	Chimwala
Lake Malombe	Chimwala	Nansenga	Mpinganjira	Changamire	Chimwala
Lake Malombe	Chimwala	Tesgula	Issa	Ukalanga	Chimwala
Lake Malombe	Chapola	Chapola	Chapola	Chapola	Chapola
Lake Malombe	Chapola	Chisumbi	Chisumbi	Changali	Chapola
Lake Malombe	Chapola	Kambulire	Kambulire	Mtambo	Chapola
Lake Malombe	Chapola	Katapwito	Katapwito	Mtambo	Chapola
Lake Malombe	Chapola	Mtanga	Mtanga	Mtambo	Chapola
Lake Malombe	Chapola	Mvela	Chisawa	Chisawa	Chapola
Lake Malombe	Chapola	Silika	Silika	Chisawa	Chapola
Lake Malombe	Kadewere	Chingwamba	Kamba	Nalikolo	Chowe
Lake Malombe	Kadewere	Kadewere	Kadewere	Kadewere	Chowe
Lake Malombe	Kadewere	Kandulu	Kadewere	Kadewere	Chowe
Lake Malombe	Kadewere	Kwisimba	Kwisimba	Kadewere	Chowe
Lake Malombe	Kadewere	Likulungwa	Likulungwa	Likulungwa	Chowe
Lake Malombe	Kadewere	Matache	Amasoni	Nalikolo	Chowe
Lake Malombe	Kadewere	Mzikizi	Kadewere	Kadewere	Chowe
Lake Malombe	Kadewere	Ngomano	Damkeni	Nalikolo	Chowe
Lake Malombe	Kadewere	Sili	Sili	Sili	Chowe
Lake Malombe	Kadewere	Chiwaula			
Upper Shire River	Upper Shire River	Chipalamawamba	Chipalamawamba	Chipalamawamba	Mponda
Upper Shire River	Upper Shire River	Dimu	Dimu	Dimu	Mponda
Upper Shire River	Upper Shire River	Kazembe	Kazembe	Dimu	Mponda
Upper Shire River	Upper Shire River	Kwitambo	Kwitambo	Kwitambo	Mponda
Upper Shire River	Upper Shire River	Madina	M'Baluku	M'Baluku	Mponda
Upper Shire River	Upper Shire River	Namakazi	Namakazi	Mpinganjira	Mponda
Upper Shire River	Upper Shire River	Mpima	Mtafu	Mpinganjira	Mponda
Upper Shire River	Upper Shire River	Msikiti 2	Chipeta	Chipeta	Mponda
Upper Shire River	Upper Shire River	Bwanali	Bwanali	Chipalamawamba	Mponda
Upper Shire River	Upper Shire River	Mtafu	Mtafu	Mpinganjira	Mponda
Upper Shire River	Upper Shire River	Chanza	Ngoyi	Chipeta	Mponda
Upper Shire River	Upper Shire River	Mtenje	Mwichande	Mwichande	Mponda
Upper Shire River	Upper Shire River	Msilanga	Mwichande	Mwichande	Mponda
Upper Shire River	Upper Shire River	Lusewa	Ngoyi	Chipeta	Mponda

Upper Shire River	Upper Shire River	Mawinga	Chipeta	Chipeta	Mponda
Upper Shire River	Upper Shire River	Mvuwika	Mosiya	Mtagaluka	Chowe
Lake Malawi	Makawa	Bakili	Bakili	Chindongo	Mponda
Lake Malawi	Makawa	Bolera	Bolera	Bolera	Mponda
Lake Malawi	Makawa	Chidongo	Chindongo	Chindongo	Mponda
Lake Malawi	Makawa	Chikundo	Chikundo	Mkungumbe	Mponda
Lake Malawi	Makawa	Chilembwe	Chilembwe	Mwalembe	Nankumba
Lake Malawi	Makawa	Chimatiro	Chimatiro	Chimatiro	Mponda
Lake Malawi	Makawa	Chipala	Chipala	Michesi	Mponda
Lake Malawi	Makawa	Chipoka 1	Chipoka 1	Chipoka	Mponda
Lake Malawi	Makawa	Chipoka 2	Chipoka 2	Chimatiro	Mponda
Lake Malawi	Makawa	Katumbiri	Katumbiri	Matewere	Mponda
Lake Malawi	Makawa	Kela	Kela	Matuwi	Mponda
Lake Malawi	Makawa	Makawa	Makawa	Michesi	Mponda
Lake Malawi	Makawa	Makokola	Makokola	Matuwi	Mponda
Lake Malawi	Makawa	Mang'Umbi	Mang'Umbi	Mwalembe	Mponda
Lake Malawi	Makawa	Masanga	Masanga	Chimatiro	Mponda
Lake Malawi	Makawa	Masanje	Masanje	Chindongo	Mponda
Lake Malawi	Makawa	Matuwi	Matuwi	Matuwi	Mponda
Lake Malawi	Makawa	Maudzu	Maudzu	Maudzu	Mponda
Lake Malawi	Makawa	Mauwa	Mauwa	Bolera	Mponda
Lake Malawi	Makawa	Mdalachikowa	Mdalachikowa	Lizimba	Mponda
Lake Malawi	Makawa	Michesi	Michesi	Michesi	Mponda
Lake Malawi	Makawa	Mpale	Mpale	Maudzu	Mponda
Lake Malawi	Makawa	Mpemba	Mpemba	Michesi	Mponda
Lake Malawi	Makawa	Mpeta	Mpeta	Chindongo	Mponda
Lake Malawi	Makawa	Mtimbuka	Mtimbuka	Chipoka	Mponda
Lake Malawi	Makawa	Nasenga	Nasenga	Mkungumbe	Mponda
Lake Malawi	Makawa	Nkali	Nkali	Chimatiro	Mponda
Lake Malawi	Makawa	Samama	Samama	Matewere	Mponda
Lake Malawi	Makawa	Mkungumbe	Mkungumbe	Mkungumbe	Mponda
Lake Malawi	Makawa	Wela	Chisigere	Michesi	Mponda
Lake Malawi	Malindi	Bela	Chipeleka	Chipeleka	Chowe
Lake Malawi	Malindi	Boli	Chindamba	Chindamba	Chowe
Lake Malawi	Malindi	Chikolomo	Chikolomo	Makumba	Chowe
Lake Malawi	Malindi	Chipole			Chowe
Lake Malawi	Malindi	Gabriel	Steven	Makumba	Chowe
Lake Malawi	Malindi	Injiniya	Dimu Bala	Chipeleka	Chowe
Lake Malawi	Malindi	Katambwali	Chipeleka	Chipeleka	Chowe
Lake Malawi	Malindi	Machemba	Machemba	Machemba	Chowe
Lake Malawi	Malindi	Makwinja	Makwinja	Makumba	Chowe
Lake Malawi	Malindi	Maliro	Maliro	Maliro	Chowe
Lake Malawi	Malindi	Mandanda	Malunda	Mtaka	Chowe
Lake Malawi	Malindi	Matwani	Matwani	Maliro	Chowe

Lake Malawi	Malindi	Mchema	Chipeleka	Chipeleka	Chowe
Lake Malawi	Malindi	Motomondo	Steven	Makumba	Chowe
Lake Malawi	Malindi	Msosa	Moyo	Maliro	Chowe
Lake Malawi	Malindi	Mwala	Moto	Moto	Chowe
Lake Malawi	Malindi	Namnumbwa	Namnumbwa	Makumba	Chowe
Lake Malawi	Malindi	Soni	Makumba	Makumba	Chowe
Lake Malawi	Madzedze	Balamanja	Balamanja	Balamanja	Nankumba
Lake Malawi	Madzedze	Chirombo	Chirombo	Chirombo	Nankumba
Lake Malawi	Madzedze	Chizale	Kamkuta	Nsumbi	Nankumba
Lake Malawi	Madzedze	Chizula	Chizula	Namakoma	Nankumba
Lake Malawi	Madzedze	Guma	Guma	Lizimba	Nankumba
Lake Malawi	Madzedze	Kalenjeka	Nthunya	Chiwalo	Nankumba
Lake Malawi	Madzedze	Kamwetsa	Kamwetsa	Mwalembe	Nankumba
Lake Malawi	Madzedze	Liganga	Liganga	Chiwalo	Nankumba
Lake Malawi	Madzedze	Lizimba	Lizimba	Lizimba	Nankumba
Lake Malawi	Madzedze	Madzedze	Madzedze	Balamanja	Nankumba
Lake Malawi	Madzedze	Masasa	Nsumbi	Nsumbi	Nankumba
Lake Malawi	Madzedze	Matayo	Matayo	Chiwalo	Nankumba
Lake Malawi	Madzedze	Mesi	Mesi	Chiwalo	Nankumba
Lake Malawi	Madzedze	Mkungeni	Mkungwi	Chiwalo	Nankumba
Lake Malawi	Madzedze	Monkey Bay	Nsumbi	Nsumbi	Nankumba
Lake Malawi	Madzedze	Mvunguti	Kamkuta	Nsumbi	Nankumba
Lake Malawi	Madzedze	Nakhalu	Nakhalu	Chiwalo	Nankumba
Lake Malawi	Madzedze	Namakoma	Namakoma	Namakoma	Nankumba
Lake Malawi	Madzedze	Namaso	Namaso	Namakoma	Nankumba
Lake Malawi	Madzedze	Namgoma	Namgoma	Chirombo	Nankumba
Lake Malawi	Madzedze	Nkhudzi	Mwanyama	Mwanyama	Nankumba
Lake Malawi	Madzedze	Nkope	Chiwalo	Chiwalo	Nankumba
Lake Malawi	Madzedze	Nona	Nona	Mwalembe	Nankumba
Lake Malawi	Madzedze	Sombe	Sombe	Lizimba	Nankumba
Lake Malawi	Madzedze	Sungo	Zumani	Chiwalo	Nankumba
Lake Malawi	Madzedze	Zambo	Kamkuta	Nsumbi	Nankumba
Lake Malawi	Kadango	Chapola	Chapola	Chapola	Namavi
Lake Malawi	Kadango	Chikulo	Chikulo	Chiponda	Namavi
Lake Malawi	Kadango	Chiponda	Chiponda	Chiponda	Namavi
Lake Malawi	Kadango	Fowo	Fowo	Fowo	Namavi
Lake Malawi	Kadango	Kadango	Kadango	Kadango	Namavi
Lake Malawi	Kadango	Machakwani	Machakwani	Kadango	Namavi
Lake Malawi	Kadango	Mpundi	Mpundi	Chapola	Namavi
Lake Malawi	Kadango	Namalaka	Namalaka	Namalaka	Namavi
Lake Malawi	Kadango	Ng'Ombe 1	Ng'Ombe 1	Ng'Ombe	Namavi
Lake Malawi	Kadango	Ng'Ombe 2	Ng'Ombe 2	Ng'Ombe	Namavi
Lake Malawi	Kadango	Nkula	Chipojola	Chiponda	Namavi
Lake Malawi	Kadango	Nyangu	Nyangu	Kadango	Namavi

Lake Malawi	Makanjira	Chilawe	Chilawe	Chilawe	Makanjira
Lake Malawi	Makanjira	Chilinda	Chilinda	Ntwana	Makanjira
Lake Malawi	Makanjira	Chioko	Chioko	Mtiule	Makanjira
Lake Malawi	Makanjira	Lukoloma	Lukoloma	Lukoloma	Makanjira
Lake Malawi	Makanjira	Malufu	Malufu	Malufu	Makanjira
Lake Malawi	Makanjira	Mchangani	Mpangama	Mpangama	Makanjira
Lake Malawi	Makanjira	Mkwawira	Mkwawira	Mtiule	Makanjira
Lake Malawi	Makanjira	Mtiule	Mtiule	Mtiule	Makanjira
Lake Malawi	Makanjira	Mtwana	Mtwana	Mtwana	Makanjira
Lake Malawi	Makanjira	Njerenje	Njerenje	Njerenje	Makanjira
Lake Malawi	Makanjira	Selemani	Selemani	Binali	Makanjira
Lake Malawi	Bakili	Bakili	Bakili	Bakili	Makanjira
Lake Malawi	Bakili	Binali	Binali	Binali	Makanjira
Lake Malawi	Bakili	Chiwana	Bakili	Bakili	Makanjira
Lake Malawi	Bakili	Hassan	Bakili	Bakili	Makanjira
Lake Malawi	Bakili	Liponzo	Liponzo	Saiti Mwasungu	Makanjira
Lake Malawi	Bakili	Liweta	Kawanga	Lukoloma	Makanjira
Lake Malawi	Bakili	Luunda	Luunda	Mapata	Makanjira
Lake Malawi	Bakili	Mbuladye	Mbuladye	Binali	Makanjira
Lake Malawi	Bakili	Mdala	Mdala	Makacha	Makanjira
Lake Malawi	Bakili	Msiwira	Msiwira	Binali	Makanjira
Lake Malawi	Bakili	Msomanga	Msomanga	Chilawe	Makanjira
Lake Malawi	Bakili	Natyosi	Kawanga	Lukoloma	Makanjira
Lake Malawi	Bakili	Atumbuka	Mdala	Makacha	Makanjira
Lake Malawi	Bakili	Nkomanji	Mkomanji	Binali	Makanjira
Lake Malawi	Fort Maguire	Chilemba	Kamtande	Kamtande	Lulanga
Lake Malawi	Fort Maguire	Chitedze	Maluma	Maluma	Lulanga
Lake Malawi	Fort Maguire	Itunde	Kalembo	Kalembo	Lulanga
Lake Malawi	Fort Maguire	Malopa	Mng'Omba	Mng'Omba	Lulanga
Lake Malawi	Fort Maguire	Mambo	Mambo	Mambo	Lulanga
Lake Malawi	Fort Maguire	Mitande	Mnomba	Mnomba	Lulanga
Lake Malawi	Fort Maguire	Mitemeni	Matola	Matola	Lulanga
Lake Malawi	Fort Maguire	Mtekete	Mng'Omba	Mng'Omba	Lulanga
Lake Malawi	Fort Maguire	Nalungu	Saidi	Matola	Lulanga
Lake Malawi	Fort Maguire	Namitumbu	Mkoka	Matola	Lulanga
Lake Malawi	Fort Maguire	Nanjete	Nanjete	Nanjete	Lulanga
Lake Malawi	Fort Maguire	Ntondo	Nyundo	Kalembo	Lulanga
Lake Malawi	Msaka	Chembe	Kafukuta	Chembe	Nankumba
Lake Malawi	Msaka	Kamphande	Kamphande	Kamphande	Nankumba
Lake Malawi	Msaka	Kasankha	Kasankha	Kasankha	Nankumba
Lake Malawi	Msaka	Madothi	Nkhono	Nkhono	Nankumba
Lake Malawi	Msaka	Mbeya	Mbeya	Mbeya	Nankumba
Lake Malawi	Msaka	Msaka	Chimphamba	Chimphamba	Nankumba
Lake Malawi	Malembo	Chilimba	Chilimba	Matekwe	Nankumba

Lake Malawi	Malembo	Kapichi	Kapichi	Kapichi	Nankumba
Lake Malawi	Malembo	Katole	Katole	Katole	Nankumba
Lake Malawi	Malembo	Kapichi	Kapichi	Kapichi	Nankumba
Lake Malawi	Malembo	Matekwe	Matekwe	Matekwe	Nankumba
Lake Malawi	Malembo	Mbinda	Mbinda	Matekwe	Nankumba
Lake Malawi	Malembo	Mpango	Mpango	Kapichi	Nankumba
Lake Malawi	Malembo	Simoni	Simoni	Khombe	Nankumba