

EFFECTS OF MWERA ON ORNAMENTAL FISHERY AND ORNAMENTAL FISHER'S ADAPTIVE CAPACITY AT SENGA-BAY

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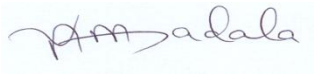
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ABSTRACT

Ornamental Fishery in Lake Malawi looks at cichlid species locally called Mbuna. Several studies in Malawi have evaluated the effects of climate change and Mwera on non-cichlid fish endemic but not Ornamental Fishery in specific. For this reason, the study sought to investigate the effects of Mwera on Ornamental Fishery and Ornamental Fishers' adaptive capacity at Senga Bay. The main objective was to determine the impacts of Mwera on Ornamental Fishery in Lake Malawi at Senga Bay. The specific objectives of the study were to determine the impacts of Mwera wind speed on the Ornamental fish-folk and Ornamental fishing duration at Senga Bay, the number of most exported Ornamental Fish from Stuart M Grant Limited during the Mwera season and non-Mwera season, the effects of Mwera wind speed on the choice of Ornamental fishing techniques and equipment used by Ornamental Fisher-Folk at Senga Bay and document the coping and adaptive strategies of the Ornamental fishing community at Senga Bay. To realise the purpose of the study, a descriptive study design was adopted. The primary data was collected from 44 randomly selected respondents at the headquarters of Stuart M Grant Limited. Secondary data was also obtained from the DCCMS and Stuart M Grant Limited to complement the study. The data generated was edited, coded and entered into Microsoft Excel 2019 and R studio packages for analysis. After that, qualitative analysis such as content analysis and quantitative analysis using frequencies, percentages and means were used to analyse data. The summary was presented by using tables and graphs. The study established that Strong Mwera wind speeds have adverse impacts on Ornamental Fishery like loss of life due to boat submergence, loss of fishing gear in the water, no exports of Ornamental fish and sickness of Ornamental fish workers. The study, therefore, concludes that Mwera affects Ornamental Fishery at Senga Bay. In respect of the finding of the study, it was recommended that there should be the implementation of sustainable alternative ways to improve the resilience of Ornamental Fish Industries. Moreover, the forecasts of Mwera by the government and private sectors should be downscaled to small spatial scales.

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ACRONYMS/ABBREVIATIONS

BBC: British Broadcasting Cooperation

CCAMIR: Commission for the Conservation of Antarctic Marine Living Resources

DCCMS: Department of Climate Change and Meteorological Services in Malawi

MUST: Malawi University of Science and Technology

SCUBA: Self Content Underwater Breathing Apparatus

UNDP: United Nations Development Programme

USAID: United States Agency for International Development

WHO: World Health Organisation

ZBS: Zodiak Broadcasting Cooperation

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CHAPTER 1: GENERAL INTRODUCTION

1.0 Introduction

Ornamental Fisheries need meteorological services for the forecasts of fish stocks (Kapetsky, 2000). Ornamental Fishery in Lake Malawi looks at cichlid species locally called Mbuna (Bootsma and Hecky, 2003). The Ornamental Industry boosts the economy of a country in terms of forex and tax (https://lakemalawi.com.fag.htm). However, the production of Fisheries also depends on weather and climatic conditions (Nkhonjera, 2020). One of the weather elements that affect fisheries in Malawi is Mwera winds (DCCMS, 2019). Allison et al. (2009) assert that Malawi has the most economically variable Fisheries on Earth due to climate change. For instance, several studies in Malawi have evaluated climate change and Mwera on fisheries of non-cichlid fish endemic like Engraulicypris Sardella (Usipa) but not Ornamental Fishery in specific. That is why there are no studies on the impacts of Mwera wind on Ornamental Fishery and Ornamental fishers' adaptive capacity in Malawi. Due to this reason, the study investigated the effects of Mwera on Ornamental Fishery and Ornamental fishers coping and adaptive strategies at Senga Bay. Specifically, it answered the question, "what are the effects of Mwera on Ornamental Fishery in Lake Malawi at Senga Bay?" The answer lay in determining the impacts of Mwera wind speed on the Ornamental fish-folk and Ornamental fishing duration at Senga Bay from 2010 to 2019. In addition, the study determined the number of most exported Ornamental fish from Stuart M Grant Limited between 2010 and 2019 during the Mwera season and non-Mwera. The study aimed at assessing the effects of Mwera wind speed on the choice of Ornamental fishing techniques and equipment used by Ornamental Fisher-Folk at Senga Bay. Not least of all, the study documented the coping and adaptive strategies of the Ornamental fishing community at Senga Bay. The significance of the study is that it contributes to the understanding of the effects of Mwera on Ornamental Fishery. It enhances the value of Mwera forecasts on Ornamental Fishery. Importantly, insights on how to adapt and cope

with the effects of Mwera on Ornamental Fishery from Stuart M Grant Limited are available for the current and future Ornamental Fishing Industries.

1.1 Background of the study

The study aimed to assess the impacts of Mwera on Ornamental Fishery and Ornamental fisher's adaptive capacity at Senga Bay. Ornamental Fishery in Lake Malawi looks at Cichlid species locally called Mbuna (Bootsma and Hecky, 2003). Ideally, Mwera is a seasonal south-easterly trade wind. It occurs immediately and occasionally during the Chiperoni outbreak. It begins to blow in late April or early May, marking the onset of the dry and cool winter season (May to August) in Malawi (Department of Climate Change and Meteorological Services in Malawi, 2019). Furthermore, Lake Malawi is the ninth larger, and third deep, a freshwater lake on Earth (Bootsma and Hecky, 2003).

The Ornamental industry boosts the economy of a country in terms of tax and forex (https://lakemalawi.com.fag.htm). However, the production of fisheries also depends on weather and climatic conditions (Nkhonjera, 2020). The Department of Climate Change and Meteorological Services in Malawi, 2019, specifies that one of the weather elements that affect fisheries in Malawi is Mwera wind. Lake Malawi is affected by Mwera winds due to the flat and obstruction-free nature of its surface. The surface allows winds of considerable height to develop (Limuwa et al., 2018).

Recently, several studies were done in Malawi to evaluate Climate Change and Mwera wind on non-cichlid fish endemic but not on Ornamental fisheries in specific. However, the connection of several studies generally addressed the relationship between Ornamental Fishery and Mwera wind. For instance, Robinson (1995) noted that Ornamental fish in Lake Malawi dominate a spatial domain when there is food and defends their spawning sites. That is justified by the increase of planktons (fish food) at a spatial domain during Mwera

winds (https://lakemalawi.com.fag.htm). As such, Ornamental fish persist in an area in Lake Malawi. Contrary, USAID (2015) specifies that Mwera causes the reallocation of fish. However, USAID (2015) is not specific on which species of fish reallocate in Lake Malawi. An assumption of including Ornamental fish in the reallocation results in the uncertainty of the response of Ornamental fish to Mwera winds.

In addition to that, aquarium keeping is amongst the popular hobbies with millions of enthusiasts worldwide (Chapman, 2000). Cato and Brown (2003) estimated that the aquarium industry is worth over $ 1000 million. Most of the fish kept in aquariums are from freshwaters (Livengood and Chapman, 2007). Most importantly, Lake Malawi is a freshwater lake (Bootsma and Hecky, 2003). British Broadcasting Cooperation (2019), broadcasted that the cichlid is the type of Ornamental fish found in Lake Malawi that is now in high demand on Earth. Very unfortunate, no studies have been conducted in Malawi on how Mwera affects Ornamental Fishery in specific. Understanding that Mwera influences the economy of the fishing industry (Nkhonjera, 2020). Therefore, the study aimed at filling the gap by determining the impacts of Mwera wind on the Ornamental fishery at Senga Bay and evaluating the coping and adaptive capacity of Stuart M Grant Limited to the effects of Mwera.

1.2 Problem statement

The Department of Climate Change and Meteorological Services in Malawi (2019) says that one of the weather elements that affect fisheries in Malawi is Mwera wind. Therefore, many recent studies in Malawi have evaluated how Mwera affects fish species like Oreochromis species and Engraulicypris Sardella but not Mbuna fish in specific. In short, there are no studies on the effects of the Mwera wind speed on Ornamental Fishery in Malawi. It is on this ground, the study aimed at investigating the effects of Mwera wind on Ornamental Fishery and Ornamental fisher's adaptive capacity. However, connecting several studies generally gives a relevant relationship between Mwera and the Ornamental Fishery. For

instance, Robinson (1995) noted that Ornamental fish in Lake Malawi dominate a spatial domain when there is food and defends their spawning sites. The planktons (fish food) increase during Mwera winds (https://lakemalawi.com.fag.htm). The previously mentioned gives a reason for Ornamental fish to persist at a spatial domain. Contrary, USAID (2015) specifies that Mwera causes the reallocation of fish. However, USAID (2015) is not specific on which species of fish reallocate in Lake Malawi. An assumption of including Ornamental fish in the reallocation results in the uncertainty of the response of Ornamental fish to Mwera winds. The gap persisted because of the lack of enough specific studies on the effects of Mwera wind on Ornamental fish in Lake Malawi. As such, the study was worth bridging the gap.

1.3 Main and Specific Objectives

1.3.1 Main Objective

The chief purpose of this study was to determine the effects of Mwera wind speed on the Ornamental Fishery in Lake Malawi at Senga Bay from 2010 to 2019. The study examined how changes in Mwera wind speed impact the Ornamental fisher folk, Ornamental fish catch, Ornamental fishing facilities and choice of fishing techniques.

1.3.2 Specific Objectives

The study addressed the following objectives:

- To determine the impacts of Mwera wind speed on the Ornamental fish-folk and Ornamental fishing duration at Stuart M Grant Limited at Senga Bay.
- To assess the effects of Mwera wind speed on the choice of Ornamental fishing techniques and equipment used by Ornamental Fisher-Folk at Stuart M Grant Limited at Senga Bay.
- To determine the difference in the number of the most exported Ornamental fish during Mwera season and non-Mwera from 2010 to 2019 at Stuart M Grant Limited at Senga Bay.

- To establish the coping and adaptive strategies of the Ornamental fishing community at Stuart M Grant limited at Senga Bay.

1.4 Research questions

The research questions addressed in the study include:

- What are the effects of Mwera wind speed on Ornamental fish-folk and Ornamental fishing duration at Stuart M Grant Limited at Senga Bay?
- How does Mwera wind speed influence the choice of Ornamental fishing techniques and equipment used by Ornamental fisher folk at Stuart M Grant Limited at Senga Bay?
- What influence do Mwera winds have on the catches of most exported Ornamental fish in Lake Malawi at Stuart M Grant Limited from 1990 to 2020?
- What are the coping and adaptive strategies of the Ornamental Fishing community at Stuart Grant Limited?

1.5 Significance of the study

The study contributes to the understanding of the effects of Mwera on the Ornamental Fishery. Moreover, the study has revealed the risks posed to Ornamental Fisher-folk at Stuart M Grant Limited by the impact of Mwera wind speed, which needs to be taken into consideration by other Ornamental Fishing companies. The mechanisms by which Stuart M Grant Limited respond to Mwera also provide valuable insights into how other Ornamental fishing companies in the current generation and the future might adapt and cope with the impacts of Mwera on Ornamental Fishery. That will enhance the social-economic growth and sustainable development of the country.

In addition, the study contributes to the existing empirical body of knowledge by providing the impacts of Mwera on Ornamental Fisheries in Malawi. Last but not least, the study scientifically contributes to the importance of Mwera forecasts on Ornamental Fishery in Malawi.

CHAPTER TWO: LITERATURE REVIEW

This chapter gives a summary of relevant literature used to conceptualise the research theme. The review first gives an overview of Mwera wind, Ornamental Fishery, Lake Malawi, Mwera Forecasts. Later on, it proceeds to present related information to the impacts of Mwera, Mwera Forecasts and Ornamental Fishery with related studies inclusive.

2.1 Mwera Wind

Mwera is a seasonal south-easterly trade wind. It occurs immediately and occasionally during the Chiperoni outbreak (DCCMS, 2019). Chiperoni stands for the influx of cool moist air from the southeast. The name is originated from a mountain in Mozambique called Chiperoni (Mkandawire, 2020). Chiperoni brings overcast conditions with drizzle on windward slopes on the Northern Highlands, lakeshore regions, Shire Highlands-Mulanje, Thyolo, Blantyre and Zomba (Mkandawire, 2020). It is not by surprise that the outbreak of Chiperoni (Mwera) has some similar characteristics. Mwera begins to blow in late April or early May, marking the onset of the dry and cool winter season (May to August) in Malawi (Department of Climate Change and Meteorological Services in Malawi, 2019). On the same note, USAID (2015) specifies that the Mwera wind blows over Lake Malawi during the cool and dry months of May to October. Robinson (1995) determined that in the cooler dry season (March to August), there are strong south-easterly trade winds that generate large waves and strong currents on Lake Malawi. At this time, the temperatures of the water decrease. Added to that, Wood and Morinière (2013) observed that Mwera wind in Malawi is involved with heavy rains. Not least of all, Nkwichi (2021) says Mwera blows

from south of the lake. The districts that experience Mwera wind in Malawi are Mangochi, Nkhotakota and Salima. These districts are allocated along Lake Malawi. Mkandawire (2020) justifies the aforesaid fact that it is Chiperoni that causes Mwera over Lake Malawi. Among studies, it indicates that Senga Bay from Salima District was worth this study. In addition, the studies give an idea that Mwera is observed in winter in Malawi. Apart from that, the recent studies in Malawi agree on the average occurrence of Mwera in May, June and July. This gives a clear picture that Ornamental Fishers should start preparing for Mwera as they approach winter in Malawi.

2.2 Ornamental fishery

Ornamental Fish are fish with beautiful colours that are kept in home aquariums. Ornamental fish are also used for aesthetic purposes. These fish encompass a wide variety of species, of many shapes, sizes, and colours (https://www.rwu.edu). Cato and Brown (2003) estimated that the aquarium industry is worth over $ 1000 million. Recent studies indicate that all countries together of the European Union are the largest market of Ornamental fish. The United States of America is the single largest importer of Ornamental Fish in the world (FAO 1996-2005; Chapman,2000). These show that participating in Ornamental Fishery is a significant livelihood. Groover et al. (2021) state that Ornamental Fish are grouped into Marine Ornamental Fish and Freshwater Ornamental Fish. Most of the fish kept in aquariums are from freshwaters (Livengood and Chapman, 2007). Malawi is one of the African countries that participate in Ornamental Fisheries. Ornamental Fishery is practised in Malawi due to the presence of Lake Malawi. Lake Malawi is a freshwater lake (Bootsma and Hecky, 2003). The oldest, largest and most experienced Lake Malawi cichlid exporter is Stuart M Grant Limited. Stuart M Grant Limited exports Ornamental Fish to Germany, Canada, France, the United Kingdom, the United States of America and China, just to mention a few (www.lakemalawi.com/fag.htm). It is no wonder that Stuart M Grant Limited was worth the study area for the research. The Ornamental Fish boost the economy of the Stuart M Grant in terms of forex. As such, there is also an improvement in the economy of the country due to income tax from Stuart M Grant Limited.

Ornamental Fishery in Lake Malawi looks at Cichlid species locally called Mbuna. British Broadcasting Cooperation (BBC, 2019), broadcasted that the cichlid is the type of Ornamental fish found in Lake Malawi that is now in high demand on Earth. The estimated number of Ornamental fish in Lake Malawi is between 200 (Owen et al., 1990) and 1000 (Ribbink, 1991). Most of the Mbuna occur in the upper 20m of water (Fryer 1959, Ribbink et al. 1983a). The shallow rocky areas appear to be the most densely populated, and here many species of fish coexist at densities of up to 20 individuals per square meter (Ribbink *et al.* 1983a). It is the upper levels of water that are directly affected by winds. The Lake Malawi cichlids are confined to the littoral zone. About 70% of the coastline consists of gently sloping sandy beaches, vegetated areas and swamps, and the remaining 30% comprises steep rocky shores (Ribbink *et al.* 1983a). Robinson (1995), observed that Mbuna depends on epilithic algal beds for food.

The existence of Lake Malawi is the privilege for the country to participate in Ornamental Fishery. However, the effective production of Ornamental Fishery also depends on weather and climate conditions (Nkhonjera, 2020). That is why it was important to determine the effects of Mwera on Ornamental Fishery in Lake Malawi and document the coping and adaptive strategies of Ornamental Fisher's to Mwera winds in Malawi. That will maintain and improve the social-economic growth of the Ornamental Fisher's and the country.

2.3 Lake Malawi

Lake Malawi is the ninth largest, and third deepest, freshwater lake on Earth (Bootsma and Hecky, 2003). Added to this, Lake Malawi is distinguished as a home to a greater diversity of fish species than any other lake. Much of the species are endemic (Ribbink et al. 1983). As a result of its large size and biodiversity- the lake is recognised as part of global heritage (Bootsma, 2006). Lake Malawi is highly used for fish farming by Malawians. Over 80% of

the total fish landings are from small-scale fishers (Bootsma, 2006). The Department of Climate Change and Meteorological Services in Malawi (2019) states that one of the weather elements that affect fish farming on Lake Malawi is Mwera. Lake Malawi is affected by south-easterly winds due to the flat and obstruction-free nature of its surface. That allows winds of considerable height to develop (Department of Climate Change and Meteorological Services in Malawi, 2019).

Furthermore, electricity, transportation and Ornamental fish trade are other benefits of Lake Malawi. However, the effects of Mwera on the Ornamental Fishery in Malawi are not well documented. The study aimed at documenting the effects of Mwera on Ornamental Fishery.

2.4 Fishing methods of ornamental fisheries in Lake Malawi

In the wild, Mbuna is caught by using artisanal fishing methods consisting of small beach nets, dip nets and a variety of small traps. In some cases, diving gears (e.g. SCUBA) are commonly employed with hand nets, fish-holding baskets, and barrier nets serving to fence the fish. Fishing occurs primarily from a small boat anchored in shallow waters less than 10 meters (Cato and Brown, 2003). One of the companies that participate in Ornamental Fishing in Malawi is Stuart M Grant Limited. Stuart M Grant Limited has its workers grouped into three. That is officials, Ornamental Fisher houses and divers. The officials are the ones who are responsible for overseeing the business of Stuart M Grant Limited. On the same note, the Ornamental Fisher Houses are responsible for taking care of Ornamental Fish and the divers go into the lake to catch Mbuna fish (www.lakemalawi.com/fag.htm).

The process of catching Mbuna fish from lake Malawi and exporting it is roughly summarised into three phases. The first one is catching, then storage and end up with shipping. The Ornamental fish are caught by divers then are brought to the fish house. This is where the Ornamental Fisher houses take the responsibility of putting the Ornamental fish

into the storage glass tanks. After that, a good overview of the caught fish is done. Then, live and healthy ornamental fish are exported to the buyers (Hofman, 2009). This implies that the effects of Mwera might affect the three phases of the process or some of the phases of the process. Therefore, the study evaluated how Mwera wind speed affects each phase.

2.5 Mwera forecasts

A weather forecast is an assessment of the future state of the atmosphere (using current meteorological information/observations) for weather elements such as precipitation, clouds, wind and temperature (American Meteorological Society, 2020). Fulakeza (2020) defines a forecast as a concise statement of expected meteorological conditions over an area. In particular, the Mwera forecast is the assessment of the future state of Mwera phenomena in a given area and its evolution. Weather forecasting and observations are the main objectives for the Department of Climate Change and Meteorological Services to achieve the National Meteorological Policy which is developed to contribute towards enhanced meteorological services to support social-economic development in Malawi. Mwera forecasts are done by Numerical Weather Predictions, satellite observations, radar observations and surface observations from meteorological stations (www.metmalawi.com). Mwera forecasts are broadcasted every year on local radio and printed media. Added to the broadcasting of Mwera forecasts on local radio, Salima District, Mangochi District and Nkhotakota District get broadcasts through community outreach units based in the districts. The outreach unit based in Salima District can be effective on Ornamental Fishery at Senga Bay when the effects of Mwera on ornamental fishery are analysed.

2.6 The effects of Mwera on fisheries

The wind is defined as air in motion relative to the rotation of the Earth (Fulakeza, 2020). The wind moves from a region of high pressure to a region of low pressure (Holton and Gregory, 2013). World Meteorological Organisation (2008), states that wind direction is given based on which the wind blows. Added to this, it is measured clockwise from true north. This implies that Mwera (south-easterly wind) is coming from the southeast.

Moreover, it is originated from a region of high pressure heading towards a region of low pressure. USAID (2003), emphasises that moist-south easterly Chiperoni winds inflow from the Indian Ocean coast of Mozambique via the Mozambique Channel. The recent statement, tells that Chiperoni is humid air and it results into Mwera. However, this is confirmed by Wood and Moriniere (2013) who states that Mwera which is the outbreak of Chiperoni comes with heavy rains. The aforesaid fact agrees with the observations of Mkandawire (2020) who says that Mwera is caused by Chiperoni. The quite sudden onset of Mwera together with heavy rains causes rapid deterioration in the condition of the lake itself. In continuation, Mwera increases the risk of operating fishing boats (Limuwa et al., 2018). This is supported by Robinson (1995) determination that strong south-easterly trade winds generate large waves and strong currents on Lake Malawi. This results in low catches of fish. According to Limuwa et al. (2018), 27% of low catches of fish in Malawi are caused by Mwera winds. It is justified that Mwera winds are major risks to fishing communities particularly on Lake Malawi (Atkins, 2015). Unfortunately, Mwera effects of the recent studies focused much on other species of fish like Oreochromis species and E. Sardella but not Ornamental fish in specific. However, these studies give a picture of how Mwera might also affect Ornamental Fishery. For example, Ornamental Fishery at Stuart M Grant also uses boats (www.lakemalawi.com/fag.htm). Therefore, there is a need to strengthen hydro-meteorological services and networks to monitor and predict the occurrence of these winds.

In contrast, other studies observed that there is a greater upward of nutrient-rich waters to the surface during Mwera winds (Bootsma, 2006). The presence of nutrients increases planktons. Planktons are fish food. That means more planktons, more Ornamental Fish. This implies, the opportunity for Ornamental Fisher Folk. Apart from that, (Nkwichi, 2021) includes that Mwera creates an ideal condition for catching Chambo fish. Chambo is a type of cichlid fish in Lake Malawi (Nkwichi, 2021). So is also Mbuna fish. The implication was that there might be the same results of an increase in catch of Mbuna during Mwera winds.

Ideally, the assumption that Mwera affect types of fishing industry differently was observed from the aforesaid arguments. That is why it was worthy to research how Mwera affect Ornamental Fishery in specific.

2.7 The adaptive capacity of Ornamental Fishers in Malawi

A natural process or phenomenon within the Earth's system (lithosphere, hydrosphere, biosphere or atmosphere) that may constitute a damaging event is called a natural hazard (Chikalamo, 2020). A hazard may cause loss of life, injury, property damage, loss of livelihood and services, social and economic disruption. Mwera is a natural weather phenomenon that is a major risk to fishing communities particularly on Lake Malawi (Atkins, 2015). Mwera together with heavy rains causes rapid deterioration in the condition of the lake itself (Limuwa et al., 2018). As such, Mwera is also a natural hazard. However, if the affected Fishing Industry is unable to cope with its resources to the impacts of Mwera, then the outcome becomes a disaster (Chikalamo, 2020).

As such, a Fishing Industry needs to have coping capacities to increase the resilient of disasters. Coping Capacity is defined as the ability of people, society or a Fishing Industry to use the available resources and skills, to face and manage adverse effects that potentially could lead to a disaster (Chikalamo, 2020).

Malawi as a country, take the responsibility of giving warnings to fishermen before and during the occurrence of Mwera winds. This is done by the Department of Meteorological Services in Malawi. Kamila (2016), emphasizes that Modernized Climate Information and Early Warning Systems in Malawi project approved by UNDP will aid in protecting fishers from strong Mwera winds. Mwera winds often take lives on Lake Malawi (Kamila, 2016). In addition to the present, The Department of Climate Change and Meteorological Services in Malawi (DCCMS), with the support of the United Nations Development Programme

(UNDP) has begun a knowledge data digitisation process of climate and weather data spanning that will reduce vulnerability to climate-induced weather patterns including strong Mwera winds (UNDP, 2018). In short, it indicates that the country is taking steps to adapt to Mwera winds by improving warning systems and data dissemination channels. Apart from steps taken by the government, there are also positive responses by the fishers. Fishermen respond by not getting into Lake Malawi once warnings have been issued. The warnings get to the fishermen through various channels of communication. That is radio and television stations from Times, ZBS and Malawi Broadcasting Cooperation.

CHAPTER 3: METHODOLOGY

3.1 Introduction

In this chapter, the methods that were used to collect and analyse data are discussed. The major sections include research design, types of data, methods of data collection, and data processing and analysis.

3.2 Research Design

The research design that was adopted for this research was a descriptive study. A descriptive study is designed to describe what is there. It is also referred to as a cross-section study because all the data are collected at one specific point of time and do not extend either backwards in the past (retrospective) or forward into the future (Vellemu, 2020). Descriptive surveys are designed to obtain pertinent and precise information concerning the current status of phenomena and whenever possible to draw valid general conclusions from the facts (Ochieng, Kiplangat & Ngala, 2018). It seeks to identify and describe phenomena (Lokesh, 1984). There is no much information known yet about the topic. As a result, the study focused on determining what impacts of Mwera are there on Ornamental Fishery. Therefore, a Descriptive research design is necessary for this study.

3.2.1 Possible threats to internal and external validity

Internal validity is the extent to which you can be confident that a cause-and-effect relationship established in a study cannot be explained by other factors. On the other side, external validity is the extent to which the results can be generalized to other contexts (Bhandali, 2021)

The possible threats to internal validity and external validity include a history of the Covid-19 pandemic. The covid-19 pandemic was initially reported to the World Health Organization (WHO) on December 31, 2019. Malawi first cases on Covid-19 were confirmed on Thursday, April 2 (https://crisis24. Garda.com). Following the confirmation of the pandemic, the former State President Prof. Arthur Peter Mutharika declared a state of Disaster in the country. Hence, the travels of foreign nationals were banned. One of these countries is China, which is one of the largest importers of Ornamental fish in Malawi (https://lakemalawi.com.fag.htm). This implies that the recent exports of most exported Ornamental fish might have been affected by the Covid-19 pandemic, not Mwera wind.

Table 1: A conceptual framework for the study which shows how the approach helped to answer research questions

Research questions	Nature of the data	Variables that were used	Method of analysis
Mwera wind speed	secondary	Average changes in Mwera wind speed (2010-2019)	Quantitative using means/averages from the recorded historical speed of Mwera (2010-2019)
What are the effects of Mwera wind speed on Ornamental fish-folk and Ornamental fishing duration at Stuart M Grant Limited at Senga Bay?	Primary	Responses based on structured questionnaires	Quantitative based on questionnaires
How does Mwera wind speed influence the choice of Ornamental	Primary and	Average changes in	Quantitative based on percentages of

fishing techniques and equipment utilised by Ornamental fisher folk at Stuart M Grant Limited?	secondary	Mwera wind speed (2010-2019) and effects on choice of fishing technique	the respondents on questionnaires about the techniques used during Mwera wind speeds and qualitative analysis based on the explanation on reasons for the changes from focus groups
What influence do Mwera winds have on the exports of most exported Ornamental fish in Lake Malawi at Stuart M Grant Limited from 2010 to 2019?	secondary	Average changes in Mwera wind speeds (2010-2019) and the effect they have on the changes of most exported Ornamental fish	Quantitative using percentage, averages based on the recorded measurements of Mwera wind speed and amount of exports of Ornamental fish.
What are the coping and adaptive strategies of the Ornamental fishing community at Stuart M Grant Limited?	Primary	Different sources of livelihood apart from Ornamental fishery (such as	Quantitative using percentages and qualitative analysis of responses from the focus groups

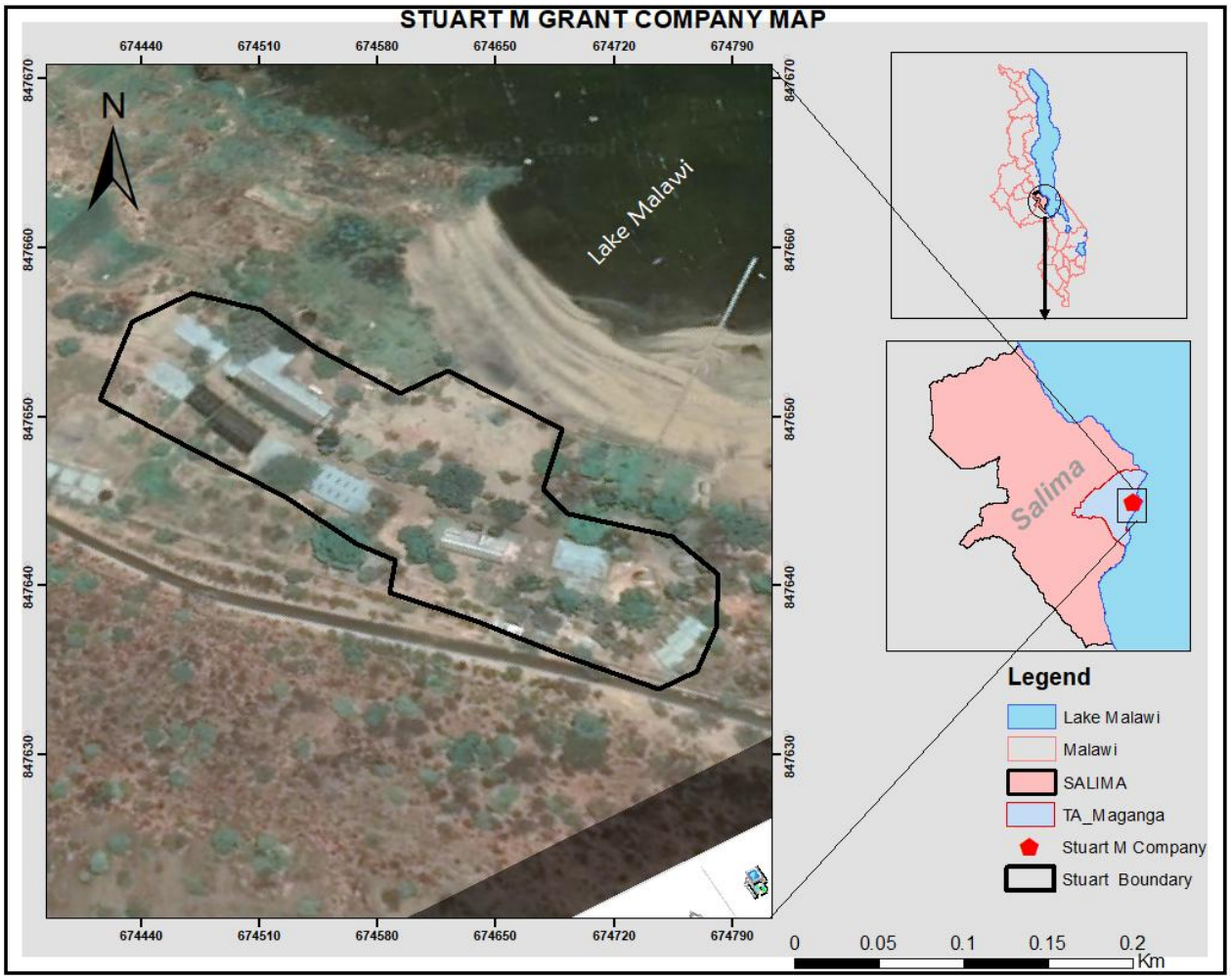
		farming, or business)	

Source: fieldwork

3.3 Setting/ study site

The study was carried out at Stuart M Grant Limited in Salima District. Stuart M Grant Limited is found at 13.7764°S and 34.6154°E (https://lakemalawi.com.fag.htm). Stuart M Grant Limited was chosen because it is the oldest, largest and most experienced Lake Malawi cichlid exporter (BBC, 2019). This makes Stuart M Grant Limited have information and knowledge of Ornamental Fishery in Malawi. The headquarters of Stuart M Grant Limited is located at plot number 54, Kambiri Point, South Senga Bay (https://www.lonelyplanet.com).

Figure 1: Map of the study area



3.4 Materials and Methods

3.4.1 Research method

The study used both a quantitative research method and a qualitative research method. In other words, the use of both quantitative and qualitative research methods is called the mixed-method (www.gradcoach.com/blog/). Quantitative focuses more on counting and classifying features and constructing statistical models and figures to explain what is observed (Vellemu, 2020). Quantitative is about numbers. The study calculated averages of

Mwera wind speed. Apart from that, the averages of the amount of the most exported Ornamental fish were calculated in the study. Calculation of the averages requires the counting of numerical values. Computation of simple statistics such as frequencies, totals, percentages and averages were done for data obtained from questionnaires. After that, the findings were presented in terms of tables, graphs and charts. Looking at this, the quantitative method fitted this approach.

Furthermore, the qualitative method asserts that data must be considered in its social context to reach a full and valid understanding. Qualitative research produces descriptions of how people get things done. It pays close attention to interactions that happen locally, without outside interference from the researcher (Vellemu, 2020). Qualitative is about words, ideas and concepts (www.gradcoach.com/blog/). The study investigated the coping and adaptive strategies of the Ornamental fishing community at Stuart M Grant Limited. Focus group discussions were used for this. In focus groups, the participants interacted with the researcher and each other. The participants provided ideas and concepts of the coping and adaptive strategies of the Ornamental fishing community at Stuart M Grant Limited during Mwera winds. As such, the qualitative method was chosen for this approach.

3.4.2 Types of data

Secondary data type and primary data type were both used in the study. Secondary data was taken from the Department of Climate Change and Meteorological Services in Blantyre. Added to this, the other secondary data was taken from Stuart M Grant Limited. The secondary data from DCCMS is the historical data of Mwera speed at Salima District. The secondary data from Stuart M Grant Limited is the historical records of the most exported Ornamental fish during Mwera season and non-Mwera season. By the way, primary data was taken by using the focus groups and questionnaires at Stuart M Grant Limited. Focus groups focused on getting primary data about the coping and adaptive strategies of the Ornamental fishing community. Furthermore, the influence that Mwera speed has on the

choice of the Ornamental fishing techniques and equipment utilized by Ornamental fish folk at Stuart M Grant Limited was recorded from focus groups. Structured questionnaires were used to gather primary data about the effects of Mwera speed on the Ornamental fish-folk and Ornamental fishing duration at Senga Bay. However, the questionnaires were also used to supplement the coping and adaptive strategies of the Ornamental fishing community at Stuart M Grant Limited. Last but not least, questionnaires also added information to the influence of Mwera on fishing techniques at Stuart M Grant Limited.

3.5 Study population

The target population was the employees and employers at Stuart M Grant Limited headquarters in Salima District.

3.6 Sample Frame

The respondents comprised employees and employers from the headquarters of Stuart M Grant Limited.

3.7 Sample Size and Sampling Procedure

The sample size is part of the target population with similar characteristics under study and which is procedurally selected to represent it. Sampling techniques describe the strategies which are used to obtain respondents from the target population (Taherdoost, 2016). There is approximate 51 to 200 employees at Stuart M Grant Limited (http://www.lakemalawi.com). Thus, the target population was the total number of employees and officials at the headquarters of Stuart M Grant Limited. The sample size was calculated using the formula indicated by Fisher et al. (2007) as below.

According to Fisher et al. (2007), at 95% confidence level and 50 % target population assume to have characteristics of interest with a Z-statistic of 1.96, the sample size was calculated using the formula:

$$n = \frac{N}{1 + Ne^2}$$

Where n = desired sample size

N = target population

e= error level.

e = 0.05

$$n = \frac{50}{1 + (50)\ (0.05)^2}$$

n= 44

Therefore, 44 respondents were given questionnaires and interviewed for the information which was required for this study. The number composed of the divers, Ornamental Fisher Houses and officials. Divers are the ones who go into Lake Malawi to capture Ornamental Fish. Ornamental Fisher Houses are responsible for giving orders to the divers and taking care of the Ornamental fish once brought to the Ornamental warehouse. The officials are responsible for providing overall leadership of the company, and communicating on behalf of the company with customers (http://www.lakemalawi.com).

Considering the three major divisions (divers, Ornamental Fish Houses, officials) of the workers at Stuart M Grant Limited, the sample sizes (n_1, n_2 and n_3) were obtained concerning their proportionality (table 2). After calculations, n_1, n_2 and n_3 were found to be 23, 18 and 3 respectively (appendix III). Systematic random sampling was used to pick the respondents from the groups of divers (N_1), Ornamental Fisher Houses (N_2) and officials

(N_3). The starting point was selected randomly. Random sampling removes bias from the researcher and thus provides a good representation of the target population. It also enables hypotheses to be scientifically tested (Mboya, 2013). After selecting the first randomly, there was a continuation of taking every 3rd name from the previous picked name on each of the lists of the divers, Ornamental Fisher Houses and officials. This was done until the numbers; 23, 18 and 3 were achieved for the divers, Ornamental Fisher Houses and officials respectively.

Table 2: proportions of the N_1, N_2 and N_3

Group	Population	Percentage weight
divers	26	52
Ornamental Fisher Houses	21	42
officials	3	6
Total	50	100

Source: records from Stuart M Grant Limited Headquarters

3.8 Data Collection Techniques

Information was collected from documented sources for secondary data. Moreover, questionnaires and focus groups were used to collect primary data. Documentary sources include Mwera wind speed from the Department of Climate Change and Meteorological Services (DCCMS), number of Ornamental fishers and the amount of most exported Ornamental fish catch and fishing equipment and techniques from Stuart M Grant Limited. Questionnaires were given to Ornamental fisher folks and officials at Stuart M Grant Limited.

3.9 Data Processing and Analysis

Data obtained from various sources was processed before analysis.

3.9.1 Qualitative analysis

Qualitative data were analyzed using qualitative analysis. Qualitative analysis has a strong emphasis on describing the world based on how different observers perceive it (Dey, 1993). Paton (1990) points out that there is no one kind of qualitative data analysis, but rather a variety of approaches related to different perspectives and purposes of researchers. The study used the content analysis approach as one of the qualitative methods. Content analysis helps in grouping content into recurring themes or categories (www.gradcoach.com/blog/).

3.9.2 Quantitative analysis

Data that was obtained through questionnaires were analyzed by using the quantitative method. The data from the questionnaire was subjected to the computation of simple statistics such as frequencies, totals, percentages, tabulation and presented in terms of tables, graphs and charts. Apart from that, the quantitative method was also used for documentary data from the DCCMS and Stuart M Grant Limited. It was subjected to the computation of the mean of Mwera wind speed, and the averages of the amount of the most exported Ornamental fish at Stuart M Grant from 2010 and 2019. R studio and Microsoft Excel 2019 were chosen as the packages for analyzing quantitative data. R studio was chosen because of its versatility in the field of statistics. Microsoft Excel 2019 was chosen because of the tabula data presentation and graph plotting. By the way, Microsoft Excel 2019 is one of the latest versions of Microsoft Excel.

CHAPTER 4: RESULTS AND DISCUSSIONS

4.1 Introduction

In this chapter, the results of the present investigation are presented and discussed. The chapter is divided into subsections where general characteristics of the respondents such as

age, gender and level of education are analyzed. The data is also analyzed around key objectives; the effects of Mwera wind speed on the Ornamental fish-folk and Ornamental fishing duration at Senga Bay, the effects of Mwera wind speed on the choice of Ornamental fishing techniques and equipment utilised by Ornamental Fisher-Folk at Senga Bay and the coping and adaptive strategies of the Ornamental fishing community at Senga Bay.

4.2 Demographic Characteristics of the Respondents

The demographics interests of this study included gender, age, education and source of income. The studies found out that 77% of the respondents were male and 23% were female. The divers contribute to 52% of the desired sample size on their own. Moreover, 2/3 of the officials were male contributing to 4.5 % of the total target sample. On the other hand, 1/3 of the officials consisted of females. This gives 2.3% of the desired sample size. Last but not least, 9 out of 18 of the Ornamental Fisher Houses were male. This gives 20.5% of the desired sample size. The other 20.5% of the desired sample size came from the female Ornamental Fisher Houses (table 3). The percentage of the male is high because the sample of divers consists of only men. Not that females are not allowed to be divers but most of the employees who apply for diving are men (http://www.lakemalawi.com).

An analysis by age revealed that 54.5% of the respondents were aged between 21-30 years. (34.1 %) were aged between 31-40 years, 6.8% were below 21 years of age, and 2.3% were between 41-50 years old while only 2.3% were above 51 years old (Table 3). This implies that a lot of the Ornamental Fish workers at the headquarters of Stuart M grant are in the age bracket of 21-40 years. Such age group is the most economically productive. The reason is that the 21-40 years' group have the energy to undertake tedious activities like diving into the lake to look for Ornamental fish. Moreover, they are responsible for taking care of the young and old aged group (Mboya, 2013).

There was a marked difference in the education status of the respondents. Nine per cent of the respondents had attended primary education only. (16%) attended secondary education and the last (75%) had attended tertiary education (Table 3). This implies that Stuart M Grant Limited employs many of the people who are qualified at their work. For instance, one of the officials during the focus group said that "we employ people who can understand what to do during Mwera…the people that knows various diseases of Ornamental fish during different weather conditions." This shows that training is one of the required qualifications at Stuart M Grant Limited.

Agriculture was the main source of income besides working at the Ornamental Fishing Company as demonstrated by most of the respondents (61.4%). Following Agriculture, there are small businesses (25%) then manual work (11.4%). The last 2.3% had the other specifications of the source of income (Table 3). The findings are in agreement with (Wikipedia, 2021) which says that the most economic activity in Malawi is Agriculture. By the way, the number of small businesses is also increasing as observed by Edward (2021). The observation indicates that many people in Malawi are now shifting to small businesses after understanding the importance of start-up enterprises. Table 3 summarises the social economics and demographics characteristics of the respondents.

Table 3: Social-Economic and Demographics of the respondents

Characteristics	Number of respondents	Per cent
Gender		
Male	34	77
Female	10	22.727

Age		
Below 21 years	3	6.8
21-30 years	24	54.5
31-40 years	15	34.1
41-50 years	1	2.3
51+ years	1	2.3
Educational level		
None	0	0
Primary	4	9
secondary	7	16
Tertiary	33	75
Other sources of income		
Agriculture	27	61.4
Small business	11	25
Manual work	5	11.4
Other specification	1	2.3

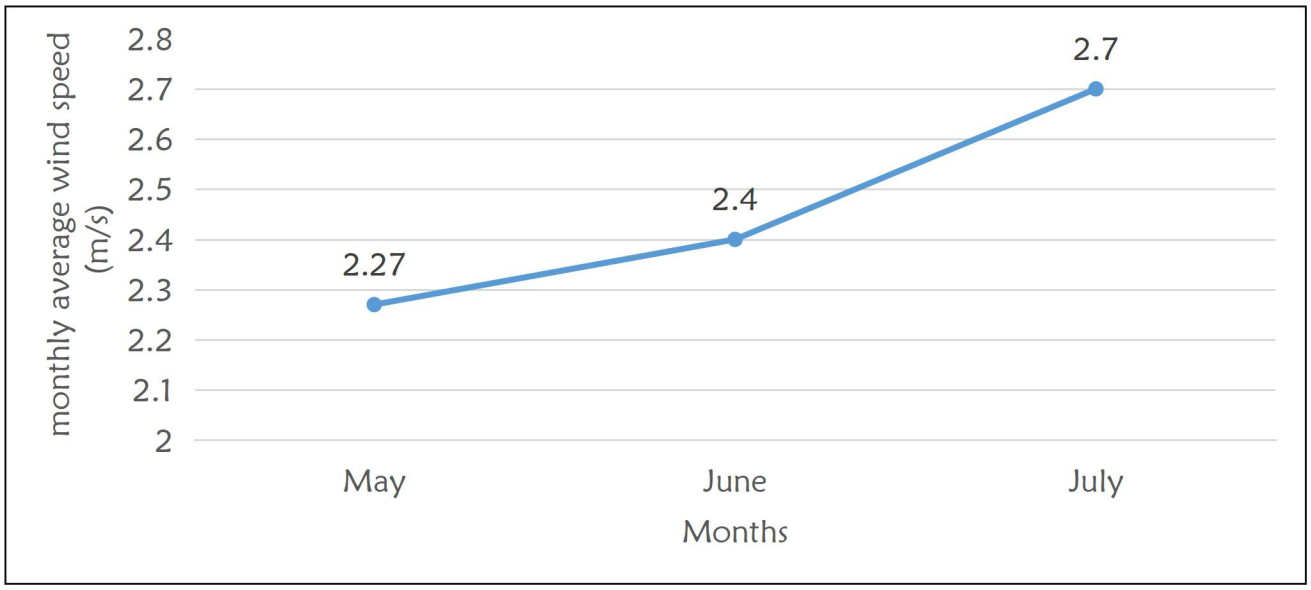
Source: Bases on the fieldwork data

4.3 Trends for wind speed during Mwera Season at Senga Bay

The secondary data of Mwera wind speed was obtained from the Department of Climate Change and Meteorological Services in Malawi (DCCMS). However, the limiting factor was the unavailability of enough stored Mwera wind speed data at the DCCMS for Senga Bay, Salima District. That is for the past years before 2010. Therefore, the study used the available digitized Mwera wind speed data from 2010 to 2019. The secondary wind data of Mwera Season obtained from the DCCMS for Senga Bay in Salima District for the period between 2010 and 2019 as presented in figure 2 showed an increasing trend in the average wind speed across the months from May to July. The highest wind speed of 2.7 m/s being experienced in July and the lowest wind speed of 2.27 m/s in May. The data indicated that

the Mwera winds increase from May to July. That indicates that Mwera occurs in Malawi in the dry and winter season in Malawi (Department of Climate Change and Meteorological Services in Malawi, 2019). This is a trend that affects Ornamental Fishing Divers. Divers do not see well in the lake due to the upwelling of dust during the Mwera wind (http://www.lakemalawi.com). Strong easterly winds according to Limuwa et al. (2018), causes rapid deterioration in the condition of the lake itself, increasing the risks for Ornamental Fish Divers. As such, there is a decrease in the export value of ornamental Fish species in May, June and July as indicated in (figure 5).

Figure 2: Monthly trend of wind data (Mwera Season) for Senga Bay: 2010 – 2019



Source: Based on data taken from the DCCMS for Senga Bay (Salima District 2010-2019)

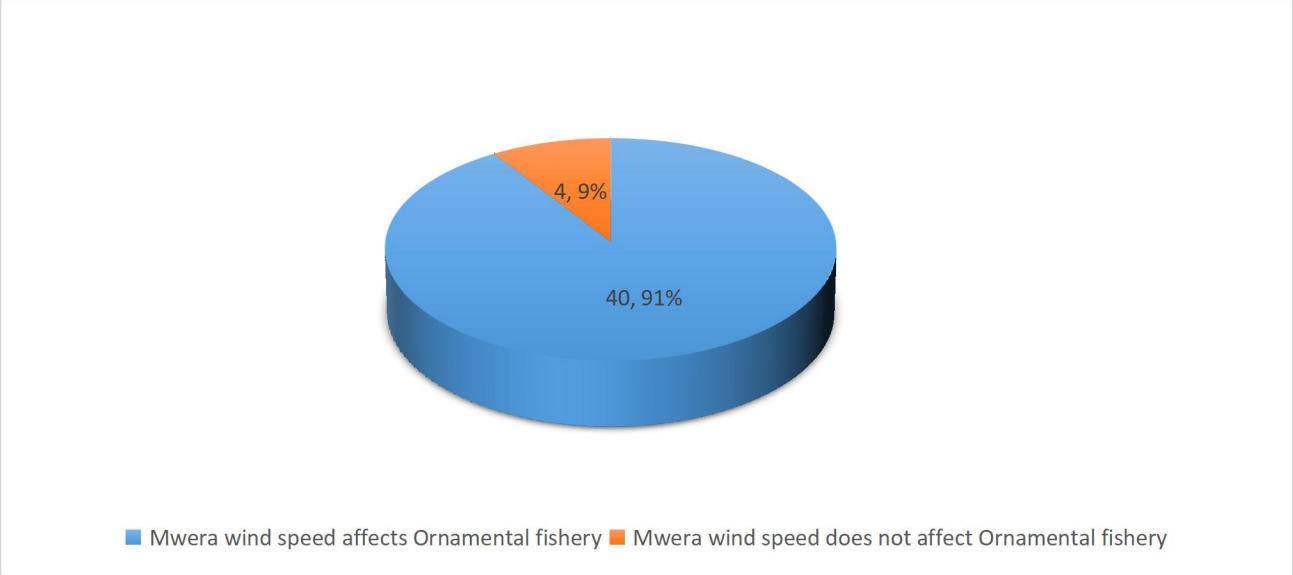
4.4 The perceptions of the respondents on whether or not Mwera wind speeds affect Ornamental fishery at Stuart M Grant Limited at Senga Bay.

Concerning the responses to the questionnaires, 91% of the respondents indicated that variability in Mwera wind speed has an effect on Ornamental fishing activities at Stuart M Grant Limited. Only 9% indicated that Mwera wind speed does not have any effect on the Ornamental fishing activities at Stuart M Grant Limited (figure 3). 31 of the respondents on the questionnaires indicated that Mwera wind speed causes loss of life as a result of boat submergence, loss of fishing gear in the water, no exports of Ornamental fish and sickness of Ornamental fish workers. 6 of the answers of the respondents on the questionnaires showed that Mwera wind speed causes loss of life as a result of boat submergence, loss of fishing gear in the water, no exports of Ornamental fish. Moreover, 2 indicated that Mwera wind speed causes loss of life as a result of boat submergence and no export of Ornamental fish. Added to that, 1 showed that Mwera wind speed causes loss of life as a result of boat submergence, no exports of ornamental fish and sickness of ornamental fish workers. Last but not least, 4 ticked that there is no effect on Ornamental fishing activities caused by Mwera wind speed (figure 4). Particularly, 61.4% of the answers on the questionnaires showed that the effects on the Ornamental fishery are caused by both strong and weak Mwera wind speeds. On the same note, 29.6% of the effects as responded on the questionnaires indicated that were caused by strong Mwera wind speeds. However, 9% indicated that neither strong nor weak Mwera wind speed has any effect on the Ornamental fishery at Stuart M Grant Limited.

The results from this study seem consistent with the previous studies done on the effects of Mwera on Lake Malawi and fish species like Oreochromis species and Engraulicypris Sardella. For example, Robinson (1995) determined that strong south-easterly trade winds generate large waves and strong currents on Lake Malawi. It is the large waves and strong currents that are responsible for the submergence of boats. Added to that, Limuwa et al., (2018), noted that Mwera increases the risk of operating fishing boats thereby affects fishing of Engraulicypris. Looking at this, it is in agreement with 29.6% of the respondents that

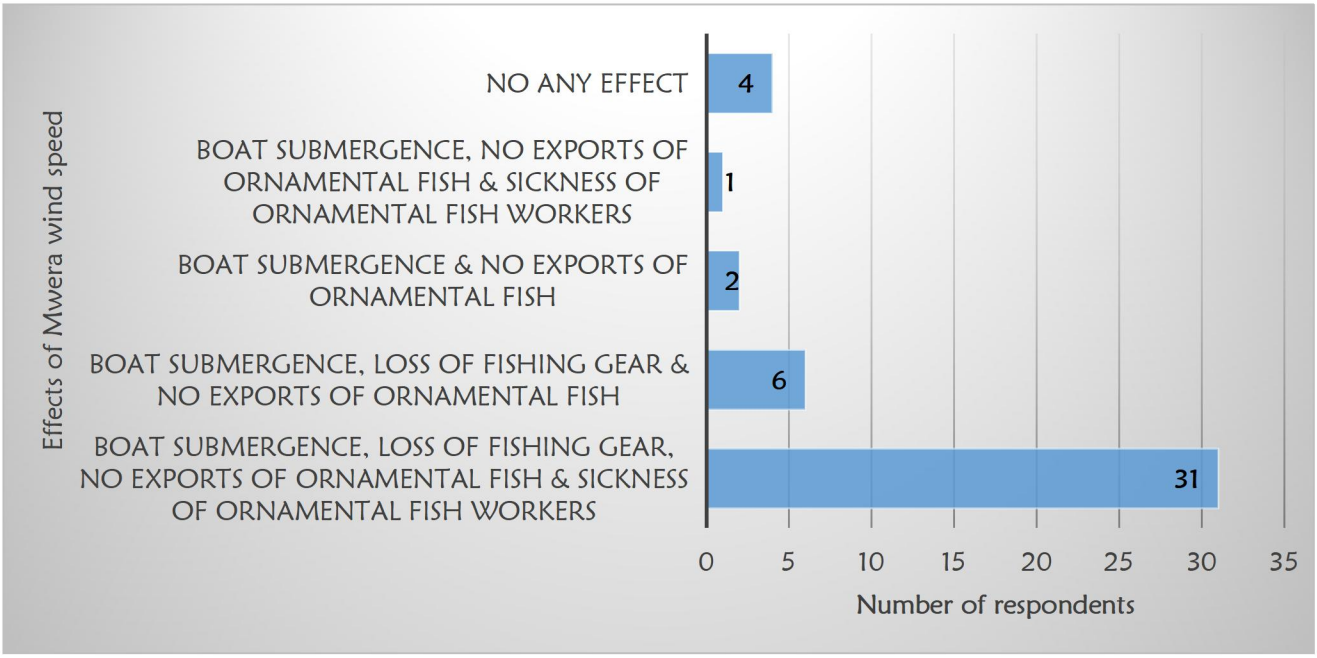
indicated that the effects are caused by strong Mwera winds. Moreover, figure 2 indicates that the strength of Mwera wind speed increases from May going upward in July. This results in a decrease in exports as shown in figure 5 between the months of May-July. The most common sickness which was noted at the fieldwork (2021), which negatively affect Ornamental Fish workers at Stuart M Grant Limited is fever. Most especially divers who are responsible for going into the lake. Apart from that, the water in Lake Malawi gets dark during Mwera winds (field data, 2021). This causes loss of fishing gear. As a response, Stuart M Grant Limited declares a holiday for workers during this time which results in no Ornamental fish catch then no or fewer exports of Ornamental fish (fieldwork, 2021).

Figure 3: perceptions of the respondents on whether or not Mwera wind speed affect Ornamental fishery at Stuart M Grant Limited at Senga Bay



Source: Based on fieldwork data 2021

Figure 4: Effects of Mwera wind speed on Ornamental fishery



Source: responses on the questionnaires, 2021

4.5 The effects of Mwera wind speed on Ornamental fish-folk and Ornamental fishing duration at Senga Bay.

The changes in Mwera wind speed have adverse effects on the fisherfolk as noted by Limuwa et al. (2018). An assumption of thinking that Ornamental fish are also affected by Mwera wind speed might be made from the general findings of Limuwa et al. As a result, this study attempted to assess the effects of Mwera wind speed on Ornamental fish-folk at Stuart M Grant Limited. The first step was to find out if the Mwera wind speed has effects on the Ornamental fishery at Stuart M Grant Limited. Following that, the second step was to find out the effects of Mwera wind speed on Ornamental fishing duration at Stuart M Grant Limited.

4.5.1 The perceptions of the respondents on the effects of Mwera wind speed on Ornamental fishing duration at Stuart M Grant Limited at Senga Bay.

The study sought to establish the effects of Mwera wind speed on Ornamental fishing duration at Stuart M Grant Limited at Senga Bay. The reason is that weather and climate can impact fishing duration in various ways (Mboya, 2013). Therefore, Mwera wind can also impact fishing duration. The findings of the study at Stuart M Grant Limited are summarised and presented in Table 4.

Table 4: Effects of Mwera wind speed on Ornamental fishing duration

Mwera	Short time		Normal time		Longer time		No Ornamental fishing at all	
	f	%	f	%	f	%	f	%
Strong	0	0	0	0	7	15.9	37	84.1
weak	8	18.2	28	63.6	5	11.4	3	6.8

Source: based on responses on the questionnaires, 2021

According to the findings in Table 4 majority of the respondents (84.1%) on the questionnaires indicated that there is no Ornamental fishing at all during strong Mwera winds. On the other hand, 15.9% responded that they take a longer time to catch Ornamental fish during strong Mwera winds. Added to that, no respondent indicated that Ornamental fishing duration is normal during strong Mwera winds as it is during the non-Mwera season. After analysing data on the questionnaires, all respondents showed that strong Mwera winds do not give them a short time to catch Ornamental Fish.

In contrast, the results observed on weak Mwera conditions showed that 63.3% of the respondents noted that weak Mwera wind speed does not affect the normal time of Ornamental Fishing duration. 18.2% responded that weak Mwera conditions are responsible for causing a short time to catch Ornamental Fish. However, it takes a longer time for Ornamental Fishing duration during weak Mwera conditions as indicated by 11.4% of the respondents. Last but not least, 6.8% of the respondents as indicated in table 4, ticked that there is no fishing of Ornamental fish during weak Mwera wind speed.

As observed on the interview guide for Ornamental Fishing Officials at Stuart M Grant Limited (Appendix II), question a), most of the respondents answered that during Mwera conditions, most of the workers are given a holiday. The reason is that there is a need to reduce losses that might be associated with the business during the Mwera season. According to Johnson (2012), increased frequency and severity of winds may be unstable for fishing. Fedeulo, Murphy and Shugousky (1996), concurs that water currents are driven very fast by the strong winds and this results in affecting fish catch. These observations are in agreement with the findings of Strong Mwera wind speed in table 4. Weak winds as observed by (Mboya, 2013), provide the fisherfolk with favourable conditions to venture into the water for a longer period without experiencing the fear of submergence or losing their fishing gear. This agrees with the 63.3% and 18.2% which shows that weak Mwera winds results in normal Ornamental fishing duration and gives a short time to catch Ornamental fish respectively (table 4). This study significantly found out that a lot of respondents (84.1%) indicate that there is no Ornamental Fishing at all during strong Mwera winds.

4.6 The influence of Mwera wind speed on the choice of fishing techniques and equipment utilized by Ornamental Fisherfolk at Stuart M Grant Limited.

To start with, the first question on the questionnaire on part D as indicated in the appendix I was to find out if the variability of Mwera wind speed has any effect on the fishing techniques at Stuart M Grant Limited. Ninety-one per cent indicated that variability in Mwera wind speed has effects on the fishing techniques. The other 9% indicated that they were no effects on the fishing techniques at Stuart M Grant Limited caused by variability in Mwera wind speed.

Table 5: effects of Mwera wind speed on the choice of fishing techniques and equipment at Stuart M Grant Limited

Mwera wind speed	Use of usual fishing methods (nets, dive boats, buckets, hookah-rig, compressor, scuba)		Use of other techniques (trapping, Hook and long lines, Hand lines, splashing and poisoning)	
	F	%	f	%
strong	2	4.6	0	0
weak	38	86.4	0	0

Source: Based on fieldwork, 2021

During strong Mwera wind speeds, 4.6% responded that they use dive boats, buckets, compressors, nets and scuba fishing methods (Table 5). 86.4% of the respondents replied that nets, dive boats, buckets, hookah-rig, compressors and scubas are used during weak Mwera wind speed. In addition to that, 9% of the respondents showed that the use of the usual fishing methods at Stuart M Grant Limited is affected by neither strong nor weak Mwera wind speeds. None of the respondents indicated that there is the use of other techniques as shown in table 5 during strong and weak Mwera wind speeds. Some of the usual Ornamental fishing methods are shown in appendix IV.

These findings on the questionnaires were complemented by discussions on focus groups where the respondents said that Ornamental fishing is about keeping Mbuna fish alive. All in all, what is needed is to capture live and healthy Mbuna fish. Take care of the fish until it gets to the buyer (Hofman, 2009). Once the company discovers that the other Ornamental fish are not healthy or dead, it removes those particular fish from the rest of the group. For unhealthy fish, it is the responsibility of the Ornamental Fisher houses to treat the fish with medication until the fish gets better. This implies that hook and long lines, splashing and poisoning cannot be used to catch Ornamental fish. Hook and long lines and poisoning, kill fish or make fish unhealthy.

The findings in table 4 concur with the findings in table 5. In table 4, the findings (84.1%) show that there is no Ornamental fishing at all during strong Mwera wind speeds. Consisted to this, only 2% in table 5 show that there is the use of usual fishing methods during strong Mwera winds. The reason is that a few uses of usual fishing methods during strong Mwera wind speeds are due to the prohibition of Ornamental fishing during strong Mwera winds. This has been observed in the analysis of the effects of Mwera wind speed on the Ornamental fishing duration. This is where Ornamental fish workers are given holidays. However, 86.4% of the respondents about the use of usual fishing methods during weak Mwera wind speeds agrees with the observations of Mboya (2013). Mboya (2013) noted that calm wind speeds provide the fisherfolk are responsible favourable conditions to venture into the water for a longer period without experiencing the fear of submergence. This implies that Ornamental fish workers get into Lake Malawi during weak Mwera wind speeds and make use of the usual fishing methods. Moreover, the Ornamental Fisher houses during the focus groups, said that Mwera winds cause the water in Lake Malawi to become dirty. This affects the water in the storage glass tanks. The reason behind this is that Mbuna Fish from Lake Malawi survive only in the water from Lake Malawi (http://www.lakemalawi.com). That means, the Stuart M Grant Limited collect water from

the lake into the storage glass tanks. Once the water gets dark, it becomes a challenge for the Stuart M Grant Limited.

4.7 Exports of Ornamental Fish during Mwera Season and non-Mwera Season

Figure 5, shows that March and July had the highest and lowest frequency of exports of the Ornamental Fish species respectively. With the frequencies of 45 and 10 respectively. A sharp increase in the number of exports was noted from January with a frequency of 23 to February with a frequency of 41. A slight increase was observed from February with a frequency value of 41, to March, with a frequency value of 45. The trend started decreasing from April to July. From August, an increase was noted up to November with a frequency value of 40. December and January were observed to have a frequency value of 23.

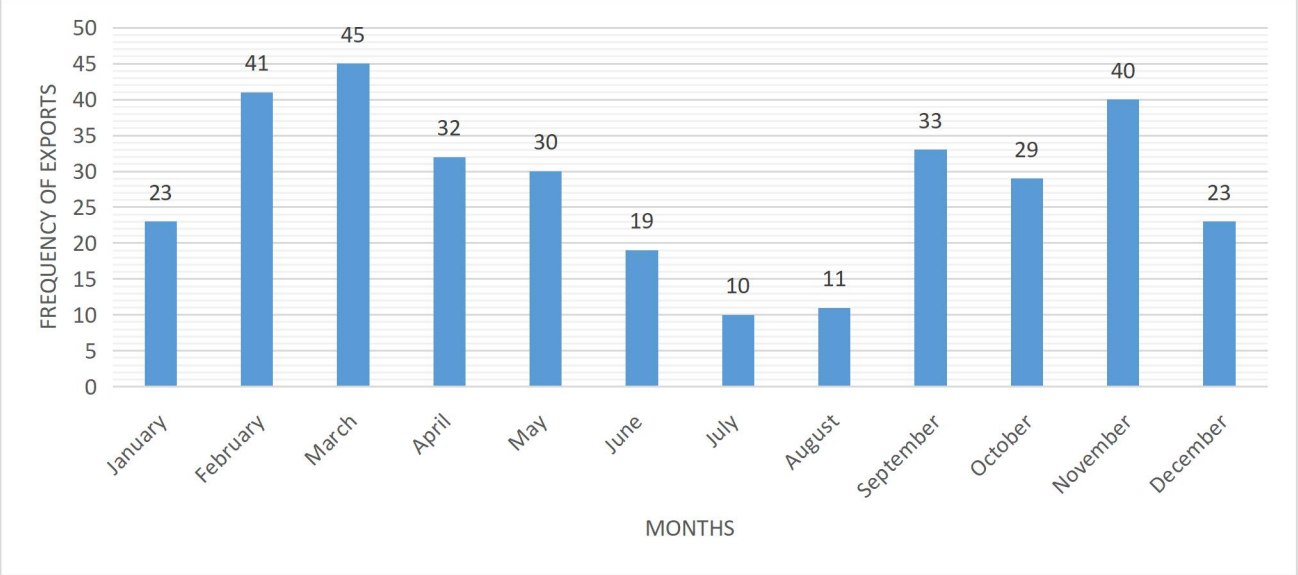
The months of the year are grouped into Mwera Season and non-Mwera Season. According to the Department of Climate Change and Meteorological Services in Malawi 2019, the Mwera season occurs from May to July. This implies that August, September, October, November, December, January, February, March and April are non-Mwera Seasons. Mwera Season contributed to 11.90% of the frequency of exports from 2010 to 2019. Non-Mwera Season contributed to 88.1% of the frequency of exports from 2010 to 2019. The maximum frequency value of 45 was also observed in the non-Mwera Season. On the other hand, the minimum frequency value of 10 was observed in the Mwera Season.

The results indicated that the number of export values of Mwera and non-Mwera Seasons are different. In the non-Mwera Season, from September to December exports are high. In these months, the lake gets warmer progressively. As a result, it becomes easy for Ornamental Fish divers. The unpleasant southeasterly winds are no longer experienced (http://www.lakemalawi.com). Moreover, from January to march, the lake is calm. This enables divers to travel longer distances on the lake with their boats. As such, they can get

to where other specific species of Ornamental Fish are located. With these conditions, the number of catches of Ornamental fish per month increases (www.bsac.com).

In contrast, in May, June and July which is the Mwera season, the catches are low. During these months, divers do not go into the lake due to south-easterly winds which increase the risk of operating fishing boats (Limuwa et al., 2018). Furthermore, the Stuart M Grant Company gives holidays to the workers during Mwera Season.

Figure 5: Total monthly exports of Ornamental Fish species



Source: secondary data from Stuart M Grant Limited

4.8 The coping and adaptive strategies of the Ornamental fishing community at Stuart M Grant Limited.

The coping and adaptive strategies of the Ornamental fishing industry at Stuart M Grant Limited at Senga Bay were observed from the responses in the focus group discussions and questionnaires. The strategies were grouped into Stuart M Grant strategies and the personal strategies of the workers.

4.8.1 The coping and adaptive strategies of the Stuart M Grant Limited

The first step was to group the respondents based on their respective places of work at Stuart M Grant Limited. The respondents were grouped into divers, officials and Ornamental Fisher houses. Following that, three focus groups were developed. The first was the focus group with officials, then divers and end up with Ornamental Fisher houses.

When the officials were asked what do the company do in the presence of strong Mwera winds, one of the officials said that most of the workers are given holiday during the Mwera season. At this time, the company notifies most of their potential customers that it does not catch Mbuna fish until when the weather is calm. On the same note, the other respondent replied that the Stuart M Grant Limited has guest houses. These houses are still used in Mwera or non-Mwera season to receive guests. The income generated from the guesthouses is used to run the day to day activities of the company. Moreover, the other response was that the company keeps on checking weather news daily. It is a routine for all workers to check weather reports. The most noted source of the news is the Department of Climate Change and Meteorological Services in Malawi. However, the challenge that the officials marked during Mwera forecasts is that it does not specify a local area. For instance, the forecasts say "there will be Mwera winds along the lake" instead of being specific on which areas of the lake. The officials continued by saying "we appreciate the job that is done by the weather forecasters but if they can get specific to an area in their forecasts that might complement their work."

Added to that, the divers were also asked to explain what they do when they encounter Mwera wind while they are already in the water. Most of the respondents said that they drive their dive boats around the huge rocks. Most especially the side that is objected from Mwera winds. This implies that they hide to the side that faces the northwest to avoid south-easterly winds. They also said that they attach a heavy mass to a rope and tie the rope to the boat. The heavy mass is thrown into the water to prevent the dive boat from being driven away by Mwera winds and currents. The divers emphasised that they carry radios with them to keep checking on weather reports. Moreover, one of the divers said that "we even use our local methods to forecast if there will be Mwera or not before we go into the lake…the water gets cold and you feel the increase in the speed of water then we know that Mwera is coming." Looking at this, it can tell how important are weather forecasts to the Ornamental Fishing industry. Furthermore, the other diver said that the company has implemented many Ornamental Fish ponds at the headquarters. Some other times, the company collects Ornamental Fish from the ponds during Mwera winds. However, the challenge comes in when the fish in the ponds do not meet the type of Mbuna that the buyers need.

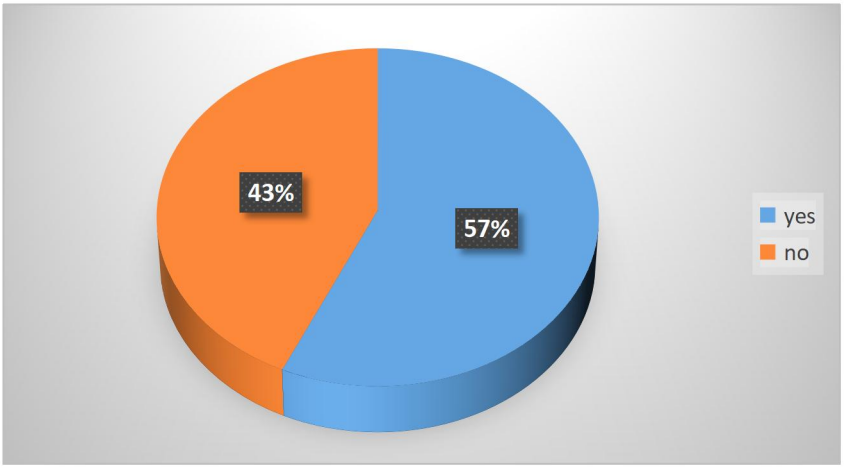
Last but not least, the most key problem faced by Ornamental Fisher houses was observed to be the shortage of water in the storage glass tanks. The reason is that; the water gets dirty during Mwera winds. As a result, they stop collecting water from the lake. This is because dirty water is not healthy for Ornamental fish. To overcome this situation, the company has installed two water reservoirs close to the warehouse. The water in the reservoirs is collected from Lake Malawi and is mostly used during emergencies. For instance, water in the storage glass tanks is collected from the reservoirs. Apart from this, the other issue that was noted is that many of the Ornamental Fish get injured when the divers encounter Mwera in the lake. To solve the situation, the Ornamental Fisher houses are trained to give medications to divers and Ornamental Fish.

4.8.2 The coping and adaptive strategies of Ornamental Fish workers at Stuart M Grant Limited during Mwera winds.

The responses on this part were observed on the answers on the questionnaires (Part E of appendix I). The first question was to find out if Mwera wind had ever had any effect on the livelihood of Ornamental Fisherfolk. Table 6 shows that 57% of the respondents replied that Mwera winds do not have an impact on their livelihood. In contrast, 43% replied that Mwera winds have affected their livelihood (figure 6). Following this, the respondents were asked to state the impacts that Mwera had on their livelihoods. The 57% that responded that Mwera winds do not have effects on their livelihood did not reply to question number 17 on the questionnaire. However, the whole 43% indicated that Mwera causes them to work for extra hours. Furthermore, 0% indicated that Mwera winds decrease salaries, increase the level of job security, increases monthly income, cause workers to abandon an Ornamental fishing company for other economic activities and reduce the working hours of the employees. This implies that the only observed livelihood impact on the workers concerning the questionnaire is an increase in the number of working hours. The reason is that divers take time to get to the land during Mwera winds (focus group discussions). Moreover, the finding concurs with the results of Robinson (1995) who determined that strong south-easterly trade winds generate large waves and strong currents on Lake Malawi. These large waves and strong currents require extra fuel to travel more especially when they oppose the direction of dive boats. To adapt and cope up with the situation, the workers who are free subject themselves to help the ones whose work has piled up. The respondents also specified that, during the holiday, they get involved in other small businesses. Recently, some workers have opened small shops at Senga Bay. When the respondents were asked to state any employee who has ever quilted job because of the impacts of Mwera on Ornamental Fishery at Stuart M Grant Limited, all the respondents replied that they do not know anyone. This was followed by not answering the question 18b and 19 on the questionnaire which was looking for the coping and adaptive strategies

of those who have ever quilted job due to Mwera winds and comments on how their livelihoods have been affected respectively.

Figure 6: Responses on whether or not Mwera winds have effects on the livelihood of the Ornamental Fish workers at Stuart M grant Limited.



Source: Based on answers by the respondents on the questionnaires at Stuart M Grant Limited

Table 6: Impacts of Mwera on the livelihoods of workers at Stuart M Grant Limited

Impacts of Mwera on the livelihoods of workers at Stuart M Grant Limited	f	%
Decrease salaries	0	0
Had to abandon working for an Ornamental fishing company for other economic activities.	0	0
Work for extra hours	19	43.2
Increases levels of job insecurity	0	0
Increases in monthly income	0	0
Reduce working hours	0	0

No any impact on the livelihood	25	56.8%

Source: responses on the questionnaires

CHAPTER FIVE: CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter presents a combined summary of all findings, conclusions, recommendations and suggestions for further investigations.

5.2 Summary of the findings

The study examined the effects of Mwera on Ornamental Fishery and Ornamental fisher's adaptive capacity at Stuart M Grant Limited at Senga Bay. The factor which was examined includes how changes in Mwera wind speed affects Ornamental fisher folk, Ornamental fish catch, Ornamental fishing facilities and choice of fishing techniques.

The results of the study showed that strong Mwera wind speeds have adverse effects on Ornamental fishery at Stuart M Grant Limited at Senga Bay as it causes loss of life as a result of boat submergence, loss of fishing gear in the water, no exports of Ornamental fish and sickness of Ornamental fish workers as noted by (31/44) of the respondents. The study also found that during strong Mwera winds, there is no Ornamental fishing at all (84.1%) due to the fear of drowning or damage to the fishing equipment. While Ornamental fishing activities return to normal time during weak Mwera winds and non-Mwera wind seasons.

On the effects of Mwera wind speed on the Ornamental fish-folk and Ornamental fishing duration at Senga Bay, the results revealed that during strong Mwera wind speeds there is either no Ornamental fishing at all (84.1%) or it takes a longer duration to catch Ornamental Fish (15.9%). During weak Mwera wind speeds, Ornamental fishing duration takes normal time (63.6%).

The study further showed that the use of usual fishing methods (nets, dive boats, buckets, hookah-rig, compressor, scuba), does not change during Strong and weak Mwera winds as indicated by (4.6% and 86.4 % respectively). Moreover, the study found out that there is no use of hook and long lines and poisoning methods during Mwera winds (0%) and non-Mwera season. The reason is that Ornamental Fish need to be kept alive and healthy.

About the number of the most exported Ornamental Fish, no doubt changes in Mwera wind speed prompt changes in Ornamental Fishing activities that result in variations in the exports of the most exported Ornamental Fish. For instance, the study found out that the number of exports of Ornamental Fish decrease during the Mwera season (11.90%) and increases during the months of the non-Mwera season (88.1%).

The findings of this study as presented in chapter number four, showed that Mwera winds do not have a direct impact on the livelihood of the Ornamental Fish workers at Stuart M Grant Limited (57%). However, a related impact that was revealed by the study is that Mwera wind speeds cause Ornamental Fish workers to work for extra hours (43%).

Last but not least, the study revealed that giving the workers a holiday, avoid getting into the lake, installing water reservoirs, instructing the divers to go and hide to huge rocks and giving medication to the injured divers and Ornamental fish during Mwera winds are some

of the coping and adaptive strategies used by the Stuart M Grant Limited. Moreover, implementation of the guesthouses to keep running during Mwera seasons and non- Mwera seasons at the Stuart M Grant Limited was noted. This still brings income to the company when Ornamental fishing is not active during the Mwera season.

5.3 Conclusions

The conclusion from this study is that strong Mwera wind speeds have significantly affected Ornamental fishing activities and exports of Ornamental fish at Stuart M Grant Limited at Senga Bay. The effects range from direct impact on the Ornamental Fisher Folk themselves due to loss of life and injuries caused by strong Mwera winds to submergence of dive boats, no Ornamental fishing at all or take longer duration during Ornamental fishing and reduced Mbuna exports. With such situations, the Stuart M Grant Limited has been forced to have holidays during the Mwera wind seasons. Moreover, most of the Ornamental Fish workers have involved themselves in small businesses during the Mwera season to sustain their livelihoods. Looking at this, there is a need for Ornamental Fishing companies to enhance resilience and adoption of sustainable mitigation and adaptation strategies. Added to that, there is a need for the weather forecasters to improve and downscale Mwera weather forecasts to local areas.

5.4 Recommendations

Regarding the findings of this study, the policy recommendations that are made include:

i. The study also revealed that strong Mwera wind speeds cause no Ornamental Fishing at all or takes a long time to catch Ornamental Fish. This results in a few exports of Ornamental Fish during the Mwera season. It is therefore recommended that the Ornamental Fishing Industries should implement a lot of

sustainable alternative ways to areas like Ornamental Fish farming to improve their resilience.

ii. The results found out that Mwera Forecasts are so important to the Ornamental Fishing Industries. Thus, it is recommended that the government through the Department of Climate Change and Meteorological Services in Malawi and other private sectors should enhance weather forecasts. For instance, the forecasts should be downscaled to specific areas.

5.5 Suggestions for Further Research

Following the study, the following suggestions for further research are put forth for consideration.

i. The study was limited to Stuart M Grant Limited at Senga Bay in Salima District. It could also be replicated in other regions where Ornamental Fishing is the source of income to compare the findings.

ii. The study looked at the effects of Mwera on Ornamental Fishery and Ornamental fisher's adaptive capacity at Stuart M Grant Limited at Senga Bay. Further studies should be done on the behaviour of Ornamental Fish during Mwera winds.

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APPENDIX I: ORNAMENTAL FISHER FOLK QUESTIONNAIRE

To Whom it may concern,

This questionnaire is to help in gathering information on the effects of Mwera wind speed on Ornamental fish-folk and Ornamental fishing duration at Senga Bay. The answer you will give will go a long way into improving the situation posed by Mwera on the Ornamental fishery.

Please respond as honestly as you can to all the Questions. Feel free to make further comments you may want to. The answers you give will be treated with the utmost confidentiality. You do not have to write your name anywhere in the questionnaire.

PART A: General Knowledge of the respondent

1. What is your sex? (*please tick one*)

Male ☐

Female ☐

2. What is your age group? (*please tick one*)

Below 21 years ☐

21 – 30 years ☐

31 – 40 years ☐

41 – 50 years ☐

Above 50 years ☐

3. What is your marital status? (*please tick one*)

Single ☐

Married ☐

Divorced ☐

Widowed ☐

Separated ☐

4. If yes, what is the highest level of your education? (*please tick one*)

Non-literate ☐

Primary School ☐

Secondary School ☐

A Level ☐

Tertiary / middle college ☐

University ☐

Other specify_____

5. What is your other source of income apart from Ornamental fishing? (*please tick one*)

Agriculture ☐

Small business ☐

Manual work ☐

Other specify _____

Part B: Impacts of Mwera wind speed on Ornamental fish-folk and Ornamental fishing duration at Senga Bay

6. Does variability in Mwera wind speed have any effect on Ornamental fishing activities at Stuart M Grant Limited? (*please tick one*)

Yes ☐

No ☐

7. Does variability in Mwera wind speed have any effect on Ornamental fishing duration at Stuart M Grant Limited? (*please tick one*)

Yes ☐

No ☐

8. What are the effects of Mwera wind on the Ornamental Fishery at Stuart M Grant? *(Tick the appropriate box)*

Mwera	Loss of life as a result of	Loss of fishing gear	No exports of	Sickness of Ornamental	No effect

	boat submergence	in the water	Ornamental fish	fish workers	
Strong					
Weak					

11. What are the effects of Mwera wind on Ornamental fishing duration? *(Tick the appropriate box)*

Mwera	Short time	Normal time	Longer time	No Ornamental fishing at all
Strong				
weak				

Part C: Impacts of Mwera on the catch of the most exported ornamental fish

12.Indicate the impact of the Mwera speed (strong, weak) on the catch of the most exported ornamental fish at Stuart M Grant Limited.

Mwera	Very low	low	Moderate/normal	High	Very high
strong					
weak					

Part D: Impacts of Mwera on the fishing techniques of ornamental fish

13 Has the variability in Mwera speed have any effect on the fishing techniques at Stuart M Grant Limited?

Yes ☐

No ☐

14 Indicate the impacts of the Mwera wind speed on the fishing techniques at Stuart M Grant Limited. *(Tick the appropriate box)*

Mwera	nets	Hookah-rig	boats	compressor
Strong				
Weak				

15. What are the effects of Mwera wind speed on the fishing techniques (boats, nets, compressor, hookah-rig)? *(Tick the appropriate box)*

Mwera	destroy	Submerged	No effect
strong			
weak			

Part E: effects of Mwera on livelihood

16 Has Mwera wind had any effect on your livelihood as Ornamental fisherfolk? (*please tick one)*

Yes ☐

No ☐

17. What impacts has Mwera had on your livelihoods?

Decrease of salaries ☐

Had to abandon working for an Ornamental fishing company for other economic activities. ☐

Work for extra hours ☐

Increases levels of job insecurity ☐

Increases in monthly income ☐

Reduce working hours ☐

Other specify

_____

18a. Do you know any Ornamental fisher folk who has a quilted job because of the impacts of Mwera on Ornamental fish folk at Stuart M Grant? *(Tick the appropriate box)*

Yes ☐

No ☐

18b. If yes, what are their coping and adaptive strategies? (*please tick all that apply*)

Farming ☐

Small scale business ☐

Boat repairing ☐

Fish trader ☐

Do not know ☐

Other specify

_____

19. Comment on how this has impacted their livelihood.

_____

_____

_____

_____

Thank you very much for your cooperation and may God bless you.

APPENDIX II: Interview guide for Ornamental Fishing Officials at Stuart M Grant Limited

Dear Sir

This questionnaire is to help in gathering information on the effects of Mwera wind speed on Ornamental fishers' coping and adaptive strategies at Senga Bay. The answer you will give will go a long way into improving the situation posed by Mwera on Ornamental Fishery.

Please respond as honestly as you can to all the Questions. Feel free to make further comments you may want to. The answers you give will be treated with the utmost confidentiality. You do not have to write your name anywhere on the questionnaire.

a) Comment on Mwera weather conditions experienced in the area over the recent past.

_____

_____

_____

_____

_____

_____

_____

b) Do the changes in the Mwera weather have any impact on the lake?

Thank you very much for your cooperation and may God bless you.

APPENDIX III: CALCULATIONS OF n. n_1, n_2 and n_3

$n = n_1 + n_2 + n_3 = 44$

$n_1 = (N_1 \div N) \times n = (26 \div 50) \times 44 = 22.88 \approx 23$

$n_2 = (N_2 \div N) \times n = (21 \div 50) \times 44 = 18.48 \approx 18$

$n_3 = (N_3 \div N) \times n = (3 \div 50) \times 44 = 2.64 \approx 3$

n= desired sample size

n_1= sample size of the divers

n_2= sample size of the Ornamental Fisher Houses

n_3= sample size of the officials

N= target population

N_1= total number of the divers

N_2 = total number of the Ornamental Fisher Houses

N_1 = total number of the officials

APPENDIX IV: SOME OF THE FACILITIES USED TO CATCH AND STORE ORNAMENTAL FISH AT STUART M GRANT LIMITED



Collecting buckets



Collecting in action

net



Scuba



Storage glass tanks



Dive boat next to rocks

Source: https://lakemalawi.com.fag.htm

: (Hofman ,2009)