SOCIO ECONOMIC IMPACTS OF THE INVASIVE *TYPHA DOMINGENSIS* ON LOCAL COMMUNITIES ALONG NGURU WETLANDS, YOBE STATE, NIGERIA.

BY

MUHAMMAD BABAGANA

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KAMPALA INTERNATIONAL UNIVERSITY

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A THESIS SUBMITTED TO THE DEPARTMENT OF BIOLOGICAL AND ENVIRONMENTAL SCIENCES, SCHOOL OF ENGINEERING AND APPLIED SCIENCES, KAMPALA INTERNATIONAL UNIVERSITY (KIU), UGANDA, IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER OF SCIENCE DEGREE IN ENVIRONMENTAL MANAGEMENT.

APRIL, 2018.

DECLARATION

I hereby declare that this thesis is original, unless otherwise stated and dully acknowledged, and has never been submitted to any institution for the same or anyother award.

Muhammad Babagana

Sign…….

Date: ……...

APPROVAL

This Thesis was read and approved by me as the supervisor for the research study which is a pre requisite for the award of Master of Science degree in Environmental Management of the Kampala International University (KIU), Uganda.

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DATE:……-.

DEDICATION

This research is dedicated to my children Khalid, Afnan and Basma, and it's an attribute to my late father Malam Babagana Mustafa, who died on the 16th day of August, 2017. May his soul rest in eternal peace.

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In the first place, all praise be to Allah who spared my life and opportuned me to attain this position.

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LIST OF ABBREVIATIONS

HNWs	Hedejia-Nguru Wetlands
KYB-WDI	Komodougu Yobe Basin Wetlands Development Initiative
NGOs	Non-Governmental Organizations
DRC	Democratic Republic of Congo
JEWEL	Jigawa Enhancement of Wetlands Livelihoods
FAO	Food and Agricultural Organization
NEAZDP	North East Arid Zone Development Programme
NCF	Nigeria Conservation Foundation
C4C	Coalition for Change
RSG	Ramsar Swiss Grant
HKYBTF	Hadejia Komodougu Yobe Basin Trust Fund
RMRDC	Raw Material Research and Development Council

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

The study was conducted in the months of July-September 2017 to assess the socioeconomic impacts of the invasive Typha domingensis (Uchytil 1992) on local communities in Nguru, Kakori and Dogon Kuka towns all along the Nguru wetland in Nguru Local Government Area, Yobe State, Nigeria. A total of 171 respondents comprising of local communities and officials of the Hadejia Nguru Wetland Conservation Project (HNWCP) and Komodougu Yobe Basin Wetlands Development Initiative (KYB-WDI) participated in the study. Descriptive Survey method of research involving both qualitative and quantitative approaches was employed while data was collected using closed ended self-made questionnaires and Structured Interview Guide. Datawas analyzed using Descriptive statistics and Pearson Linear Correlation Coefficient. The study revealed that all of the respondents (100%) were young muslim Nigerian males within the age group of 25-34 years and majority of them (45.9%) lacking the basic formal education. Household sizes were relatively big (74.2%) and majority of the respondents (51%) belong to the Kanuri tribe while Hausa, Fulani, Kare Kare and Bade tribes were represented by 26.45, 25.8%, 3.8% and 10.15 respectively. Yobe state had the largest number of its indigenes living along the wetlands (62.3%) followed by Jigawa and Bauchi states having 23.3% and 9.4% respectively. Very good number of the respondents was engaged in fishing (32.7%) followed by crop farming (23.9%), livestock farming (27%), irrigation (10.7%), transportation (3.77%) and hunting (1.9%). Furthermore, problems associated with Typha invasion were found to be immense with 67.4% of the respondents strongly agreeing that the situation is very bad (3.12±0.363) while 78.75% of them also strongly agreed that the socioeconomic impacts of Typha invasion was as well very bad (3.72±0.04). PLCC results showed significant relationship between problems associated with Typha and the socio economic problems facing the local communities (0.988 Pearson correlation at 0.01level (2-tailed) and 0.650 Pearson correlation at 0.01level (2-tailed). Manual cutting, use of fire and chemicals were found to be the main control measures employed by the local communities. Based on the study findings, reintroduction of NEADZDP, judicious use of ecological fund, use of biological control, employment of zero grazing, giving entrepreneurial skills to local people, training people on how to improve their productivity, provision of loan facilities, subsidized pesticides as well as conversion of Typha into positive uses among others, were recommended.

***KEY WORDS**: Local communities, Nguru wetlands, Socio economic impacts, Typha*

CHAPTER ONE
1.0 INTRODUCTION

1.1 Background of the study

Wetland is a land area that is saturated with water, either permanently or seasonally, such that it takes on the characteristics of a distinct ecosystem. The primary factor that distinguishes wetlands from other land forms or water bodies is the characteristic vegetation of aquatic plants adapted to the unique hydric soil. Wetlands play a number of roles in the environment, principally water purification, flood control, carbon sink and shoreline stability. Wetlands are also considered the most biologically diverse of all ecosystems, serving as home to wide range of plant and animal life (Butler, 2010).Wetlands occur naturally on every continent except Antarctica, the largest including the Amazon River basin, the West Siberian plain and the Pantanal in South America. The water found in wetlands can be freshwater, brackish or saltwater. The main wetland types include swamps, marshes, bogs and fens; and subtypes include mangrove, carr, pocosin and varzea (Fraser, 2005).

While some view wetlands as wasted land, in reality they are one of the most valuable resources. Indeed, its importance to the protection of our lakes and streams cannot be overstated. For this reason, many wetlands, particularly the larger ones and those bordering the Great Lakes are protected by state and federal laws. Some of the benefits derived from wetlands include: Helping to control flooding and storm water, protecting water quality by filtering and breaking down sediments, nutrients, and toxins and then slowly releasing the water to recharge the ground water, providing habitat for many different species of wildlife including fish, birds and insects, providing numerous recreational opportunities, for fishing, bird watching etc. Other benefits include, treating pollution by serving as a biological and chemical oxidation basin, controlling erosion by serving as a sedimentation area and filtering basin for silt and organic matter as well as providing avenue for fishing, farming and irrigation farming (www.mywatersheds.org).

The Nguru wetlands located in the north eastern part of Nigeria particularly in Yobe state, is a part of the Hedejia-Nguru Wetlands (HNWs) located in an area in the southern edge of the Sahel Savanna in north eastern Nigeria comprising of permanent lakes and seasonally flooded

pool connected by a network of channels.(Ringim, *et. al*., 2015). The wetland complex is formed by the Hedejia –Jama'are Rivers which drain into Lake Chad. The wetlands cover an area of about 3,500 km^2 (Birdlife international, 2015). Besides, the wetland supports at least 250 species of flowering plants, over 136 types of aquatic flora and fauna, more than 13 species of fishes and 378 species of birds (Oduntan *et. al*., 2010). About 1.5 million people depend on the wetlands ecosystem for their livelihood in the form of agriculture, grazing resources, non-timber forest resources, fuel wood and fishing. It is one of the sites declared as Ramsar site in Nigeria. The wetlands serve as a major source of fish, supplying approximately 6% of Nigeria's inland fish catch with a market value of nearly US $300s,000 per annum (Birdlife International, 2015).

The Hadejia-Nguru Wetlands (HNWs) is confronted by multiple natural, ecological, social and economic problems. (Haladu and Bello,2014). For instance, there are natural changes, for example the impacts of drought, that have serious implications for the future of the wetlands and the sustainability of their production systems. There are also major economic changes within the wetlands themselves such as the increase in irrigation largely as a result of the advent of small petrol – powered pumps and the ban on the importation of wheat in 1988. As the use of small pumps spreads, conflicts are beginning to emerge between farmers and pastoralists and between small and large scale farmers for land access (Haladu and Bello, 2014).The wetlands have also been affected by the construction of dams which has exacerbated the effect of the low rainfall resulting in the reduction in the extent of flooding in the wetlands. Besides, the Hadejia-Nguru Wetlands is also affected by biological invasion as a result of natural and human induced influence which makes many species to invade new regions at an unprecedented rate exerting strong impacts on ecosystems and human welfare (Van Kleunen *et. al*., 2010).

Similarly, the Nguru wetland has been infested by the invasive species known as *Typha* locally referred to as "Kachala" for many years. Disturbances such as wildfire, nutrient enrichment (Eutrophication), overgrazing, land use changes, added fertilizer and use of agricultural chemicals enhance the growth of these and other invasive plant species. Other human activities that encourage establishment of invasive species in the wetlands include

changes in hydrology e.g. freshwater diversion, constructing ponds, reservoirs and lakes (Westbrooks, 1998). These alter resource availability, creating condition suitable for plant invasion that may have profound effects on native plant community composition with direct and/or indirect influence on local fauna (Hager, 2004). Therefore, bio-invasion is so frequent nowadays in every continent and island that continues to alter and degrade natural wetland habitats (Hager, 2004).They have been considered second major threat to biodiversity following habitat destruction (Elizabeth and Scott, 2000). *Typha* also known as catail is a plant locally referred to as "Kachala" by the people living around the Hadejia-Nguru Wetland area (Akinsola, 2000).*Typha*is suspected to have invaded Nigerian inland wetlands from East Africa (Sabo*et. al*., 2016). According to Uchytil, (1992), *T. capensis* (formerly *T. latifolia*) and *T. domingensis* (formerly *T. Australia*) are the two African *Typha* species.

Most of the areas covered by *Typha*fall within the critical areas that are best suitable for flood rice farming and recession farming. The plant colonizes these areas very quickly due to the wide and efficient dispersal of seed by wind and water movement (Akinsola, 2000). Therefore as a result of the numerous agricultural, social and economic threats posed by the invasion of the Hadajia – Nguru Wetlands by*Typha*, this research is aimed to assess the particular socioeconomic problems caused by the invasion on local communities living along the Nguru wetlands in Yobe state, Nigeria.

1.2 Problem Statement

The Hadejia-Nguru Wetlands (HNWs) is confronted by multiple natural, ecological, social and economic problems. (Haladu and Bello, 2014).For example, the impacts of drought that have serious implications for the future of the wetlands and the sustainability of their production system. The Nguru wetland has also been infested by the invasive species of *Typha (Typha domingensis*) (Uchytil, (1992) locally referred to as "Kachala" for many years. Disturbances such as wildfire, nutrient enrichment (Eutrophication), overgrazing, land use changes, added fertilizer and use of agricultural chemicals enhance the growth of these and other invasive plant species. Other human activities that encourage establishment of invasive species in the wetlands include changes in hydrology e.g. freshwater diversion, constructing ponds, reservoirs and lakes (Westbrooks, 1998).

Consequently, most of the communities living along Hadejia River in Nigeria are currently embattled with proliferation of *Typha*, which is colonizing most importantly, irrigated lands, ponds, grazing lands, river channels and reservoirs causing blockages and siltation added by *Typha* (Sabo *et. al.,* 2016). According to Yarima (2016), *Typha* invasion significantly affected the socioeconomic status of people whose livelihood depended on wetlands. In his study, he found that there was a significant impact of *Typha* plant on the livelihood of crop farmers through reduced or complete loss of cultivation of some crops, particularly irrigated crops such as maize, wheat, rice, and vegetable; fish farmers are also affected through reduced fishing sites and fish catches as well as livestock farmers through loss of grazing lands.

The economy of the people living along the Hadeejia – Nguru Wetlands is threatened with proliferation of an invasive *Typha* which is colonizing most irrigated lands. The people are currently living in abject poverty and apprehension in fear of what to do next. Considerable numbers of farming and fishing communities have migrated from the area while many are planning to migrate to other places following what they regard to as the failure to rescue their farmlands from invasion by *Typha,* which they describe as the most dreadful threat to their sources of livelihood. (Ringim *et. al.,* 2015).

The Raw Material Research and Development Council (RMRDC) in collaboration with the Yobe state government had developed a technology to briquette the *Typha* of the HNWs into fuel pellets for local use and export using technology from neighbouring Mali. The Federal Ministry of Environment in collaboration with the three states of Yobe, Jigawa and Bauchi embarked on mechanical clearance of *Typha* in addition to dredging the wetlands all in attempt to curb the spread of this stubborn plant. However, despites these efforts by governments at all levels and of several NGOs, proliferation of *Typha* still persists affecting all ecological aspects of the wetlands and livelihood of the local communities living along the Hadejia – Nguru Wetlands.

In view of the above, therefore, there is a greater need to actively engage in research in order to fully study and understand the situation on ground in an attempt to address this serious

threat by the invasive *Typha* that is impacting negatively on the wetlands ecosystem as well as people's livelihood and their socioeconomic being.

1.3 Main objective of the Study

The main purpose of this research was to examine and assess the socioeconomic impacts of invasive *Typha* on local communities along the Nguru wetlands Yobe state, Nigeria as well as the common control measures being employed to manage the invasion.

1.4 Specific Objectives

The specific objectives of this research were:

1. To examine characteristics of the local communities living along the Nguru wetlands, Yobe State, Nigeria.
2. To determine impacts of the invasive *Typha* on socioeconomic activities of the local communities living along Nguru wetlands, Yobe State, Nigeria.
3. To assess the management/control measures of the invasive *Typha* along the Nguru Wetlands, Yobe State, Nigeria.

1.5 Research Questions

In order to draw answers to the research objectives stated above, the following research questions are put forward

1. What are the characteristics of the local communities living along the Nguru Wetlands, Yobe State, Nigeria?
2. What are the impacts of invasive *Typha* on socioeconomic activities of the local communities along the Nguru Wetlands, Yobe State, Nigeria?
3. What are the management/control measures of the invasive *Typha* along the Nguru Wetlands, Yobe State, Nigeria?

1.6 Research Hypothesis

Ho: *Typha* invasion has no significant effect on the socio economic activities of local communities along the Nguru wetlands, Yobe state, Nigeria.

1.7 Scope of the study

1.7.1Geographical Scope of the Study

The scope of this study was restricted to only cover the three settlements selected for the study along the Nguru Wetlands in Nguru Local Government Area of Yobe State, Nigeria. These settlements were Nguru, Kakori and Dogon Kuka towns. Nguru wetlands is the segment of the Hadejia-Nguru Wetlands found in Yobe State Nigeria which lies along a central coordinates of Longitude 10^0 33' East and Latitude 12^o 39' North, with altitude of 152 – 305m. It is an extensive area of floodplain located in the north-eastern Sudano-Sahelian zone of Nigeria, covering an area of approximately 3,500 square kilometer (FAO, 2009). Data was also collected from two organizations (NGOs) concerned with conservation of the Hadejia-Nguru Wetlands namely, Hadejia-Nguru Wetlands Conservation Project (HNWCP) and the Komodougu Yobe Basin Wetlands Development Initiative (KYB-WDI).

1.7.1.1 Hadejia-Nguru Wetlands Conservation Project (HNWCP)

The ornithological importance of the Hadejia-Nguru wetlands at both national and international levels is well known. Current efforts at conserving the avifauna of the wetlands started with the establishment of the Hadejia-Nguru Wetlands Conservation Project (HNWCP) in 1987, as a joint international initiative to promote sustainable use of this hydric ecosystem in the otherwise semi-arid zone of north eastern Nigeria. The present phase of the project started in 1995 with the major goal of maintaining the natural resources and function of the wetlands. However, recognition of the vital and central role of water in maintaining the ecological health of the wetlands has prompted the project to evolve a new strategy of regular meetings of the wetlands' water stakeholders (tagged "water-use advocacy"), to resolve periodic water-shortage and distribution problems (Derek and Marie-Theresa, 1997).

Uncontrolled hunting of birds and habitat loss remain pressing problems throughout the wetland. The HNWCP has made efforts to curb these problems by sensitizing the local communities through awareness campaigns and harnessing the efforts of concerned local and national organizations (Akinsola *et. al.,* 2000).

1.7.1.2 Komodougu Yobe Basin Wetlands Development Initiative (KYB-WDI)

The Komadugu Yobe Basin Wetlands Development Initiative (KYB-WDI) project is a joint initiative of the then Nigeria Federal Ministry of Water Resources (now the Nigeria Federal Ministry of Agriculture and Water Resources), the World Conservation Union and Nigerian Conservation Foundation aimed at improving equitable and sustainable management of land and water resources in the Komodougu Yobe Basin (KYB).

The Komadugu Yobe Basin (KYB) covers a total area of about 148,000 km2 in north eastern Nigeria (comprising about 57% of basin area) and south-eastern Niger (constituting the remaining 43%). The basin is drained by two main river sub-systems. The first sub-system, the Yobe River, is formed by the Hadejia and Jama'are tributaries, which create the Hadejia Nguru floodplain at their juncture. The second sub-system is the Komadugu Gana (or Missau) River. Historically, it is a tributary of the Yobe River. The Nigeria portion of the basin contributes more than 95% of the basin's water.

Phase 1 of the project with duration of 2 years and three months has the main aim of improving the institutional framework for managing water resources in the basin. This phase of the project has the following main components: (a) establishment and sharing of a sound knowledge base to facilitate stakeholder negotiations and inform decision making; (b) pilot-testing of improved water management interventions in selected sites (Jibrin, 2007)

1.7.2 Theoretical Scope

Theoretically, this research was based on the Invasive Meltdown Theory proposed by Daniel Simberloff and Betsy Von Holle in 1999 (Simberloff and Betsy, 1999). This Theory states that as species are added to an ecosystem, each one representing a potential disturbance, the native system is perturbed in such a way that the system reaches a threshold, at which point it cannot resist any further and invasions occur exponentially. Every individual invader is a threat, but it is their collective impact that can cause the greatest damage to a habitat. This phenomenon is termed Invasional Cartels, and creates the conditions for a meltdown.

1.7.3 Content Scope

This research was restricted to only study characteristics of the local communities living along the Nguru wetlands, socioeconomic impacts of the invasive *Typha* on the local communities living along the wetlands as well as the common control measures being employed to manage the invasion.

1.7.4 Time Scope

This study covered the period between the periods 2012 – 2017 while the study was conducted between the months of July – September, 2017.

1.8 Significance of the Study

The findings of this research will be of great benefit to government agencies, agricultural/ environmental agencies and institutes, Non-Governmental Organizations (NGOs) as well as students of Agriculture and Environmental Management. The findings of this study shall benefit governments at all levels by providing data on the impacts of invasive *Typha* plant and its effects on the socio-economic livelihoods of the local communities living along the wetlands for efficient and effective planning and necessary interventions. Similarly, relevant agricultural and environmental agencies can also benefit from the findings of this study including Non-Governmental Organizations (NGOs) for record keeping, efficient planning, necessary interventions and raising awareness. Students of Agricultural and Environmental Management can also benefit.

CHAPTER TWO
2.0 LITERATURE REVIEW

2.1 Theoretical review

Theoretically, this research study will be based on the Invasive Meltdown Theory proposed by Daniel Simberloff and Betsy Von Holle in 1999 (Simberloff and Betsy, 1999). This Theory states that as species are added to an ecosystem, each one representing a potential disturbance, the native system is perturbed in such a way that the system reaches a threshold, at which point it cannot resist any further and invasions occur exponentially. Every individual invader is a threat, but it is their collective impact that can cause the greatest damage to a habitat. This phenomenon is termed Invasional Cartels, and creates the conditions for a meltdown.

In summary, the theory postulates that, invasive alien species can lead to habitat destruction as a result of the disorganization of ecological systems. Thus, it is for this reason that this study is based on this theory because the invasion of the Nguru wetlands by *Typha* is believed to be as a result of partial or total collapse of the ecological aspects of the wetlands. Invasive species such as *Typha domingensis* can cause habitat destruction by altering community structure through exploitation competition (indirect in interactions such as resources use) and interference competition (direct interaction such as allelopathy in plants as well as plant succession (Charles and Dukes, 2007). *Typha* in dense biomass has the ability to influence plant structure and distribution. Extensive litter deposition by Typha also buried mineralised substrates necessary for many native plants to germinate (Hager, 2004). Thus, it spreads fast and invades large spaces along wetlands with consequent effects on the ecosystem as well as those people whose livelihoods depend directly or indirectly on these wetlands. Hence, this theory is deemed relevant to this study.

2.2 Conceptual framework

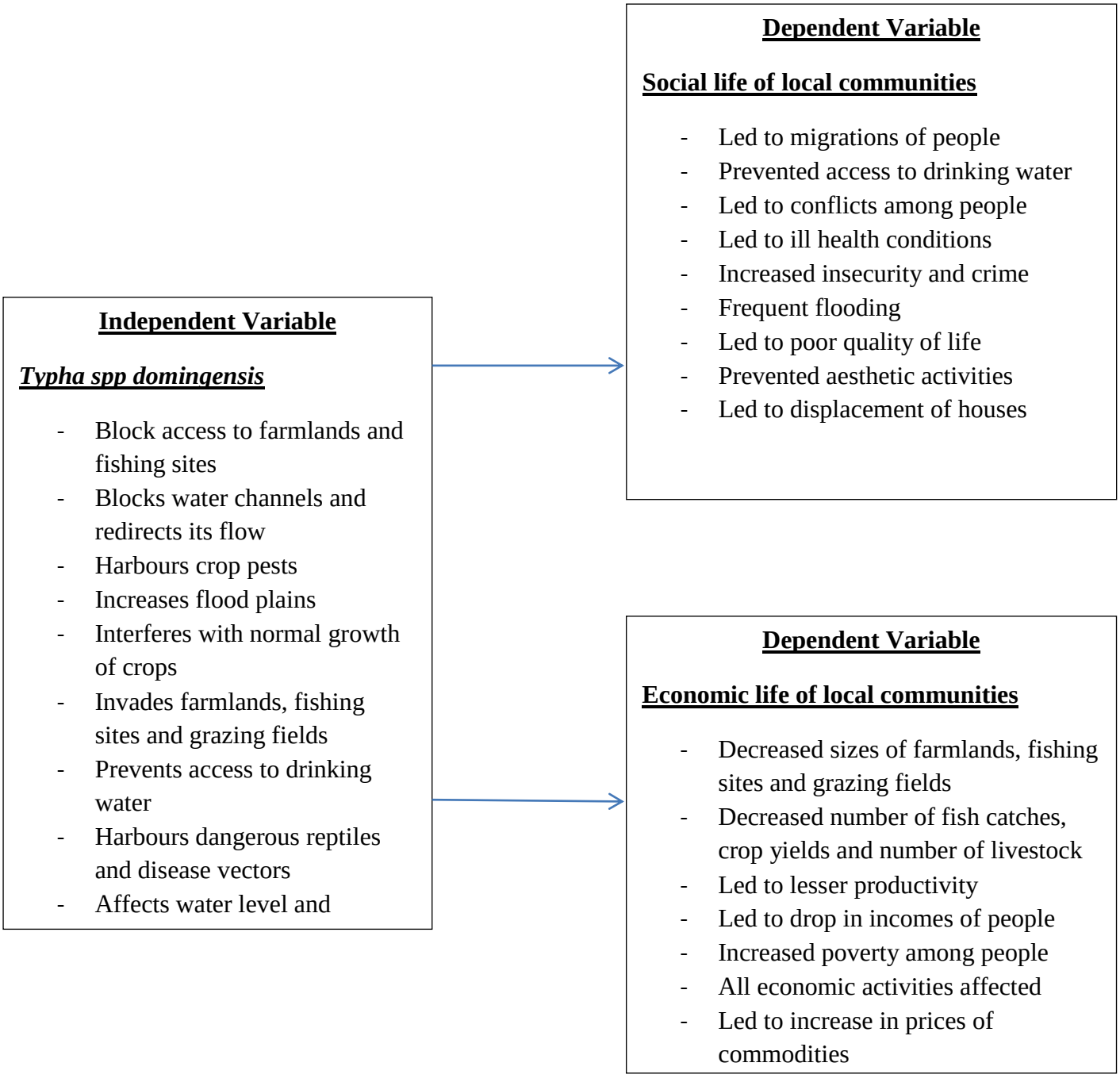

Figure 2.1 Model of Conceptual Framework

2.3 Conceptual review

2.3.1 Characteristics of people living along wetlands

The Niger Delta is one of the largest wetlands in the world and currently has three sites listed as Ramsar Wetlands of International Importance. The region is home to nearly 30 million people, 60 percent depend directly on the services provided by the environment – such as fish and clean drinking water– for their well-being. The Abobiri, Obia-yagha and Opume communities in the Niger Delta have changed the way they manage their wetland environment. 58 community member-groups provided with access to micro-credits have stopped wetland-detrimental livelihood practices (mainly mangrove cutting) and switched to wetland-friendly livelihood practices such as fish, periwinkle, plantation and poultry farming. In addition, they are contributing to wetland restoration through wetland tree nurseries and restoration, tree planting and clearing of waterways overgrown by invasive plant species (www.wetlands.org/case study).

The Hadejia-Nguru Wetlands is the first Nigerian wetland named as a Ramsar site. The area is dominated by Hausa, Fulani, Kanuri, and Bade ethnic groups with population capacity of 1million people; these people depend on the wetland for water supply and other daily activities. About 1.5 million people depend on the wetlands ecosystem for their livelihood in the form of agriculture, grazing resources, non-timber forest resources, fuel wood and fishing. Many of the inhabitants of the area emigrated around the 60s at the time of drought. Fishermen and farmers in the HNWs represent about 75% of the indigenous community population (Birdlife international, 2015), and the wetlands represents their entire source of livelihoods through farming and fishing activities. Farming in particular accounts for about 25% and major crops grown include rice, maize, sasame, sorghum, wheat, millet, and some vegetables such as tomato, pepper, onions, and carrot (Kaugama and Ahmed, 2014; Birdlife international, 2015). The wetland area has abundant agricultural resources worth about € 26, 982, 651.60 and the region serves as a centre point of cattle trade worth of 250,000 cattle. (Elegbede, *et. al*. 2014). In dry seasons, many nomadic herdsmen mostly Fulanis inhabit the area with large number of animals especially cattle. According to Kaugama and Ahmed (2014), Hausa, Kanuri and Fulani are the most dominant tribes in the wetlands with an estimated population of about1.5 million Including farmers, herders and fishermen who entirely depend on the ecosystem for their livelihoods.

2.3.2 About *Typha*

Typha is an aquatic macrophyte (an aquatic plant that grows in or near water and is either emergent, submergent, or floating) often regarded as weed due to their ability to form dense non specific stands which reduce the biodiversity of wetlands and clog water channels (Miklovic, 2000). *Typha* also known as cattails is a plant locally referred to as "Kachala" by the people living around the Hadejia – Nguru Wetland area (Akinsola, 2000).

Typha is a genus of about 30 species of monocotyledonous flowering plants in the family *Typhaceae*. The genus is largely distributed in the Northern Hemisphere, where it is found in a variety of wetland habitats. These plants have many common names. They are known in British English as bulrush or reedmace, in American English as cattail, punks or corn dog plant, in Australia as cumbungi or bulrush in Canada as bulrush or cattail and in New Zealand as raupo (Boers, 2007). The taxonomy of *Typha* is: Kingdom – Plantea (Angiosperms, Monocots, Commenlinids) Order – Poales*:* Family-Typhaceae; Genus-*Typha.*

2.3.3 Morphology of *Typha*

Typha can reach a height of up to 2.5 -4 produce a greater number of leaves between 5-15 mm when dry, stems are 3-4 mm thick and shoots are 1-2 cm thick when flowering and can produce 20,000-700,000 seeds per inflorescence (Miklovic, 2000).

Typha leaves are alternate and mostly basal on a simple, joint less stem that bears the flowering spikes. The plants are monoecious with unisexual flowers that develop in dense recemes. The numerous male flowers form a narrow spike at the top of the vertical stem. Large numbers of tiny female flowers form a dense, sausage-shaped spike on the stem below the male spike. The seeds are minute, 0.2 mm long attached to fine hairs. When ripe, the heads disintegrate into a cottony fluff from which the seeds disperse by wind. Nutritional values of the *Typha* are carbohydrate (sugar and dietary fibers), fats, proteins, vitamins, minerals and water (Shipley, 1989).

2.3.4 General ecology of *Typha*

Typha is often among the first wetland plants to colonise areas of newly exposed wet mud with their abundant wind dispersed seeds. Buried seeds can survive in the soil for long periods of time. They germinate best with sunlight and fluctuating temperatures which is typical of many wetland plants that regenerate on mud flats. The plants are spread by rhizomes, forming large, inter connected stands.

Typha is considered to be the dominant competitor in wetlands in many areas, and it often excludes other plants with its dense canopy. Different species of cattails are adapted to different water depths. Even the dead stalks are capable of transmitting oxygen to the rooting zone. This makes them very stubborn to eliminate. .

2.3.5 Uses of *Typha*

However, despite the threats to the sustainability of wetlands for which *Typha* are largely known, they also possess some important uses. *Typha* have been used in chair making, many parts of the plant are edible to humans and animals, the seeds have high linoleic acid content and can be used to feed cattle and chickens, *Typha* are also used to construct rafts and as thermal insulation in buildings as well as in paper making. *Typha* can be used as a source of starch to produce ethanol (biofuel), the seed hairs were used as tinder for starting fires. Besides, *Typha* can be dipped in wax or fat and then lit as a candle, the stem serving as a wick. Without the use of wax or fat, it will smoulder slowly somewhat like incense and may repel insects. Other informal experiment has indicated that *Typha* are able to remove arsenic from drinking water. The boiled root stocks have been used as a diuretic for increasing urination, or mashed to make a jelly- like paste for sores, boils, wounds, burns, scabs and small pox pustules (Miller, 1999).

According to Sabo *et al.*, (2016), because of the presence of large quantity of *Typha* in the Hadejia Rivers, the people around use it for cooking, using the leaves to cover Kola nuts and for construction of a local storage facility (granary) locally called “Rumbu”.

2.3.6 Socioeconomic impacts of *Typha*

Agricultural losses to invasive species are enormous in all parts of the world. For example the cassava mealybug which was accidentally introduced into the Democratic Republic of Congo

(DRC) in 1973, rapidly spread causing yield losses of over 80% with an estimated cost to small holders and subsistence farmers of US $ 4.5 billion (Zeddies *et. al*., 2001).

According to Yarima (2016), *Typha* invasion significantly affected the socioeconomic status of people whose livelihood depended on wetlands. In his study, he found that there was a significant impact of *Typha* on the livelihood of farmers through reduced or complete loss of cultivation of some crops, particularly irrigated crops such as maize, wheat, rice, vegetables and fish farming. The study further revealed that the significant effect of *Typha* on fishery farmers' output was 32.5%, income 48.6% and level of living was 26.5%. Effects *Typha* on crop farmers' output was 37.4%, on income was 29% and on level of living was 55.1%. Effects of *Typha* on livestock farmers' output was 44.9%, on income was 57.7% and on level of living was 23.6%. These findings sufficiently signify that impacts of the invasive *Typha* on the socio economic status of people are eminent and further prove the findings of many other researchers who undertook similar researches.

Typha is a serious problem threatening the sustainability of the whole irrigation scheme along the Hadejia- Nguru Wetlands. Over 80% of the main canal and other water distributary channels have been overtaken by this type of weed, there by blocking the free flow of water into the irrigation fields (Haruna, 2006). Twenty years ago, waters of the river Hadejia and Jama'are seasonally flooded their intricate network of smaller river channels providing fish ponds and Fadamas in abundance as productive resources for fishermen, farmers and livestock rearers (Sabo *et. al.,* 2016). It is on record that fish catches from the Hadajia- Nguru Wetlands contributed about 6% of the annual national income of inland fish sales in Nigeria. Today it provides only 0.6%. Cultivation of wheat, maize and vegetables brought local Fadama farmers an average income of nearly 10,000 Naira per season a decade ago, but now brings barely 2000 Naira even after investment in Fadama development technology (Sabo *et. al*., 2016). Rice production, which rapidly expanded in the wetlands during the mid-90s as a lucrative form of dry season flood recession farming has dwindled in recent years to invisibility (Ramsar Convention Bureau, 2000).

Typha which naturally breeds birds also constitutes a tangible impediment to fish-farming, call it "Natural Conservation". The growth of this plant has no adverse effect on the fish itself or its aquatic life but would not give room for the hide-out for the fish which has to come out in the open to be caught. Judging from the above, traditional methods of fish- farming are employed and these methods only accounts for a small proportion of the fish population thereby fulfilling the aim of conservation in a natural way (Animal Right in Nigeria, 2010).

Impacts of invasive species on ecosystem services related to agriculture, industry, and human health are substantial. These impacts affect the delivery of food, freshwater, and fiber, as well as water purification, pollination, natural pest control, disease regulation, soil fertility, nutrient and water cycling (Charles and Dukes, 2007). In the HNWs, about 1.5 million people depend on the wetlands as their primary source of livelihood (Ringim *et. al*., 2015). For example, in Guri village, many farmers reported that before the emergence of *T. domingensis*, they could harvest 200 bags of rice in a 10 hectares farmland, but hardly have they harvested 50 bags in the same piece of land nowadays. Similarly, in Hadin village, some respondents complained that, during 2007 season they recorded less than a quarter of the expected harvest as the result of crop damage by quelea birds. Besides, channel blockages caused by *Typha* have caused reduced flooding in many parts of the wetlands that lead to decrease in fish abundance (Ringim *et. al*., 2015). Similarly, the Jigawa Enhancement of Wetlands Livelihoods (JEWEL) project (2004) reported that the average income of fish catch per fisherman has reduced from about $5 per day to less than $3 per day.

Meanwhile, still according to Ringim *et al.* (2015), the invasive *Typha* does not only cause economic and ecological nuisance, but also causes substantial losses to recreation and tourism, particularly ecotourism. Aquatic macrophytes such as *T. domingensis* that form dense layers or beds along the shore are a notorious nuisance for boating, swimming, and diving activities.

Furthermore, with regards to this research, the concept of socioeconomic impacts of the invasive *Typha* is perceived as reduction in farming, fishing, grazing and irrigation sites, drop in outputs from socioeconomic activities as well as overall decrease in people's incomes and livelihoods.

2.3.7 Ecological problems associated with *Typha* invasion

According to Ringim *et. al*., (2015), the problems associated with invasive alien species such as *Typha* are reflected in their impacts on biodiversity such as plant community, water bird community and invertebrate community. Other impacts are on farming and grazing activities, fishing activities and others which include impacts on recreation and tourism, boating, swimming and diving activities

Invasive species may alter community structure through exploitation competition and interference competition. About 1.5 million people depend on the Hadejia -Nguru Wetlands as their primary source for livelihood (Ringim *et. al.*, 2015). Thus, reduction in its biodiversity as a result of invasive species may have a detrimental effect on the communities' well-being through farming and fishing in addition to loss of aesthetic, cultural and spiritual values of the wetlands.

Bioinvasion is so frequent nowadays in every continent and island that continues to alter and degrade natural wetland habitats (Hager, 2004).They have been considered second major threat to biodiversity following habitat destruction (Elizabeth and Scott, 2000).*Typha* has become a common feature along the Hadejia-Nguru Wetlands (HNWs) and a nuisance to the communities. It blocks the passage of canoes used for fishing or access to remote farmlands. Besides, the thickness of the *Typha* provides nitch for thieves especially cattle rustlers and also for dreaded migratory birds that destroy crops (Haladu and Bello, 2014).

According to Temitope and Folaranmi (2012), invasion by alien species such as *Typha* causes extensive damage on the habitat they invade which include impact on indigenous species diversity, soil nutrients composition altering forest fire cycle and loss of productivity of invaded ecosystems. It also becomes a threat to endangered or threatened plant species around the world (Pimentel *et al*., 2005). Invasive species may as well cause changes in environmental services, such as flood control and water supply, water assimilation, nutrient recycling and conservation and regeneration of soils (Levines and D'Antonio 2013).*Typha* invasion may deplete soil nitrates with resultant poor crop yields which will require the use of artificial fertilizers and pesticides. If these chemicals are added in excessive quantities, however, they percolate into the ground water supplies, flow into streams and rivers and trapped by *Typha*. This may have effects on aquatic

and marine life ecosystems and may lead to public health problems when the water is used for drinking and irrigation (Sabo, 2010).

Most of the communities along the Nguru wetlands are currently embattled with the proliferation of *Typha*, which is colonizing most importantly irrigated lands, ponds, grazing lands, river channels and reservoirs, causing blockages and siltation added by the plant (Sabo *et. al*., 2016). Reason to these annual flood seem to lie on the blockage of channels by *Typha*, growing rapidly and taking over farmlands, fishing ponds, canals, reservoirs in Hadejia,Jigawa state and Nguru in Yobe state (Gomes, *et. al*., 2003). *Typha* has also completely blocked the Hadejia-Jamaare River down to Lake Chad (a distance of about 1,000 km) thereby making fishing occupation cumber-some for the inhabitants because the Hadejia-Jamaare River apart from its fertile arable farmlands is a veritable farming zone. Fish-farming to the inhabitants, is the next occupation to crop farming. (Animal Right in Nigeria, 2010).

2.3.8 Management/ Control of *Typha*

Cattail control or reduction may be desirable where noticeable increases threaten natural plant diversity and habitat heterogeneity. Management may be necessary to control the spread and domination of potential habitat by cattail in and perhaps adjacent to natural areas, circumvent declines in other plant species with cattail proliferation and to prevent development of monotypic cattail growth and loss of habitat heterogeneity.(Steven, 2015.)

Most cattail controls have been made by wildlife managers interested in waterfowl production. Some methods would not be considered for use in designated nature preserves or natural areas. These methods include chemical and physical control, prescribed fire, shading, and water level modifications (Steven, 2015).

Chemical Control

For designated preserves or natural areas, especially where system-oriented stewardship is used, chemical application may not be appropriate. However, use of chemicals to control an overabundance of cattail may have certain applications. Chemicals such as herbicides interrupt metabolic pathways and have been used successfully to kill cattails.

Physical Control

Cattails can be controlled physically by cutting, crushing, shearing, or disking. These can impede starch storage if done during growing season. Deep disking can retard shoot formation and can damage rhizome, but the effect on plant survival is variable. Hand or mechanical cutting of cattails followed by submerging of all cattail stems results in high control.

Prescribed Fire

Burning cattails is difficult during the growing season, except during extreme low-water conditions. The fire usually does not kill the plants but can stress starch storage. Fires that destroyed cattail roots offered control; however, most fires only burned above-ground biomass and did little to control cattail.

Shading

Black polythene tarps were used to cover cattails in an attempted control measure. Actively growing cattail tips were killed when completely covered at least sixty days.

Water Level Modification

The depth of water necessary to kill the plant depends on temperatures; the quantity of starch the plant stored the previous year, and the general vigor of the plant. Therefore, no minimum water depth can be prescribed, but a rule of thumb would be to maintain 3-4 feet (0.9-1.2 m) of water over the tops of existing shoots in spring. If water remains only a few inches above the top of the growing shoots and standing dead leaves, oxygen is prevented from reaching the rhizomes. The use of water is efficient if the water level is raised progressively, so that all plant parts remain submerged by no more than a few inches.

Other techniques of controlling cattails are Grazing and Salinity alterations. Grazing by cows, geese, muskrats, and other animals on seedlings and young cattails without extensive rhizome can remove entire plants. Seawater is used locally to kill cattails in coastal areas in the south eastern United States where historic salt marshes have been impounded and managed as freshwater wetlands (Richard and Kent, 1993).

According to a research conducted by Yarima (2016), to control the proliferation of *Typha* along the Hadejia – Nguru Wetlands, majority of the farmers (56%) employ the method of cutting and at the same time flooding the area to avoid seed germination and stem sprouting. About 36% of

the farmers use mechanical clearing method by slashing the weed while about 9% of the farmers use chemical method as a strategy to reduce the weed.

Uncontrolled hunting of birds and habitat loss remain pressing problems throughout the wetland. The HNWCP has made efforts to curb these problems by sensitising the local communities through awareness campaigns and harnessing the efforts of concerned local and national organisations (Akinsola *et. al.,* 2000).

2.3.9 Importance of wetlands

Wetlands provide valuable ecosystem services thus ranked among the earth's most productive ecosystems (Ramsar, 1997). According to Ringim, *et. al*., (2015), the Millennium Ecosystem Assessment (2005) framework places these services into four categories as follows: Provisioning services are products obtained from ecosystems and include food (crops, livestock, fisheries), fresh water, fiber (timber, cotton, silk), fuel, genetic resources, natural medicine and ornamental resources; Cultural services are non – material benefits and include aesthetic values, recreation, tourism, spiritual/religious values, educational/ scientific values and cultural heritage values; Supporting services that are necessary for the maintenance of other services such as photosynthesis, primary production, nutrient cycling, water cycling as well as regulating services that are obtained from the regulation of ecosystem processes and include air quality regulation, climate regulations, pollination, erosion control and coastal storm protection.

Also, wetlands perform two important functions in relation to climate change. They have mitigation effects through their ability to sink carbon, and adaption effects through their ability to store and regulate water (US EPA, 2009).

2.3.10 Prospects of farming along wetlands

Wetlands have been used for agriculture for thousands of years. They provide a range of valuable ecosystems services such as the provision of food and clean water, the retention of soil and the cyclic of nutrients (www.environment.gov.au).

There are many different ecosystem services provided by wetlands that can benefit agriculture and contribute to human well-being. Wetlands can support fertile soils, reduce erosion and retain

sediments and nutrients as well as reduce the potential for salinity and acid sulphate soils. Wetlands also support aquaculture or grazing, provide habitat for harvestable plant and animal species, provide drinking water for livestock, provide shade, wind buffering, protection from floods and habitat for birds. Other benefits of wetlands are provision of a range of raw materials such as timber, stock fodder, salt peat and fire woods, act as natural filters in waste treatment as well as assisting in drought resilience, a key challenge for farmers throughout many nations.

According to Elegbede, (2014), the Hadejia-Nguru Wetland community benefit from various activities that surround the wetlands, such as income generation and provision of food, from the different activities such as agriculture, land grazing, wood for domestic fuelling, other wood products and mechanisms for protection against drought. The Hadejia-NguruWetlands is considered to have an economic value of around $ 11.7 million (Idris, 2008).

In dry seasons, nomadic farmers move to the area for grazing and the environment has the capacity to accommodate about 32,000, 370,000 and 375,000 cattle, goats and sheep respectively (Idris, 2008). The livelihood status of the people is strengthened by the construction of water dams and irrigation construction for the public, thus, has promoted the income and standard of living of the people (Elegbede, 2014).

2.3.11 Challenges of farming along wetlands

Globally, different threats have been observed affecting the world wetlands, namely pollution, over intensification of agricultural activities, industrialisation and urbanisation (Elegbede, 2014). One of the major challenges is the overuse of the resources in the dry arid regions which are faced with the decrease of water resources for the establishment, construction of irrigation for agricultural and for other purposes. In the western part of Africa, more than 100 dam projects have been constructed which affected the existence and sustainability of wetlands (Thompson and Hollis, 1995). Besides, the conversion of wetlands to agricultural production area has greatly impacted on fish and wildlife habitats throughout the world (Lemly *et. al.*, 2000).

The rate and level of wetland reduction is highly alarming all over the world, a reduction percentage of about 50% have been observed (Jos and Tim, 2010). These have affected the

wetland resources hence, species become affected and endangered. Climate change is also a challenge to the wetlands resources. This is significantly affected by change in hydrology and biogeochemistry of the aquatic eco system (Nwankwoala, 2012).

Bioinvasion has been recognized as a major problem affecting wetlands. *Typha* has been reported to invade the rice and cassava fields which blocks and redirects the flow and channels of the associated river, also the fisheries resources of the area are affected (Rebelo, 2009). The HNWs is prone to environmental degradation and ecosystem, food chain imbalance, biodiversity deformation, which are majorly caused by human induced impacts such as industrialization, mineral exploitation and urbanization.

2.4 Empirical review

Sabo *et. al*., (2016) conducted a study on *Typha* militating against agricultural productivity along Hadejia Rivers in Jigawa state, Nigeria. His findings revealed that *Typha* had led to lower productivity of farmlands. Data obtained showed that there was reduced or complete loss of cultivation of some crops, particularly irrigated crops such as maize, rice and vegetables in all the areas investigated. He further added that the impact of blockage caused by *Typha* resulted in reduced flow of water in the area. This had consequently resulted in reduction of fish catches in the area, which reported that, the average fish catch by fishermen per day had reduced form 3-4 basins to just half a basin of catch per day.

The study also found out that *Typha* harbours birds, snakes and mosquitoes. More than 30% of cereal crops grown by the communities are consumed by quelea birds. It was found out that during 2007 season, the farmers recorded less than a quarter of the expected harvest which the attributed to quelae birds invading their farms. This agrees with the findings made by Suleiman *et al.,* (2014) in a study titled Bird Diversity and Abundance in Relation to Typha occurrence at the Hadejia-Nguru Wetlands. He found out that, increase in *Typha* abundance had significant effects on both bird abundance and bird diversity. He added that, for every 10% increase in *Typha* abundance, number of bird species was found to increase by 1.5%. Likewise, bird diversity increased by 0.02% for every 10% increase in *Typha* abundance.

In another study conducted by Ringim *et. al*., (2015), on the implication of invasive plant *T. domingensis* on biodiversity of Hadejia – Nguru wetlands, Nigeria, it was found out that the impact on plant community of *Typha* is the alteration of community structure through exploitation competition and interference competition as well as plant succession. Besides, it was also revealed that *Typha* in dense biomass have the ability to influence plant structure and distribution. Extensive litter deposition by *T. domingensis* also buried mineralized substrates necessary for many native plants to germinate (Hager, 2004). This may strongly affect plant community composition by inhibiting their establishment that may lead to habitat homogenization. Consequently, this may decline the abundance of economically valuable species, in particular those used for food, medicinal plants and loss of local genetic resources and genetic diversity (Lynn, 2005).

Large biomass of *T. domingensis* has also been found to be responsible for the decline in fish catch, diversity, as well as size and abundance. Channel blockage caused by *T. domingensis* has caused flooding in many parts of the wetlands that led to decrease on fish abundance. Moreover, it was established by Ringim, *et. al.,* (2015), that, about 1.5 million people depend on the wetlands as their primary sources of livelihood. Thus, reduction in its biodiversity may have a detrimental effect on the communities well – being through farming and fishing.

Haladu and Bello, (2014), in their study Prospects and Challenges of Farming along Hadejia - Nguru Wetlands, Nigeria, found that *Typha* has become a common feature in the area and a nuisance to the communities blocking the passage of canoes used for fishing or access to remote farmlands. It was also discovered that the thickness of the *Typha* provides nitch for thieves especially cattle rustlers and also for the dreaded migratory birds that destroy crops.

According to Yarima (2016), *Typha* invasion significantly affected the socio – economic status of people whose livelihood depended on wetlands. In his study, he found that there was a significant impact of *Typha* on the livelihood of farmers through reduced or complete loss of cultivation of some crops, particularly irrigated crops such as maize, wheat, rice, vegetable and fish farming.

Summarily, all the findings made by the above research studies imply that invasion of communities by *Typha* led to detrimental effects on farming and fishing activities, signified by low farm yields and perhaps loss of crops as well as low fish catches; low socio-economic status of the people through reduction of gains from farming and fishing and increase in costs of controlling the plant. Meanwhile, *Typha* was also found to harbour dreaded crop destroying birds and also affected the health status of the people by harbouring mosquitoes and snakes. Recreation and tourism especially ecotourism were also affected; Physical hazards such as threat of losses from flooding, habitat destruction, loss of biodiversity, loss of grazing fields, social and security hazards such as provision of hideouts for thieves as well as clashes among people and communities over farmlands were all consequences of *Typha* invasion of wetlands as discovered by the different research studies.

2.5 Research gap

Considering the findings of many similar researches conducted including those mentioned above, one fact remains clear that almost all of the researches conducted on the Hadejia – Nguru Wetlands in Nigeria concentrated mainly on the two other states bordering the wetland (i.e. Bauchi and Jigawa state). Moreover, no study of this nature was found to have been conducted in the three areas selected for this study especially pertaining to the local communities' characteristics. Therefore, this study was aimed to fill the contextual and content gaps created. It concentrated mainly on describing the demographic, cultural and socioeconomic characteristics of the local communities as well as determining the socioeconomic impacts of the invasive *Typha* on local communities living along the Nguru wetlands.

CHAPTER THREE
3.0 RESEARCH METHODS

3.1 Study area

The Nguru Wetlands found in Yobe State Nigeria is a segment of the Hadejia – Nguru Wetlands which lies along a central coordinates of Longitude 10^0 33' East and Latitude 12^o 39' North, with altitude of 152 – 305m. It is an extensive area of floodplain located in the north-eastern Sudano-Sahelian zone of Nigeria, covering an area of approximately 3,500 square kilometer (FAO, 2009). It has an annual rainfall which ranges between 200 – 600 mm, with a rainy season that lasts three to four months, confined to the period late May – September. It comprises of permanent lakes and seasonally flooded pools connected by a network of channels (Birdlife international, 2012).The wetlands complex is formed by the Hadejia – Jama'are Rivers which drain into Lake Chad. The topography of the area is mostly low lying flat surfaces on the north-eastern side and limited local relief in the southern and western sides.

At one time, the wetlands might have covered up to 3000 km^2. Between 1964 and 1971 over 2000 km^2 were flooded. By 1983 less than 900 km^2 were flooded and less than 300 km^2 were flooded in the drought year of 1984 (FAO, 2009). The HNWs is bordered by three states of Bauchi, Jigawa and Yobe with human population of about 1.5 million (Sabo *et al.*2016). It is one of the sites declared as Ramsar sites in Nigeria.

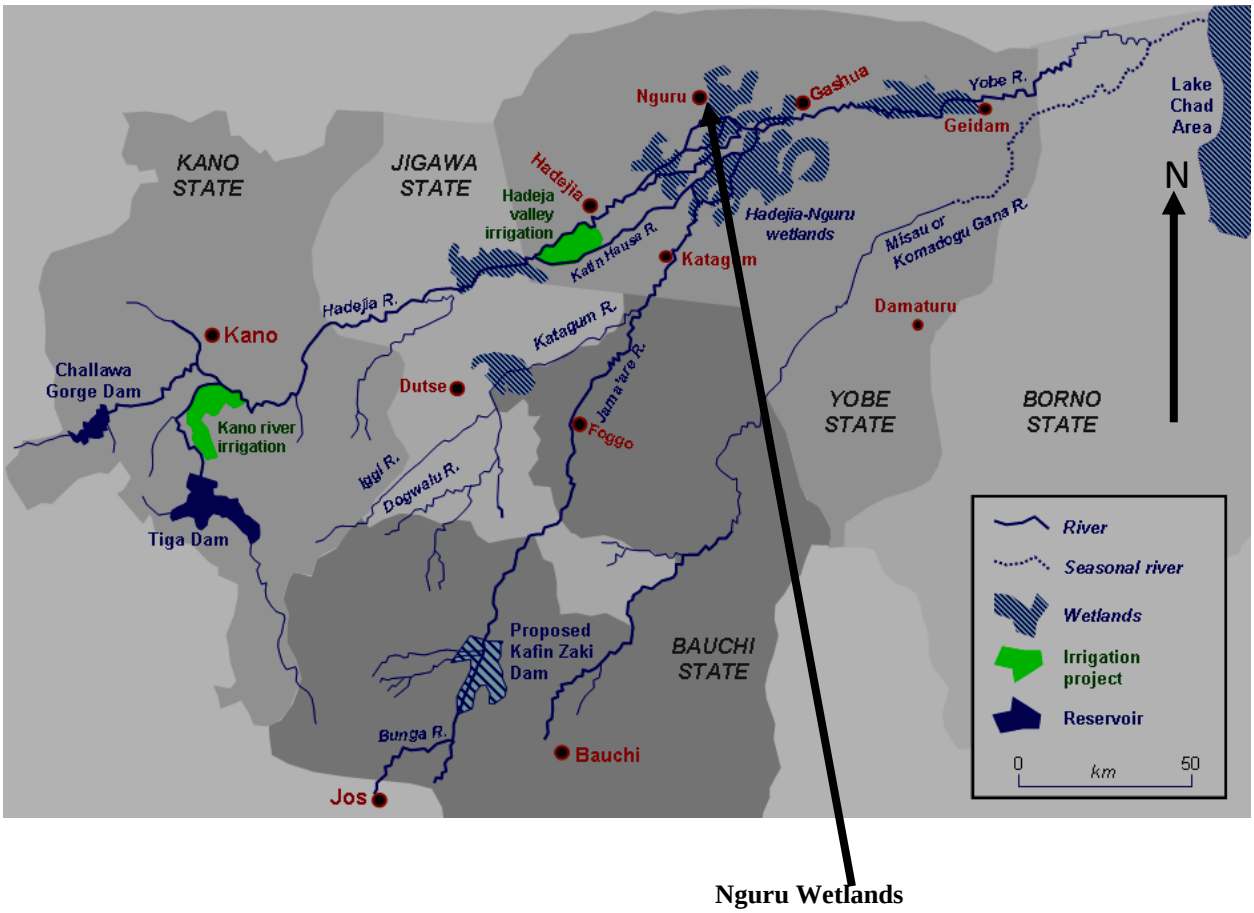

Figure 3.1:**Map of Hadejia-Nguru Wetlands**

3.2 Research design

The Descriptive Survey Design involving both qualitative and quantitative approaches was used in the conduct of this research to describe the characteristics of the local communities living along the Nguru wetlands as well as the problems associated with *Typha* and its socio-economic impacts on the people's livelihoods.

3.3 Target population

The target population of this study was 300 people which comprised of 280 local community people living along the Nguru wetlands in Nguru Local Government Area of Yobe state, Nigeria as well as 20 officials of the Komodougu Yobe Basin Wetlands Development Initiative (KYB-WDI) and the Hadejia – Nguru Wetlands Conservation Project (HNWCP).

3.4 Sample size

The Slovene's formula was used to determine sample size of the study as follows:

$$n = \frac{N}{1 + N(e^2)}$$

$$n = \frac{300}{1 + 300(0.05^2)}$$

$$n = \frac{300}{1 + 300x0.0025}$$

$$n = \frac{300}{1 + 0.75}$$

$$n = \frac{300}{1.75}$$

=171

Thus, the sample size for this study was 171 respondents. To obtain the sample size proportion for the study, the formula below was used:

$$n_1 = \frac{N_1}{N} Xn$$

n_1= sample size proportion

N_1= population size proportion

N= population size

n= sample size

(1) $= \frac{280}{300} X171 = 159$

(2) $= \frac{10}{300} X171 = 6$

(3) $= \frac{10}{300} X171 = 6$

Table 3.1:**Population and sample size distribution**

CATEGORY	POPULATION SIZE	SAMPLE SIZE PROPORTION
Local community people	280	159
KTB-WDI Officials	10	6
HNWCP Officials	10	6
TOTAL	**300**	**171**

3.5 Sampling technique

In order to select the sample size of the study (171) consisting of 159 local people and 12 officials, the Convenient Sampling and the Snowball Sampling Techniques were used. The two techniques were used because it would be very difficult to get the local people assembled in one place to administer the questionnaires and the interview hence, those respondents who could be easily accessed were selected (Convenient Technique) who then led other possible respondents (Snowball Technique). Also, the Systematic Random Sampling technique was used to select respondents at the KYB-WDI and HNWCP.

3.6 Research instruments

This study made use of a self-made closed ended questionnaire in order to collect quantitative data on characteristics of the respondents, problems associated with *Typha* invasion as well as its socioeconomic impacts on the local communities living along the Nguru Wetlands. The questionnaires comprised of closed ended opinion questions with responses of Strongly Agree (**SA**), Agree (**A**), Disagree **(D**) and Strongly Disagree **(SD**). (See appendix 1). In addition, in order not to miss other important information from the respondents as a result of the use of closed ended questionnaires, Structured Interview Guide was also used to garner qualitative data from them (see appendix II).

3.7 Validity and Reliability of the instrument

In order to ensure validity of the questionnaires used in this study, Content Validity Test Method was used by serving the questionnaires to 3 experts in the field (Academics) to rate the validity

of the questions. Eventually, Content Validity Index (CVI) was calculated using the formula below.

$$C.V.I = \frac{\text{No of questions declared valid}}{\text{Total number of questions}}$$

$$C.V.I. = \frac{25}{30} = 0.83$$

According to Amin (2005), C.V.I. of 0.7 and above is considered valid.

Meanwhile, reliability of the questionnaires was determined by using the Text Retest Method whereby the questionnaires were administered on 20 local residents and the responses recorded. After 10 days, same questionnaires were administered on the same set of respondents for the second time. The responses were found to be very much similar to those recorded from the first set of questionnaires administered. Hence, the questionnaire was considered to be reliable. Besides, to ensure reliability of the Interview Guide, all factors necessary for its reliability were considered viz; Transferability, Conformability, Credibility and Dependability.

3.8 Data collection procedure

For successful administration and collection of data, the Letter of Introduction was presented at every data collection point where necessary. A research assistant who was well conversant with the local communities was sought for assistance. For all respondents met, the purpose of the study was explained and their consents obtained.

A total of 159 questionnaires were administrated on the local people in the three towns selected for the study as follows: 49 in Kakori, 70 in Nguru and 40 in Dogon Kuka. Because the majority of the respondents could not read or write in English, the questions were read and explained to them then their views and opinions recorded. In addition, 12 questionnaires were also administered on the officials of the Komodougu Yobe Basin Wetlands Development Initiative (KYB-WDI) and the Hadejia – Nguru Wetlands Conservation Project (HNWCP). In order to administer the Interview, eight (8) participants from among the local communities and two (2) from the officials of the two organisations were subjected to One on One Interviews.

3.9 Data analysis technique

Descriptive Statistics was used to analyze quantitative data obtained on respondents' characteristics; problems associated with *Typha* invasion and socio economic impacts of the invasion. Similarly the Pearson Linear Correlation Coefficient (PLCC) was also employed using the Scientific Package for Social Sciences (SPSS) version 20 to establish a relationship between problems associated with *Typha* invasion of the Nguru wetland and its impacts on socio economic activities of the local communities. Qualitative data obtained from the interviews conducted was analysed using the Thematic analysis method. Besides, the Table below will as well be used to interpret the mean values for the respondents' questionnaire responses.

Table 3.2: Mean interpretation of the questionnaire responses

S/N	Mean Range	Response Mode	Interpretation
4	3.26-4.00	Strongly Agree	Very high
3	2.51-3.25	Agree	High
2	1.76-2.50	Disagree	Low
1	1.00-1.75	Strongly Disagree	Very low

Mean levels of 3.26 - 4.00 signify that the respondents strongly agreed with the fact put to them in the questionnaire which means that the level of the situation as per the item or fact was very high. Mean levels of 2.51 – 3.25 signify that the respondents had agreed with the fact put to them in the questionnaire which means that the level of the situation as per the item or fact was high. Mean levels of1.76 – 2.50 signify that the respondents disagreed with the fact put to them in the questionnaire which means that the level of the situation as per the item or fact was low. Mean levels of 1.00 – 1.75 signify that the respondents strongly disagreed with the fact put to them in the questionnaire which means that the level of the situation as per the item or fact was very low.

3.10 Ethical considerations

In order to abide by the ethics of research studies, it was made sure that a valid Introduction Letter (see Appendix V) was obtained from the Kampala International University (KIU) which was presented at every place necessary. Data on respondents' profiles was treated with confidentiality while study data collected was used only for the purpose of the study. Besides, to avoid plagiarism, all quoted works and literature were properly cited and referenced.

3.11 Limitations of the Study

No much hitch was encountered in the conduct of the research study except that of funding. All questionnaires administered on the farmers and fishermen were successfully retrieved while only one questionnaire administered on the officials of the HNWDP and the KYB-WDI could not be retrieved. Besides, the North East Arid Zone Development Programme (NEAZDP) an EU assisted programme operating in the area that was earlier selected as one of the organizations to be included in the study had to be changed as a result of the closure of its office in Nguru Local Government Area. Instead, officials of the Komoudugu Yobe Basin Wetland Development Initiative (KYB – WDI) were involved in the study. Besides, some challenges were also faced in sampling respondents for the study especially in efforts to avoid bias such that, respondents who could easily be gotten were selected who then directed to other possible respondents and as a result of that all respondents selected happened to be male. However, in that area, culturally women are not known to engage in activities such as farming, fishing, grazing etc.

CHAPTER FOUR

4.0 DATA PRESENTATION, ANALYSIS AND INTERPRETATION

4.1 Demographic characteristics of the respondents

This section determines the demographic characteristics of the respondents.. Frequency and Percentage distribution tables were employed to summarize demographic characteristics of only the local people in terms of gender, age, marital status, education level, and household size. Table 4.1below gives the summary of the findings.

Table 4.1: Demographic characteristics of the respondents

Gender	**Frequency**	**Percent (%)**
Male	159	100.0
Female	0	00.0
Total	**159**	**100.0**
Age		
15-24	12	7.5
25-34	75	47.16
35-44	30	18.86
45-54	26	16.35
55-64	16	10.06
65 and above	0	0.0
Total	**159**	**100.0**
Marital status		
Single	39	24.5
Married	107	67.3
Divorced	13	8.2
Total	**159**	**100.0**
Education		
Arabic	73	45.9
Primary	50	31.44
Secondary	21	13.20
Diploma	13	8.17
Degree	2	1.25
Total	**159**	**100.0**
Household size		
1-5	68	42.76
6-10	50	31.44
11-15	18	11.32
16-20	12	7.55
21 and above	11	6.01
Total	**159**	**100.0**

The results presented in Table 4.1 revealed that all respondents who participated in the study were male. This may be attributed to the fact that culturally strenuous activities such as farming, fishing and grazing animals are usually engaged by men. However, women do engage in minor irrigations, backyard farming, firewood fetching, fetching of water for the house hold use etc.

Furthermore, the Table also revealed that majority 47.16% of the respondents were within the age group of 25-34 years while the least represented were within the age group of 55-64 years 10.06%. However, none of the respondents was above 65 years. The dominance of respondents within the age group of 25-34 years implies that it is the young adults who mostly live along the Nguru wetlands and actually engage in various socioeconomic activities may be as result of the numerous livelihood opportunities offered by the wetlands.

Similarly, the Table also revealed that the majority (67.3%) of these young adults were married, only 8.2% are divorced with 24.5% still being single. The dominance of married men in the study area can be attributed to the culture of the area where marriage is taken seriously and cohabiting is a taboo. Meanwhile, perhaps due to the strong emphasis given to Islamic knowledge in the area, the majority of the respondents (45.9%) possess only Arabic education; only 8.17% have obtained Diplomas and 1.25% of them were Bachelor degree holders. The dominance of Arabic education coupled with less prevalence of formal western education among the communities could undermine the peoples' efforts to improve their productivity and control *Typha* invasion as a result of their inability to seek, employ and appropriately use modern means of controlling the invasion.

Not only that, the communal lifestyle of African tradition has also been demonstrated in this study where majority (42.76%) of the households have relatively large family members of at least 1-5 members and 6-10 members (31.44%) respectively. However, according to the study, no household had more than 21 family members.

4.2: Cultural characteristics of the respondents

This section captured the cultural characteristics of the local community people who took part in the study with respect to tribe, nationality, religion and so on

Table 4.2: Cultural characteristics of respondents

Are you resident in the area?	**Frequency**	**Percent**
Yes	133	83.6
No	26	16.4
Total	**159**	**100.0**
Nationality		
Nigerian	159	100.0
Other	00	00.0
Total	**159**	**100.0**
State of Origin		
Yobe State	98	62.3
Jigawa	37	23.3
Bauchi	15	9.4
Others	9	5.7
Total	**159**	**100.0**
Tribe		
Kanuri	51	32.1
Huasa	42	26.4
Kare Kare	6	3.8
Fulani	41	25.8
Bade	16	10.1
Total	**159**	**100.0**
Religion		
Islam	159	100.0
Other	00	00.0
Total	**159**	**100.0**

The findings presented in Table 4.2 revealed that the majority of the respondents (133, 83.6%) were resident in the three settlements where the study was conducted (Nguru, Kakori and Dogon Kuka) along the Nguru wetlands and all of them (100, 100%) happened to be Nigerian citizens.

Similarly, majority of them (98, 61.6%) were from Yobe State and were of the Kanuri tribe (51, 32.1%). Other states represented in the communities were Jigawa state (37, 23.3%) and Bauchi states (15, 9.4%) while other states were represented by (9, 5.7%) only. Other tribes present in the communities were Hausa, Kare Kare, Fulani and Bade represented by 42, (26.4%), 6, (3.8%), 41, (25.8%) and 16, (10.1%) respectively. Other tribes not mentioned here were only represented by 3(1.9%). Besides, all the respondents do practice the Islamic religion and no faithful of other religions were found.

4.3 Economic activities of the local communities

This section captured information regarding the first objective of the study that was intended to describe the economic characteristics of the local communities living along the Nguru Wetlands. These characteristics were measured using type of economic activity engaged in such as fishing and farming, farm size, types of crops grown, animal species reared, number of animals owned, type of means of transportation used, time of fishing as well as type of animals hunting. The following graphical figures give the results of this study.

The presentation in Figure 4.1 below shows that the majority of the respondents (52) were fishermen, followed by crop farmers who were 38. Other economic activities engaged by the local communities were livestock farming with 43 respondents, hunting with 3, transportation with 6, and irrigation with 17. None of the respondents was found to be a tourist's guide. Reasons for the dominance of fishing activity could be because it is relatively easier, cheaper, less time consuming, less laborious and less financially risky than the other economic activities and yet more profitable since it does not involve a lot of start-up capital and expenses compared to farming. Besides, there is an abundance of water resource that provides a platform for all year fishing without necessitating any artificial fish rearing.

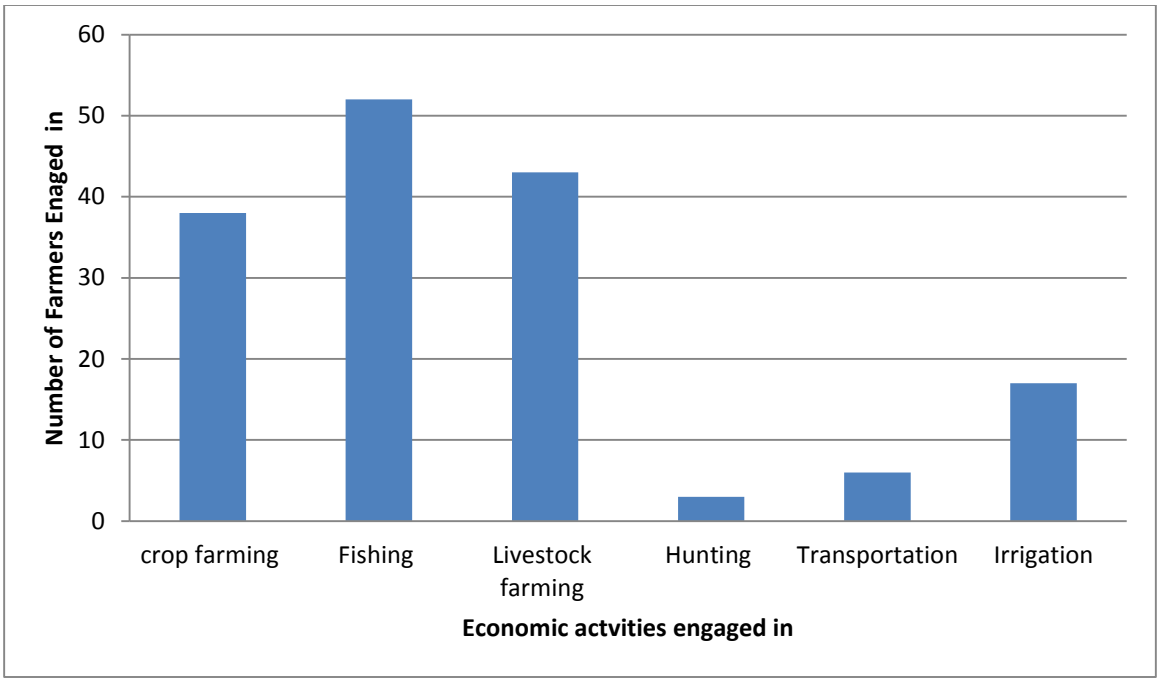

Figure 4.1: Economic activities of the local communities

The results presented in Figure 4.2 below revealed that the majority of the respondents (22) owned 1-2.5 hectares of land, followed by 8 respondents who owned 2.6-3 hectares of land while those who owned more than 3 hectares and 1 hectare were represented by 5and 3 respondents respectively. The dominance of those who owned 1-2.5 hectares confirms the fact that most of the farmers were not large scale farmers but sustenance or small scale farmers.

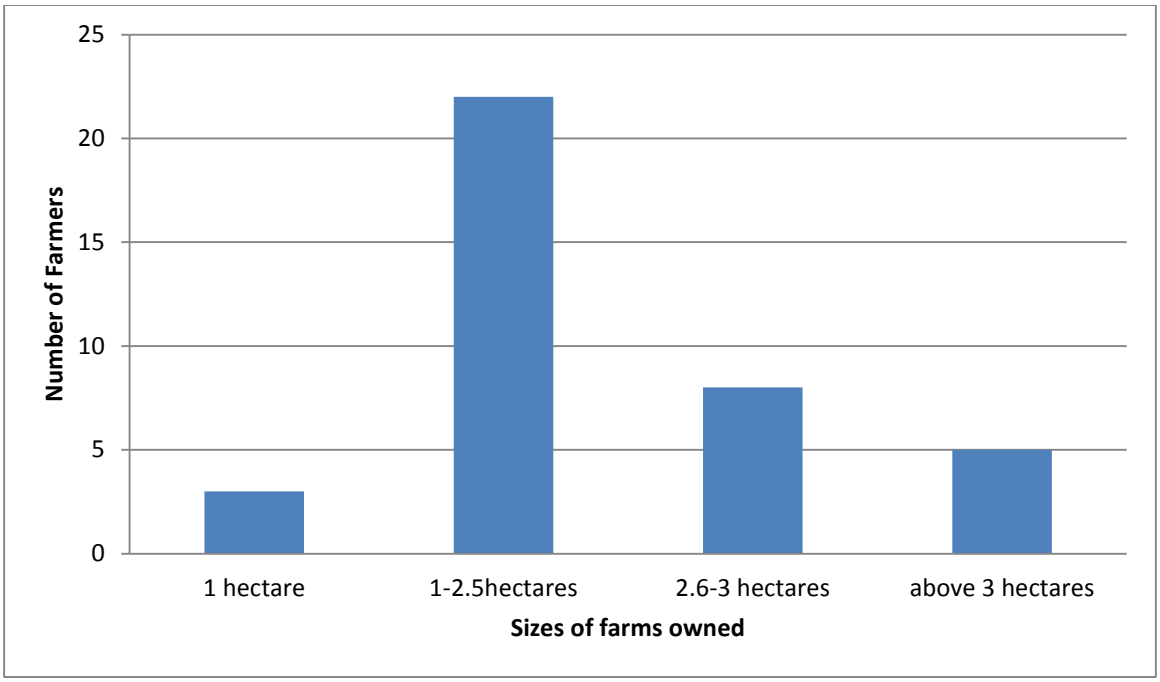

Figure 4.2: Farm sizes of the crop farmers

Figure 4.3 below shows the different types of crops commonly grown along the Nguru wetlands. From the Table it can be seen that maize (*Zea mays*) was the most commonly grown crop with a total of 9 respondents followed by rice (*Oryza sativa*) and sorghum (*Sorghum bicolor*) farmers with 6 respondents each. About 6 farmers also grow beniseeds or seasame *(Sesamum indicum)* while farmers growing cassava (*Manihot esculenta)*, corn (*Zea mays)* and beans (*Phaseolus vulgaris*) were represented by 4 respondents each. The mostly grown crops, maize, sorghum and rice were culturally the dominant food crops in the area.

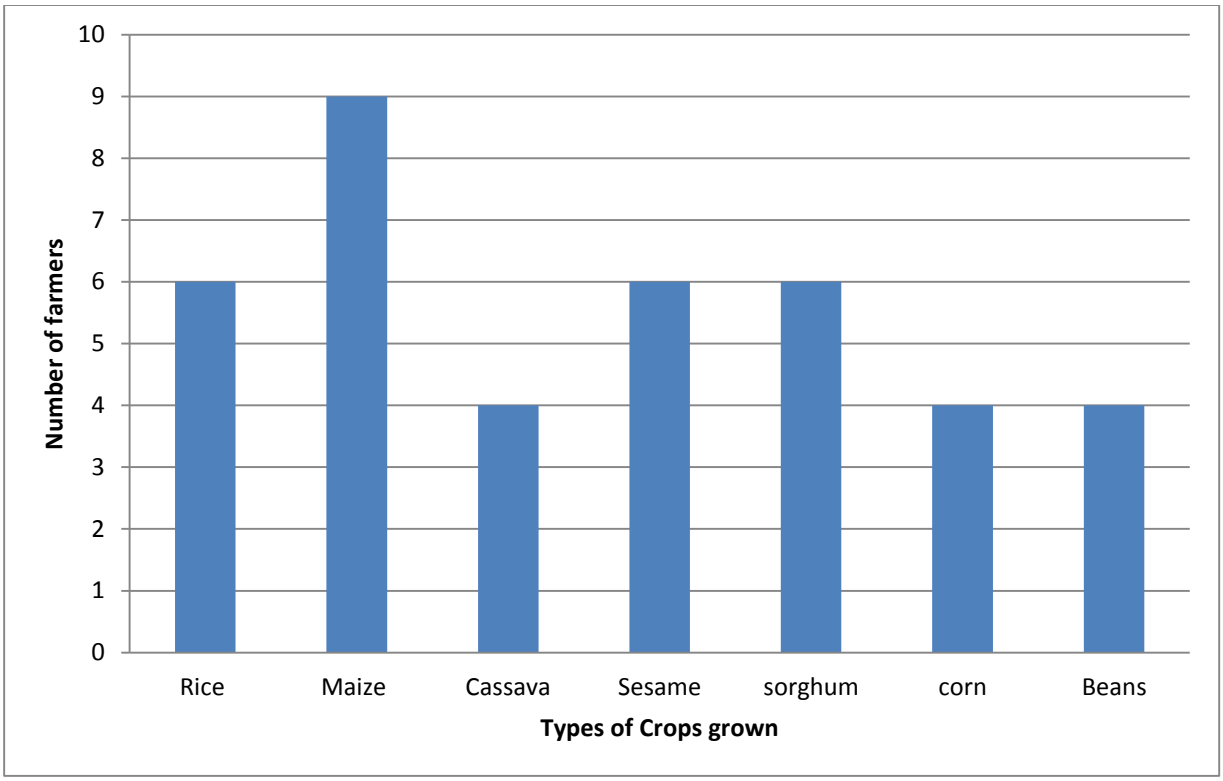

Figure 4.3: Types of crops grown

The results presented in Figure 4.4 below revealed that the majority of the respondents (21) rear cows (*Bos taurus*) only, followed by those rearing mixed animals with 10 respondents. Goat farmers (*Capraaegagrus hircus*) were represented by 5 respondents while sheep *(Ovis aries*) rearers were 7 in number. The dominance of the respondents who rear only cows implies that there are a considerable number of Fulani herdsmen who are mostly known to be cattle rearers. Moreover, cows are known to be more preferred in the African tradition as a symbol of wealth and power.

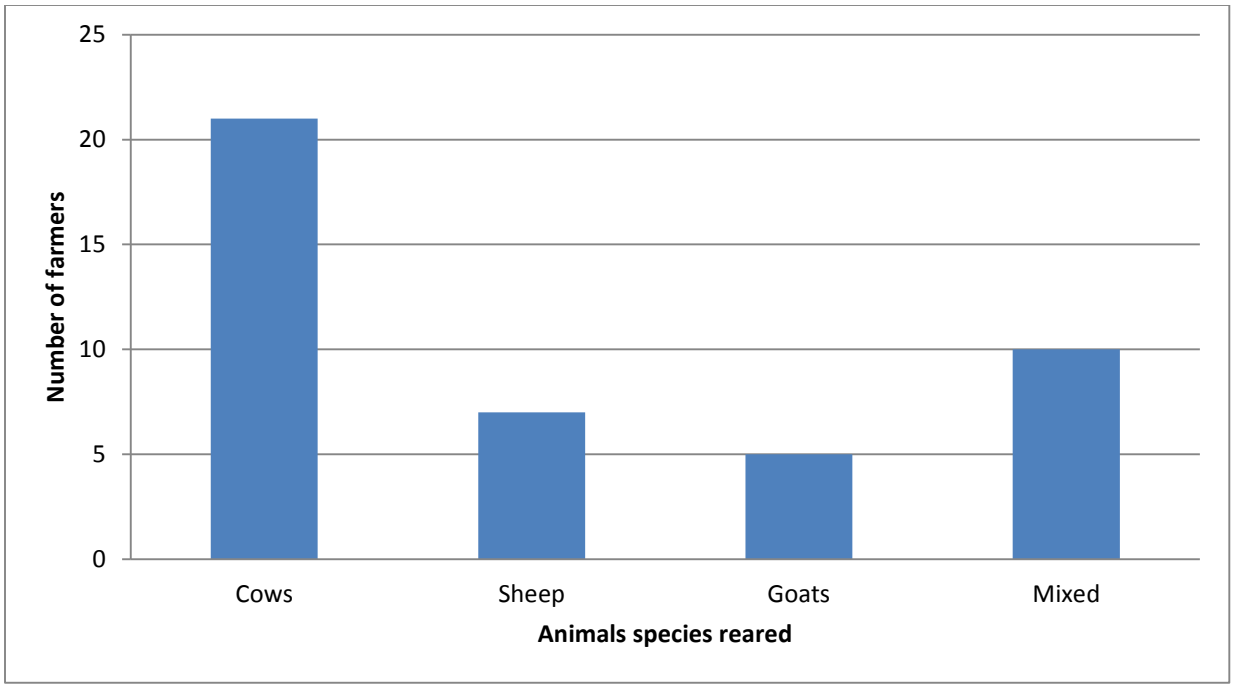

Figure 4.4: Animal species reared

The results presented in Figure 4.5 below revealed that the majority of the respondents (20) possess between 41-50 animals, followed by those who own between 31-40 animals who were 9 in number. Livestock farmers having more than 50 animals were only 7 in number while those who own 10-20 and 21-30 animals were represented by 2 and 5 respondents respectively. The fact that those respondents who own 41-50 animals were the dominant implies that most of these local livestock farmers can be regarded as rich. It is also worthy to note that, most of the times Fulani herdsmen in the area do not go for grazing with all their animals at once.

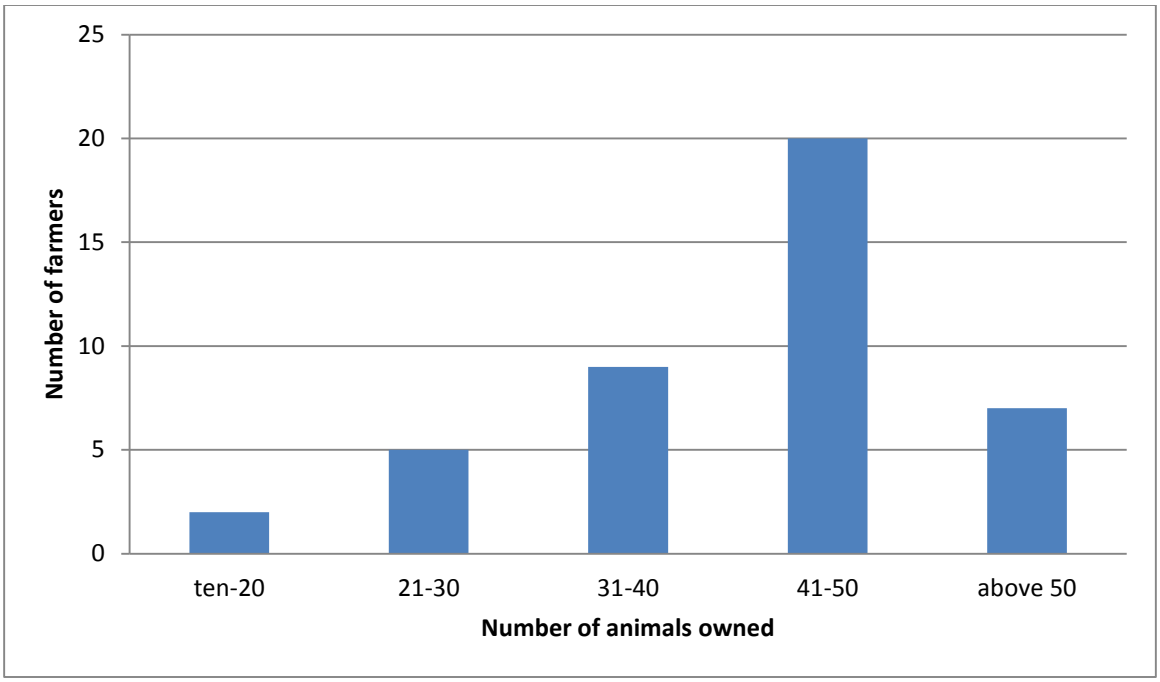

Figure 4.5 Number of animals owned

Figure 4.6 below shows the different fishing seasons engaged by local fishermen along the wetlands. It was revealed that the majority of the fishermen who were 26 in number engage in active fishing only during the rainy or wet season while those engaging in all year round and dry season fishing activities were 18 and 8 respondents each. Fishing activities along the wetlands are known to be at their peak during the wet season when the wetlands are fully flooded and fish abundance is relatively high.

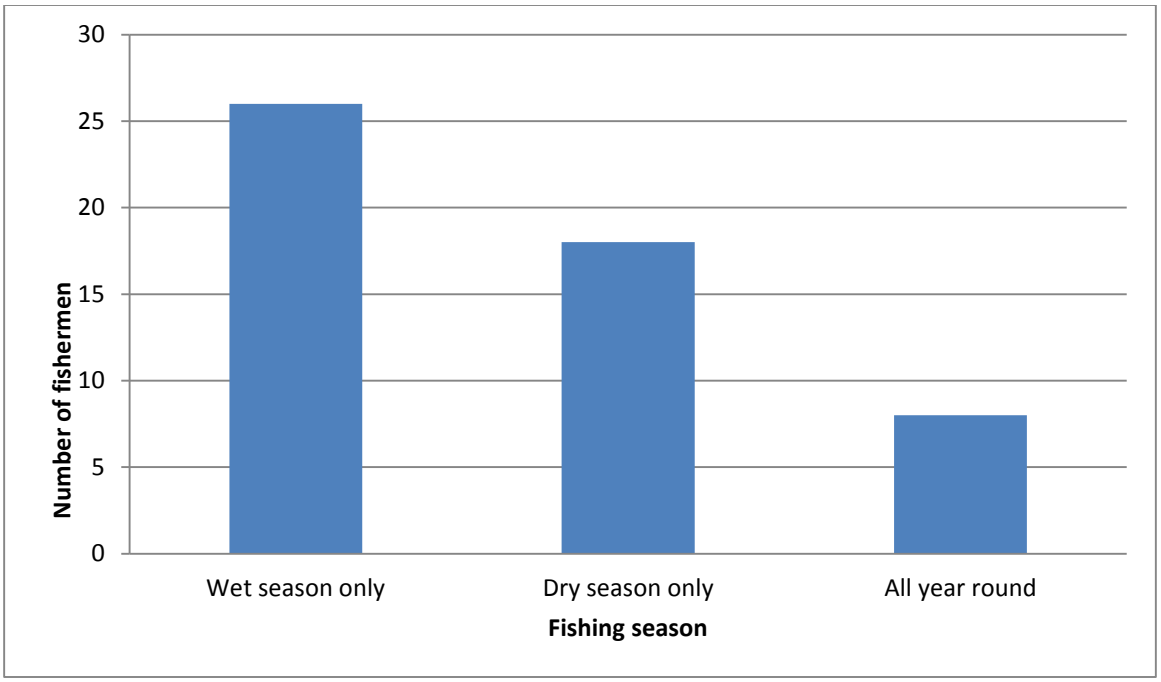

Figure 4.6: Fishing seasons engaged by the fishermen

Figure 4.7 below shows the different types of commercial transportation means found along the wetlands. The Figure revealed that 33.33% of the respondents who claimed to be transporters engage in commercial transportation using canoe as the means of transportation while another 33.33% use vehicles. Only 16.7%respondent claimed to use carts/wheel barrows along another 16.7% who stated that he used motorcycle. Canoes and motorcycles were the most convenient means of transportation along the wetland to access remote fishing sites and farmlands.

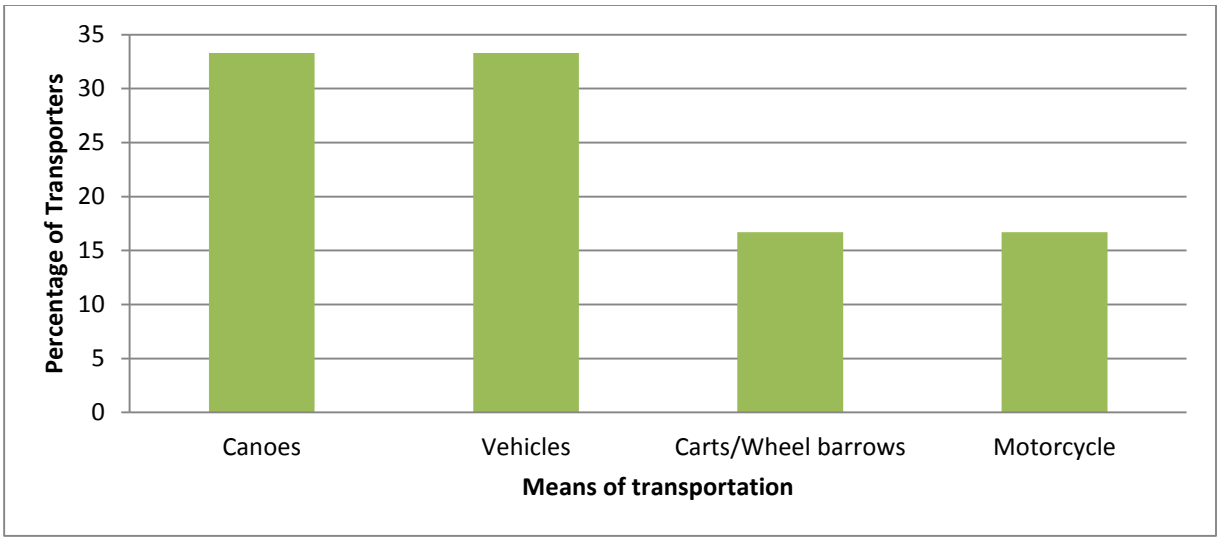

Figure 4.7: Types of means of transportation used

Figure 4.8 below shows types of animals hunted along the wetlands. Out of the respondents contacted who claimed to be hunters,66.7% were bird hunters while the remaining 33.3% were animal hunters. According to them, hunting activities along the wetlands have dropped considerably perhaps as a result of decrease in the abundance of birds and other animals usually hunted.

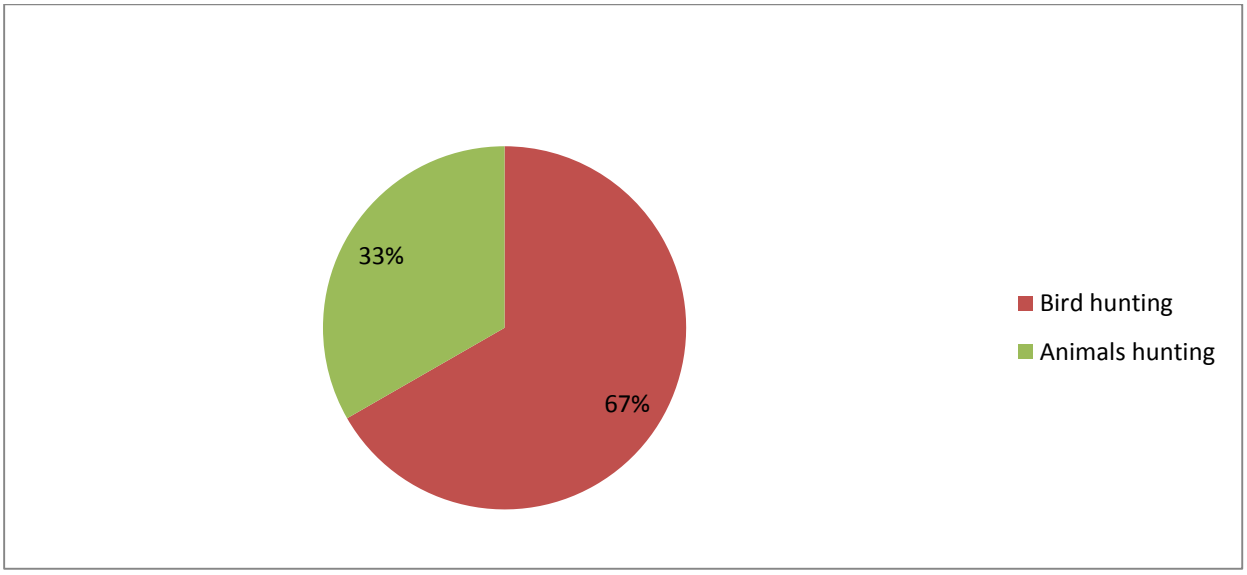

Figure 4.8: Types of animals hunted

4.4: Problems associated with *Typha* invasion and its socio economic impacts on local communities living along Nguru wetlands

This section captured information regarding the second objective of the study that was intended to assess the socioeconomic impacts of the invasive *Typha* on local communities along Nguru wetlands, Yobe State, Nigeria. In order to clearly assess the socio economic impacts of *Typha* invasion, problems associated with it was also examined so as to enable scientific inferences possible. Questionnaire in respect of that was distributed to both the local communities and officials of KYB-WDI and HNWCP. Table 4.3 gives the result of statistical correlation of problems associated with *Typha* invasion and social impacts of the invasion using Pearson Linear Correlation Coefficient (PLCC), Table 4.4 indicates the results of statistical correlation of problems associated with *Typha* invasion and the economic impacts of the invasion using PLCC, Table 4.5gives the mean interpretations of the questionnaire responses while Table 4.6gives summary of the findings made from questionnaire responses using Descriptive Statistics.

Table 4.3: PLCC results of the relationship between *Typha* related problems and social problems

Correlations

		Problems	Social impacts
Problems	Pearson Correlation	1	.988**
	Sig. (2-tailed)		.000
	N	171	171
Social impacts	Pearson Correlation	.988**	1
	Sig. (2-tailed)	.000	
	N	171	171

**. Correlation is significant at the 0.01 level (2-tailed).

The Table above showed that for 0.988 Pearson correlation at 0.01level (2-tailed), there was a very significant relationship between problems associated with *Typha* invasion and the social problems bedevilling the local communities living along the Nguru wetlands. Hence, the H_O is

rejected and the social problems facing the local communities can be attributed to the problems associated with *Typha* invasion.

TABLE 4.4: PLCC results of the relationship between *Typha* related problems and economic problems

Correlations

		Problems	Economic impacts
Problems	Pearson Correlation	1	0.650**
	Sig. (2-tailed)		0.000
	N	171	171
Economic impacts	Pearson Correlation	0.650**	1
	Sig. (2-tailed)	0.000	
	N	171	171

**. Correlation is significant at the 0.01 level (2-tailed).

The Table above showed that for 0.650 Pearson correlation at 0.01level (2-tailed), there was a very significant relationship between problems associated with *Typha* invasion and the economic problems bedevilling the local communities living along the Nguru wetlands. Hence, the H_O is rejected as such the economic problems facing the local communities can be attributed to the problems associated with *Typha* invasion.

Table 4.5Questionnaire responses of the respondents showing their numbers, percentages (%) as well as the mean values and standard deviation (std)

S/N	Problems associated with *Typha*	4	3	2	1	Mean	std
1	Prevents transportation with canoes.	69 (40.4)	102 (59.6)	0 (0)	0 (0)	3.40	0.492
2	Increases flood plains	23 (13.5)	99 (57.9)	30 (17.5)	19(11.1)	2.74	0.830
3	Blocks water channels and redirects water flow	72 (42.1)	99 (57.9)	0 (0)	0 (0)	3.42	0.495
4	Prevents aesthetic activities	36 (21.1)	101(59.1)	25 (14.6)	9 (5.3)	2.96	0.754

5	Reduces sizes of fishing sites, grazing fields and farmlands	88 (51.5)	83 (48.5)	0 (0)	0 (0)	3.51	0.501
6	Reduces water depth	40 (23.4)	106 (62.0)	25 (14.6)	0 (0)	3.09	0.612
7	Prevents access to fishing sites and farmlands	97 (56.7)	74 (43.3)	0 (0)	0 (0)	3.57	0.497
8	Affects water level.	46 (26.9)	109 (63.7)	16 (9.4)	0 (0)	3.18	0.578
9	harbours crop pests such as quelae birds	102 (59.6)	69 (40.4)	0 (0)	0 (0)	3.60	0.492
10	Interferes with the normal growth of crops.	27 (15.8)	76 (44.4)	55 (32.2)	13 (7.6)	2.68	0.829
Total		**60 9(35.0)**	**92 (53.8)**	**15 (8.77)**	**4 (2.2)**	**3.22**	**0.587**
	Economic Impacts	**4**	**3**	**2**	**1**		
11	Reduced fish catches and crop yields	133 (77.8)	38 (22.2)	0 (0)	0 (0)	3.78	0.417
12	Reduced sizes of reared animal stocks	61(35.7)	87 (50.9)	23 (13.5)	0 (0)	3.22	0.667
13	caused an overall decrease in people's incomes	152 (88.9)	19 (11.1)	0 (0)	0 (0)	3.89	0.315
14	Has greatly affected people's productivity	111(64.9)	56 (32.7)	4 (2.3)	0 (0)	3.63	0.531
15	Has caused increase in poverty rate among people	96 (56.1)	75 (43.9)	0 (0)	0 (0)	3.56	0.498
16	Increased the cost of farming and fishing	59 (34.5)	99 (57.9)	13 (7.6)	0 (0)	3.27	0.592
17	Complete invasion of Irrigation sites	40 (23.4)	86 (50.3)	39 (22.8)	6 (3.5)	2.94	0.776
18	Generally increased the prices of commodities	71(41.5)	88 (51.5)	10 (5.8)	2 (1.2)	3.33	0.642
19	Farmers spend a lot in trying to control *Typha* invasion	133 (77.8)	38 (22.2)	0 (0)	0 (0)	3.78	0.417
20	Other economic activities affected	82 (48.0)	79 (46.2)	10 (5.8)	0 (0)	3.42	0.602
Total		**94 (55.0)**	**67 (39.2)**	**10 (5.85**	**1(0.58)**	**3.48**	**0.545**

	Social impacts	4	3	2	1		
21	Prevents access to safe drinking water	126 (73.7)	45 (26.3)	0 (0)	0 (0)	3.74	0.442
22	Led to migrations of people	103 (60.2)	68 (39.8)	0 (0)	0 (0)	3.60	0.491
23	Has led to conflicts among people	26 (15.2)	89 (52.0)	41(24.0)	15 (8.8)	2.74	0.823
24	Rate of insecurity and crime have increased as a result of *Typha* invasion	36 (21.1)	80 (46.8)	41 (24.0)	14 (8.2)	2.81	0.863
25	Affected health conditions among people and animals	44 (25.7)	97 (56.7)	26 (15.2)	4 (2.3)	3.06	0.709
26	People are displaced as a result of flooding caused by *Typha* invasion	62 (36.3)	86 (50.3)	23 (13.5)	0 (0)	3.23	0.669
27	Serves as hiding place for criminals such as thieves and cattle rustlers	90 (52.6)	46 (26.9)	31(18.1)	4 (2.3)	3.30	0.846
28	Harbours dangerous animals such as snakes and disease vectors such as mosquitoes	139 (81.3)	32 (18.7)	0 (0)	0 (0)	3.81	0.391
29	Tourism activities were affected	106 (62.0)	47 (27.5)	18 (10.5)	0 (0)	3.51	0.680
30	*Typha* is converted into useful benefits by the local people	36 (21.1)	79 (46.2)	44 (25.7)	12 (7.0)	2.81	0.847
TOTAL		**77 (45.0)**	**70 (41.0)**	**23 (13.5)**	**4 (2.3)**	**3.26**	**0.676**

The findings presented in Table 4.6above revealed that the majority (88.89%) of the respondents strongly agreed that there were a lot of problems associated with invasive *Typha* along Nguru wetlands (overall average mean 3.26±0.676). This was further confirmed by the fact that all the respondents (100%) (mean 3.40±0.492) strongly agreed that *Typha* invasion of the Nguru wetlands resulted in the prevention of transportation with canoes, blockage of water channels and redirecting its flow, considerable sizes of farmlands, fishing sites and grazing fields were overtaken, prevention of access to farmlands and fishing sites, reduction in water levels as well as harbouring crop pests such quelae birds and locusts.

Furthermore, findings in the Table also indicated that the majority of the respondents also agreed that *Typha* invasion increased flood plains and prevented aesthetic activities such as swimming. Although about 38.8% of the respondents disagreed with the fact that *Typha* interferes with normal growth of crops.

With regards to economic impacts of *Typha* invasion of the wetlands, Table 4.15 above revealed that almost all of the respondents 171 (100%) agreed with the fact that *Typha* invasion had led to drastic drop in the number of fish catches and crop yields as well as an overall decrease in people's incomes with resultant increase in the rate of poverty among them. They also overwhelmingly agreed that farmers and fishermen spend a lot in trying to control the proliferation of *Typha*. Similarly, majority of the respondents did also agree that, invasion of the wetlands by *Typha* had led to a considerable decrease in the number of livestock reared, affected people's productivity, increase in the cost of farming, drying up of many irrigation fields as well as a general increase in the prices of other goods and commodities. Besides, good number of the respondents also believed that as a result of the invasion caused by *Typha*, all other economic activities engaged by the local community people had been affected.

Meanwhile, findings on social impacts of the invasive *Typha* indicated in Table 4.15 above revealed that, almost all the respondents 171 (100%) did agree that *Typha* invasion of their communities prevented them from access to safe drinking water from the waters around on which they depend, led to migrations of many residents to other places as a result of loss of their sources of livelihoods and also believed that dense biomass of *Typha* harbours dangerous reptiles such as snakes which scare many farmers and fishermen from active farming and fishing as well as disease vectors such as mosquitoes that spread Malaria which seriously affected people's productivity.

Still on the social impacts of *Typha* invasion, good percentage of the respondents stated that, invasion of the wetlands by *Typha* led to conflicts among the people over ownership of farmland and fishing sites, increased rate of insecurity by harbouring criminal such as thieves and cattle rustlers, increased rate of crime especially among youth such as drug abuse, thefts and pick pocketing as a result of loss of their livelihoods due to *Typha* invasion and also caused health

problems such as eye and respiratory problems among people. Socially, *Typha* invasion of the Nguru wetlands also led to frequent flooding leading to the displacement of communities and affected tourism which was once a very popular and lucrative activity along the wetlands. Surprisingly, despite the numerous problems associated with the *Typha*, more than half of the respondents (67.3%) agreed that some of the local people convert dried biomass of *Typha* into positive uses. According to them, dry *Typha* is used as a building material especially for roofing, manufacture of furniture and as a source of energy used in cooking.

4.5: Qualitative data on problems associated with *Typha*, its impacts on socioeconomic activities of local communities living along Nguru wetlands as well as control measures

This section captured information on the problems as well as the impacts of *Typha* invasion on socioeconomic activities of local communities along the Nguru wetlands. A One on One interview with 8 Key Interview Informants (KIIs) from the local communities as well as 1 official each from the Hadejia-Nguru Wetlands Conservation Project (HNWCP) and the Komodougu Yobe Basin Wetlands Development Initiative (KYB-WDI) was conducted. They were asked this question:

Q1) What other problems were associated with the Invasive *Typha* along the Nguru wetlands?The responses of the participants to this question were summarised as follows: *it expands floodplains, increased silting of channels caused by slow all-year-round flows, channels and ponds have become shallow, harboured crop pests such as quelea birds and locusts and led to loss of aquatic biodiversity (both plants and animals)and also caused eye and respiratory problems as a result of numerous dispersed seeds around the months of January and February.*

Q2) What other economic impacts of *Typha* invasion are being experienced here? The responses of the participants to this question were also summarised as follows: *as a result of Typha invasion, there was* a *general decrease in people's incomes due to drastic drop in crop yields, fish catches as well as loss of transportation and tourism activities, all other businesses carried out in the area were also adversely affected with consequent hike in prices of many other goods and commodities such as fish, crops such as rice, animals such as cattle as well as daily provisions such as sugar and soaps. Similarly, decrease in people's incomes sometimes forced*

local people to change to other environmentally devastating occupations such as felling down of trees for firewood in spite the fact that Yobe state is one of the hardest hit states by desertification with many of its Local Government Areas such as Yusufari, Yunusari and Machina being seriously threatened.

Q3) What measures are being employed to control the proliferation of *Typha*? A summary of the participants' responses to this question is as follows: (Local people) *The local people mainly use manual cutting with cutlasses and sickles, use of chemicals sprayed to kill the plant, burnings during dry seasons to avoid seed germination and stem sprouting and area flooding as control measures against the spread of Typha.*According to Yarima (2016), to control the proliferation of *Typha* along the Hadejia-Nguru wetlands, majority of the farmers (56%) employ method of cutting and at the same time flooding the area to avoid seed germination and stem sprouting. About 36% of the farmers use mechanical clearing method by slashing the weed while about 9% use chemical method as a strategy to reduce the weed.

According to the 0fficials of the HNWCP and the KYB – WDI, control measures taken by the two organisations for the control of *Typha* include the followings: *organisation and sponsorship of communal efforts to clear the plant, organisation of workshops and seminars for the local communities on how to control the spread of Typha, participation in mechanical clearance of Typha and making available to farmers and fishermen chemicals effective in the control of the plant. Other efforts being made include assisting farmers and fishermen to access loan facilities, training of farmers and fishermen on improved methods of farming amidst Typha invasion, provision of water pumps to boost irrigation farming as well as provision of clinical services and advises on how to treat livestock diseases.*

Q4) How do you assess effectiveness of the control measures being employed in managing the proliferation of *Typha*? In response to this question all the participants stated that, *most of the control measures being used proved to be effective except that the rate of the spread of the plant always overshadowed the control measures making them look to be ineffective. However, some of the participants stated that the use of chemicals proved to be the most effective measure.*

Q5) What are the challenges faced in controlling *Typha* invasion along the wetlands? In response to this question, the local people stated that they face some challenges in controlling the spread of *Typha* summarized as follows: *as a result of the Typha induced poverty, they could neither pay sufficiently for the clearance of Typha from their farmlands and fishing sites nor purchase chemicals used for the control, lack of government support also affects their efforts to control the spread, fear of spirit attacks as well as lack of appropriate control equipment also affect their efforts.*

CHAPTER FIVE

5.0 DISCUSSION, CONCLUSION AND RECOMMENDATIONS

5.1 Discussions

5.1.1 Demographic characteristics of the local communities

Demographically, this study found out that that all those engaged in different socioeconomic activities in the three settlements where the study was conducted were male. This could perhaps be attributed to the fact that culturally in the area; women do not engage in strenuous physical activities like farming and fishing but are left with household responsibilities such as fetching firewood and water for the family use. Majority of the men were young married adults within the age group of 25-34 years. Dominance of the youth along the wetlands implies that it is the young adults who actually engage in various socioeconomic activities in the area virtually as a result of the numerous livelihood opportunities offered by the wetlands. According to Elegbede, (2014), the Hadejia-Nguru Wetland communities benefit from various activities that surround the wetlands, such as income generation and provision of food, from the different activities such as agriculture, land grazing, wood for domestic fuelling, other wood products and mechanisms for protection against drought. The wetland is considered to have economic value of around 11.7 million USD (Idriss, 2008).

In addition, perhaps due to the strong emphasis given to Islamic knowledge coupled with the lack of basic educational infrastructures such as good schools in the area, majority of the local people possess only Arabic education and lack the basic formal western education needed for meaningful development. This can be a contributing factor towards the dwindling productivity among the local people as well as their inability to seek and employ modern means of controlling *Typha* invasion. Besides, the relatively large family sizes found in most of the households may also constitute extra financial burden on the local men and coupled with the abject poverty raging in the local communities as result of general decrease in people's incomes due to *Typha* invasion, most of the men are made less productive and financially handicapped.

5.1.2 Cultural characteristics of the local communities

Unlike many other places found in Nigeria bordering other countries, the fact that Nguru Local Government Area does not border any country may perhaps be the reason why all the local people engaged in different socioeconomic activities along the Nguru wetlands were Nigerian citizens and more than 83% of them were permanent residents in the area meaning only few came from other places within the country. Being the state that geographically houses the wetlands studied, majority of the local communities were indigenes of Yobe state a reason good enough to describe why most of the local people were also found to be from the Kanuri tribe. Yobe state is a predominantly a Kanuri settlement although many other minor ethnic groups are also found. Unsurprisingly, other states bordering the wetlands including Jigawa and Bauchi states also have their indigenes engaged in different economic activities along the Nguru wetlands as well. Besides, other ethnic groups such as Hausa, Bade, Fulani and Kare Kare do also inhabit the shores of Nguru wetlands.

All the above findings agree with those of other authors in the field. In a report by Birdlife International (2015), the area is dominated mainly by Hausa, Fulani, Kanuri, and Bade ethnic groups with population capacity of 1million people; these people depend on the wetland for water supply and other daily activities. The Nguru wetland is mostly dominated by Hausa, Fulani, Kanuri, and Bade ethnic groups with population capacity of 1million people (Elegbede, *et. al*., 2014). Noteworthy also, is the fact that all of the local communities inhabiting the shores of the Nguru wetlands according to this study were Muslim faithful which further confirms the record that northern Nigeria is predominantly a Muslim dominated region. Secondly, faithful of other religions are usually scared to declare their faiths in the area as a result of security issues relating to Boko Haram insurgency that has bedevilled Yobe State since 2011. This could also be a reason why all the respondents were found to belong to the Islamic faith.

5.1.3 Economic activities of the local communities

The first objective of this study was to describe the characteristics of local communities living along the Nguru wetlands especially their socioeconomic activities. This became necessary particularly because of the fact that the purpose of the study was to assess the impacts of the invasive *Typha* on socioeconomic livelihoods of the people. Thus, in the course of conducting the study, it was discovered that majority of the local communities were engaged in fishing and

farming activities; a finding that further confirmed the report by Birdlife International (2015) that fishermen and farmers in the HNWs represent about 75% of the indigenous community population. Fishing activity is the most dominant occupation in the area as the main economic activity providing the locals with employment and consequently income generation. Fisheries and aquaculture activities account for 50% in the wetlands representing the main source and livelihoods of the indigenous communities and is carried out throughout the year. Fish farming to the inhabitants of the Hadejia-Nguru wetlands is the next occupation to crop farming (Animals Right in Nigeria, 2010). The dominance of fishing activity in the area could be because it is cheaper, less time consuming, less laborious with little financial risks than the other occupations and yet more profitable since it does not require huge start up capitals. According to Sabo *et al., (*2016), it is on record that, fish catches from the Hadejia-Nguru wetlands contributed about 6% of the annual national income of inland fish sales in Nigeria.

Similarly, it was also gathered that not all the fishermen do fish at the same time. Nearly half of them claimed to fish only during the wet season when the wetland is fully flooded and fish abundance and diversity are expected to be high while a good number of them fish all year round. Only 15 fishermen stated that they fish during dry seasons. However, all the fishermen complained of drastic fall in the abundance and diversity of fish as a result of *Typha* invasion. Although, according to Oduntan *et al.,* (2010) was known to support at least 250 species of flowering plants, over 136 types of aquatic flora and fauna, more than 13 species of fish and 378 species of birds. That notwithstanding, it was discovered that some species of catfish and tilapia such as Silver catfish locally known as Musko, Heterotis or African arowana known as Bargi and Upside down catfish known as Kurungu are still caught though in little number. Basically, invasion of the wetlands by *Typha* makes the use of modern methods of fish catching difficult as a result of which traditional methods of fish farming majorly the use of canoes are employed which account for a small proportion of the fish population thereby fulfilling the aim of conservation in a natural way (Animal Rights, 2010).

Furthermore, the study found that the majority of the local communities were crop farmers who mostly own only 1-2.5 hectares of land suggesting that they were most likely to be small scale farmers engaged in sustenance farming. The inability to own large chunks of land in the area can be attributed to the high population density in a small area in addition to the loss of considerable

sizes of farm sites to *Typha* invasion. Commonly grown food crops by farmers along the wetlands include Rice, Sorghum, Maize, Corn, Beniseeds or sesame, Beans, wheat and Cassava. Cultivation of wheat, maize and vegetables brought local Fadama farmers an average income of nearly 10,000 Naira per season a decade ago (Sabo *et al*., 2016). According to Ringim *et al.*, 2015, farmers in Guri village of Jigawa state, before the emergence of *Typha* they could harvest 200 bags of rice in a 10 hectares farmland.

Meanwhile, the study also found out that fishing and crop farming were not the only socioeconomic activities engaged by the local communities along the wetlands but perhaps the dominant ones. Other groups of the local people have ventured into other economic activities such as livestock farming, hunting, transportation and irrigation. Second to fishing and crop farming in dominance was livestock farming and the majority of those engaged in this occupation were the Fulanis who mostly rear cattle and are nomadic in nature. The ownership of large herds of cattle is seen by many people in the area as a symbol of pride, power and wealth. According to Idriss (2008), in dry seasons, nomadic farmers move to the area for grazing and the environment has the capacity to accommodate about 32,000, 370,000 and 375,000 cattle, goats and sheep. The wetland area has abundant agricultural resources worth 26, 982, 651 million euro and the region serves as a center point of cattle trade worth of 250, 000 cattle (Elegbede *et al.*, 2014). They do not practice any modern form of animal farming such as zero grazing or fencing but entirely depend on free range grazing along the shores of the wetlands. Such practices of animal rearing usually expose the animals to parasitic infections such as helminthiasis. Although the unprecedented reduction of grazing fields as a result of *Typha* invasion threatens the future of livestock farming along the wetlands, many of the herdsmen were found to own big numbers of animals as well. Very few own goats and sheep though some were found to rear mixed species of animals.

Another major economic activity engaged by local communities along the Nguru wetlands was irrigation. Some years back, yields from irrigation farming such as maize and vegetables contributed immensely to people's incomes as well as the national economy. Besides, farmers had in the past witnessed increase in irrigation along the wetlands largely as a result of the advent of small petrol-powered pumps unfortunately, in recent years, majority of the irrigation sites could visibly be seen to have been overtaken by the stubborn *Typha* or had dried up

completely as a result of the blockage of water channels by *Typha*. Possibly, the ordeal of irrigation farmers along the wetlands could have been exacerbated by the construction of dams at the Hadejia Valley Irrigation project site in Jiagawa state and those constructed for water storage upstream between the period of 1971- 1974 (Tiga dam), and in 1992 Challawa Gorge for hydrological power reducing flooding downstream into the HNWs with significant socioeconomic impacts (Thomas and Adams, 1997, Barbier *et al*., 1997). According to Thomas and Adam (1997), farming activities are severely affected due to the local communities' reliance on seasonally flooded irrigation system (Fadama in Hausa language) after the wet season by the construction of dams at Tiga, Chalawa and at the Hadejia Valley Irrigation sites all along the Hadejia-Nguru wetlands. These dams greatly reduce the free flow of water into most irrigation fields. However, pockets of the local people still manage to practice irrigation producing handful yields of maize, vegetables and fruits.

Besides, many irrigation sites not overtaken by the plant had dried up as a result of blockage of water flow into the sites caused by blockage and redirection of water flow by *Typha*. According to Haruna (2006) *Typha* is a serious problem threatening the sustainability of the whole irrigation scheme along the Hadejia-Nguru wetlands. Over 80% of the main canal and other water distributary channels have been overtaken by *Typha* thereby blocking the free flow of water into the irrigation fields.

Perhaps, the hardest hit economic activities by the impacts of *Typha* invasion along the Nguru wetlands could be transportation, hunting and tourists guiding. Though few people still manage to survive on the transportation activities using means such as canoes, vehicles, motorcycles, carts as well as wheel barrows, transportation activities can generally be said to be at the verge of coming to an end. Evidently, canoes are the most important means of transportation along the wetlands because it is the only means that can be used to access many remote fishing and farming sites, however, most of the routes or passages being used have been completely overtaken by *Typha*. According to Haladu and Bello (2014), *Typha* has become a common feature along the Hadejia-Nguru wetlands and a nuisance to the communities. It blocks the passage of canoes used for fishing or access to remote farmlands. Transporters using vehicles and motorcycles along the wetlands have also been left stranded with no job at hand as a result of the invasion. Due to the unprecedented drop in fish catches and crop yields, transporters who

mostly earn their living by transporting cartons of fish and bags of crops such as rice, corn, sorghum etc. from shores of the wetlands to markets and other places, virtually have very little or nothing at all to transport now as results of which very few of them still maintain the occupation. Years back when things were good, transportation was a very lucrative activity and different means of transportation ranging from buses and Lorries conveyed fish and other crops from the shores of the wetlands to different parts of the country.

Furthermore, Tourists guiding which used to be a very lucrative economic activity some years back is no longer practiced now along the Nguru wetlands. This can be rightly attributed to the fact that recreational activities such as tourism and swimming have been prevented by the invasive *Typha*. In the past, many tourists from within Nigeria and other parts of the world visit the Hadejia-Nguru wetlands for recreational activities which earned the government huge revenue as well as more income to the local communities. Migratory birds especially those coming from temperate regions of the world were very much popular with the tourists especially the whites. Generally, It was because of its economic, ecological as well as social values coupled with its enormous importance as a natural ecosystem that the Hadejia-Nguru wetland was declared as a Ramsar site. According to Ringim *et al.,* (2015), impacts of *Typha* on recreation and tourism, boating, swimming and diving activities are enormous. Although Tourists guiding was once practiced along the wetlands, no respondent out of the 159 local people was found to be a Tourists guide.

Some years before the invasion of Nguru wetlands by *Typha*, hunting was also one of the lucrative activities engaged by the local communities living along the shores of the wetlands as their major source of livelihood. Many species of birds and other animals were hunted some years back. But because of the drastic decrease in the abundance and diversity of animal species being hunted possibly due to *Typha* invasion of the wetlands, almost all the hunters with the exception of very few living in the area had either migrated to other places of have changed to other occupations. However, with only 3 respondents who claimed to be hunters in an area of thousands of inhabitants, generalisations from their responses can be unrealistic. In a study that contradicted this finding, Suleiman *et al*., (2013) reported that increase in *Typha* abundance had significant effects on both bird abundance and bird diversity. He added that, for every 10% increase in *Typha* abundance, number of bird species was found to increase by 1, 5%. Likewise,

bird diversity also increased by 0.02% for every 10% increase in *Typha* abundance. The only three respondents who claimed to be hunters stated that they still hunt few species of birds although in few numbers such as White stock locally called Galantoyi, Double-spurred francolin known as Fakara, Ducks known as Agwagwan ruwa and Dinya. However, all the hunters did not claim to hunt other animals now.

5.1.4Problems associated with *Typha* invasion

For better understanding of the impacts of *Typha* invasion along the Nguru wetlands, problems associated with it were also studied because all impacts of the invasion whether social or economic were directly related to problems posed by the invasive plant (0.988 Pearson correlation at 0.01level (2-tailed) and 0.650 Pearson correlation at 0.01level (2-tailed)).In line with this, it was found out that majority of the respondents (88.17%) agreed that problems associated with invasive *Typha* along the Nguru wetland were enormous. *Typha* was found to be significantly associated with prevention of transportation activities especially canoes, blockage of water channels and redirecting its flow leading to the drying up of many irrigation fields as well as the invasion of considerable number of farmlands and fishing sites. It also prevented access to fishing sites, affected water levels making ponds to become shallow, haboured crop pests such as quelae birds and locusts, served as nitch for thieves and cattle rustlers and interfered with normal growth of crops.

Cumulatively, all these problems led to catastrophic impacts on both social and economic lives of communities living along the wetlands. These findings do agree with the works of many other authors. According to Haruna (2006), *Typha* is a serious problem threatening the sustainability of the whole irrigation scheme along the Hadejia- Nguru Wetlands. Over 80% of the main canal and other water distributary channels have been over taken by this type of weed, there by blocking the free flow of water into the irrigation fields. According to Sabo *et al.,* (2016), along the HNWs, *Typha* is colonizing most importantly irrigated lands, pond, grazing lands, river channels and reservoirs, causing blockages and siltation added by the plant. Gomes *et al*., (2003), stated that, *Typha* blocks water channels growing rapidly and taking over farmlands, fishing ponds, canals and reservoirs in Hadejia, Jigawa state and Nguru in Yobe state.

Haladu and Bello (2014) believed that, *Typha*has become a common feature along the HNWs and a nuisance to the communities blocking the passages of canoes used for fishing and access to

remote farmlands. Generally, *Typha* has completely blocked the Hadejia-Jamaare River down to Lake Chad (a distance of about 1,000 km) thereby making fishing occupation cumber-some for the inhabitants because the Hadejia-Jama'are River apart from its fertile arable farmlands is a veritable farming zone. Fish-farming to the inhabitants, is the next occupation to crop farming (Animal Right in Nigeria, 2010). Although a good number of the respondents disagreed that *Typha* interferes with normal growth of crops, a good number of findings made by other authors revealed that *Typha* does not only interfere with the normal growth of plants around it but also causes excessive damage to the ecology of the environment it invades leading to significant changes in the ecosystem.Sabo *et al*., (2016) was of the view that *Typha* invasion may deplete soil nitrates with resultant poor crop yields which will require the use of artificial fertilizers and pesticides. Besides, invasive species such as *Typha* can cause habitat destruction by altering community structure through exploitation competition (indirect interactions such as resources use) and interference competition (direct interaction such as allelopathy in plants as well as plant succession (Charles and Dukes, 2007). *Typha* in dense biomass has the ability to influence plant structure and distribution

According to Temitope and Folaranmi (2012), invasion by alien species such as *Typha* cause extensive damage on the habitat they invade which include impact on indigenous species diversity, soil nutrients composition altering forest fire cycle and loss of productivity of invaded ecosystems. It also becomes a threat to endangered or threatened plant species around the world (Pimentel *et al*., 2005). Invasive species may as well cause changes in environmental services, such as flood control and water supply, water assimilation, nutrient recycling and conservation and regeneration of soils (Levines and D'Antonio 2013). *Typha* invasion may deplete soil nitrates with resultant poor crop yields which will require the use of artificial fertilizers and pesticides. If these chemicals are added in excessive quantities, however, they percolate into the ground water supplies, flow into streams and rivers and trapped by *Typha*. This may have effects on aquatic and marine life ecosystems and may lead to public health problems when the water is used for drinking and irrigation (Sabo, 2010).

Furthermore, the most important problem of concern caused by *Typha* invasion was blockage of access to safe drinking water. Certainly, all the local communities living along the wetlands solely depend on the wetlands for drinking water as they lack any modern infrastructure for the

supply of potable water. Hence, the catastrophic consequences of this cannot be over emphasised. Besides, due to blockage of river channels by *Typha,* there has been recurring floods in the study area as well as impacts on biodiversity. Ringim *et. al.,* (2015) in his study found that the problems associated with invasive alien species such as *Typha* are reflected in their impacts on biodiversity such as plant community, water birds community and invertebrate community.

Evidently, all the above findings imply that, most of the communities along the Nguru wetlands are embattled with the proliferation of *Typha* with resultant adverse consequences on their overall livelihoods; a reason good enough to force many of the local communities to migrate to other places in search of survival.

5.1.5 Economic impacts of invasive *Typha* on local communities

Certainly, the numerous problems found to be associated with *Typha* invasion along the wetlands were enough to assert that the economic impacts of the invasion can be so numerous and devastating. Overwhelmingly, all respondents in the study agreed that the most important economic impact of concern caused by the invasion was the drastic drop in the number of fish catches, drop in crop yields as well as the number of livestock reared. The drop in fish catches, crop yields and number of livestock was normally attributed to the dwindling fish abundance, destruction of crops by crop pests such as quelea birds, locusts and grass hoppers, disease conditions among livestock and moreover, reduction in sizes of farmlands, fishing sites, grazing fields and number of animals, all of which aroused from problems caused by *Typha* invasion of the wetlands.

It was gathered from the respondents that, despite their efforts to control spread of *Typha*, every year about 10 – 20 feet of their farmlands was overtaken by the invasive plant. According to the local people, chemicals used in the control of *Typha* sometimes led to the death of livestock while cost of farming and medication for the animals also increased significantly. In a study, Sabo *et al*., (2016) stated that more than 30% of cereal crops grown by the communities were consumed by quelea birds and during the 2007 season, the farmers recorded less than a quarter of the expected harvest as a result of quelea birds invading their farms. These drops coupled with unprecedented increase in the costs of farming and huge spending in controlling the spread of the plant resulted in serious decrease in people's productivity and incomes leading to abject poverty

among the local communities. In addition, invasion of the wetlands by *Typha* had negatively affected all other economic activities practiced in the area leading to the extinction of activities such as tourists guiding and hunting.

The devastating drop in fish catch and crop yields led to general hike in the prices of these commodities as well as all other goods traded along the wetlands such as sugar, detergents and so on. For instance, a medium carton of smoked catfish that used to be sold at the cost of 4500 – 6000Naira before, now costs about 8000 -12,000 Naira while a bag of maize that was sold at the cost of 6500- 8000Naira before, now costs up to 10,000 – 14,000 Naira. These findings do agree with that of Sabo *et al.,* (2016), that, it is on record that fish catches from the HNWs contributed about 6% of the annual national income of inland fish sales in Nigeria but today it provides only 0.6%. Similarly, cultivation of wheat, maize and vegetables brought local Fadama farmers an average income of nearly 10,000 Naira per season a decade ago, but now brings barely 2000 Naira even after investment in Fadama development technology. According to Yarima (2016), *Typha* invasion significantly affected the socioeconomic status of people whose livelihoods depend on wetlands. In his study, he found out that there was a significant impact of *Typha* on the livelihoods of crop farmers through reduced or complete loss of some crops particularly irrigated crops such as maize, wheat, rice, and vegetable; fishery farmers through reduced fishing sites and fish catches as well as livestock farmers through loss of grazing lands.

In a study conducted by Yarima (2016), he found out that, the significant effect of *Typha* on fishery farmers' output was 32.5%, income 48.6% and level of living 26.5%. Effects of *Typha* on crop farmers' output was 37.4%, income 29% and level of living 55.1%. Effects of *Typha* on livestock farmers' output was 44.9%, income 57,7% and level of living 23.6%. Sabo *et al.*, 2016, reported that as a result of *Typha* invasion of the HNWs, the average fish catch by fishermen per day had reduced from 3 – 4 basins to just a basin of catch per day. In addition, rice production which rapidly expanded in the wetlands during the mid-90s as a lucrative form of dry season flood recession farming has dwindles in recent years to invisibility (Ramsar Beureau Convention, 2000). The Jigawa Enhancement of Wetlands Livelihoods (JEWEL) project report (2015) reported that the average income of fish catch per fisherman has reduced from about $5 per day to less than $3 per day. Certainly, the economic impacts of *Typha* invasion on people did

not only stop at decreased incomes only but also affected people's productivity as well as their level of living.

About 1.5 million people depend on the HNWs as their primary source of livelihoods. Thus, reduction in its biodiversity as a result of invasive species may have a detrimental effect on the communities' wellbeing (Ringim *et al.,* 2015). As a result of all the described impacts of *Typha* on the local communities, their economic status as well as their overall incomes were seriously affected. This caused poverty to prevail in the communities making many of the local people financially handicapped thereby generating mass exodus from the area to other places in search of survival. Ringim *et al., (2015),* stated that the people living along the HNWs are in abject poverty and apprehension in fear of what to do next and considerable number of farming and fishing communities have migrated from the area while many are planning to migrate.

5.1.6 Social impacts of *Typha* invasion on local communities

Consequently, direct social impacts of *Typha* invasion on the local communities were also found to be enormous the most worrisome of which was the blockage of access to drinking water from the wetland waters upon which the local communities wholly depend for drinking water. Other impacts discovered were sporadic conflicts among the people over ownership of farmlands, fishing sites and grazing fields, heightened insecurity and crime rates, ill health conditions among people and livestock, frequent flooding as a result of blockage of water channels and redirecting its flow as well as habouring dangerous reptiles such as snakes and disease vectors such as mosquitoes which do not only affect those communities living along the shores of the wetlands but also those living far away in the nearby towns. According to the local people, the area had become an epicenter of malaria infection where mosquitoes affect both people and livestock as a result of which cases of malaria fever was so frequent in the communities. Worthy of note is that, the people claimed that prevalence of malaria among the communities really affected the people's productivity by keeping farmers and fishermen at home taking treatment instead of being working. Hence, the people must always sleep in mosquito nets and burn dry plants near their animals in order to drive away mosquitoes.

Most importantly, migration of people to other places induced by the numerous problems associated with *Typha* invasion was of great concern. Due to the fact that majority of those engaged in most of economic activities were young physically able men as revealed by this

study, migration of people from the shores of the wetlands can be said to be so catastrophic for the existence and sustenance of many economic activities along the wetlands. According to the local people, the more the invasion of the wetlands increased, the more the influx of people from other places into their communities reduced. Due to its importance and necessity in life, shortage or total lack of potable water supply can have serious consequences in communities. Dense biomass of *Typha* prevented access to drinking water from the wetlands as a result of which many communities had to go to long distances to fetch water using cattle and donkeys which they claimed affected their productivity by reducing the number of hours they were supposed to spend working in their farms or fishing sites. Similarly, reduction in farmlands as well as fishing sites usually led to conflicts among the people over ownerships sometimes with devastating consequences. I t was also gathered that dense biomass of *Typha* especially around shallow waters served as hiding places for criminals such as thieves and cattle rustlers who wreak havoc on the local communities leading to heightened insecurity. As a result of this, cases of cattle rustling are very rampant in the area. Besides, loss of sources of livelihoods due to *Typha* invasion also led to increased crime rates especially among the youth who usually resort to drug abuse and thefts.

Meanwhile, frequent flooding as a result of blockage of water channels and redirecting its flow by *Typha* led to the displacement of communities who had to move to safer places sometimes far away from their farmlands. According to them such occurrences greatly affected their productivity. During the months of January and February, cases of eye and respiratory problems were usually reported along the wetlands which the local communities attribute to the millions of microscopic seeds of *Typha* dispersed by wind. According to them, these ill health conditions arise as a result of the microscopic *Typha* seeds lodging on people's eyes or being inhaled. According to Miclovic (2000), when flowering, *Typha* can produce 20,000 – 700,000 seeds per inflorescence that are easily dispersed by wind.

However, despite the series of problems associated with the invasive *Typha* along the Nguru wetlands, majority of the local derives some benefits from dry biomass of the plant. According to them, when fully dried, the plant is used as a building material especially for roofing in the making of thatched roof because of its high insulation ability. I t is also used in the manufacture of furniture and as a source of energy used in cooking. This finding agrees with that of Sabo *et*

al., (2016), who stated that, because of the presence of large quantity of *Typha* in the Hadejia Rivers, the people around use it for cooking, using the leaves to cover Kola nuts and for construction of a local storage facility (granary) locally called "Rumbu".

5.1.7 *Typha* control/management measures along the Nguru wetlands

It was revealed from the interviews conducted that the most widely used control measures by local communities along the Nguru wetlands against the proliferation and consequent invasion by *Typha* were manual cutting and slashing, burning, use of chemicals as well as area flooding. According to the people, they mainly employ manual cutting using cutlasses and sickles to clear dense biomass of *Typha* from their farmlands and fishing sites. However, they lamented that this method of clearing *Typha* was so laborious, tiresome and time consuming thus; most often the people had to hire and pay for the services of labourers to help in the clearance. This they stated costs them a lot and not all farmers could afford it. Use of chemicals was also used to clear *Typha* from fields which according to the local people was the most effective control measure but complained that they spend significant amount of money in purchasing these chemicals because they are very expensive and only few farmers could afford it. However, it should be noted that the local people also depend on the wetland waters as their only source of potable water supply so; the use of chemicals to clear *Typha* could pollute the water and lead to catastrophic environmental consequences.

According to Deborah (1993), *Typha* has been controlled by a number of herbicides including 2, 4-D, Monuron, MCPA, TCA, Amitrole, Diuron, 2, 2-DPA, Terbutryn, Tandex. Dalapon and Glyphosate are the most widely recommended herbicides for the control of *Typha*. Herbicides can be applied to prevent sprouting of cut stumps, or to kill seedlings after felling or burning. Herbicides can target, for example, plants or broad-leaved species, leaving other plants unharmed. However, there are legitimate concerns over the use of herbicides in terms of potential environmental impacts. Although newer herbicides tend to be less toxic, have shorter residence times, and are more specific, concerns over detrimental environmental impacts still remain (Deborah, 1993).

The use of chemical control is often governed by legislation, and the effective and safe use of herbicides requires a relatively high level of training; both of these factors can restrict the use of chemical control on a large scale. Many invasive plants have been kept at acceptable levels by

herbicides. For instance, in Florida, water hyacinth was drastically reduced and subsequently managed by use of the herbicide 2,4-D, combined with some mechanical removal (Schardt 1997). Glyphosate is also another herbicide widely used for controlling invasive species globally. This is because it is a relatively non-toxic chemical that does not persist in the environment. Care must be taken during application to minimize effects to surrounding desirable vegetation. However, herbicide application in a large piece of land taken over by invasive species can be very expensive.

Furthermore, to control *Typha* proliferation, the local people also use burnings during dry seasons when good portion of the plant are dry to avoid seed germination. However, the people stated that this was not an effective control method because even after being burnt, *Typha* seeds do germinate immediately when the fields are flooded during rainy seasons. Besides, area flooding to avoid stem sprouting was also used by the local people as control measures against the spread of *Typha*. This method was found to be very effective when advanced technologies were employed in its implementation.

Certainly, all the above findings further confirmed the findings of other authors. According to Yarima (2016), to control the proliferation of *Typha* along the Hadejia-Nguru wetlands, majority of the farmers (56%) employ method of cutting and at the same time flooding the area to avoid seed germination and stem sprouting. About 36% of the farmers use mechanical clearing method by slashing the weed while about 9% use chemical method as a strategy to reduce the weed. According to Steven (2015), cattail control or reduction may be desirable where noticeable increases threaten natural plant diversity and habitat heterogeneity. Management may be necessary to: control the spread and domination of potential habitat by cattail in and perhaps adjacent to natural areas, circumvent declines in other plant species with cattail proliferation and to prevent development of monotypic cattail growth and loss of habitat heterogeneity. Most cattail controls have been made by wildlife managers interested in waterfowl production. Some methods would not be considered for use in designated nature preserves or natural areas. These methods include chemical and physical control, prescribed fire, shading, and water level modifications.

Meanwhile, based on the findings made from One on One interviews conducted with officials of the HNWCP and the KYB-WDI, it was gathered that, the two agencies do engage in the control of *Typha* proliferation along the wetlands through organisation and sponsorship of communal efforts to clear the plant, organisation of workshops and seminars for the local communities on how to control the spread of *Typha*, participation in mechanical clearance of *Typha* and making available to farmers and fishermen chemicals effective in the control of the plant. Other efforts made to control the spread of *Typha* include assisting farmers and fishermen to access loan facilities in order to enable fight the invasive plant as well as giving training to farmers and fishermen on improved methods of farming amidst *Typha* invasion.

Similarly, the study was also able to find out that apart from the HNWCP and the KYB-WDI, there was also the presence of some other Non-Governmental Organizations (NGOs) in the area such as the Nigeria Conservation Foundation (NCF), Coalition for Change (C4C) and the Ramsar Swiss Grant all engaged in many different efforts aimed at combating the spread of *Typha* as well as ameliorating the problems associated with *Typha* invasion. Some of the measures being taken by these NGOs include channel clearance, raising awareness for the people to engage in communal efforts and funding some proposals by the communities.

When asked what were their assessment of the effectiveness of the control measures employed in combating *Typha* invasion along the wetlands, all the local people and officials of the HNWCP and the KYB-WDI lamented that, almost all control measures were effective in combating *Typha* proliferation except that the rate of spread of the plant was unprecedented and beyond human imagination and always overshadowed control efforts making the control measures such as the use of chemicals, cutting and area flooding look ineffective.The plant produces vast quantities of long lived and persistent seeds which can out crop even after some dry spans, thus, re-emergence of *Typha* is very rapid after each removal. This phenomenon makes the spread of this weed fast and difficult to control (Sabo *et al.,* 2016).

However, according to the participants of the interviews conducted, efforts to combat *Typha* invasion along the wetlands face certain challenges ranging from institutional, logistic and human factors. According to the local people, some of the challenges faced were as a result of the *Typha* induced poverty which rendered them incapacitated to pay sufficiently for the

clearance of *Typha* from their farmlands and fishing sites nor purchase chemicals used for the control. In addition, lack of government support and modern control equipment also affect their efforts to control the spread. According to the people, dense biomass of *Typha* harbour spirits as a result of which many farmers shy away from clearing it out of fear of spirit attacks.

In their response, officials of the HNWCP and KYB-WDI stated that some of the challenges faced by the agencies include: lack of cooperation and basic formal western education on the side of the local communities, lukewarm attitude of government towards combating *Typha* invasion, widespread corruption, insufficient funding and lack of enough modern control equipment were some of the major challenges being faced. The fact established by this study that more than half of the local community people involved in the study did not possess the basic formal western education needed for meaningful development further affirmed this finding.

5.2 Conclusion

5.2.1 Characteristics and economic activities of the local communities

The study was able to find out that majority of the people living in communities along the Nguru wetlands who engage in different economic activities were physically able young men within the age group of 25 – 34 years and lack the basic formal western education. Hence, continuous migration of these potentially vibrant able young men to other places in search of livelihood as a result of *Typha* induced poverty spells nothing but total doom for the economic value of the wetlands. Thus, if left unchecked, *Typha* induced problems with resultant consequences on both social and economic livelihoods of the local communities will one day leave the shores of the wetlands completely deserted with no human to harness its resources. Most importantly, more than 1.5 million people depend solely on these wetlands for survival thus, the loss of its economic value will mean catastrophe to the local communities as well as governments at all levels. Besides, the lack of basic formal western education among the communities can have devastating impacts on the people's productivity as education is a pre requisite for meaningful development. With good education, the local communities will be able appropriately address *Typha* induced ill health conditions, be able to seek and employ effective modern control measures against *Typha* invasion as well as be able to diversify their sources of survival.

5.2.2 Socio economic impacts of *Typha* invasion

Based on the findings made by this research, it can be concluded that, with the unprecedented proliferation of *Typha* along the Nguru wetland which was further exacerbated by the inability of the local communities to control the spread, inadequate control strategies embarked upon by both governments and other NGOs to combat *Typha* invasion as well as the numerous challenges facing the control efforts, the numerous problems posed by*Typha* invasion will definitely continue to escalate with resultant impacts on both social and economic lives of the local communities living along the wetlands (0.988 Pearson correlation at 0.01level (2-tailed) and 0.650 Pearson correlation at 0.01level (2-tailed)).Consequently, the local communities will experience serious threats to their social lives and to their various economic activities upon which they survive with resultant significant drop in their incomes. In such a situation, the people will be compelled to abandon their professions and poverty will prevail in each and every house in the communities. When this happens, migration becomes the only option.

Besides, due to the fact that the communities were heavily dominated by people who do not possess any certificates of education to enable them secure white collar jobs or skilled jobs somewhere, the communities will have no options other than migrating to other places in search of livelihoods as a result of the total loss of the wetlands economic value. Most importantly, it should be noted that more than 1.5 million people depend on the wetlands for survival. This can have adverse effects on the economies of the Nguru Local Government Area, the Yobe State Government as well as that of the Government of the Federal Republic of Nigeria. For instance, since in terms of fishing alone, the wetlands serve as a major source of fish, supplying approximately 6% of Nigeria's inland fish catch with a market value of nearly US $300,000 per annum (Birdlife International, 2015), with continuous migrations of vibrant farmers and fishermen from the shores of the wetlands, the capacity of the wetland to continue to provide the 6% of Nigeria's inland fish requirement cannot be guaranteed.

5.2.3 *Typha* control/management measures

In conclusion, based on the findings made by this research study, proliferation of *Typha* along the Nguru wetlands still continues creating numerous social and economic problems while its control from all perspectives is still meagre and inadequate. Truly, more has to be done in order to bring the spread of this very stubborn invasive plant under control. With the slow and inadequate governmental efforts in clearing*Typha*from the wetlands coupled with the local

communities' inability to afford effective control measures as a result of *Typha* induced poverty and low productivity, effective control of invasion of the wetlands by *Typha* seems to be just a mirage.

Although the use of chemicals, cutting and burning were found to be the most common methods of control used by the local communities, full and effective control of this stubborn invasive plant especially by cutting requires advanced technologies whereas manual cutting using cutlasses and sickles is just a laborious, tiresome and not very effective method. Burning and the use of chemicals as control measures are not very much welcomed because of their adverse environmental effects especially for the fact that the local people depend solely on the wetlands as their only source of drinking water. Moreover, the situation with respect to the control of *Typha* invasion along Nguru wetlands is further worsened by factors such as poverty, superstitious beliefs, corruption, insufficient funds as well as luck warm attitudes of the government.

5.3 Recommendations

5.3.1 Characteristics and economic activities of the local communities

Based on the findings made in respect of the characteristics and economic activities of the local communities living along the Nguru wetlands, the following recommendations are forwarded:

- Government should build more schools and furnish them with qualified teachers as well as teaching and learning materials so that local children who are the future potential farmers and fishermen along the wetlands can be given the required formal education.
- Mass literacy centres should also be provided to give the adults basic formal education
- Governments should enlighten the local people on the need and importance of western education
- Women should be encouraged and enlightened on the need to engage in different economic activities along the wetlands

5.3.2 Socio economic impacts of the invasive *Typha on the local communities*

Based on the findings made by this study with respect to the item mentioned above, the following recommendations are hereby proffered:

1. In the first place, Ecological Fund being allocated by the Federal Government of Nigeria to all states vulnerable to ecological disasters such as desertification and bioinvasion should be judiciously used wholly for the purpose it is meant.

2. The major sources economic activities along Nguru wetlands; fishing, crop farming and livestock farming are being seriously threatened by *Typha* invasion leading to mass exodus of people to other paces. To curtail this menace, all levels of government, Federal, State and Local Governments Areas should employ effective control measures such as regular cutting and subsequent maintenance of 15 to 18 inches of water above the cut stalks, dredging, chemical sprays and the use of biological control agents such as the plant carp or white amur (Ctenopharyngodon idella Val) which have some potentials for biological control of *Typha.*

3. Governments should consider coming up with programmes aimed at converting *Typha* into positive uses for the rural populace. For example, it can be harvested and processed to charcoal which can serve the domestic energy needs of the people.

4. The Federal government of Nigeria should reintroduce the North East Arid Zone Development Programme (NEAZDP), an European Union assisted programme aimed at developing arid zones in the country that was in operation in this area some years back to assist in the control of *Typha i*nvasion and boosting the productivity of the local communities.

5. Governments at all levels should encounter the problems associated with Typha invasion as well as its social impacts such as provision of potable water supply, provision of mosquitoes nets, provision of medical care to address *Typha* induced health challenges, improve security etc.

6. Government and all other stakeholders should give entrepreneurial training and financial support to the local communities in order to broaden their skills and diversify their sources of livelihoods such as carpentry, welding, shoe making, tailoring and so on so as to cushion the impacts of *Typha invasion.*

7. Governments at all levels should consider the provision of soft loans to farmers and fishermen along the wetlands in order to boost their financial capabilities as well as the provision of subsidized pesticides for *Typha control and* other modern fishing and farming equipment.

8. Government should consider the establishment of zero grazing area along the shores of the wetlands especially because of the fact that most of herdsmen depend on milk production by their cattle for survival.

9. The establishment of well protected permanent irrigation fields for sustainable irrigation activities should also be considered.

10. Furthermore, with the help of Agricultural Extension Workers, the local people should be trained and sensitized on more productive and profitable modern methods of crop farming, fishing and livestock farming amidst *Typha* invasion.

11. Finally, this research only studied the socioeconomic impacts of invasive *Typha* on the local communities thus, it is recommended that more research into the impacts of Typha plant invasion on aquatic biodiversity, impacts on normal growth of crops, impacts on fish abundance and diversity as well as the relationship between *Typha* invasion and disease related cases such as eye and respiratory problems should be carried out.

5.3.3 *Typha* control/management measures along the Nguru wetlands

From the foregoing, it could be deduced that the management of invasive species is taking another dimension and is not business as usual. Its impacts affect all aspects of human life affecting the environment, health, social as well as economic status. Based on the findings made by this study, the following recommendations are thereby proffered:

1. Though *Typha* control can be difficult where cattails have formed large monocultures and dense rhizomal systems which allows them to grow back quickly, proper application of control measures such as mechanical clearance, Lake draw-down and fires could help. However, through the adoption of chemical and biological control methods which are already in use in other countries and have proved to be effective, the menace of *Typha* invasion along Nguru wetlands can be eradicated. Dalapon and Glyphosate are herbicides widely used for controlling invasive species globally. This is because it is a relatively non-toxic chemical that does not persist in the environment. Other herbicides also used are 2, 4-D, Monuron, MCPA, TCA, Amitrole, Diuron, 2, 2-DPA, Terbutryn and Tandex.

2. Biological control, instead of eliminating the target organism aims at establishing an equilibrium which maintains its population at a level of negligible harm (Bani 2002). It has been practiced for many decades by a host of countries, especially the USA, Australia, South Africa, Canada, and New Zealand. In the past 150 years, until the end of 1996, more than 350 species of invertebrates and pathogens were deliberately released in 75 countries for the control of at least 133 weed species (Julien and Griffiths 1998). The plant carp or white amur (*Ctenopharyngodon idella Val)* which has some potential for biological control of *Typha* can also be used. Deborah (1993) made a list of insects which parasitize *Typha*. These include many species of *Lepidoptera* and *Hemiptera* which damage the inflorescence while feeding. Larvae of *Calendra pertinax* are stem borers and also feed on the starchy cortex of the rhizomes. Also, entire stands of *Typha* were eliminated after being colonised by boring moth larvae (*Arzana spp.*).

3. Governments in Nigeria should come up with policies on how to convert process and recycle *Typha* into positive uses such as fuel source, building materials, feed for animals, furniture e.g. mats, household usages such as baskets etc.

4. Local communities should be empowered to control *Typha* proliferation through the provision of proper tools, herbicides, funds etc.

5. Federal Government of Nigeria should reintroduction of the North East Arid Zone Development Programme (NEAZDP), an EU assisted project that was present in the area some years back. NEAZDP helped greatly towards the eradication of *Typha* from the Hadejia-Nguru wetlands and assisted farmers in many respects with the aim of enhancing their economic activities and boosting their productivity.

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APPENDIX I

QUESTIONNAIRE FOR LOCAL COMMUNITIES AND OFFICIALS OF THE HNWCP AND KYB - WDI

Dear Respondent,

I am a student of Master of Science degree in Environmental Management of Kampala International University (KIU), Uganda. Currently I am conducting a research titled **"Socioeconomic Impacts of Invasive *Typha* on Local Communities along Nguru Wetlands, Yobe State, Nigeria".** All information provided will be used and treated with utmost confidentiality.

SECTION A: Demographic characteristics of the respondents

1. Gender

a) Male ( ) b) Female ( )

2. Age

a) 15-24 ( ) b) 25-34 ( ) c) 35-44 ( )
d) 45-54 ( ) e) 55-64 ( ) f) 65 and above ( )

3. Marital Status

a) Single ( ) b) Married ( ) c) Divorced ( )

4. Level of Education

a) Arabic ( ) b) Primary ( ) c) Secondary ( )
d) Diploma ( ) e) Degree ( ) f) Masters ( )
g) PhD ( )

5. Household Size

a) 1-5 ( ) b) 6-10 ( ) c) 11-15 ( )
d) 16-20 ( ) e) 21 and above ( )

SECTION B: Socioeconomic activities of the local communities

1. Occupation

a) Crop Farming ( ) b) Livestock Farming ( ) c) Fishing ( ) d) Hunting ( )
e) Transportation ( ) f) Tourists Guiding ( ) g) Irrigation Farming ( ) h) Others ( )

2. Farm Size

a) 1 hectare ( ) b) 1-2.5 hectare ( ) c) 2.6-3 hectare ( )
d) More than 3 hectares ( )

3. Animal species reared

a) Goats ( ) b) Sheep ( ) c) Cows ( )

d) Mixed ( )

4. Number of animals

a) 10-20 ( ) b) 21-30 ( ) c) 31-40 ( )
d) 41-50 ( ) e) 50 and above ( )

5. Type of fishing

a) Wet season ( ) b) Dry season ( ) c) All year round ( )

6. Type of Hunting

a) Bird hunting ( ) b) Animals hunting c) Others ( )

7. Type of transportation

a) Canoes ( ) b) Vehicles ( ) c) Carts/Wheel Barrow ( )d) Motorcycle ( )

SECTION C: Cultural characteristics of the local communities

1. Are you resident in the area Yes ( ) No ( )
2. Are you a Nigerian? Yes ( ) No ( )
3. What is your state of origin? Yobe state ( ) Jigawa state ( ) Bauchi state ( ) others ( )
4. What is your tribe? Kanuri ( ) Hausa ( ) Kare Kare ( ) Fulani ( ) Bade ( ) others ( )
5. Which religion do you belong to? Islam ( ) Christianity ( ) Others ( )

SECTION D: Problems associated with *Typha* invasion as well as its socioeconomic impacts on communities living along the Nguru wetlands

Kindly tick the option that you agree or disagree with regarding the problems associated with Typha plant invasion as well as its socioeconomic impacts on the livelihood of communities living along the Nguru wetlands. Use the following scales to indicate your opinion. **4=Strongly Agree, 3=Agree, 2=Disagree, and 1=Strongly Disagree**

S/N	PROBLEMS ASSOCIATED WITH TYPHA PLANT INVASION	4	3	2	1
1	*Typha* prevents transportation with canoes.				
2	*Typha* invasion increases flood plains				
3	*Typha* blocks water channels and redirects water flow				
4	*Typha* prevents aesthetic activities				
5	Considerable sizes of fishing sites, grazing fields and farmlands are invaded by *Typha*				
6	Water bodies such as ponds become shallow due to invasion by				

	Typha				
7	*Typha* prevents access to fishing sites and farmlands				
8	*Typha* invasion affects water level.				
9	*Typha* harbours crop pests such as quelae birds				
10	*Typha* interferes with the normal growth of crops.				
	ECONOMIC IMPACTS OF TYPHA PLANT INVASION	**4**	**3**	**2**	**1**
11	*Typha* invasion led to drop in the number of fish catches and crop yields				
12	*Typha* invasion caused drop in the number of animals reared				
13	*Typha* invasion has caused an overall decrease in people's incomes				
14	*Typha* invasion has greatly affected people's productivity				
15	*Typha* invasion has caused increase in poverty rate among people				
16	*Typha* invasion led to increase in the cost of farming and fishing				
17	Many Irrigation sites have been overtaken by *Typha*				
18	*Typha* invasion led to general increase in prices of commodities				
19	Farmers spend a lot in trying to control *Typha* invasion				
20	All other economic activities are affected by *Typha* invasion				
	SOCIAL IMPACTS OF TYPHA PLANT INVASION	**4**	**3**	**2**	**1**
21	*Typha* invasion prevents access to safe drinking water				
22	Invasion of the wetlands by *Typha* led to migrations of people				
23	*Typha* invasion has led to conflicts among people				
24	Rate of insecurity and crime have increased as a result of *Typha* invasion				
25	*Typha* invasion affected health conditions among people and animals				
26	People are displaced as a result of flooding caused by *Typha* invasion				

27	*Typha* serves as hiding place for criminals such as thieves and cattle rustlers				
28	*Typha* harbours dangerous animals such as snakes and disease vectors such as mosquitoes				
29	Tourism activities are also affected by *Typha* invasion				
30	*Typha* is converted into useful benefits by the local people				

APPENDIX II
STRUCTURED INTERVIEW GUIDE

1. What other problems are associated with *Typha* invasion in this area?

2. Are there other socio economic impacts of *Typha* invasion in this area?

3. What control measures are being employed to manage the proliferation of *Typha* here?

4. How do you assess the effectiveness of these control measures?

5. What challenges do you face in the control of *Typha* invasion?

APPENDIX III

RESEARCH BUDGET

ITEM	**AMOUNT**
Transportation	5000 Naira (USD 11)
Research equipment and stationary	3500 Naira (USD 7)
Communication	2500 Naira (USD 5)
Secretarial work	6000 Naira (USD 12)
Subsistence	4000 Naira (USD 8)
Accommodation	25000 Naira (USD 51)
Miscellaneous	4000 Naira (USD 8)
TOTAL	**50,000 Naira (102)**

APPENDIX IV

RESEARCH TIME FRAME

Activities	Dec. 2016	Jan. 2017	Feb. 2017	March 2017	April 2017	May 2017	June 2017	July 2017	Aug. 2017	Sept. 2017	Oct. 2017	Nov. 2017	Dec. 2017
Topic definition													
Proposal write up													
Proposal submission and defense													
Decision on methods of data collection													
Preparation for data collection													
Data collection													
Data organization for analysis													
Data analysis													
Results write up													
Report submission and defense													

APPENDIX V: INTRODUCTORY LETTER

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EXPLORING THE HEIGHTS

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SCHOOL OF ENGINEERING AND APPLIED SCIENCES
DEPARTMENT OF BIOLOGICAL AND ENVIRONMENTAL SCIENCES

20th February, 2017

TO WHOM IT MAY CONCERN

RE: **MR. MUHAMMAD BABAGANA**

I am writing in support of **Mr. Babagana's** request to collect data for his research on Assessment of the Impact of Invasive Typha Grass on Socio-Economic Activities, case study of Nguru wetlands Yobe state, Nigeria

Mr. Muhammad Babagana with Registration Number **1161-03126-04487** is pursuing his Master's degree in Environmental Management which is a two year program at Kampala International University in the department of Biological and Environmental Management.

We appreciate the service rendered to him.

Yours faithfully,

Ms. Anne Tumushabe
Head of Department – Biological and Environmental Management