GRAZING EFFECTS ON THE RIPARIAN VEGETATION AND HUMAN COMMUNITY ALONG RIVER BENUE, ADAMAWA STATE, NIGERIA

BY

MADUBE TUMBA KWABE

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DECLARATION

I do hereby declare that this dissertation is my own work and has not been presented for a degree or any academic award at any university or institution of learning.

Signature of student: ……………………………………… …………………………………

MADUBE TUMBA KWABE Date

APPROVAL

We confirm that the work compiled in this dissertation was by the candidate under our supervision and is ready for further examination by other examiners.

Supervisors:

Signature of supervisor………………………………… Date……15/10/2018…………………

PROF. JACINTA OPARA. A.

Signature of supervisor………………………………… Date……15/10/2018…………………

DR. NUWE JOHN BOSCO

DEDICATION

This piece of work is dedicated to my family, memories and wisdoms of my late parents.

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LISTS OF ACRONYMS

AUM	Assets Under Management
BMPs	Best Management Practices
DPSIR	Driving force, Pressures, State or condition, Impacts, and Responses
EEA	European Environmental Agency
ERA	Environmental Rights Actions
FAO	Food and Agriculture Organization
FCT	Federal Capital Territory
GHS	Green House Gas
GPS	Global Positioning System
IBM	International Business Machines
IFAD	International Fund for Agricultural Development
OST	Open System Theory
SPSS	Statistical Package for the Social Sciences
ST	System theory
US	United States
SEAS	School of Engineering and Applied Sciences

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

ABSTRACT

This study purposely investigated the grazing effects on riparian vegetation and human communities along river Benue, Adamawa states. The objectives were; i) to determine grazing effects on the plant community; ii) to determine the socio economic effects of grazing along river Benue on human community; and iii) to identify effective management strategies for conservation and sustainability of riparian area along river Benue. The study used cross-sectional and observational survey design. The target population was 550 participants who included: sixty-five (65) River Basin Development Authority, fifty-five (55) State Environment Management Agency, twelve (12) Non-Governmental Organizations, thirty-six (36) Community Base Organizations and four hundred and thirty (430) local community members. Sample size of 232 was determined using Sloven's formula. The data instruments included questionnaires, interview and observation guides. The questionnaires response rate of the study was 96 percent of the contacted respondents. Data was analyzed using inferential techniques, frequency and percentage distribution. Tables and graphs were used to present the data. Study revealed that grazing has significant effect on the riparian plant species community with decrease in species growth, decrease in palatable native species diversity, decrease in plant productivity of the riparian, decrease in species composition, increase in exotic species diversity, increase in native unpalatable plant species. furthermore, the study found that there was increase in plant extinction, increase in plant diebark and decrease in the vigor and resilience status of plant species along river Benue. Again the study found out that there was variation in plant species density between the grazed and ungrazed sites and also, a slight difference on the species attributes amidst the upper and lower riparian. The study indicated a very strong positive socio-economic effect of grazing along river Benue. including insecurity, destruction of water sources, poor quality of life (poor health quality), increase in communicable diseases e.g. Epidemic Cholera, hepatitis and typhoid, poor sanitation, limited access to safe and quality water. Furthermore, the study revealed the destruction of habitat and decrease in fish productivity decrease in wild foods (fruits/vegetable e.g. cashew nuts, hackberries) and medicinal plants e.g. combretum nigrican and lamiaceae; decrease in the navigability level of riparian water; destruction or upsetting of riparian educational potential (53 percent). The study revealed that the most effective management strategies for this riparian area included but limited to: fencing strategy, alternative watering point strategy, and using shade and shelter grazing strategy. Considering the fact that degraded riparian environments demand innovative and pragmatic approaches to restoration and significant of the effects of grazing in riparian area along river Benue, and the need for sustainable vegetation cover and economic activities, the study recommends that the Government of Adamawa State together with Federal Government should strengthens grazing related policies promoting awareness of the negative effects of traditional grazing and ensuring the adoption of best grazing management practices such as tree planting and establishing Grass reserves, specific watering points e.g. ground tanks within pastures, planting palatable forage species e.g. on depleted upland areas, programing prescribed burning as a vegetation treatment improvement, system improving Stockmanship through traing , engineering interventions for invasive species e.g. Cenhrus cilliaris. Herd management and animal husbandry practices of cows Sheep and goats, Supplementation of feeds Culling and fencing techniques.

CHAPTER ONE

INTRODUCTION

1.1 Background of the study

The Federal Republic of Nigeria commonly referred to as Nigeria is a federal constitutional Republic in West Africa, bordering Benin in the west, Chad and Cameroon in the East and Niger in the North. Its coast by the South lies on the Gulf of Guinea in the Atlantic Ocean. It comprises 36 states and the Federal Capital Territory (FCT) where the capital, Abuja is located. Nigeria is officially a democratic secular country (Environmental Rights Action (ERA, 2012).

Nigeria is often referred to as "giants of Africa" owing to its large population and economy. With approximately, 184 million people, Nigeria, is the most populous country in Africa. Nigeria has one of the largest populations of youth in the world. The country is viewed as a multinational state as it is inhabited by over 500 ethnic groups of which the largest are Hausa, Igbo and Yoruba. These ethnic groups speak about 500 different languages and are identified with wide variety of cultures. The official language is English. Nigeria is divided roughly in half between christian who lives mostly in the Southern part and Muslims mostly in the Northern part of the country. Majority of the population practices religions indigenous to Nigeria such as those native of lgbos, and Yoruba (ERA, 2012).

There are three district systems of law in Nigeria, common law, derived from its British colonial past and a development of its own after independence, customary law derived from indigenous traditional norms and practices. These includes the dispute resolution of pre-colonial Yoruba land secret societies, the Ekpo and Okonko of Igbo land, Ibibio land and Sharia law used only in the predominantly Muslim Northern States of the country. The sharia is an Islamic legal system that had been used long before the colonial administration. In late 1999 Zamfara emphasized its use, with eleven States following suits, these are: Kano, Niger, Bauchi, Borno, Kaduna, Gombe, Sokoto, Jigawa, Yobe, and Kebbi (Ikusemaran and Marryah, 2013).

The Adamawa state - mainly covered Adamawa Plateau – a Plateau in West Central Africa stretching from South Eastern Nigeria through North Central Cameroon (Adamawa and North central provision) to the Central Africa Republic. The Plateau was named after Fulani leader Madibo Adama. The Adamawa Plateau is the sources of many rivers or water ways including Benue River. It is important for its deposits of bauxite.

The average elevation is about 33000 feet (1000 meters), but elevation can reach as high as 2,650 meters. The average is mostly savanna and is sparsely populated. Cattle grazing are the main occupation in the area (ERA, 2012; Blench, 2010).

The Benue River (French La Be'noue) previously known as the Chad River or Tchadda, is the major tributary of River Niger. The River is approximately 1.400km long and is entirely navigable during the summer months. As a result, it is an important transportation routes in the region through which it flows. It rises in Adamawa-Plateau in Northern Cameroon from where it flows west through Jimeta, Ibi and Makurdi before meeting the River Niger at Lokoja. Its large tributaries are the Faro River, Gongola River and the Mayo-Kebbi which connects it with Logone river part of the Lake Chad system. During the floods other tributaries are: Taraba River, Donga River and River Kastina-ala. At the point of confluence, the Benue exceeds the Niger by volume. The average discharge before 1960 was 3,400 cubic meters per-second and (120,000 cu-fit/s) for the Benue and 2,500 cubic meters per second (88,000 cu ft./s) for the Niger during the following decades the run-offs of both rivers were low, decreased due to irrigation activities (Onouha, 2008; Hogan, 2013).

Vegetation provides a substantial part in the preservation of nature by daylight transformation into energy; it aids the structure, a large quantity and diversity of herbal species (Theobold. *et al.*, 2010). Indeed riparian flora is essential to the existence of livestock, nature, and the surrounding people through its social and economic importance (Morris & Reich, 2013). However, in spite of its significance, plant communities are susceptible to human intrusions which are a serious universal problem. The threats facing the vegetation growth in the riparian areas include among others uncontrolled harvests of bio-resources and overgrazing. These threats have had detrimental socio-economic effects to human livelihood (Julien, 2014). The preservation of riparian vegetation alongside livestock grazing has over the years been recognized by researchers as at variance due to their interdependence and susceptibility. Furthermore, it is true that both resources require harmonious management for the survival of the community (Bastin. *et al.*, 2012; and Onouha, 2008).

1.1.1 Historical Perspective

Livestock grazing have for long been reputable for being the global economic activity that largely affects riparian vegetation and has conventionally been practiced unguided among many societies across the world (Oholmart, 2011). Different researches have recognized the predominance of cattle grazing in riparian during the pre-settlement era, across America and Europe. Grazing was purely practiced on different perspective limited to each community and region across the world (Fleischer, 2010). Across America and Europe grazing became rigorous after industrial revolution and protracted into the riparian after the development of the cattle industry (Todd, 2014). Indications show that early explorers grazed along Santa-Cruz and San-Pedro riparian ecosystem in America, flood plains of Spain and the coast of Italy (Abouguendia, 2009).

According to historical facts, riparian grazing was common across Africa and particularly across savanna of sub-Sahara where grazing was noted to be primarily focused along rivers and coastal areas. In addition, the same practices were observed across East and South of Africa which was stated to be accountable for the degradation of vegetation on the mountain valleys of Kenya, Ethiopia and South Africa (Charles, 2010; Kidane. *et al*., 2015). Also along the narrow hall of the rift valleys plane in Uganda, concentrated grazing has become a serious environmental problem among some communities that are mainly pastoralists (Twaha. *et al*., 2016). Grazing mainly is responsible for riparian vegetation degradation in the semi-arid savanna of Southern Zimbabwe (Patience. *et al.*, 2013). On the mountain valley of South Africa, grazing practices were documented to be intolerable on the natural species (Bothwell. *et al.*, 2013; Roba. *et al.*, 2013).

Grazing is a common phenomenon all through the globe though with disparity in effects due to climatic hanges and the employment of different grazing management mechanisms by different communities. Nevertheless, in spite of the conceptualization of management, grazing appears to be devastating where uninhibited practices are common. In Nigeria, grazing on the extraterrestrial landscape is as old as crop cultivation among people. Nonetheless, due to the commonness of tsetse fly and inadequate nature of technology and economic, grazing activities along the riparian was not early like on the uplands but, it is a recent development (Blench, 2010).

Even though riparian grazing looks to be a new development but, it has caused more overwhelming effect across African states particularly along the riparian of river Benue in Adamawa State, North East of Nigeria (Adefioye, 2013).

1.1.2 Theoretical perspective

This study took on System Theory (ST) by Vonbertalanffy, 1968). System Theory was advanced for the biological sciences, but later was extensively acknowledged for use in both social and physical sciences. It was used by academics to appreciate and explain internal and external responses of system components to interferences. Ludwig Vonbertalanffy a biologist, in the 1940s recommended system theory and he believed all things both living and nonliving could be viewed as a system, and has characteristics capable of being experimented and studied (Vonbertalanffy, 1968). He professed ecosystem as a systematized structure that acts and reacts to different forms of correlation interferences within and outside which lead to positive and negative effects.

The work of Vonbertalanffy was later validated by many scholars who came up with countless related work but, with slight difference in characteristics. This was to meet up the demands of specific disciplines, resultantly, Open System Theory (OST) among others, emerged as one that is extensively accepted in environmental studies. Believing that it is more efficient in determining cause – effects relationship among variables inter-reactions (Cristina. *et al.*, 2010).

The Open System Theory (OST) postulates that every system has energetic process of responding to life-threatening pressures and that system components are associated in responding to conflicts (Cristina. *et al.*, 2010). Because of the different responses to effects, it is challenging to single out an individual driving force either external or internal as responsible for the actions. Nevertheless, their views are comprehensible though the claims that effect cannot be attributed to precise variable are a weakness. This eventually disreputes the power in system component reactions. It also failed to understand that technology has changed human perception and behaviors towards utilization of ecosystem resources.

The study also considered the view of the model “Tragedy of Commons”. This model was devised by Garrett Hardin in 1965.He extracted the idea from a Victorian economist, which assumed that resources are common to all. Overgrazing in this instance was used as an example in the economic concept, reflecting on overgrazing of common land as an example of behavior. Interestingly, Garrett Hardin’s idea could only apply to unregulated use of land resources like vegetation among others which is the case under study in the riparian area of rive Benue.

Therefore, effectiveness of Open System Theory (OST) towards analysis of riparian vegetation utilization is questionable, considering the socio economic effects of grazing. Of course when applied appropriately may become relevant when tested under strict observation. Nonetheless, the study in order to complement used the DPSIR model, founded in 1999, by European Environmental Agency (EEA) as an integrated environmental impact Assessment Instrument (EEA, 2005).

1.1.3 Conceptual perspective

Riparian area is defined by Nener. *et al.,* (2006) a portion of land nearby a stream of river, or swamp, or a water body. According to Miner. *et al.,* (2012), riparian area is a space of land having lasting water and characterized by physical features of water vegetation. On the other hand, Ehrhart and Hansen (2014), defined riparian as the green zones found within channels of flowing water and moorlands. Similarly, Campbell (2009) defined riparian area as the green zone directly next to streams, rivers, lakes, and ponds. Furthermore, Moen (2008) defined riparian area as the intermediate area linking terrestrial and aquatic surrounding.

According to Zhou (2012), grazing is one technique employed whereby domestic livestock are used to change grass and other forage into meat, milk, and other products. Grazing is defined by Bradford and Ernest (2013) as a way of feeding in which an herbivore feeds on plants such as grasses, or other multicellular organisms such as algae. Grazing effects is defined by Zoheir (2011) as the likely effect of grazing on the plant species, water quality, and soil composition.

1.1.4 Contextual perspective

Livestock grazing have for centuries been and is still to a great extent a source of livelihood for a big number of Nigerians (Oyinloye & Kufoniyi, 2011). Grazing in Nigeria is traditionally practiced like in the pre-settlement period conventionally with difference in approaches restricted to the communities and region. The interaction between cattle grazing and riparian vegetation has long been recognized as a contradictory exercise. Both resources are of significance values to the existence of human beings which requires to be managed amicably to escape contradictory circumstances. However, old-fashioned grazing management approaches still in use are grave issues of concerns among communities of the savanna region of Nigeria, where freehand cattle grazing has triggered a severe ecological problem due to overgrazing (Adefioye, 2013).

The profound effect cattle grazing in Nigeria prior post-independence was related to native landscapes vegetation only (Aremu & Onadeko, 2010). Again, before the colonial master's policy of breakoff of land and individual ownership in 1861, all communities were organized with compelling methods of managing their land and natural resources (Meagher & Yunusa, 2012). These methods ensured that the communities, clans and families took responsibility that ensured the protection of the natural resources. Before the era of the colonial masters, in Nigeria cattle were few and breeds were purely native, ownership was limited and traditional management strategies were commonly used in stock production (Blench, 2010). The riparian vegetation was untampered with and still in excellent conditions providing its ecological services. The riparian areas were then relatively free from human activities especially grazing and the plant community was wide matured with standard succession level (Olaotswe. *et al.*, 2013).

Furthermore, the productivity of riparian vegetation then was due to less economic and low technology adaptation combined with the community's self set authority and policies (Kufoniyi, 2010). Because of the above argument, there was restricted interaction with riparian vegetation which was boosted by low population, technology, and predominance of tsetse fly, which carry trypanosomaisis parasites deadly to both human beings and animals (Blemch, 2010). These circumstances favored riparian vegetation to be comparatively free from human pressures which improved plants community maturity and functional ecological services.

Nevertheless, calamity of cattle grazing in riparian ecosystem began in Nigeria when the authority capitalized on the community leaders who unfortunately were taken over by the colonial masters (Meagher & Yunusa, 2012). Local policies that safeguarded riparian resources were lost and management of nature resources was no longer based on norms and values of the community (Faburoso & Sodiya, 2011). On the other hand, before independence the vegetation state of affairs was still good and stable, and offering ecological services (Blench, 2010).

However, the State of affairs became most awful at post-independence because the old-style management approaches were thought-out to be insufficient to enhance livestock production; hence different agricultural programs were established with the intention of improving production particularly animal proteins (Meagher & Yunusa, 2012).

The programs corresponded with growth in population, technology and economic advancement that led to a high demand for grazing lands among individuals. This led to increase in cattle population, possession and enhancement in cattle breed due to upgrading in veterinary service (Blench, 2010).

These growths, tested the sustainability of the highlands and riparian vegetation because, there are millions of people living and profiting in many ways from riparian vegetation for sustenance (Theobold, 2010). Riparian grazing is of recent, unlike the native vegetation where grazing has been ongoing centuries (Adefioye, 2013). Because of these advances, need for grazing land became greater than before with no change in cattle management approaches (Blench, 2010). Regrettably, these progresses made the situations of moorlands vegetation damaging to riparian grazing (Adefioye, 2013). The tsetse flies' free riparian and those claimed through extermination were not forbidden to the pastoralists for grazing purpose (Faburoso & Sodiya, 2011). This was the beginning of grazing drifting into the riparian without realizing the future implications on the environment. It was also one of the most catastrophic error made with a long term impact on the riparian resources after petroleum exploration (Oyinloye & Kufoniyi, 2012).

The wandering of cattle grazing into the riparian area was attributed to the depletion of the natural land vegetation and the increase in population size that encouraged riparian encroachment (Adefioye, 2013).

Riparian grazing is on no occasion a severe problem if properly contained because; it helps in enhancing the soil condition and growth of other elements of the system (Doselly, 2010). But then, again unrestrained practice has become a grave problem in the riparian; more disturbing is the rapidity at which it is becoming deepened in riparian ecology. This could be devastating to the vegetation and other components of riparian ecosystem. This is because unrestrained grazing practices could be responsible for deteriorating situation of riparian vegetation.

Therefore, if the above situation is not studied it could change into a more severe problem, like scarcity of quality water downstream, fading of river channels, beds sedimentation and temperature upsurge, lack of rain, decrease in fish production, annihilation of amphibians, macroinvertebrates and deterioration in geomorphic composition and fertility (Shao. *et al.*, 2013).

Because riparian ecosystems occupy comparatively small percentage of land mass, it plays important role in the sustenance of the community (Morris & Reich, 2013) by offering socio economic activities and increasing biodiversity (Julien, 2014). However, the locals are still uninformed of the relevance of the riparian in the development of ecosystem and general survival of the society.

River Benue and Lake Chad with their surroundings is a passage to the main drainage grasslands and different riparian bionetwork in the north east (Onouha, 2008). However, the riparian flora of North Eastern Nigeria is in awful condition and the socio economic benefits of vegetation are been ruined by the increased and unrestrained grazing along the riparian (Adefioye, 2013). Also Linus. *et al.*, (2014) lamented over the dreadful conditions of the vegetation and the disappearing socio economic benefits such as: sporting, cultural/educational and provision services of the riparian, and the source of livelihood of the for majority of the communities.

1.2 Problem statement

Overgrazing in the riparian is significantly affecting the vegetation of the riparian area and the subsequent effects on both economic and social life of the communities living along the riparian. In spite of Nigeria government measures and struggles to preserve the ecological resources caused by intensification of livestock grazing there are other variables inter play hindering the success.

Also, Adefioye (2013) indicated that grazing in the riparian area is affecting the vegetation. Again, Abila and Ayawei, (2015) reflected on the fact that, weak implementation of the environmental policy intensifies chaotic grazing in the riparian. This creates a serious threat or serious danger to the sustainability of riparian vegetation and the environment, as well a danger to the survival of people living and benefiting in several ways from the riparian vegetation resources.

It should be noted that over grazing causes reduction in eatable plant life in a riparian area hence leading to depletion of the vegetation. As a result, soil erosion increases, fish productivity reduces, water quality and quantity reduces, leading to increase in temperature and drought. Furthermore, due to grazing in riparian area, there will be increase in sedimentation and exposure of the deltas to salty water. Therefore, the study investigated into the need to mitigate the situation.

1.3 General objectives

The overall objective of this study was to investigate and establish grazing effects on riparian vegetation along river Benue, Adamawa State, Nigeria.

Specific objectives

i. To determine grazing effects on the plant community in the riparian zones along river Benue.
ii. To determine the socio economic effects of grazing along river Benue.
iii. To established effective management strategies put to use for conservation and sustainability of riparian area along river Benue.

1.4 Research questions

i. What possible effects does grazing have on the riparian vegetation along river Benue?
ii. What socio- economic effects does grazing pose to the communities in the riparian areas along river Benue?
iii. What effective management strategies have been put in place for the conservation and sustainability of the riparian?

1.5 Research hypothesis

i. Ho1: Grazing has no effects on the vegetation in the riparian area along river Benue.
ii. Ho2: There is no socio economic effect of grazing along river Benue.

1.6 Justification of the study

Traditionally, ecologists have focused studies purely on either terrestrial or aquatic attributes or processes. It is important to understand the river basin and riparian vegetation in order to integrate the functional processes linking the terrestrial and aquatic components for effective water resources management and development.

While there are studies on water resources and watersheds in Nigeria, the riparian zones have received limited attention. The study aimed at providing information to stakeholders (cattle grazers, water resources and catchment users, managers, developers and physical planners) on the biophysical conditions of the riparian zones and the sustainable development of this area.

1.7 Operational definition of terms

Overgrazing: refers to the intensity of grazing animals (cows, goats and sheep) in an area for an extended period of time without sufficient rest periods causing reduction in the usefulness, productivity and biodiversity of the land.

Riparian area: refers to groups of land next to streams, rivers, wetlands, and other surface water bodies.

Defoliation: refers to the removal of above ground plant material.

Browsing: refers to a type of herbivory in which herbivore (cow, sheep, goat, or horse) feeds on leaves, soft shoots or fruits of high-growing, generally woody, plants such as shrubs.

Tramping: refers to the movement of livestock from highland to riparian area and back to highland causing surface soil breaking, erosion and transfer of plant species using their hooves.

Socio-economic activities: refers to non-farming various economic and cultural life supporting activities meeting individual needs.

Socio-economic effects: refers to destructions of the lineup social, economic and cultural functions of life supporting resources along the riparian.

Conservation strategies: refers to effective and efficient grazing management tools, measures or processes for sustainable riparian.

1.8 Scope of the study

1.8.1 Geographical scope

The area of study is the riparian ecosystem along River Benue the upstream of the river in Nigeria, which is known as (Upper Benue) located in Adamawa State, North East of Nigeria. It is a portion of river Benue with a distance of 90 km with its upper and lower sections.

Its lower section or downstream in Adamawa, consist of Lamurde, Numan, Demsa and Girei. Its upper section or upstream in the state consist of Yola North, Yola South and Fufore. Therefore, the river cut across six local governments in the state which are: Numan, Demsa, Girei, Fufore, Yola North, and Yola South.

The study area was chosen because it is the largest river with wide riparian ecosystem in the Savanna North East of Nigeria. It is where cattle grazing is much predominating economic activity.

1.8.2 Theoretical scope

The study was driven by the System Theory (ST) advanced by Ludwig Vonbertalanffy (1968), and DPSIR model advanced in 1999 by European Environmental Agency (EEA, 2005) and the Tragedy of the commons devised by Garrett Hardin (1965). This provides a rich complex view of riparian ecosystem as system and resources. The System Theory explains the internal and external reactions of system components to interferences within and from outside that lead to impacts. The DPSIR model explains the actions and reactions of systems components to disturbances. Its measurable variables are: the (D) Driving force, (P) Pressures, (S) State or condition, (I), Impacts, and (R) Responses. The model handles chains of patterns of disturbances on system. Overgrazing is use as an instant in the economic concept known as the “Tragedy of the commons” Hardin’s example could only apply to unregulated use of land as resources. Emphasizing a limit on numbers of animals each commoner allowed to graze, these regulations were reaction to demographic and economic pressures. Under some condition these pressure lead to the riparian ecosystem resource degenerating which have direct effects on communities.

1.8.3 Content scope

This study was limited to grazing effects on the vegetation in the riparian area along river Benue, variation of seasonal livestock grazing effects on riparian vegetation along river Benue, the socio-economic effects of grazing along river Benue and the effective management strategies for conservation and sustainability of riparian area along river Benue.

CHAPTER TWO
LITERATURE REVIEW

2.1 Theoretical review

Overgrazing is a problem due to cattle grazing, it occurs when plant community are exposed to intensive grazing for a long period without sufficient recovery time (Papanastasis, 2014). It can be caused both by poor cattle grazing strategies and by immobile travel restricted populations of native or non – native animals (Cristina. *et al.*, 2010). Intensive livestock grazing also reduce the usefulness, productivity, and biodiversity of land and is one of the causes of desertification and erosion. Also is seen as a cause of the spread of invasive species of non – native plants and weeds (Golodet. *et al.*, 2010;). Such phenomenon is mostly caused by Fulani Nomadic pastoralists grazing in huge population of travel herds, such as the cattle in the Africa Savanna along river Benue in Adamawa, Nigeria (Adefioye, 2013). Sustainable grass land production is based on grasses and grassland managements and livestock marketing.

Therefore, it is obvious to note that, proper cattle grazing management with sustainable agriculture and agro – ecology practices, is the function of grassland based livestock production. Since it affects health productivity of both plants and animals, for these reasons, there are several grazing models and theories systems that attempts to identify and reduce or eliminate overgrazing effects (Salatir, 2016). Under continued grazing, grazed plants do not have enough time to recover to the proper height between grazing events. Because the plants restored and reserves carbolic rates which make grown back roots are lost after defoliation actions (Cristina. *et al.*, 2010). Studies identified that on continue grazing tall – grass species die faster than short grass when subjected to injuring through browsing and defoliation during dry season (Susan. *et al.*, 2011). For example, unpalatable species such as imperatia spp and dristida spp are found to be more tolerant and dominant of grass land (Golodet. *et al.*, 2010).

Grazing increases soil erosion and reduced soil organic matters, depth and soil fertility which destroys land’s values and agricultural productivity (Green, 2010). The fact that soil fertility can be corrected using organic fertilizer, but the loss of soil depth can take centuries to correct.

The loss is critical in determining water holding capacity and how well pasture plants do during the dry weather (Hansen. *et al.,* 2015).

Both individual and bunch grasses and plants native species are always vulnerable to such conditions (Rayburn, 2010; Susan, 2011). Grazing is used as an example in the economic concept known as the “Tragedy of the common” devised in a 1965 paper, by Garrett, Hardin. Interestingly, the work cited the effort of Victorian economist, who used the overgrazing of common land as an instance of behavior. However, it should be noted that Hardin’s example could only apply to unregulated use of land as a resources.

Usually, the authority to use communal land in Nigeria was and up to now are closely regulated and available only to “commoners” (Faburoso & Sodiya, 2011). Nevertheless, there is currently an oversight in regulating some land resources and situations are exposing the commoners’ behaviors. If excessive use was made of common land, for example in grazing a common would be “stinted” that is, a limit would be put on numbers of animals each commoners were allowed to graze (Susan. *et al.,* 2011).

Obviously, these regulations were responsive to demographic and economic activities pressures, thus, rather than let a common land become degraded, access was restricted even further. The EEA (2005) DPSIR model equally hold similar view on the anthropogenic economic activities pressures on the ecosystem. It is an oversight that indeed, this significant part of actual historic use of common land in practice was absent from the economic model of Hardin. However, in reality despite the variation in traditional norms the use of common land in Nigeria is a triumph of considering scarce resources. This agreed to traditional customs, laws and practice, like in any country across the globe (Rayburn, 2010; Olaotswe. *et al.,* 2013).

An understanding of an efficient ecosystem nowadays should have a root of the 1940s understanding of ecosystem, which was around the acknowledgement of the significance of interruptions process on ecosystem. This led to development of theories and models regarding ecosystem. System theory (ST) was then developed and was widely accepted for use in social and physical sciences. It was used by scholars to understand and expound internal and external reactions of system components to interferences.

Ludwig Vonbertalanffy a biologist, in the 1940s proposed system theory and he believes, all things both living and nonliving could be regarded as a system, and has properties capable of being observed and study (Vonbertalanffy, 1968).

He perceived ecosystem as an organized component that acts and reacts to different patterns of relationship interferences within and outside which lead to positive and negative effects.

The work of Vonbertalanffy was validated by many scholars who came up with much similar work but, with little variation in attributes. This was to meet up the demands of specific disciplines, of which open system theory (OST), emerged as one that is widely accepted in social and environmental studies. Believing that is more efficient in determining cause – effects relationship among variables inter-reactions (Cristina. *et al.*, 2010).

The open system theory holds the view that every system has dynamic process of responding to extreme pressure and that system components are linked in responding to disturbances (Cristina. *et al.,* 2010). With such a bound of reactions to effects, it is difficult to single out an individual driving force either external or internal as responsible for the actions. However, their views are understandable but, the claims that effects cannot be attributable to specific variable is a weakness. Which of course, discredited the linked and strength in system components reactions. It also failed to understand that technology has changed human perception and behaviors towards utilization of ecosystem resources.

Therefore, effectiveness of open system towards analysis of riparian vegetation utilization is questionable, considering the socio economic effects of grazing. Of course when applied appropriately can be tested. However, the study in order to complement will use the DPSIR model. It was developed in 1999, by European Environmental Agency (EEA) as an integrated environmental impact Assessment Instrument, (EEA, 2005).

The model framework has the capacity to identify either single or complex bunch of driving force (s). The model believes that driving force can be single or many variables, and it has the following components thus:

D = the driving force (s)

P = Pressure(s) from the driving force(s).

S = Situation or condition of an ecosystem due to pressure.

I = an impact or effects of the forces on the environment, a change in quality.

R = Response of the environmental or system components to the society and societal response to the negative changes affecting livelihood of the society.

The model handles chain of patterns of disturbances on environment or ecosystem that force pro – actions, as illustrated diagrammatically below (EEA, 2005).

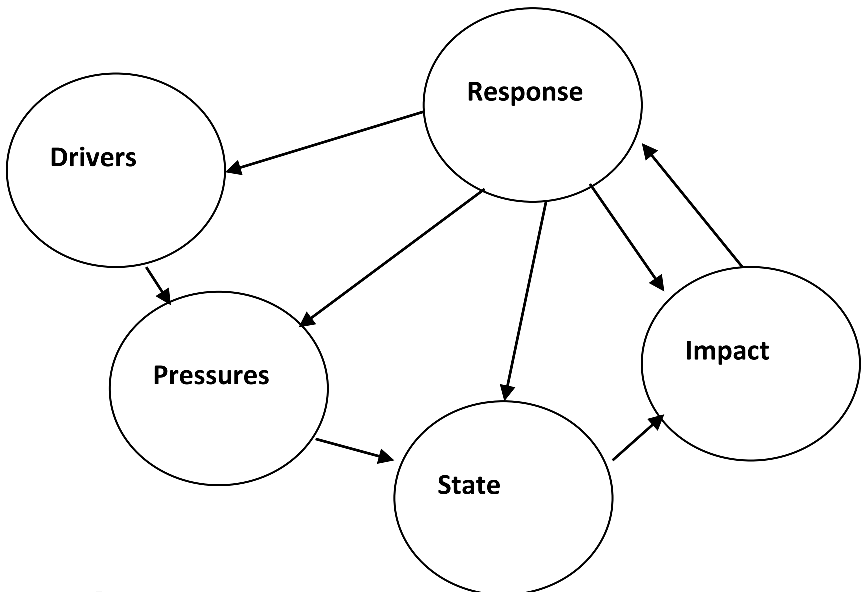


Figure 1: DPSIR (Frame work)

The models relevance is linked to the measurable variables of anthropogenic activities on the riparian vegetation. For example, as in the study, cattle grazing as an activity are a pressure with direct and indirect effect on other riparian ecosystem components. The driving force(s) identify and explain the economic activities of the society, (Changes in needs, consumption and production pattern) of man (EEA, 2005). The primary need of man in the riparian is farming activities which are the primary driving force(s), which can either be irrigation or grazing. Any of these needs provoke changes at all level of production resulting into a serious pressure on the ecological community. The pressure(s) indicator describe actions or substance(s) physical, biological or otherwise an element(s) actions that become pressure on the ecological resources.

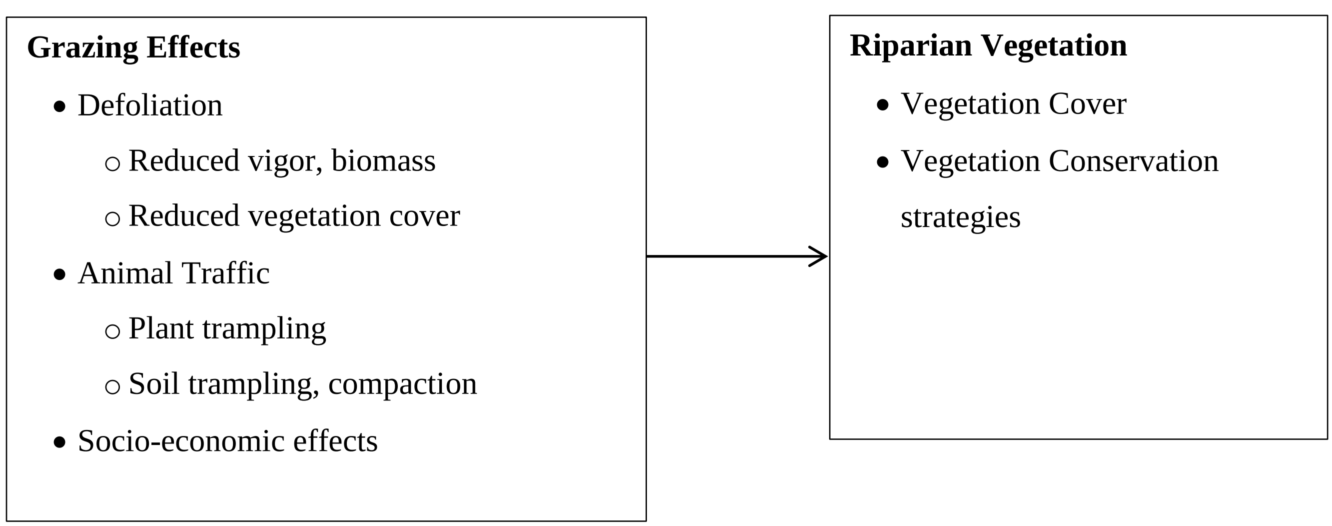
Pressurizing the stability of riparian components brings about a change in the state or condition of environmental quality. Further, impact indicators describe the changing condition riparian resources especially vegetation, such effects occur in sequences leading to another problem(s) due to first effect (EEA, 2005). For example, unregulated grazing activity may lead to vegetation degradation as the first effect, (which is the primary effect). This may lead to channel erosion, bed sedimentation and loss in water quality as secondary effects.

Therefore, losses in one of the riparian plant community attributes, will affect the other vital components of riparian ecosystem. This is referred to as tertiary effect directly or indirectly on human beings (Julien, 2014).

On the serious point, a decline in plants community of the ecological system will subsequently cause a change in the ecology and will directly affect the socio – economic values (services) which are vital for human livelihood (Jones. *et al.*, 2010) The responses usually are call for immediate solution from the society which comes as policy decision directly on target project. Thereafter, interestingly policy or decisions are transformed into action program for conservation and sustainability of the ecosystem.

2.2 Conceptual framework

Independent Variable **Dependent Variable**



Source: Adapted from Water and Rivers Commission (2010), Fleischner (2014)

Figure 2: Conceptual framework

Riparian vegetation is imperative to the existence of both the wildlife, and the community through its socio-economic benefits. But, in the face of its relevance, threats to plant community such as uncontrolled harvests of bio-resources and unregulated livestock grazing are a worldwide challenge which is causing defoliation and tramping whose effects are detrimental to the vegetation and subsequent socio-economic activities.

2.3 Related Studies

2.3.1 The riparian zone

The narrow surrounding of the riparian zones intertwined with the aquatic and terrestrial areas have landscape ecosystem. Forman and Gordon (2010) expound that riparian zones are corridors that make a network within the background of a watershed and frequently function as ecological resource reinforcements by playing the role of a basin and source for materials. Riparian zones correspondingly function as passageways and waterways for flow of energy, abiotic materials, and biotic organisms within the watershed. Riparian floor covering are normally arranged in a dendritic array which shows drainage collections and backlog of water within a watershed. The riparian channels are time and again disturbed by human activities like roads and railway constructions, resulting in incoherence of the riparian web. This disjointedness can change the flow of species and materials along the system and within the watershed (Malanson, 2013).

Another challenge affecting the smooth flow of riparian materials and species is the small size of its breadth. However, when water is available, it controls the size of the riparian and allows it to serve its purpose. It should also be known that the size of the riparian area can define and determine the interconnection between land and water areas, and subsequently affect its existence (Schulz. *et al.*, 2010). Extensive riparian zones are usually more varied and have more multifaceted arrangement, purpose, and species structure (Malanson, 2013). The role of riparian zones and neighboring moorlands is determined by the size of riparian. More often, riparian zones play the role of controlling the flow of biotic organisms and abiotic material hence shielding the extraterrestrial and marine ecosystems. The relevance of the protective shield is attributed to a larger extent to the size of the riparian zone.

Due to the presence of water and nutrients, riparian land often supports significant plant communities that are generally denser, faster growing and have a greater number of layers or strata, than adjacent plant communities. They also perform a variety of valuable functions, many of which improved the ecological services to the advantages of human survival (Theobold. *et al.*, 2010). There are three district of law in Nigeria, common law, derived from its British colonial past and a development of its own after independence, customary law derived from traditional norms and practices. Such free-riding often leads to underinvestment in management and protection of an area and its natural resources resulting in degradation, (Byaruhanga and Nuwe, 2008).

2.4 Functions of riparian vegetation

2.4.1 Pollution, sediment and nutrient trapping

According to Water and Rivers Commission (2010), most contaminants for example nutrients, insecticides and thick metals are attached to residue particles and riparian flora can play a significant function in trapping this residue and its close impurities before they get drained into the waterway. Water and River Commission, also added that; meadows and shrubbery plants are very good in realizing a 'buffer zone' effect. This is the reason why several scholars argue that a buffer zone of up to 2,000 centimeters from the top of the bank is required to realize an excellent pollutant and nutrient stripping and that, the broader the buffer zone is the more effective it is. Additionally, buffer zones are also very effective when the current is low and stable.

2.4.2 Channel stability

It has been debated that watercourse bank undergrowth reduces the risk of soil destruction (Bryne, 2011). First and foremost, root structures of vegetation and plants safeguards brook banks from erosion by supporting and increasing the hardness of the soil, and by guaranteeing shielding outward floorcovering. Plants absorb water in the banks and speeds the drainage of the soils which reduces the risk of bank failure due to substantial waterlogged soils. Additionally, Byrne (2011) explicates that riparian zone undergrowth and the associated deposit of rubbles increases waterway coarseness, decelerating the movement and plummeting the capacity of the water current to erode and relocate residue. Rather, residue is deposited amongst the flora. This helps to enhance downstream sections of waterways, such as river pools, from large inputs of material.

2.4.3 Riparian ecosystems

Riparian zones are an interface between extraterrestrial and marine ecological unit and as well perform a serious function in supporting biota and consequently biodiversity (Woodfull. *et al.,* 2013). Healthy, native riparian vegetation decreases the water temperature of marine ecosphere by covering. It also yields tannin that give a unique yellowish-brown colour to stream water, which further moderates' sunlit infiltration of the water column (Pettit, 2009). When watercourse calefaction rises, liquefied oxygen altitudes drop, generating circumstances which are challenging to bear for animals that are cool-blooded, whose metabolic rates may exceed the reasonable oxygen in the rising temperatures. Accordingly, more daylight in the riparian zone also upsurges the development of soft leaved energetic weeds and algae that can clog the waterway. Because the leaf material of these plants is soft, and tears instantaneously, it reduces the oxygen attainable in the water completely. This circumstance is one cause of fish destruction, relocation and reduction in yield (Land and Water Resources Research and Development Corporation, 2014).

According to Waterways Commission (2014), riparian undergrowth provides vigor in the form of residue and other biological fragments, which affects the marine survival chain. The comparative significance of the riparian belt upon ecological system differs as one goes from small to narrow upland streams. Where the riparian vegetation has an energetic control on larger, wider lowland rivers, where many of marine ecological processes occur separate from the primary riparian forest, but alternatively count on inputs from upstream (Kinch, 2009). As a result, it is ordinarily valuable to observe rivers as sequence and ascertain that fringe floristic communities play an important role in the whole function of river system.

2.4.4 Habitat provision and corridors

With the decrease in natural plant community and large variety between remnant habitats, Woodfull, *et al.,* (2013), point out that riparian passages provide a vital action in allowing the movement of plants and wildlife between remnants as well as between habitat areas in their own right. The high production and multiplicity of foliage groups found within the riparian belt provides important home for different animals and can support varied and plentiful groups. According to Zoheir (2011), a majority of wildlife spend their whole lifecycles in the riparian zone, although others use it as a source of food, shelter, nesting and nursery sites.

For example, big woody rubbish and active plants within the stream provides fortification, food and laying environment for many native birds, fish and invertebrates.

Latest study shows that for a riparian bumper area to function effectively as a habitat passageway, a least width of 30 meters, and up to 100 meters in some cases, is necessary, in order to attain the full range of plant communities needed for a range of species and to link effectively with adjacent land-dwelling bionetworks (Land and Water Resources Research and Development Corporation, 2014).

2.4.5 Flood control

According to Water and Rivers Commission (2010), surprisingly vegetated riparian areas can decrease the strength, height and capacity of floodwaters at a specific point along stream by letting water to spread out horizontally along the flood way and across the flood plain. Nevertheless, flora can also slow and hence increase water levels in other areas, so flood management using foliage must be carefully planned.

2.4.6 Economic values

Progressively, scientists are learning that a well-managed riparian zone is an asset to landholders, rather than a net burden (Land and Water Resources Research and Development Corporation, 2014). Among others, the values of a good riparian bionetwork consist of better-quality water with a related growth in stock health, a reduction in insect and bird pests that damage pastures and crops, chances for diversification such as agroforestry or firewood, provision of windbreaks and shelter which can lead to improved stock growth and productivity through reduction of heat or cold stress, reduced bank erosion and topsoil undressing, and even an upsurge in capital value of land and the likelihood for eco-tourism (Land and Water Resources Research and Development Corporation, 2014).

2.4.7 Recreational and aesthetic values

According to Byrne (2011), a healthy riparian zone not only has biological value but also offers pleasant surroundings that are popular recreational areas near which people every so often choose to live. Rivers and the riparian zone are significant recreational resource, with fishing, swimming, boating, walking, picnicking and bird watching all being common riparian zone activities.

Byrne (2011), further clarify that, the river and riparian zone tend to control the local scenery and may also contribute meaningfully to the regional landscape. It should be noted that the presence of such resources in any community are central to the artistic worth of an area.

2.4.8 Spiritual values

Shores are spaces of divine significance. Old property-owners have strong spiritual connections to water courses, as creeks, streams, rivers and estuaries are all linked to the Dreaming (Waterways Commission, 2014). The path of water passages is time and again credited to the actions of the Waugyl (rainbow serpent) who is believed to have carved out river valleys and streamlines from the landscape.

The Water and River Commission (2010) opined that, shores too have strong spiritual values for non-Aboriginal people. That is, calming and life giving properties of water may evoke powerful emotional responses from people who recognize spiritual qualities of water. Fathomably, Spiritual links are not the same as recreational values as they are normally more inert and may have spiritual qualities. Meditation, prayer, visualization, and healing activities often rely on shores as a setting in which to demonstrate spiritual association between humans and nature (Water and River Commission, 2010).

2.5 Characteristics of livestock that potentially affect riparian vegetation

According to Water and Rivers Commission (2010), the grazing behaviors among livestock species differ considerably, and grazing effects on the growing plant can also differ. Because some of the more useful forages store reserves energy in organs above the ground, the grazing characteristics of specific animals can influence plant survival following various defoliation intensities. Water and River Commission, further argues that, for the most part, animals do not prefer to bite plants off at the soil surface. But it will be an over sight to ignore the dynamic of behaviors, when feed availability is limited, obviously they may graze the plants so close to the soil surface that reserve energy storage is consumed. If sufficient rest time for the plant to replenish reserve energy and leaf area is not provided between defoliations, the plant cannot maintain its vitality (Provenza, 2013). Therefore, a successive defoliation increasingly weakens the plant species. Under such grazing practices, animals cannot meet their daily nutrient requirement because of limited intake. The plant is being sacrificed to provide very limited feed supply, and the animal is not performing because of underfeeding.

If the top growth of a plant is continually defoliated, the root system weakens, thus contributing to less stable soil conditions and potentially subjecting the site to greater surface soil erosion and nutrient movement (Byrne, 2011).

2.5.1 Cattle

Ganskopp. *et al.*, (2011) explain that cattle can graze herbaceous plants to within 2 cm of soil surface, but they generally do so only when feed availability is limited. Cattle will browse on young woody species and forbs that are found in riparian areas, but if forage supply is adequate on upland site the severity of defoliation can be controlled.

Cattle will "spot graze" certain areas within a pasture, which is an indication that animals have access to more forage than is needed. According to Samson. *et al.*, (2012), plants in those spots will eventually weaken and not produce to their potential because of low leaf area and low reserve energy storage. Which imply that; Botanical composition of plant community will likely shift to species most tolerant of short, frequent defoliation, such as Bermuda grass (*Cynodon dactylon*) crabgrass *(Digitaria Panguinalis*) Kentucky bluegrass (*Poa pratensis*), endophyte-infected tall fescue, or white clover *(Trifolium repens*).

2.5.2 Sheep

Sheep choose very specific plant parts because of their lip and teeth arrangement. Sheep will bite the leaves from the stems or bite the entire tiller off near the soil surface, even in situations where the grass may be at an ideal height for cattle to graze easily (Samson. *et al.*, 2012) If they remain on an area until forage supply becomes limited, sheep may bite all plants off to ¼-inch stubble. Such grazing will make a significant impact on a plant's reserve energy storage and regrowth rates. Plants that store reserve energy underground or that has lots of leaves near the soil surface will have the best survival in sheep pastures (Heady and Child, 2014).

Sheep are easier to control than cattle and can be less damaging to riparian ecosystems. The habitat preferences of sheep result in less damage to riparian areas because they tend to prefer hills more than cattle do (Heady and Child, 2014). Heady and Child, further suggested that grazing management of riparian zones depends upon a combination of strategies: fencing to improve grazing distribution on upland and riparian zones and rotational grazing to adjust for seasonal changes in use. Riparian sites can be restored without eliminating grazing, yet reducing the stocking rate alone is seldom effective. A grazing system for a riparian site usually requires several practices: the creation of one or more additional pastures by fencing, development of off-stream livestock water, removal of upland brush, and seeding of areas alongside the stream (Clary, 2010). Together these practices led to improved overall management.

Like all grazing management systems, they must be designed for the site, flexible to meet climatic and operating variables, and monitored for evaluation of success. Repair of small riparian areas usually requires increasing vegetation cover on the watershed, channel structures, or both.

2.5.3 Goats

Howery, (2012) argue that goats prefer to graze with their heads above their knees. If supplies of both browse and pasture are available, they may select a diet that is more than 50 percent browse. They will graze close to the ground when the feed supply is severely limited. Goats can be the most selective in what plant parts they eat. They will eat seed stalks, heads, and other plant parts that cattle, sheep, or horses do not readily eat. Likewise, they will eat plant species that cattle, or sheep, do not readily eat. Goats tend to graze a canopy from the top down in a fairly uniform manner. They do not spot graze as much as other animals.

Small ruminants naturally select diets of higher quality than large ruminants. In addition, the efficiency with which small versus large ruminants ingests different plant parts and life forms may not be the same (Samson. *et al.*, 2012). Therefore, if given limited access to a riparian area, small ruminants such as goats are not as likely to overgraze because they will select the most nutritious plant parts. Goats can also act as a biological control for such species as kudzu (*Pueria lobata*), greenbrier (*Smilax bona-nox*), multiflora rose (*Rosa multiflora Thumb*.), brambles (*Rubus spp*.), honeysuckle (*Lonicera japonica*), and hardwood seedlings (Luginbuhl. *et al.*, 2012; Jones, 2010).

2.6 Grazing practices that affect riparian vegetation use

2.6.1 Grazing intensity

Reviews by Marlow, (2015) and Sattler, (2012) have pointed out that in mesic grazing lands, plant communities may produce more herbage as a result of some degree of defoliation, whereas plant communities in arid situations may produce less herbage as a result of almost any amount of defoliation. In his study of livestock in a mountain meadow with annual precipitation ranging from 18 to 39 cm, (Clary and Booth, 2013) reported that defoliation of redtop (Agrostis stolonifera L.) at a vegetative and mature stage of growth to 5 cm once or twice per year and associated trampling damage and nutrient return had little effect on biomass production. But such defoliation did reduce the biomass production of communities dominated by sedge (*Carex spp*.). A single defoliation of the sedge communities to 10 cm did not reduce biomass. Clary and Booth, further suggest that; "recommended residual stubble height of herbaceous forage" for riparian areas, suggested by the majority of land management agencies, indicates defoliation to 10 to 15 cm. If streams are important to endangered fish species, then stubble height can be managed at 10 to 20 cm for sustainable management.

Buckhouse. *et al.,* (2011) reported no significant increase in stream bank erosion when areas with various managed grazing patterns were compared to ungrazed areas. There were wide-ranging variances among treatment areas, but those differences may be attributed to other factors: (i) Stream banks respond differently to perturbations; (ii) some lengths of a stream are more susceptible to disturbance than others; and (iii) the duration, intensity, and time of year of the perturbation could also be variance indicators.

Ehrhart and Hansen (2014), maintained that winter grazing by elk reduced plant cover and increased soil bulk density on winter range areas north of Yellowstone National Park. He suggested a minimum groundcover of 70 percent and maximum bulk density of 1.04 grams' cm^{-1}, with soil erosion increasing rapidly outside these guidelines. In a compaction study on mixed prairie and fescue grasslands in Alberta, Sedgwick and Knopf (2012), reported that heavy-intensity grazing had a greater impact on compaction than light-intensity grazing. Early season grazing was also implicated as having a greater impact on compaction than late season grazing.

2.6.2 Seasonal use

Riparian zones generally represent a small percentage of the land area within a pasture; however, they may be the most productive zones and can be the location where animals spend a disproportionate amount of time, especially during hot, dry times of the year. In a southwestern Montana study, Marlow and Pogacnik (2015), reported that cattle spent up to 80 per cent of their time in upland sites during the early grazing season. As plants matured, however, and temperatures increased, they spent up to 60 per cent of their time in the riparian areas. Animals obtained nearly 80 per cent of their forage from riparian areas in the late grazing season. To correct or limit this situation, the length of the grazing period can be based on the areas cattle are actually using and not the entire pasture.

Clary and Booth (2013), concluded that spring grazing could be favored in many areas because cattle are less likely to concentrate along streams and wet bottoms during that season. They studied cattle grazing during June in the mountains of central Idaho. The study reported that as stocking rates increased from light (1.19 AUM ha^{-1}) to medium (2.08 AUM ha^{-1}), cattle tended to concentrate most additional use on drier uplands while only slightly increasing use of riparian sites.

In an early summer grazing study in Oregon, Roath and Krueger (2012) observed that 81 per cent of the forage removed by livestock on a mountain allotment came from the riparian zone. The area of the riparian zone comprised just 1.9 percent of the total area and produced ~21 percent of available forage. The combination of green forage, shade, and drinking water often associated with riparian habitat increases the attraction to grazing animals, especially on hot rangelands during drier periods of the grazing season.

The season of use is also important when considering bank and channel damage. Marlow and Pogacnik (2015), reported the highest level of channel damage in a sequential grazing experiment during late June and early July when cattle use of the riparian zone was relatively low (~20 to 30 per cent of time) compared to later in the season when the soil moisture content of the banks was 18 to 25 per cent. By early August, soil moisture had declined to 8 to 10 percent and bank damage did not exceed natural changes though riparian usage by the cattle was much higher.

2.6.3 Alternative water sources

Offering off-stream water sources to animals can reduce the amount of time spent drinking from streams, without fencing off the stream (Gordon, 2009). In their study in Oregon, four cows with access to water solely at a stream spent an average of 60 min day^{-1} at the stream. However, when provided with a watering at a tank 75 ft. away from the stream in a 3-acre pasture, they spent only 15 min day^{-1} at the stream, a 75 per cent reduction in the amount of time spent at the stream. Gordon (2009), also monitored two horses grazing a fenced 3-acre pasture (s 1.5-acre wet site and s 1.5-acre dry site) with access to a creek. Providing a pasture pump located 175 ft. from the stream and with no stream access, the amount of stream water used was reduced by 17 to 53 percent, depending on whether the pasture site was dry or wet. This indicates that on dry pasture, a pasture pump can greatly reduce the amount of water horses take from a stream. On wet pasture, horses may not be taking any more water from the stream but obtaining more of their water from the pasture.

In an alternative water source study, Miner. *et al.*, (2012), monitored drinking and lounging habits of cattle on a winter-feeding site with a stream traversing the area. The stock density of the paddock containing the water tank about 300 ft. upslope of the stream was about 20 heifers' a^{-1} (50 head on a 2-acre paddock).

Animals with stream only access to drinking water spent 25 min day^{-1} in the stream, whereas those animals with access to a tank spent 1.5 min in the stream and 12 min at the tank. The tank was more than 99 percent effective at attracting the animals during periods when thirst was the driving factor of behavior. At other times, the tank effectively competed with the stream as a lounging area more than 80 percent of the time. The authors suggested that the tank's 2º to 14ºF warmer water temperature and ease of access as compared to the steep and muddy streamside explained at least part of the cattle's preference for drinking from the tank.

In southwestern Virginia, Sheffield. *et al.*, (2013), studied the potential for off-stream water sources to improve water quality and prevent stream bank damage. After best management practices (BMP) installation of water tanks near an off-stream water source, an 89 per cent reduction in time (6.7 to 0.7 min.) spent by each animal drinking from the stream was reported. In addition, researchers reported that the amount of time spent within 4.6 m of the stream was reduced by ~75 percent if forage available in the pasture was adequate for herd demands.

However, when cattle were put into a paddock that had been harvested for hay on the day before, there was no reduction in time spent in the stream area. On a farm site with a stock density of 200 cows and 170 calves on 136 ha, a 77 percent reduction in stream bank loss due to sloughing by cattle was reported. This was likely part of the reason for an 89 percent reduction in the “flow-weighted” concentration of total suspended solids at the watershed outlet.

In Georgia, Byers. *et al.*, (2014), used global positioning system (GPS) collars to track cattle movement in unfenced pastures with and without off-stream water troughs. Availability of a water trough decreased the time cattle spent in the stream area in a pasture with little no riparian shade, but had no influence on the time cattle spent in the stream in a pasture with a significant amount of shade outside of the riparian area. This study demonstrates that off-stream water and off-stream shade work together to alter cattle activity in the stream area and that both should be considered when BMPs are installed in attempts to redistribute cattle activity on the landscape.

In another Oregon study, Clawson, (2013), reported that cattle preferred to use water tanks rather than streams or springs as sources of water. Daily stream or spring use per cow was reduced from ~5 min before installation of a trough to ~1 min after installation. Each cow used a stream or spring in a “bottom area” about 8 min day^{-1} before trough installation, and only ~4 min day^{-1} afterwards. Cattle preferred to drink from the watering trough, watering 73 per cent of the time at the trough, compared to 24 percent at the “bottom area” and 3 per cent at the stream. However, the tank size limited the number of animals that could drink at once. Therefore, some animals moved to the bottom or stream because of competition for water during the peak gathering periods.

Data from a second experiment (Clawson, 2013) showed that cattle tended to trail to the watering site around noon and spend the afternoon loafing in shaded areas close to water. Loafing accounted for 91 per cent of the time each cow spent in the riparian area, an average of 47 min day^{-1} of loafing. With many implications for water quality, 60 per cent of loafing time was spent at the stream. However, cattle mainly used the area for watering rather than loafing during the morning and evening.

To reduce time spent loitering near the stream, the researchers experimented with providing restrictions to the animals' access to the stream by providing narrow access areas across the stream. The researchers reported that no defecations from the 124 cows landed directly in the water during a 6-day observation period in May when stream access was restricted.

The distance livestock must travel to reach water can significantly impact animal performance, Ganskopp. *et al*., (2014) researched the effect of water restriction and trailing distance to water on cattle performance. When cattle did not have to walk to water, weight gains were improved by 6 to 25 per cent for calves and 22 to 41 percent for yearling cattle. This can have important implications for encouraging farmers to adopt certain Best Management Practices (BMPs).

Although off-stream water has been shown to reduce the time that livestock spend in the riparian zone, Bryant (2012), reported that salt placement did not attract cattle away from the riparian zone. However, the salt placement was approximately 1 km from the riparian zone (as estimated from the study area map) and up a slope greater than 35 percent. The author suggested that the cattle were unwilling to expend the energy necessary to obtain the salt.

2.7 The Grazing effects on the riparian vegetation

According to Zoheir (2011), the riparian flora of a site imitates countless factors, as well as: the regional weather; site physiognomies, such as soil dampness, quality, carbon-based matter and chemistry; landscape and drainage; ordinary and human-induced disturbances; and land-use history. In many riparian areas, Bryant (2012), reflect that the incidence of disturbance is high and courses such as soil destruction, soil removal, and changes in water accessibility, are the rule rather than the exception. Because of this lively nature of riparian areas, Hansen. *et al.,* (2015), argues that riparian flora is normally grouped in terms of seral or successional community types; Climax, or natural potential, plant communities may be contingent from knowledge of site characteristics and from comparison with undisturbed or lightly disturbed sites of comparable physical characteristics. Hansen, *et al.,* (2015) further stressed that most community types they described are sufficiently stable for the time frames essential in making land management decisions.

Zoheir (2011), pointed out that the potential effects of grazing on the riparian area include among others: defoliation of plants, crushing of plants, walk over and compaction of the soil; redeployment of nutrients through dropping urine and feces in areas away from browsing sites, including water bodies, and restructuring of plants by transferring seed and other propagules from one location to another. However, with controlled grazing management, the above effects can be minimized or mitigated and grazing land can be maintained in a healthy condition. However, inappropriate grazing can have a consequence in adversative effects on the physical and biological elements of the grazing land resource and can reduce the economic benefits and/or the value of the resource (Mel. *et al.*, 2013).

Grazing impacts on both lentic and lotic riparian surroundings are expected to be largely similar. However, according to Clary. *et al.*, (2010), influences on lentic or standing water systems, such as lakes and ponds, may be more disposed to strain since toxins have a tendency to accrue. Furthermore, Clark (2010) claims that the flowing water systems tend to be less strained by pollutants, as they have a superior ability for self-flushing and cleaning.

A study by Zoheir (2011) on the effect of rangeland beef cattle excrement on water quality established that cattle feces and urine dropped straight into the water affected the water quality. Possible challenges happen in cases where animals come together for feeding, drinking water or resting near a water channel. They stated that water quality can be managed by employing spatial circulation of cattle through salting, and fencing for rotational purposes that makes pasture timely available.

In addition, Clark (2010) studied livestock impacts on water quality with special reference to humid temperate regions. The researcher found that the impact of grazing differed from one place to another due to weather and temperature, landscape, the biophysical features of the waterway itself, and with meadow and grazing supervision practices. The researcher recommended that better understanding of the dynamics underlying livestock behavior in, and impact on, waterways may aid to better focus on precautionary remediation initiatives by both producers and policy makers.

Even though unrestrained right of entry by cattle into riparian areas can have an overwhelming effect on riparian ecologies, regulating access may expressively decrease many undesirable effects of livestock grazing. A study was carried out in Ontario to determine the direct and indirect impacts of livestock access and grazing (Clary. *et al.*, 2013). The results of the study revealed that the likelihood of livestock openly dropping dung into the water was low and high-frequency excretion or urination (more than 10 percent of the herd) happened intermittently and did not appear to be related to stream features or management practices. Downstream water quality was also tested in this study. Water samples taken downstream from grazed areas were not different from water entering the pasture upstream, except nearly after cattle crossed the stream or drank that there is effect on the available plants community along the stream banks'

Abt. *et al*., (2014), agree that cattle entry to a waterway can and does remove and interrupt bottom sediments and promote downstream movement of resident microbes, phosphorus, and other sediment-bound pollutants from whatever source. The researchers recommended mitigation strategies such as fortification of favorite entry areas and establishment of alternate livestock water. Cattle can likewise contribute to downstream contamination by amplified sedimentation triggered by overgrazing on riparian vegetation which considerably decreases vegetation protection. The researchers recommended implementation of suitable grazing management strategies to maintain the health of the riparian flora.

There is no uncertainty from the accessible writings that inappropriate or unrestrained grazing can badly affect the riparian plant and animal communities as well as the physical surroundings. Nonetheless, with correct valuation, preparation and implementation of suitable grazing management strategies and tools, the health of riparian areas can be improved and maintained. Proper grazing can also improve forage quality for wildlife (Phillips. *et al.,* 2011).

This study looked at grazing effects on riparian vegetation in terms of defoliation and animal traffic. The following sections discussed the mentioned constructs in details.

2.7.1 Defoliation

2.7.1.1 Reduced vigor, biomass

The physical structure of plant communities is often changed by grazing (Fischer. *et al.,* 2010). Fleischner (2014) mentions numerous instances where defoliation by grazing herbivores changed plant height and awning cover, and transformed species composition to comprise physically dissimilar kinds of florae. Treading on may also modify the structure of plant communities by breaking and thrashing down vegetation.

According to Walker (2014), defoliation can promote shoot growth and enhance light levels, soil moisture, and nutrient availability. Overgrazing, however, can significantly reduce biomass production. Although defoliation of individual plants reduced plant production by an average 52 per cent, grazing at the ecosystem level decreased midair net main production by less than 20 percent (Buckhouse & Gifford, 2010). At the ecosystem level, grazing increases return of nutrients for plant growth and promotes plant community diversity (Kenny, 2013). Grazing cattle in grassland ecosystems promote diversity in grasslands by creating disturbance at the soil surface which allows germination of forbs and annual plants while removing portions of the above ground plant biomass reduces the competition of dominant grasses for nutrients and sunlight (Burrows and Butler, 2011).

However, the response in diversity and productivity of plant communities varies between stocking densities, defined as the weight of animals per unit area. As stocking density increases, grazing faunae are required to graze the obtainable fodder more evenly and be less selective, possibly lessening the competition for nutrients from less palatable species (Hairsine. *et al.*, 2012). In addition, at increased stocking densities, treading damage to plants is likely more significant, thereby, reducing the regrowth of established plants (Fischer. *et al.*, 2010).

2.7.1.2 Reduced vegetation cover

Livestock have a variety of effects on vegetation. The most obvious is the direct grazing and trampling of ground covers, shrubs and saplings (Hairsine, 2012). Undisturbed riparian vegetation usually contains a diverse range of species, including trees and shrubs of various ages, height and form, as well as ground covers (including grasses, sedges and herbs). This contributes not only to the site's biodiversity but also to its structural diversity.

The presence of a range of different plants influences the nature of the root zone and the depths to which roots penetrate and this, in turn, affects the water table in stream banks and their stability. Waterways commission, (2014) also unfold that, plant diversity supports and enhanced nutrient cycling uptake, soil aeration, soil structure and levels of microbial activity.

Bohn and Buckhouse (2012), explain that when livestock graze they remove plant parts from ground cover vegetation, bushes and seedlings, which are as well impaired through walking over. These transformations lead to loss of ground cover and biomass of vegetation, through the loss of grazing-sensitive species that cause deteriorations in natural plant variety. They again explain that, soil compaction due to trampling reduces the macrospore space in soil and this reduces infiltration, root growth and overall plant production. Furthermore, Buckhouse and Gifford (2010) emphasized that the loss of important species or functional groups within riparian vegetation affects the diversity at a particular site, and can thereby result in changes in microclimate, nutrient cycling and soil structure. Obviously, these changes can lead to disruption of ecosystem function and degeneration of the system which cannot be easily reversed.

Fleischner (2014), explains that stock preferentially graze on more edible vegetable class, either eliminating them from a site or plummeting them to dense, low tussocks, woods or badges. Plants with different life forms respond to grazing in different ways. Grazing may favour sedges, grasses and other species whose growing point is protected from grazing animals (for example, by being at or below the soil surface and thus able to survive, albeit with reduced vigour) over other life forms. He additionally expounds that these courses lead to changes in plant community composition towards species more lenient to grazing.

In Australia, the above described changes have a tendency to include loss of native specialist riparian species and replacement with exotic annual species, something that has also been recorded as occurring in North America (Belsky. *et al.*, 2009). The formation of open sites by grazing or stamping on provides a perfect opportunity for weed species to become established, (Jansen and Robertson, 2012). They also argue that, weeds are also spread by the movement of stock, either in their feces or by attachment to the animal. Similarly, stock feces and urine also contribute large quantities of nutrient to the soil (especially nitrogen and phosphorus), that further encourages the growth and spread of weed species.

Trimble and Mendel (2011) opine that vegetation and trees may be only temperately affected by grazing in the small term but over extended time frames become more and more degraded. Overgrazing limits the recruitment of most riparian plants, particularly overstorey plants, and so prevents the replacement of plants as they mature and senesce. This occurs because new seedlings are grazed, or because trampling leads to changes in the soil structure which prevent germination. The reduced tree or shrub canopy may then favour the development or expansion of ground covers especially of annual plants that require higher light levels, further restricting germination of woody species (Kirkpatrick, 2013).

In addition to the direct impacts that grazing has on shrubs and saplings through browsing and trampling, Pettit (2009) agrees that livestock grazing in Australia typically goes hand-in-hand with the removal of overstorey vegetation. This means that heavily grazed sites tend to have a very simplified vegetation structure, with few trees and shrubs and little recruitment of different plant species (Robertson & Rowling 2010). As time goes on, too much grazing in an area can cause the growth of even-aged stands of flora, a decrease in species variety or both. These changes to vegetation structure have significant consequences for riparian wildlife.

In addition to direct impacts of grazing on vegetation, there can be much subtler effects. For example, Meeson. *et al.*, (2012), found that heavily grazed sites had more seed-eating ants than lightly or ungrazed sites, and that rates of predation of river red gum seeds were higher in the heavily grazed sites. Thus, recruitment of river red gum trees was potentially limited in more heavily grazed sites by the availability of seeds. Another complication to this finding is the influence of changed flooding regimes. Meeson etal, further found that sites which flooded less frequently (as is often the case on regulated rivers), were more strongly influenced by the effects of grazing, having greater populations of seed-eating ants, than those which flooded regularly. Hence, grazing may interact with altered flooding regimes to have even more significant impacts on riparian vegetation than would be the case for either effect on its own.

Damien (2010), explains that the physical effects of large, hoofed animals promotes erosion and also damages vegetation which reduces cover and increases potential for erosion. In addition, trampling may break sediment down into finer particles which remain in suspension in water longer, thus exacerbating turbidity problems in waterholes. Fleischner (2014), found that grazed stream banks eroded up to 6 times faster than ungrazed banks.

This was not related to consumption of the vegetation, but the physical trampling effects of cattle utilizing ramps down the banks. The provision or encouragement of less steep or hardened access paths to waterholes would aid in reducing stream bank erosion.

2.7.2 Animal traffic

2.7.2.1 Trampling (soil compaction)

Trampling, pawing, and wallowing by ungulates destroy the plant roots which are outside the soil and can sometimes totally destroy the plants and topsoil layers (Bothwell. *et al.*, 2013). Plants and other macrobiotic soil crusts play an important role in regulating nutrient cycling, biomass production, soil stability, and water infiltration. In ecosystems that evolved with frequent grazing disturbance, soil crust disruption maintains natural ecosystem processes and biological communities. However, some authors argue that in arid and semi-arid ecosystems, loss of Macrobiotic crusts can have detrimental long-term effects (Fleischner, 2014). The most severe effect of trampling may be compaction of soils, which harms plant roots and makes the roots to be stacked close to the soil surface (Clary & Booth, 2013). These modifications may stop plants from obtaining adequate resources for energetic development.

The impact of livestock trampling on soil compaction bulk density and subsequent effects on forage growth have been documented: Rauzi and Hanson (2013), found soil compaction increased linearly with increases in grazing intensity. Bryant. *et al.*, (2012), found that grazing and trampling Kentucky bluegrass *(Poa pratensis)* highland pastures to a l-inch (2.5 cm) growth stature caused decrease in flora cover, reduction in yields, reduced capillary absorbency, and escalated the volume weight of the O-1 inch (O-2.5 cm) layer of soil.

Rauzi and Hanson (2013), found water intake rates on silty clay and silty clay loam soils to be 2.5 times greater in an area grazed at 1.35 acres/AUM compared to an area grazed at 3.25 acres/AUM. After 22 years of grazing at this intensity, not only had species composition been altered but soil properties had been changed as well due to the degraded nature of vegetation.

In a riparian zone continuously grazed season long has implications, Orr (2006), found bulk density and macropore space to be significantly greater in grazed areas over enclosures. Differences in total pore space (both macro- and micro-pores) between grazed and enclosed areas were small because of a transformation of macropore spaces to microspore spaces by trampling. Macropore space is a more sensitive indicator of compaction or recovery from compaction than either micro or total pore space (Sarr. *et al.*, 2009).

Bryant. *et al.,* (2012), found increasing trampling pressure had an adverse effect on Kentucky bluegrass swards, particularly during the months of June and September. After one overwinter period, there was a significant difference in soil compaction between an area trampled by 120 cow trips over bluegrass plots and an area that was untrampled.

The effect of animal grazing in savanna bionetworks can have a substantial impact on soil physical features and has been widely studied by scholars (Greenwood and McKenzie, 2011; Bilotta. *et al.,* 2013). Improving soil structure is related to increasing macro porosity from formation of large soil aggregates (Mueller. *et al.,* 2013). However, when soil loading exceeds the soil's strength, macro porosity is reduced, resulting in increased soil penetration resistance and bulk density, along with reduced water infiltration rates (Franzleubbers, 2012). Daniel. *et al*., (2012), found rotational grazing increased penetration resistance and bulk density in the upper 10 cm of soil compared to no grazing in western rangelands. Nevertheless, rotational grazing has less impact on soil structural characteristics than continuous grazing likely as a result of rest periods which allow soil structure and plants to recover following grazing (Teague. *et al.,* 2011).

Although Teague. *et al.,* (2011), found water infiltration rate was reduced in pastures that were rotationally grazed, rotational grazing does not always reduce water infiltration rates in comparison to no grazing (Haan. *et al.*, 2010). Differences in the impact of rotational grazing on soil structural characteristics may be a result of differences in the timing and duration of grazing episodes, however antecedent soil structure is also likely a factor on the impact of grazing on soil structural characteristics (Murphy. *et al.*, 2014).

According to Drewry. *et al.,* (2014), the impact of animal grazing on soil physical appearance are to a greater extent reliant on soil moistness. Increasing moisture in the soil profile increases the risk of compaction as a result of water reducing the stability of soil structure.

In addition, increasing the frequency of grazing during high soil moisture conditions reduces soil strength potentially increasing the risk of compaction (Scholefield and Hall, 2011). However, soil moisture is not the only factor affecting soil structural stability. Soil texture and mineralogy can also influence the impact of grazing on soil structure likely as a result of their impact on innate soil structural characteristics (Bilotta. *et al*., 2013).

2.7.2.2 Herbage removal

Impacts of herbage removal can be divided into 2 categories according to vegetation structure: (i) utilization of herbaceous vegetation and subsequent impacts on species composition, species diversity, and biomass produced, and (ii) utilization of wood vegetation and subsequent impacts on foliage cover, structural height diversity and stand reproduction (Marlow, 2015). The most important flora transformation that has occurred in highland riparian systems of the Pacific Northwest is substitution of native bunch grass with Kentucky blue grass. It has successfully established itself as a dominant species in native bunch grass meadows as a result of overgrazing by herbivores and subsequent site deterioration (Voliand, 2009).

Scholefield and Hall (2011), in Wyoming, found clipping native bunchgrass meadows every two weeks for four years caused a marked reduction in native sedges *(Carex* spp.), tufted hair grass *(Deschampsia caespitosa)* and fostered the appearance of Kentucky bluegrass where it was not present before. Kauffman. *et al.,* (2009), found that when grazing was halted in moist meadows, progression in the direction of a more mesic/ hydric plant community transpired. Unusual grasses such as meadow timothy *(Phleum pratense)* and forbs more attuned to drier environments were decreasing and were being replaced by native sedges and mesic forbs.

In central Oregon, Evenden and Kauffman (2010), compared plant communities on each side of a fence that was heavily grazed on one side and protected from grazing on the other. The grazed site was dominated by Kentucky bluegrass and Baltic rush (Juncus balticus), while the ungrazed site was dominated Panicled bullrush *(*Scirpus microcarpus*).* Twenty herbaceous species were recorded in the grazed area with 12 herbaceous species recorded in the ungrazed area. Dobson (2013), also found an increase in species numbers due to grazing in a riparian zone in New Zealand. He summed that the impact of animal grazing caused the opening up of flora hence making room for the weeds to spring. Hayes (2008), in central Idaho also observed that the abundance of forb species appeared to be higher in grazed areas than in pristine areas.

The impact of cattle on herbaceous productivity in riparian zones has been examined along several stream sides in the western United States. Duff (2009), Gunderson (2014), Kauffman. *et al.,* (2009), and Marcuson (2013), found either decreases in biomass due to herbage removal or increases in biomass due to cessation of grazing in riparian ecosystems.

Kauffman. *et al.,* (2009), compared grazed and ungrazed responses on 10 riparian plant communities in northeastern Oregon from1978 to 1980. Three of 10 communities displayed significant standing biomass differences. Production in ungrazed moist meadows dominated by Kentucky biomass, meadow timothy, and sedges was significantly less after two years of rest compared to grazed meadows but was not significantly different after three years of rest.

Standing biomass in a Douglas hawthorn-dominated community and in a Kentucky bluegrass-dominated community was significantly greater in ungrazed stands compared to grazed stands after three years. Conversely, Voliand (2009), could find no significant differences in biomass between a Kentucky bluegrass meadow grazed annually and one that had been rested for 11 years. Effect of herbivore on shrub and tree production is a critical impact in riparian ecosystems, because of the importance of theory vegetation to wildlife habitat and its dominant influence in altering the riparian microclimate. While mature vegetation approaches senescence, extreme grazing gravities have stopped the formation of seedlings, thus creating an even-aged non-reproducing vegetative community (Carothers 2007; Glinski 2011).

The effects of excessive herbivore use on woody vegetation bordering streamside's can generally be termed as negative. Knop and Cannon (2010), found that cattle significantly altered the size, shape, volume, and quantities of live and dead steams of willows.

Cattle grazing were also found to impact the distribution of plants and the breadth of the riparian area. Marcuson (2013) established that hedging plant production was 13 times more in an ungrazed area than in brutally overgrazed area. Cover was 82 percent greater in the natural area. On a stream rested from continuous grazing for ten years, Claire and Starch (unpublished) established that alders (Alnus sp.) and willows (*Silk*s.) provided 75 percent shade cover over areas that had been without bush awning cover before enclosures. Similar herbivore-woody vegetation relations have been reported by Davis (2012); Duff (2009); Evenden and Kauffman (2010) and Kauffman (2012).

2.8 The Socio-Economic Effects of Grazing Along the Riparian Area

In as much as livestock are important they have, however, extensive variety of unwanted direct environmental influences upon the quality of air and water, nutrient leaching, soil erosion and biodiversity (Capper, 2013). According to Meissner. *et al.*, (2013), the major environmental impact of livestock is land degradation, air pollution, water pollution and sometimes biodiversity conservation where production systems are not well managed. However, the rapidly increasing demand for livestock products also exerts pressure on the environment. Indeed, a lot of rumor on the effect of the ever-increasing animal production on the environment as worldwide livestock demand intensifies to meet the increasing population demands. Much attention has been paid to greenhouse gas (GHG) emissions due to their effect on global warming and climate change. In industrialized countries, the GHG emissions from the energy sectors are much greater than the GHG emissions from agriculture (Scholtz. *et al.*, 2013).

Cattle grazing are often seen as a potential danger to water resources in two ways: firstly, they take possession of water points for their own use and secondly they destroy local vegetation and cause soil degradation as livestock are herd in water points (IFAD, 2013). Improper management of manure and waste products from livestock could also contaminate water resources and affect the resilience ability of some native species.

Livestock is one of the main land users. This is because of the nature of pastoral production, which usually requires a very large expanse of land and efficient management (Herrero. *et al.*, 2013). According to Seré (2012), livestock systems inhabit 45 percent of the earth's surface. This is not astonishing as 70 per cent of the agrarian land in South Africa is used by livestock as such, majority of the valley species are conquered by unusual or aggressive plant that are of less value, (Meissner. *et al.*, 2013); furthermore, 75 percent of land in Namibia is used for comprehensive animal grazing (Lange. *et al.*, 2011); and beef cattle production alone inhabits 75 million hectares in Northern Australia (Nyariki. *et al.*, 2009). However, livestock production is normally presumed to be undesirably affected by land degradation, which ultimately replicates on the economic performance (Macleod. *et al.*, 2014).

Inappropriate management of cattle grazing and activities is evident in heavy stocking beyond the lands' carrying capacities, which exposes pastureland to erosion and loss of vegetation as a result of overgrazing. Trampling and constant veld fires are also said to have contributed to land degradation. Macleod. *et al.*, (2014), studied the productivity of livestock under dissimilar grazing systems; they established that variations in land environments had both positive and negative special effects on livestock production, depending on the stocking rates and levels of feed utilization used. The association between land condition, livestock and economic outcomes was determined using a combination of experimental data and simulating models. It was proven that as land conditions depreciate, decrease in animal figures was eminent; and that extensive cases of deprived land conditions with high livestock numbers resulted in poor livestock performance, with poor market value and hence low profitability.

Grazing in the riparian area of river Benue is a common site in the dry seasons due to lack of water and grass in the upland area. Nevertheless, other economic activities such as fishing, farming, weaving, hunting, transportation (navigation), boating, swimming and fruits /vegetable harvest, also take place in the rural settlements. The people occupying the areas along river Benue are mixed-up with very many cattle keepers who keep large herds of cattle and some few goats and sheep. Most of the herds men are uneducated and only few have acquired formal education, most of them are herding livestock of the rich men. Others of the pastoralists are foreigners from neighboring countries like Chad, Niger and Cameroon, (Meagher and Yunusa,2012).

In the communal settlements, traditionally, men prefer grazing, fishing, hunting, boating and weaving with their young male children. While the women prefer doing domestic house chores such as cooking, fetching water, collecting firewood, weaving, and collecting of wild fruits/vegetables with mostly their daughters Meagher and Yunusa (2012). The female is also often engaged in fish processing, bush meat selling and selling of local fruits, fibers and vegetables in the markets. However, given the low education level and low civilization among the rural settlements, coupled with traditional norms and values decision making regarding income, land, assets, children are entirely a household head's role which are mostly men, (Linus. *et al.*, 2014).

The women have very little say in any family matters since they are treated as household property. The old men and women prefer staying at home while the able bodied men go hunting, fishing, grazing and other income activities.

Grazing which is the most prevalent economic activity has caused depletion of plant species, destruction of soil structure and water quality over the years, thus impacting the environment negatively (Patience. *et al.*, 2013). Due to overgrazing, shrubs, and other palatable trees have been cut to provide food for the animals. Grass and herbaceous has been cleared and burnt for purposes of providing better grazing ground but, this has escalated soil erosion in the areas since the plants and the grass have failed to recover due to soil tramping and browsing (Adefoiye,2013). In addition, due to overgrazing and tree cutting, herbal and medicinal plants have been lost and some important plant species have completely been destroyed, consequently hunting grounds are no more.

In the riparian areas, river banks have been broken and widened by the continued hoofing of the animals. Swamps have been reclaimed for farming, water levels have dropped and some streams have dried hence fishing activities have slowed in the recent years (Linus. *et al.*, 2014). In addition, because of the nomadic way of life, ethnic clashes have come to be the custom because of the inadequate grazing areas. Human life, property and animals have been lost in these battles and little is been done by the local authorities and the local government.

2.8.1 The role of policy on livestock grazing and environmental in Nigeria

Nigeria's national policy on environment and environmental protection generally is founded on goals. Firstly, securing the quality of the environment for health and wellbeing; secondly, conserving and using the environment and natural resources for the benefit of present and future generations; thirdly, restoring, maintaining and enhancing the ecosystem and ecological processes essential for the functioning of the biosphere to preserve biological diversity and the principle of optimum sustainable yield in the use of natural resources; fourthly, promoting public awareness of the link between development and environment and fifthly ensuring international co-operation with countries and international organizations' in the protection of the environment (Abila and Ayawei, 2015).

According to Abila and Ayawei (2015), a literal reading of this policy goals show that there is both a domestic and international dimension of Nigeria's existing policy. The extent to which governments in Nigeria have achieved these policy goals especially in the Niger Delta Region and North Eastern region of Nigeria is highly contestable given the environmental challenges especially high level of environmental degradation which is largely responsible for the crises raging in the Niger Delta and North East.

For that reason, the civil liberties of use of "common land" in Nigeria which were and still been regulated and available only to "commoners" should be retraced. As there is an oversight or misdirection in regulating some of the land resources situation which presently expose the commoners' behaviors (Adefioye, 2013). This is evident as the case in riparian ecosystem of Niger Delta and those along river Benue in the North East of Nigeria.

Abila and Ayawei (2015) argue that apart from policy, the Nigeria environmental protection is supposedly guaranteed by laws. The state legislation and other laws on environmental protection in and across the region are determined. But, in spite of the numerous laws and global concern governing the protection of the Nigerian environment generally and the riverine in particular, it is to be examined the question why the environmental conditions across the nation terrestrial landscape and in the riparian is degenerating per day. For example, with particular regards to the provisions dealing with environmental protection, the 1999 Constitution is credited to be the first constitution, in the history of Nigeria, to make provisions for the protection of the environment. This is irrespective of the fact that by the very tenor of the constitutional provisions, the said provisions are arguably not justiciable and therefore, unenforceable in a Court of law.

However, it is instructive that under section 20 of the said Constitution, it is certainly provided that "the State shall protect and improve the environment and safeguard the water, air and land, forest and wildlife of Nigeria" while Section 16(2) expressly provides that: "the State shall direct its policy towards ensuring: the promotion of a planned and balanced economic development."

In the same vein, Section 17(2) (d) provides "In furtherance of the social order, exploitation of human or natural resources in any form whatsoever for reasons, other than the goal of the community shall be prevented" (Abila and Ayawei, 2015).

It is submitted that although the above provisions are sound to the extent of sign posting ideal of protecting the environment, the fact that the said provisions are lumped with other pious provisions which are enacted to be non-justiciable renders their biting powers impotent. This is more worrisome especially as the above provisions fall short of constitutional developments in South Africa, Ethiopia and other African countries where the right to a clean environment, for example, is now regarded as a fundamental human right and so made justiciable in those jurisdictions. This is however without prejudice to recent developments in Nigeria's judiciary where some courts have held that environmental rights under the constitution remain justiciable (Abila and Ayawei, 2015).

However, it was in regards of the weakness of the environmental policies that commoners took advantage and abusive the common land resources. If excessive use was made of common land as the case is across Africa, for example in grazing a common would be "stinted "that is a limit would be put on numbers of animals each commoners were allowed to graze (Susan, 2011), unfortunately, such limited number as policy is far from been achieved. According to Ifeany (1998), the Federal Environmental Protection Agency Act (FEPA) of 1992 was mandated to perform the following functions: I) establish such procedures for agricultural activities in order to minimize damage to the environment from such activities; ii) establish such environmental criteria, guidelines, specifications or standards for the protection of the nation's air and inter-state waters as may be necessary to protect the health and welfare of the population from environmental degradation. The FEPA also had responsibility for setting standards for water quality, noise control, effluent limitation, ozone protection, control of hazardous substances.

Ifeany (1998) argues that another very important statute conferred with powers to protect the Nigerian environment is the Environmental Impact Assessment Act of 1992. By its provisions, the Environmental Impact Assessment Act of 1992 is the fundamental legislation in Nigeria that governs environmental impact assessment in respect of proposed projects in Nigeria.

As stated above, the provisions of this Act enacts the principle 17 of Rio Declaration; "Environmental Impact assessment as a national instrument shall be undertaken for proposed activities that are likely to have a significant adverse impact on the environment and are subject to a decision of a competent national authority."

Abila and Ayawei (2015), the schedule to the FEPA Act lists potential projects for which a mandatory impact assessment must be carried out. These include: Agriculture, Airport, Drainage and Irrigation, Land reclamation, Fisheries, Forestry, Housing, Industry, Infrastructure, Ports, Mining, Petroleum, Power generation and transmission, Quarries, Railways, Transportation, Resort and Recreational Development, Waste treatment and disposal and Water supply. However, by section 36 of the National Environmental Standards and Regulation Enforcement Agency established Act of 2007 (NESREA) "The Federal Environmental protection Agency Act of 1992 is [now] repealed". It is submitted that the outright repeal of the FEPA Act by this later Act is not only backward in effect but operates to undermine the laudable initiatives contained in the various provisions of the FEPA Act. This view is without prejudice, however, to the provisions of section 2 of the NESREA Act 2007 which now operates to confer on the National Environmental Standards and Regulations Enforcement Agency, the responsibility for: "the protection and development of the environment, biodiversity conservation and sustainable development of Nigeria's natural resources in general and environmental technology, including coordination and liaison with relevant stakeholders within and outside Nigeria on matters of enforcement of environmental standards, regulations, rules, laws, policies and guides".

Section 7 of the Act which creates awesome and far reaching functions for the said agency given it the powers to:(a) Enforce compliance with laws, guidelines, policies and standards on environmental matters; (b) coordinate and liaise with stakeholders, within and outside Nigeria, on matters of environmental standards, regulations and enforcement; (c) enforce compliance with the provisions of international agreements, protocols, conventions and treaties on the environment, including climate change, biodiversity, conservation, desertification, forestry, oil and gas, chemicals, hazardous wastes, ozone depletion, marine and wild life, pollution, sanitation and such other environmental agreements as may from time to time come into force; (d) enforce compliance with policies, standards, legislation and guidelines on water quality, environmental health and sanitations, including pollution abatement; (e) enforce compliance with guidelines and legislations on sustainable management of the ecosystem, biodiversity conservation and the development Nigeria's natural resources; (f) enforce compliance with any legislation on sound chemical management, safe use of pesticides and disposal of spent packages thereof;

(g) enforce compliance with regulations on the importation, exportation, production, distribution, storage, sale, use, handling and disposal of hazardous chemicals and waste other than in the oil and gas sector; (h) enforce through compliance monitoring, the environmental regulations and standards on noise, air, land, seas, oceans and other water bodies other than in the oil and gas sector; (i) ensure that environmental projects funded by donor organizations and external support agencies adhered to regulations in environmental safety and protection; (j) enforcement of environmental control measures through registration, licensing and permitting systems other than in the oil and gas sector; (k) conduct environmental audit and establish data bank on regulatory and enforcement mechanisms of environmental standards other than in the oil and gas sector; (i) create public awareness and provide environmental education of sustainable environmental management, promote private sector compliance with environmental regulations other than in the oil and gas sector and publish general scientific or other data resulting from the performance of its functions; (m) carryout such activities as are necessary or expedient for the performance of its functions.

The Agency is further empowered, amongst other things, under section 8 of the NESREA Act of 2007 to submit to the Minister charged with the responsibility of environment proposals for the evolution and review of existing guidelines, regulations and standards on environment in the areas of atmospheric protection, air quality, ozone depleting substances, noise control, effluent limitations, water quality, waste management and environmental sanitation, erosion and flood control, coastal zone management, deforestation and bush burning, other forms of pollution and sanitation, and control of hazardous substances and removal control methods (Abila and Ayawei, 2015).

Laudable as the above and similar provisions are, it is submitted that this law holds out little or no hope for the peoples of Nigeria, especially the Niger Delta Region as it relates to their devastated Niger Delta environment as the said law is dotted with provisions outlawing its operation or applicability in the oil and gas sector, (Abila and Ayawei, 2015).

Since the responsibility of enforcing environmental laws entrusted to FEPA was taken over by the Federal Ministry of Environment, there were serious lapses in the implementation of the policies to safe guard the natural resources. As a result, across the country uncontrolled or free range grazing became very distressing which enflamed government of the affected areas to reacts. As such, “Open Grazing Prohibition Establishment Law, 2017” was constituted by the designated members State House of Assembly of Benue state was the first among others to exercise her power as provided for by section 4 of the Constitution of Federal Republic of Nigeria 1999.

From all indication policies safe guarding the environment and natural resources are there reasonably but, the power to re-enforce the policies are weak. Unfortunately, the gainful ecosystem services proffered by riparian areas in Nigeria are constantly constrained to intensive pressure that has repercussion for human health and livelihood. However, despite the available policies it renders petite concern to riparian management, which is an indication that the degenerating condition of riparian is due to absences of grazing policies. As well as weakness in the enforcement of general natural conservation policies. Bu also there is a loosed or weak enforcement measures of the policies to salvage the riparian. Therefore, desirably is the need to encourage the assimilation of riparian safeguarding approaches. A cohesive and diligence condition of exaction of the policies with an emphasis that efforts have to be directly on national riparian laws of the holistic approach should be pen down.

2.9 Effective management strategies for conservation and sustainability of riparian areas

Heady and Child (2014) argues that in order to recover and preserve healthy riparian areas in the light of growing, and time and again inconsistent demand for manifold land use, they must be managed correctly. Riparian area supervision must be founded on an understanding of the riparian ecology, its biotic and abiotic components as well as the connections among those components and should employ the recognized philosophies of range management (Tiedemann & Higgins, 2013).

According to Wyman. *et al.*, (2006), a reasonable goal for managing livestock grazing in riparian areas is to provide adequate forage and water to livestock while maintaining or improving the functional condition of the riparian area. Proper functioning condition is when sufficient undergrowth, landform or big forested debris is existing to: drive away stream energy, sieve deposits and improve overflow grasslands, calm down stream banks, improve biota habitation and support greater biodiversity (Prichard. *et al.*, 2000). Numerous factors contribute to proper functioning condition of riparian areas, many of which are not influenced by livestock grazing. These include topography, climate, soils, geology and hydrologic conditions.

Grazing management can have a profound influence on the kind and amount of riparian vegetation and the associated condition of the stream channel. These attributes should be the focus of grazing management in riparian areas. However, there is no single grazing management technique that is appropriate for every riparian area. In fact, application of a management strategy may be successful in one situation and fail miserably in the next (Miner. *et al.*, 2012). This implies that after addressing site specific aspects of each riparian area, managers should consider options for grazing.

Wyman. *et al.*, (2006) listed the following basic principles as guide to improve grazing management in riparian areas: avoid grazing repeatedly in the same area every year and in the same place multiple times in one growing season; optimize regrowth opportunities with short grazing periods and adequate rest periods; limit selective grazing by increasing stock density; provide for adequate plant development prior to the initiation of grazing; provide for adequate residual following the grazing period; maintain flexibility and identify options for unforeseen conditions; be able to preserve or improve riparian area physical functionality; gauge riparian area condition at a rate tolerable to permit quick counteractive management action, if needed, to protect the health of the riparian area; and manage grazing based on plant community productivity and resilience (uplands and riparian plant communities are not the same) (Wyman. *et al.*, 2006).

Furthermore, Wyman (2006) enlightens that the best and most effective grazing approaches consist of management tools and techniques that promote distribution of livestock, such as: techniques that attract livestock away from riparian areas; herd management and animal husbandry practices that promote mobility; and techniques that restrict livestock from riparian areas.

2.9.1 Techniques that pull livestock away from riparian areas

2.9.1.1 Offsite water developments

Aquatic expansion in moorland areas that lack water is often a significant aspect in plummeting livestock absorptions in riparian areas. Ganskopp (2014) established that moving transferable stock tanks or closing access to specific watering points within pastures is very effective at changing the distribution patterns of beef cattle on arid rangelands in Oregon. A south-central South Dakota rancher found out that allocating water tanks all over a large pasture and having the capability to turn the water on and off at each tank worked well to distribute livestock to various parts of the pasture and decreased the amount of interior fence needed in rough terrain.

Offsite water can be developed by installing solar, hydraulic ram, or conventional pumps; developing springs, seeps, wells, or guzzlers; and piping water to several troughs. Mobile systems can provide watering sites in different pastures with the use of one pump and existing water sources (Chamberlain and Doverspike, 2011). Solar-powered pumps provide offsite water opportunities in areas where electricity is not available or is too expensive to install. Mobile solar-powered pumps with portable tanks placed on the edge of the riparian area decrease the amount of time livestock spend in the riparian area. Livestock prefer to drink from a tank rather than from a stream (Ganskopp, 2011). Livestock do not have to stretch their heads below their front feet to drink out of a tank. They prefer this because of problems with depth perception and behaviors adapted for predator avoidance. Tanks also provide easier access for the animals; they do not have to push themselves through shrubs or trees, so trampling impacts to young seedlings, sprouts, or saplings are reduced or eliminated.

Pasture nose pumps are another option for offsite use of water from the stream, pond, or shallow well. Nose pumps are most effective for small herd situations, and each pump is able to water 25-50 animals, depending upon the brand of pump. Livestock use their noses to pump water into a small trough. Pumps are portable and can be moved to different pastures as livestock are rotated (Howery. *et al.*, 2011).

Frost-free nose pumps are becoming available for winter use (Kuipers, 2012). Developed in Alberta, Canada, the frost-free pump can be used from a well or from stream or pond water diverted underground to the bottom of a culvert that supplies water to the pump.

The nose-powered lever operates a piston pump submersed in the culvert, which is similar to how old hand pumps work. This pump requires no energy; other than the energy the cow uses to operate the lever.

Even within riparian areas or riparian pastures, water developments, ponds, or troughs can reduce stream bank-trampling damage (Miner. *et al.*, 2012). However, they tend to concentrate disturbance rather than distribute it. Water developments should not create new problems, such as excess soil erosion or vegetation and habitat impacts. Creating shade and locating rubbing posts and oilers nearby may augment the effectiveness of water development in helping to reduce the time livestock spend in riparian areas.

2.9.1.2 Upland seeding

Planting palatable forage species on depleted upland areas or cropland can attract livestock away from riparian areas (Tiedman and Higgins, 2013). Livestock are drawn to the upland forage, decreasing time and use on the riparian area. When developing a seeding plan, the season of use and the use of native or nonnative plant species should be considered.

2.9.1.3 Prescribed burning as vegetation treatment

Prescribed burning and other vegetation treatments that favor herbaceous plants, such as brush beating or tree clearing, often enhance forage production, accessibility and palatability, and correspondingly increase upland use (Bailey, 2010). In fact, the attraction of livestock to the burned areas often enables temporary rest of riparian areas until vegetation recovers. Wildlife habitat needs should be considered when developing prescriptions. A mosaic pattern is more conducive to wildlife habitat needs than block-shaped treatment areas. However, treating only one or a few small patches may not be effective, and may unintentionally attract wildlife or livestock to these small areas (Bailey, 2014).

According to Wyman. *et al*., (2006), in much of the West, plants and plant communities are adapted to periodic fire. Without a natural disturbance regime to shift the competitive balance, woody species increase and eventually dominate. Highly competitive shrub and tree species, such as juniper or pinyon pine, may displace herbaceous vegetation, leading to accelerated soil erosion, loss of habitat for some wildlife, hotter fires when the accumulated fuels eventually burn and increased risk of invasion by noxious weeds or species such as cheat grass or red brome.

A well-designed treatment and follow-up management actions that are implemented before crossing an ecological threshold keep the watershed functioning and keep plant communities in a dynamic equilibrium Bailey. *et al.,* 2012). This equilibrium supports wildlife with a diversity of habitat needs through disturbance and succession cycles. Watershed areas benefit when treatments shift use away from impacted streams. Prescribed burning, brush beating, and tree clearing are alternatives that can be used to mimic or replace natural fire regimes.

2.9.1.4 Grass reserves

Grass reserves are pastures that are set aside for use when alternate forage sources are needed, such as during a drought or following a fire. A grass reserve was used by the Malpai Borderlands Group to provide forage in exchange for a conservation easement. The participating rancher was able to rest his land by grazing his livestock on the largest of the Malpai ranches in New Mexico (Gripne, 2015).

The Wyoming Nature Conservancy also used grass reserves on its Heart Mountain Ranch near Cody to provide local producers with forage alternatives and promote long-term conservation improvements (e.g., prescribed burning or grazing deferment) on rangelands by providing forage at a discounted fee. Livestock forage values can be exchanged for a desired resource outcome on land that is under restoration while the cattle graze the grass reserve (Gripne, 2015).

2.9.1.5 Supplementation/ placement as a livestock distribution tool

Placing salt, hay, grain, molasses, and other supplements only in upland areas away from riparian areas improves livestock distribution. In general, supplements should be placed no closer than 1/4 mile, and preferably 1/2 mile or more (depending on the topography), from riparian areas and intermittent drainages, except where salt and supplements are used intentionally to localize animal impacts (Provenza, 2013). If supplements are placed near riparian areas, livestock use of shrubs and other riparian forage may increase and needs to be closely monitored to prevent overuse.

Proper salting improves both distribution and utilization. According to Ganskopp (2011), sawing salt blocks in half allows frequent movement of salt stations to minimize localized impacts of concentrated use.

Although strategic salt placement is an inexpensive and effective distribution tool, recent research has shown that it is not as persuasive in modifying livestock distribution patterns as water developments or the strategic placement of energy or protein supplements such as low-moisture blocks.

According to Bailey and Welling (2011), protein supplements containing products such as cottonseed or soybean meal can increase consumption of cured, low-quality grasses and are especially attractive to livestock as forage matures and becomes dormant.

On one Montana ranch, Bailey and Welling (2011), pointed out that the use of low-moisture blocks increased the number of livestock that used the east half of the ranch by 35 per cent. Low-moisture blocks were an effective attractant for cattle in both moderate and difficult terrain. In a comparable area within the same pasture that did not contain low-moisture blocks, forage utilization did not change during the same period. The increase in forage use extended for about 600 yards from the location where low-moisture blocks were placed. In a second Montana study (Bailey. *et al.*, 2012), forage use in difficult terrain increased by 14 per cent, from 6 to 20 per cent, during a 2-week period for areas up to 600 yards from placements of low-moisture blocks. Furthermore, the study established that cows spent about 5 hours per day within 100 yards of low-moisture blocks and only 1 hour per day within 100 yards of where range cake was fed. After consuming the cake, cows appeared to return to preferred areas, while cows fed low-moisture blocks were more likely to remain nearby. The study showed that cattle fed strategically placed low-moisture blocks used higher elevations than cows that were hand fed range cake.

Ranchers also use pressed blocks and loose, dry mineral formulations to supplement livestock on rangeland. A study conducted in New Mexico (Bailey. *et al.*, 2014) showed that both low-moisture supplements and pressed blocks attracted cattle to areas far from water, but low-moisture blocks were more effective. Consumption of the pressed blocks was lower than the low-moisture supplements and much lower than the manufacturer's recommendations for the pressed supplement. Supplements will not be as effective in luring animals to underused upland areas if the consumption of the supplement is relatively low.

According to Bailey and Welling (2011), loose, dry mineral formulations are usually mixed with salt and fed in open containers. They, like salt, are attractive to livestock.

In another study conducted in Montana, Bailey and Welling, found that although cattle were willing to travel to consume the dry mineral product, low-moisture blocks were more effective for modifying cattle grazing patterns. Cows spent more time near low-moisture blocks than near the feeders containing dry mineral formulations.

However, Bailey, (2010), advices that supplements should be placed in a restricted area so that social interactions among animals are more likely to occur and the placement site is more likely to become a loafing area. In a similar study in Montana, eight low-moisture supplement containers were placed in a 200- by 200-yard area. Salt was also placed in this area because salt was not added to low moisture supplement products. If supplements are repeatedly placed in the same area, nearby forage use becomes excessive. New supplement barrels should be placed at least 300 yards from old sites to improve livestock distribution and forage use. This becomes an anticipated reward (conditioned response) when livestock are herded from one portion of the pasture to another (Bailey. *et al.*, 2012).

2.9.2 Herd management and animal husbandry practices

2.9.2.1 Culling practices

Culling practices are conventionally used to increase certain feature of livestock performance such as number of pregnancies, weaning weights, or conformation. Nevertheless, some ranchers also cull on habitation use trends and scavenging physiognomies established that within herds, or even within breeds, certain individuals tend to spend more time at the bases while others tend to forage far and wide (Howery. *et al.*, 2011).

A three-year study in northern Montana revealed that individual animal assortment has the possibility of increasing grazing distribution patterns (Bailey. *et al.*, 2014). Variances in individual grazing patterns witnessed in common meadows persevered even after faunas were separated. Animals such as cows that were earlier witnessed on steeper slopes and in areas beyond flat and straight up from water (hill climbers) continued to use sheer and higher topography and areas beyond from water than cows that were previously observed in moderate slopes near water (bottom dwellers).

Landscape use of hill climber and bottom dweller cows not only varied statistically, but common fodder stubble stature standards for riparian areas (e.g., 5 inches) were higher in the hill climber treatment area than in the bottom dweller treatment area.

Even though the findings from the Montana research were promising, more study is required before individual animal assortment can be generally used to increase consistency of grazing. Primarily the assortment stress reported in this research was high, because the herd was classified and then split in half. Assortment techniques founded on culling would result in less selection pressure. Genetic progress from culling alone without sire selection is slow even when heritability is relatively high. Second, the relative contributions of genotype and early learning on terrain use patterns of cattle must be determined. If terrain use is reasonably heritable, grazing patterns can be modified by sire and family selection. If early learning is important, terrain use could be modified by management and training when replacement animals are calves (Howery. *et al.*, 2011).

2.9.2.2 Kind of livestock

Frequent mixing of varied types of animals may influence both the distribution pattern and fodder preference. Uncontrolled use by those cow-calf pairs that have a habit of concentrating and foraging in the lower sections can have detrimental effect on riparian areas more than use by some other species of livestock. Yearling cattle, predominantly steers, normally tend to be extensive ranging and use more of the neighboring moorlands. Horse grazing during the wintertime might result in bark being exposed from deciduous trees in some areas (Kindschy, 2013). Nevertheless, horses are mainly viewed as grass eaters, and usually gather together less than cattle. They feed in an area and then relocate to other virgin areas while cattle have a tendency to assemble in a grazed area waiting for flora regrowth. Overgrazing of wild horses on riparian pastures was described to harmfully affect that area (Platts, 2011); and Crane. *et al.*, (2013) established that sedges in streamside and swamp and field areas were significant fodder for wild horses. Problems have occurred in other locations because of concentrated use of springs or seeps by feral horses. Horses pull plants out by the roots from areas that have moist soils more than most other Animals (Pieratt, 2011).

Sheep that are under controlled grazing provide many choices for achieving proper management in certain riparian areas. Sheep use may be more desirable than cattle use in some areas due to the range managers' control over site, timing, extent, period, and regularity of use. Sheep have a preference for hillsides to the restraining nature of riparian bottoms. The herder can easily locate sheep to moorland or edge top areas rather than bedding them in a riparian area field. Normally, rangers desire to keep herds or groups moving to enable fodder choosiness. The superiority of steering controls impacts to riparian areas and rates of gain in the lambs (Glimp & Swanson, 2014). When correctly looked after, sheep cause less trampling destruction than cattle.

According to Pieratt (2011), sheep and goats can only cause small valuable destruction to herbaceous plants due to their chewing features; however, cattle and horses can remove plants from the soil for the reason that they eat with a pulling habit. Sheep and goats can as well help to prevent the incursion of hostile plant species such as leafy spurge and knapweed. Since dissimilar animal species have unlike plant inclinations, the incorporation of various grazing species may increase plant species collection. This incorporation may perhaps lessen misuse of preferred fodder species, reduce the possibility for different species to take over a conservation site, and allow careful control of unwanted plant species without making the use of herbicides, which is strongly controlled close to water.

Pizel (2014) discusses that goats can successfully regulate different challenges or aggressive plants such as leafy spurge, multiflora rose, knapweed, and brush species. They can put to check the necessity for herbicides, fertilize the soil, and control weed species in areas that are difficult to treat with other methods. Farmers have integrated goats into their livestock operations to help preserve and increase herbaceous silage species through hostile plant control. People will occasionally deal with landowners and ranchers to provide fodder for the goats, which in turn control weed species. Goats characteristically have a preference for forb and browse species, so there is not an overlay of use by goats and cattle (Coffey, 2012).

2.9.2.3 Breed of livestock

It is importantly considered by most range managers to change breed of livestock as to improve distribution. On the other hand, grazing patterns might become a deliberation in breed assortment if a range manager is bearing in mind a change for other motives. Greater heat forbearance and associated foraging physical characteristics of Brahman, Brahman crosses, and other Zebu types is often a consideration in Southern and Southwestern States. For example, Herbel and Nelson (2014) found that Santa Gertrudis cattle (3/8 Brahman) traveled further when foraging than Hereford cattle in an investigation in southern New Mexico.

In the case of poor and rough grasslands, cattle producers and land managers can improve consistency of grazing by choosing breeds that are much more established in hilly topography. Tarentaise cattle developed in the French Alps regularly mounted higher and used higher altitudes than Herefords on northern Montana rangeland (Bailey. *et al.*, 2012). Further investigation likened terrain uses of cows sired by Angus, Charolais, Piedmontese and Salers bulls. Cows sired by Piedmontese bulls used higher terrain than cows sired by Angus bulls (VanWagoner. *et al.*, 2014, Bailey. *et al.*, 2014). Piedmontese cattle were developed in the foothills of the Italian Alps, whereas Angus cattle were developed in flatter terrain in eastern Scotland.

2.9.3 Techniques that exclude livestock use or promote avoidance of riparian areas

2.9.3.1 Fences

According to Provenza (2013), the precise kind and extent of fencing necessitated differ extensively depending on the grazing scheme used, landscape, and the intentions of the manager. Nevertheless, once a grazing scheme is carefully chosen, supplementary fencing can be added to increase control of livestock distribution. Fences can be used to improve distribution by excluding or including livestock. For example, fences around riparian areas can be used to exclude livestock during periods when there is high potential for damage or when other suitable forage is available in the upland. In addition, a riparian fence can be employed to contain animal when riparian zones are not so much vulnerable to physical destruction or when quality of highland silage has reduced late in the growing period (Bailey, 2010). If fences are employed to contain livestock in a riparian zone, it is imperative to base the stocking rate on the fodder resources of the riparian pasture.

Ganskopp (2011) reasons that fencing when correctly positioned, well-constructed and preserved, can be an excellent instrument for managing distribution of livestock. In other words, fencing aids the management of riparian zones by sometimes including or excluding livestock use, depending on management intentions. Occasionally exclusion fencing can be the most reliable technique for introducing rapid riparian reclamation. It can also be a provisional measure for kicking off reclamation. The damage of fodder from exclusion fencing may be insignificant on watercourses in poor condition that do not have foliage (Kinch, 2009). Fencing water sources during springs and seeps, and piping water to neighboring areas for use is frequently the most effective technique for protecting small riparian areas (Herbel & Nelson, 2014).

VanWagoner. *et al.*, (2014) maintains that fencing could as well restrain biota and livestock movements in an unwanted way. Furthermore, erecting a fence and maintaining it has often remained costly and take a lot of time to accomplish. Provisional electrically powered fencing can be an excellent method for improving distribution so that some areas of a pasture can be grazed while others are rested. Similarly, provisional fencing is important for assessing numerous placement sites before building costlier lasting fencing. Employing momentary fencing every year to disrupt grazing network and promote employment of rangeland supervision methods provides easiness in achieving long-term goals.

According to Kinch (2009), livestock adapt to provisional electrically powered fencing easier in a well-managed environment like spring calving meadow than much bigger rangeland meadowlands. Animals must learn to keep away from the electrical fence to avoid injury. It is imperative to note that provisional electrically powered fencing does not provide the same level of control as permanent barbed-wire or wooden-rail fencing and should be used to influence rather than control animal behavior.

2.9.3.2 Stockman ship

According to Armour, *et al.*, (2011), regular range riding and shepherding can successfully regulate animal distribution in different circumstances. On some poorly watered ranges, appropriate stockman ship may cause increase in breeding, conception, and calf crops.

A number of the positive tactics described by Howery, (2012) and Sattler (2012) similarly integrate riding and herding into overall management. Low-stress stockman ship practices are once again becoming more popular as a tool to distribute livestock.

Clary. *et al.*, (2011), clarify that low-stress stockman ship is a technique of managing livestock with prompts rather than force. Ancient techniques of animal management take advantage of some natural characters of livestock, encouraging herds to live in one place where they are placed. Animals often become more manageable with these practices and their production and health every so often improve since the supervision is low-stress and their health is observed more efficiently by the riders.

According to Phillips, *et al.*, (2011), properly managed range livestock will want to live in one location, rather than scattering or hiding in preferred places like fields and riparian areas. Properly placed animals will go to water, such as a creek or trough, drink, and then return to bed down and graze around the area in which they have been placed. This lets the rider or range supervisor to freely control the results of grazing to a high degree, even on big areas of unfenced range and on steep or brushy topography (Phillips. *et al.*, 2011).

Marlow (2015) contends that effective use of low-stress stockman ship aids the rider or range supervisor to control the period that plants and soils are unprotected from grazing animals. This controls overgrazing and over resting, both of which affect range health. However, good management techniques can help to improve livestock distribution and rangeland health and trend, as well improve riparian conditions that profit fisheries and wildlife while improving water quality. Livestock can be moved away from life-threatening territories at critical times to abate social dislodgment of flora and fauna (e.g., elk and deer winter range, fawning sites).

Low-stress livestock management is important because it provides room of employment of good handing practices where animals are readily moved and are comfortable where they are settled. Although good stockman ship is synonymous with high-intensity, and short-period grazing systems, it can imply the difference between success and failure with rest-rotation, deferred-rotation, and seasonal grazing tactics on large pastures or open range because areas within the large pastures may be overgrazed without intensive management (Tiedman, *et al.*, 2013).

When management recommendations require animal grazing during one of the critical times, or in high livestock densities, a rotation grazing system can be used to provide wildlife the opportunity to move into pastures where livestock are not present (Sarr. *et al.*,2009). Integration of offsite water developments along with the placement of salt, mineral, and protein blocks has been found to complement low-stress stockman ship.

Bailey (2014) studied moving cow-calf pairs during midday by using low-stress management techniques (with and without low-moisture supplement) as a controlling tool to protect riparian areas. Bailey reported important differences between the free-roaming control cows and the herded cows (with and without supplement). The study evidently exhibited that herding (with and without supplement) can moderate the time cows spend near streams and riparian areas and increase the time spent in moorlands, and the change in cattle grazing patterns with herding will result in less fodder use and higher stubble heights near streams.

According to Marlow (2015), acquiring low-stress stockman ship skills necessitates commitment and a change in both attitude and how cattle are perceived. Likewise, the accidents can be detrimental if smaller animals are put together with big ones. In some areas, existing water tanks may lack the capability to handle the number of animals in a larger herd. The herd may need to be kept split into smaller herds based on available water and forage.

2.10 Empirical studies

Tara and Possingham (2015) conducted an investigation forecasting the influence of livestock grazing on birds using foraging height data. In their investigation, forest and riparian areas signifying the grazing treatments were plotted to establish the likely effect of grazing on the great quantity of bird species. Eight (8) similar sites of each grazing treatment in each habitat were selected. Accordingly, each grazing treatments had a minimum of twenty hectares in coverage. Riparian sites were located inside woodlands with a grazing level that is similar to the experimented riparian site. Spearman’s rank correlations were used to determine the strength of the correlation between the research’s forecasts from the grazing impacts model and the comparative change in density value for each grazing level conversion. The results indicated that was a significant relationship between the forecasts from the impact-of-grazing model based on foraging height liking and variations in bird density as grazing concentration upsurges.

In addition, the relationships were strongest for both woodland and riparian habitats from low to moderate grazing and, the most dramatic change in grazing state, low to high grazing. The number of species forecast to deteriorate was three times the number forecast to upsurge and most woodland birds forecast to deteriorate did, in fact, deteriorate.

Belsky. *et al.*, (2009) conducted a study on livestock grazing influences on stream and riparian bionetworks in the Western United States. The study basically concentrated on findings from peer review, experimental studies, and secondarily on comparative studies of grazed versus naturally or traditionally protected areas. Livestock grazing was established to destructively affect water quality and seasonal quantity, stream channel morphology, hydrology, riparian zone soils, instream and stream bank vegetation, and aquatic and riparian wildlife. There were no positive environmental impacts found. Livestock were as well indicated to cause undesirable impacts at the landscape and local levels.

Van Woudenberg (2010) conducted an investigation on grazing influences on the biodiversity of Riparian Ecosystem. The study design included 5 enclosures at 4 ponds, with 2 unfenced ponds (control). The findings revealed that past and existing grazing effects have reduced the woody component in riparian habitations. Restoration of woody plant species was not experimented. Pretreatment inventory findings of wildlife communities showed that the arrangement of shrub-aspen complexes was imperative for species richness. Quite a lot of species, predominantly birds, were related only with shrub aspen habitat types. Open habitat types that did not have the structural complexity of woody riparian vegetation tended to have a different species composition, including more generalists. Generally, riparian habitat was established to be exploited unreasonably by wildlife. It was recommended that seasonal schedules exclusive to only riparian vegetation would be a justifiable management alternative.

Richardson. *et al.,* (2014) conducted an investigation on the biogeography and the determining factor of structure and composition of riparian plants in moderate and subtropical regions and hypothesized the components of flexibility in these systems. the investigation took into consideration the alterations in the structure and functioning caused by unfamiliar plant invasions, specifically those that lead to breached abiotic thresholds. Persistent and increasing human-related modifications to various elements and at a range of scales in riparian environments necessitated inventive and realistic methods to refurbishment.

The submission of a new outline compliant with such complication was confirmed with reference to assumed riparian ecosystem under three circumstances: i) system unaffected by intrusive plants; ii) system originally uninvaded, but with flood-generated invasion of foreign plants and ever-increasing invasion-driven modification; and iii) system affected by both invasions and engineering interventions. The scheme since then has been used to derive a decision-making structure for reinstating riparian zones in South Africa and could guide similar ingenuities in other parts of the world.

Von Behren, Dietrich and Yeakley (2013), conducted a study on riparian flora assemblies and related scenery factors across an urbanizing city zone. The authors assumed that native and hydrophilic species assemblages would associate with forest cover in the landscape. For each of thirty sites in the Portland–Vancouver metro area, the investigation documented vegetation at 1-cm intervals along 3 bisects using the line-intercept technique. Land cover was branded at 2 scales: within 500 m of each site and across the whole watershed. Multivariate analyses were used to evaluate correlations between species composition and land cover outlines. A taxonomy tree was created to regulate landscape forecasters of riparian community type. The findings revealed a strong association between watershed land cover and flora variety and physical density. The postulation of natural species relationship with landscape woodland cover in urban riparian areas was confirmed, but the investigation established that there was no evident correlation between terrestrial cover and swamp indicator status. The findings revealed that high watershed woodland cover (at least 15 per cent) may enable the perseverance of functionally diverse, native riparian vegetation communities in urban landscapes.

Schulz and Leininger (2010) conducted a study on the structure of riparian vegetation in grazed and ungrazed riparian areas in Colorado. In ungrazed areas, livestock grazing was paused for 30 years and grazing testing area of roughly 65 per cent of the present year's growth was used. Awning cover of undergrowth, graminoid, and total vascular flora was greater in animal excluded areas than in grazed areas. Highest straight up crop averaged over twenty years was 2,410 kg ha^{-1} in ungrazed areas and 1,217 kg ha^{-1} in gazeted plots within grazed areas. Animal excluded areas had nearly 2 times more litter cover whereas grazed areas had 4 times barer ground.

According to Schulz and Leininger (2010), animal grazing also altered the arrangement of flora. Awning cover of rackets was more than eight times bigger in animal excluded areas than grazed areas. Similarly, rackets established in animal excluded areas were of age and larger than those witnessed in grazed areas. The arrangement of the different species in the riparian zones as well varied amongst grazing areas. Shelter of Kentucky bluegrass was about 4 times better in grazed zones and fowl bluegrass was 6 times larger in animal excluded area. Furthermore, cover of species such as tufted hair grass, Nebraska sedge, and beaked sedge, was significant in grazed and ungrazed zones.

Furthermore, McCalla, *et al.,* (2012) investigated the consequence of livestock grazing on residue deposits in zones occupied by midgrasses and shortgrasses. The researchers correlated the influence of short period grazing, modest continuous grazing, heavy continuous grazing, and grazing exclusion on residue deposits. The researchers found out that residue deposits were smaller from midgrass community compared to the community of short grasses. However, livestock grazing was established to possess the capacity to regulate the quantity and kind of flora inhabiting an area and so can acclimatize to the functioning of the riparian zone.

In their study, McCall, *et al.*, (2012) found out that heavy and nonstop grazing led to extreme soil erosion due to the deterioration and depletion of midgrasses in the grazed areas. Likewise, residue production from the small period of grazing pasture increased during the study period. Consequently, pasture lost a lot of sediment from different grass communities than the controlled grazing area. Without a doubt the findings from the study reaffirm the theory that livestock grazing impacts watershed role by changing the structure of the flora. Stocking ratio and concentration of grazing are livestock regulatory variables that need to be carefully set to meet the necessities of each treatment area being grazed. McCalla. *et al.*, (2012) established that the key element influencing sediment production are standing crop, mulch accumulation, and overall undergrowth cover. The study similarly revealed that each factor was affected in a dissimilar way by grazing, and the response varied amongst grazing areas.

Bohn and Buckhouse (2012) investigated the effects of rest-rotation, deferred rotation, season long grazing, and no grazing on riparian soil features like infiltration and bulk density. The researchers found out that rest-rotation grazing intensified infiltration and slowed bulk density whereas the deferred rotation and season long grazing did not do much to support these features and led to poor soil condition in some areas. Late season grazing in September likewise improved infiltration and weakened bulk density, but a comparable action in October produced contradictory effects (Bohn & Buckhouse, 2012). The diverse results of the study were triggered by the modification in soil water as a result of rains during the fall season. The findings demonstrate that the hydrologic role of the riparian zones can be influenced contrarily by diverse management structures and interrelating variables, such as snow and soil water, can alter the impacts of livestock grazing in riparian areas in comparatively small period of time.

2.11 Gaps of the study

Livestock grazing impact on riparian vegetation and its implications on the socio economic activities on communities' livelihood had not been fully investigated by prior studies in Africa specifically in Nigeria. Most studies on interplay between livestock and riparian vegetation are concentrated in the advanced world, e.g. Tara and Possingham (2015); Richardson. *et al.*, (2014);

Von Behren, Dietrich and Yeakley (2013); McCalla. *et al.*, (2012); Bohn and Buckhouse (2012); van Woudenberg (2010); Schulz and Leininger (2010); and Belsky. *et al*., (2009). Such studies presented a contextual gap that necessitated the current study.

Furthermore, studies by Tara and Possingham (2015), concentrated on predicting the impact of livestock grazing on abundance of bird species in riparian area; Van Woudenberg (2010) concentrated on grazing impacts on the biodiversity of Riparian Ecosystem; Richardson. *et al.*, (2014), looked at the biogeography and the determinants of composition and structure of riparian vegetation; Von Behren, Dietrich and Yeakley (2013), concentrated on riparian vegetation assemblages and associated landscape factors; while McCalla. *et al*., (2012), studied the effect of livestock grazing on sediment production in communities dominated by midgrasses and short grasses. As can be clearly seen, none of the above studies looked at grazing effects on riparian vegetation and socioeconomic livelihood of local communities. Hence the above studies present a content gap that the current study intended to close.

Studies that hold concepts closely related to the current study include that of Belsky. *et al.*, (2009); and Schulz and Leininger (2010); however, the methodologies they used make them irrelevant in the current study. For example, Belsky. *et al*., (2009), used peer review, experimental studies, and secondary data, while Schulz and Leininger (2010) used ungrazed treatments for 30 years. The current study however used cross-sectional survey design and observation method for one year.

In addition, most of the studies by (McCalla. *et al.*,.2012; Bohn and Buckhouse 2012; Van Woudenberg 2010; Schulz and Leininger 2010; and Belsky. *et al*.,2009), were conducted many years ago and therefore might lack validity due to environmental dynamics, of which results may not be applicable to Nigeria in the current situation. The current study therefore was intended to provide new data that explains the current variation in the riparian vegetation due to grazing and its consequent effect on the socioeconomic activities of the local inhabitants.

CHAPTER THREE

METHODOLOGY

3.0. Study area

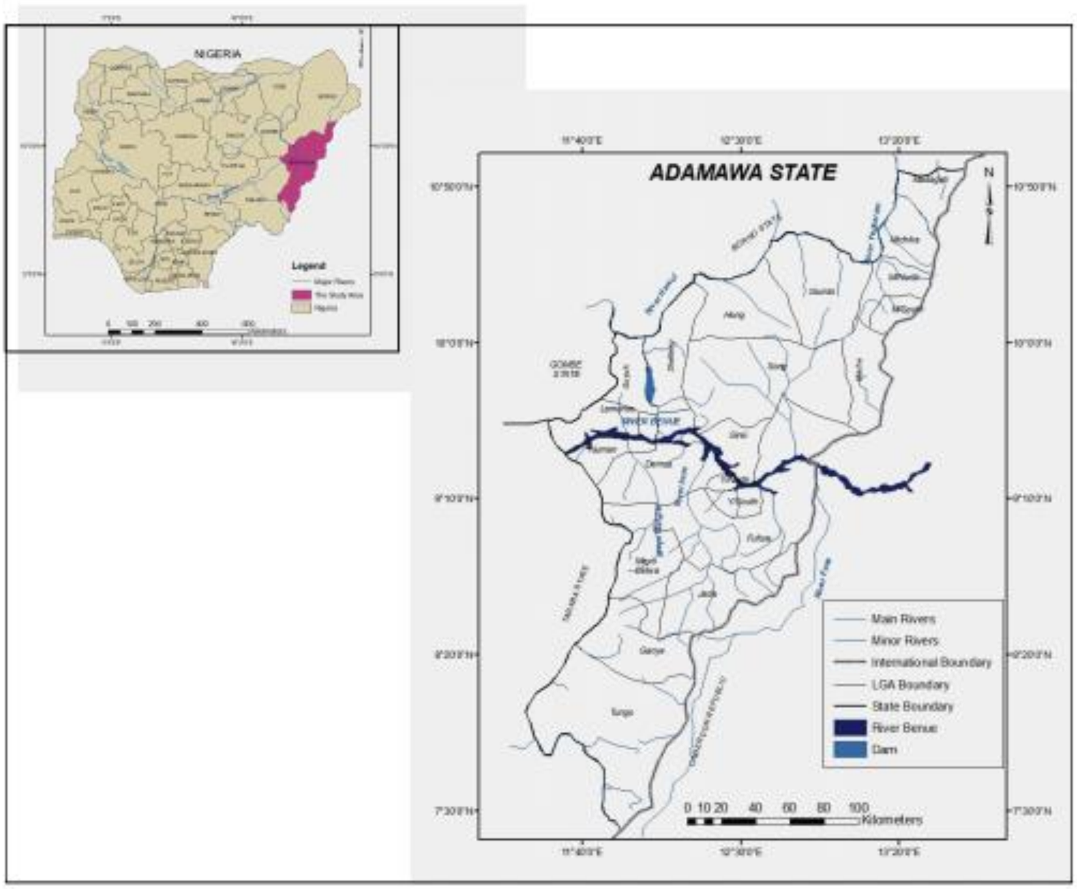


Figure 3: Map of the Study Area: Adamawa State, Nigeria

Adamawa lies between latitudes 7^0. 28' – 10^0.56' north and longitudes 11^0.30' –13^0. 75'east (Appendix X). It is bounded to the north by Borno state, to the north west by Gombe state, to the south by Taraba state and to the east by the Republic of Cameroon with which it has the largest boarder of about 492km. River Benue raises on the Adamawa plateau in northern Cameroon and it proceeds to Nigeria via south west Mandara mountains. The river passes through Adamawa state which formed the (upper Benue) in Nigeria before discharging its water into river Niger, Lokoja in Kogi state Nigeria from Adamawa plateau. The upstream section (upper Benue) comprise of the areas below the linking of Gongola river which include: Lamurde, Numan and Demsa. The river passes across seven communities in the state which are: Lamurde, Numan and Demsa at the downstream of the river, while Girei, Yola north, Yola south and Fufore are at the upstream (upper section) of the river (Hogan, 2013).

The climatic type is that of tropical continental north characterized by the Sudan Savanna zones and tropical hinterland represented by the northern and southern Guinea zones. There are two distinct seasons, the wet season which start from late April to October and the dry season from November to early April. The mean annual rainfall for Savanna zones in the north is between 750—850mm, and 1400 –1500mm for the Guinea zone in the south. The wettest months are July–August while driest periods are March – May the mean annual temperature is 27—28^o C in the Savanna and 18—27 C for the Guinea zones. The aridity index for Savanna is about 2, and 1-6.6 for the Guinea zones temperature of up to 43—45 C have been recorded during March—May (Hogan, 2013).

3.1. The study population

In this research, the target population included River Basin Development Authority (65 officials), State Environment Management Agency (55 officials), Non-Governmental Organizations (12 officials), Community Base Organizations (36 officials) and the local community members (382 members). Total target population was 550 participants.

3.2. Sample size

Sample size refers to the number of individual pieces of data collected in a survey. Sample size measures the number of individual samples measured or observation used in a survey.

Table 1: Target population and sample size

Category of Respondents	Target Population	Sample Size
River Basin Development Authority(RBDA)	65	27
State Environmental Management Agency(SEMA)	55	23
Nongovernmental Organizations (NGOs)	12	5
Community Based Organizations (CBOs)	36	15
Local community	382	162
Total	**550**	**232**

A sample size is part of the target or accessible population that the researcher has chosen to study, representing the rest of the other members of the population (Morse,2013). The sample size of this study was determined using Sloven’s formula:

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

Where, n=sample size, N=target population, α=level of significance at 0.05

$$n = \frac{550}{1 + 550\,(0.05)^2}$$

$$\boldsymbol{n = 232}$$

3.3. Sampling technique

According to Mugenda and Mugenda (2008), sampling technique is very essential in any social science research because it aids in responding to some questions relating to what type of participants will be invited to provide response to the questionnaire. In this study, simple random sampling was adopted to select the staff from River Basin Development Authority, Non-Governmental Organization, Community Base Organization and State Environment Management Agency. The researcher went to the relevant departments staff officers of these organizations and got the total number of employees in each.

The names of the employees were written in small pieces of papers and placed in a bowel. The bowel was shaken to randomize the pieces of papers. The papers bearing the names of the employees randomly were selected until the desired sample size was achieved. This sampling technique was preferred because it gives equal opportunity for each participant to be included in the study without bias.

Since river Benue stretches up to 90km, the researcher chose to use 20km where grazing in riparian area is most practiced. The local communities' homesteads located along the 20km stretch were subdivided into 10 equal strata. The study selected 43 homesteads in each stratum. Similarly, one family head was selected from each home. The study preferred to use stratified random sampling because it reduces selection bias. This is because stratifying the entire population before applying random sampling methods helps ensure a sample that accurately reflects the population being studied in terms of the criteria used for the stratification. In other words, it ensures each subgroup within the population receives proper representation within the sample.

The study area (the riparian along the river Benue) was stratified into two Upper and Lower sections, the vegetation was also stratified into non-grazed area and grazed area. The riparian width was identified along the river gradient this was in determination to delineate quadrat plot size and counts transect along the gradient. In both the upper and lower sections of the riparian, a quadrat plot of 10meters x 50meters was drawn in the non-grazed site and grazed site of each section. Any area (space) along the riparian of the river that is engaged or occupied with other development or activities rather than grazing and conserved or reserved area(enclosures), was not considered or included in sampling and delineation. That is sampling and delineation of macro plot were restricted to grazed and non-grazed areas identified.

The macro plot of 10 m x 50 m was delineated horizontally along river gradients from the upper, down to the lower section in both the non-grazed and grazed sites of the sections respectively. It began with a horizontal base line (transect line) of 18000m in total along the stream bank upper section of the riparian at the zero-point angle, with 11250m in the grazed site and 6750m in the non-grazed site. The vertical side of the 10 m is directed towards the earthbound landscape, while the 50 m side is horizontal along the riparian stream bank.

In the upper section of 36 quadrats plot of 10 m x 50 m was demarcated, with 22 in the grazed sites and 14 quadrat plots in the non-grazed site of the section of grouped as A. In the same vein, a quadrat plot of 10 m x 50m was demarcated in the grazed site and in the non-grazed spot of the lower segment.

The 10meters x 50meters quadrat plot were outlined along a bisect line of 30000min total in the lower sections, with a bisect line of 18250m in the grazed site and a bisect line of 11250m in the non-grazed site. The 50m side of the quadrat plot is horizontally along the stream bank and the 10 m side on the vertical line towards the earthbound landscape. In the lower section, the grazed areas have 36 quadrats and the non-grazed areas has 23 quadrat plots grouped as B. The grazed sites of both upper and lower sections in total has 58 quadrat plots, while the non-grazed sites of both upper and lower sections in total has 37 quadrat plots. To be concise, there are 59 quadrats in the lower sites and 36 quadrats in the upper sites, in total there were nine five square meters detected, study documented grazing impacts on plant community at 0.6 meters' interval bisects using the line intercept approach. The variation in the number of quadrat plots in the study sites was due to the nature of landform and availability of the free grazing areas and the conserved vegetation along the river gradients.

3.4. Data collection method

The study used; secondary data which was obtained from the documents of various corporations related to the study. Such as text books, handbooks, reports, journals and other relevance scientific papers. Primary data was used as derived from the following:

3.4.1 Survey

The goal of vegetation survey is to compare plant cover, distribution and species composition of the quadrat in group A and disturbance comparable less frequently grazed reference site quadrats in group B. The appropriate size for a quadrat depends on the items to be measured.

For instance, if the plant numbers per unit area are to be measured, then the quadrat size will be critical, that is 50cm^2. However, it should be noted that a plot size should be big enough to contain important numbers of individuals, but slightly small so that plants can be separated, counted and measured without duplication of omission of individuals (Cox, 1990). Therefore, the formula to measure was as follows:

$$Density = \frac{Number\ of\ individuals}{Area}$$

$$Relative\ Density = \frac{Species\ desnity}{total\ density\ for\ all\ species} x100$$

$$Frequency = \frac{Number\ of\ quadrats\ in\ which\ species\ occur}{total\ number\ of\ quadrat\ sampled}$$

$$Relative\ Frequency = \frac{species\ frequency}{total\ of\ frequency\ value\ for\ all\ species} x100$$

The research preferred to use survey method because it is good for gathering descriptive data, relatively easy to administer, cost effective and time saving. This method was used to collect data on grazing effects on the vegetation structure in riparian area, effective management strategies for conservation and sustainability of riparian area and the socioeconomic drawbacks of grazing along river Benue. The main research instrument used to achieve this was questionnaires which were administered to the staff of River Basin Development Authority, Federal Environment Protection Agency, Non-Governmental Organizations, Community Base Organizations and the members of the local community.

3.4.2 Field observation

Creswell, (2010) and Lazo (2010), defines observation as a purposeful, systematic and selective way of watching and listening to an event as it takes place. This watching is accompanied by taking records. The researcher preferred to use observation method in this study because it helps in collecting data where and when an event or activity is occurring, and does not rely on people's willingness to provide information, but provides the study with real life situation and experience. Observation method was used to collect data on grazing effects on the flora community composition in the riparian area, and variation of seasonal livestock grazing effects on riparian vegetation structure along river Benue. The instrument mainly used to achieve this was the observation guide.

3.5 Research instruments

According to Amin (2005) and Heinz and Myers, (2010), research instruments are study tools designed to collect field data from respondents and translate attributes or traits into quantities. In this study, the main research instruments were questionnaires guide (Appendix I II III IV), interview guide (Appendix ii), and observation.

3.5.1 Questionnaire guide

A questionnaire is data collection tool used for collecting evidences, concepts, insight and attitudes of a big number of participants at a specific time (Amin, 2005). In this study, the research used 5-Likert scale to design the closed ended questionnaires, The Likert Scale was used to assess the extent to which a respondent agrees or disagree with a statement of an attitude, belief or judgment. The research achieved this by identifying all sub-areas of the topic or variable being measured for questions to be asked for one to agree or disagree with. The 5-Likert scale included the following scales: 5=strongly agree, 4=agree, 3=not sure, 2=disagree, and 1=strongly disagree. The Table 2 gives the interpretation of the 5-likert Scale and their respective mean values.

Table 2: Likert scale and interpretation of the mean values

#	Mean Range	Response Mode	Interpretation
5	4.21-5.00	Strongly Agree	Very satisfactory
4	3.41-4.20	Agree	Satisfactory
3	2.61-3.40	Not sure	Fairly satisfactory
2	1.81-2.60	Disagree	Unsatisfactory
1	1.00-1.80	Strongly Disagree	Very Unsatisfactory

Furthermore, the questionnaire was subdivided into four sections; Section A, B, C, and D. Section A captured the demographic characteristics of the respondents in terms of gender, age, marital status, educational level, occupation and household monthly income. Section B captured data on grazing effects on riparian area along river Benue, measured using ten items. Section C captured data on the effective management strategies for riparian conservation and sustainability measured using ten items. And lastly, section D captured data on socioeconomic effects of grazing along river Benue using twelve items.

The closed ended questionnaires were all distributed to the staff of River Basin Development Authority, Federal Environment Protection Agency, and the local community members.

3.5.2 Observation guide

When using this method, the research observed the events or situation as they actually occur like (Bryman, 2007) and Creswell, (2011), also contends that observation is an attempt to observe events or phenomenon as they naturally occur.

This study used checklist or observation guide sheet to observe the variation of seasonal livestock grazing effects on riparian vegetation structure along river Benue (Appendix III). The checklist or the observation guide assessment sheet was used to captured data on variation of livestock grazing effects on riparian vegetation structure along river Benue during the dry season. It was used to captured information on the same regard during rainy/wet season. In both seasons, the study observed the level of defoliation and animal trafficking caused by grazing.

Specifically, the research observed under defoliation the following: productivity of floristic community, composition covers, diversity and its vigor and biomass, and buffer vegetation over hang. The study in this case observed whether these components increased or decreased during the different seasons and across the grazed and ungrazed sites, and if the changes were directly as result of grazing in the riparian area. Furthermore, the research also observed similar condition of other supportive components like the soil, (the soil moisture, erosion and infiltration rate). Specifically, the study observed whether any changes in these components were as a result of tramping /hoofing, and compaction of grazing cattle.

3.6 Validity and Reliability

3.6.1 Validity

Validity is concerned with whether the study is credible and accurate and whether it is assessing what it is hypothesized or purports to assess. In this regard, (Creswell, 2011) stresses that “validity is an essential criterion for evaluating the quality and acceptability of research.” Normally, scholars use different tools to collect data. Therefore, the quality of these tools is very critical since the conclusions scholars make is founded on the data they gather using these tools (Fraenkel & Wallen, 2013).

Thus, it is imperative that the data and the instruments to be validated. There are different procedures of establishing validity of a research instrument and they include among others the following: content validity, internal validity, criterion validity, and external validity. However, this study chose only one procedure of validity, that is, content validity.

Content validity is associated to a kind of validity in which diverse fundamentals, skills and behaviors are sufficiently and effectually determined. The instrument was given to experts in the field of environmental management to review. Grounded on the reviewer's commentaries, the uncertain and ambiguous questions were modified and refined. Furthermore, the useless and no relevant items were rejected completely (Creswell, 2011). According to Amin (2005), time and again, most often academicians calculate the Content Validity Index (CVI) for each item in the instrument as rated by two or more experts in order to determine how valid the study instrument is. Amin (2005) says, if the CVI $\geq$ 0.70, the tool can then be considered valid.

Content Validity Index formula:

$$CVI = \frac{Number\ of\ items\ rated\ relevant\ by\ all\ judges}{total\ number\ of\ items\ in\ the\ instrument}$$

$$CVI = \frac{28}{31}$$

$$\boldsymbol{CVI = 0.903}$$

Therefore, this study's content validity was acceptable given the 0.88 value (Amin, 2005).

3.6.2 Reliability

Reliability refers to uniformity, trustworthiness and replicability of the outcomes attained from a piece of study (Fraenkel., 2013). Finding comparable results in quantitative research is rather upfront since data are in statistical form. However, in qualitative methods to research, attaining the indistinguishable results are fairly challenging and problematic. It is for the reason that the data are in description form and subjective. Creswell, (2011) point out that instead of finding similar results, it is preferable to mind about the reliability and constancy of the data. In this case, the purpose is not to attain the same results rather to agree that based on the data collection processes the findings and results are consistent and dependable.

Amin, (2005), agrees that reliability is about accuracy and consistency of the instruments. Reliability enhances repeatability and generalization of study findings. It can be ensured through: test re-test method, split-half method, parallel form reliability method and internal consistency method. This study preferred to use internal consistency method.

This method involves pre-testing the instrument once to a sample of respondents, and the scores of the responses are correlated using Cronbach's alpha coefficient; if the Cronbach's alpha value $\alpha \geq 0.70$ then the instrument will be considered reliable (for Likert scale items involving more than two response categories). Cronbach's alpha determines the internal steadiness, that is, how closely correlated a set of items are as a group. The higher the α-value, the more reliable the instruments will be considered. A generally recognized rule for relating internal consistency using Cronbach's alpha is as follows (creswell,2011): Table 3).

Table 3: Interpretation of Cronbach's Alpha results

Cronbach's alpha (α)	Internal consistency
$\alpha \geq 0.9$	Excellent
$0.9 > \alpha \leq 0.8$	Good
$0.8 > \alpha \leq 0.7$	Acceptable
$0.7 > \alpha \leq 0.6$	Questionable
$0.6 > \alpha \leq 0.5$	Poor
$0.5 < \alpha$	Unacceptable

As regard the findings of this study, the Cronbach's alpha values indicate that all the items measured were reliable because they were all interpreted as Acceptable and Good respectively (Kline, 2000). The results were summarized in table 4 below.

Table 4: Reliability results

Items measured	No. of items	Cronbach's alpha	Interpretation (Kline, 2000)
Grazing Effects on Riparian Vegetation	9	0.775	Acceptable
Management Strategy For Riparian Conservation	10	0.789	Acceptable
Social economic effect of grazing along river Benue	12	0.826	Good

3.7. Data collection procedure

An introduction letter was obtained from the School of Engineering and Applied Sciences of Kampala International University, Kampala, Uganda for the researcher to solicit approval to conduct the study in the Riparian Area. The researcher also sought approval from the leadership of the local communities, Community Base Organization, River Basin Development Authority, and Federal Environment Protection Agency from Adamawa State.

During the administration of the research instruments to the selected respondents; they were properly and adequately oriented on the study and why it was being carried out. The respondents were requested to sign the informed consent form. They were also guided on how to fill the questionnaires, and the importance of answering every item of the questionnaire without leaving any part unanswered. The respondents were requested to kindly respond to the questionnaire on time. After retrieving them back, they were thoroughly checked to ensure that all items were adequately answered by the respondents. Similarly, during the field observation of the riparian vegetation conditions to ascertain the grazing effects, the researcher and two other research assistants, biologist and a geographer used the observation guide sheet in observing and recording the effects of grazing. Each quadrat in the sites were inspected on foot moving in closely traverse from one quadrat to another. Grazing effects was determined by the presences of cattle hoofing marks, sapling pools, reduced plants heights through browsing, trampled steams, herbaceous bare ground etc.

3.8. Data analysis

In this study, data regarding the demographic characteristics of the respondents and main constructs of the study were all coded using numerical values. The coded values were then entered into the computer using IBM SPSS version 23 (International Business Machine Statistical Package for Social Sciences) Data editor. The scale of measurement for demographic characteristics of the respondents was Nominal while for the other constructs of the study, was Ordinal.

The data analysis was conducted using percentage distribution. This is because percentage enable us to compare the absolute level of each category, relative to the total number of objects (or respondents), thus getting the "relative percentage" of the category. This study used percentage distribution to present data on objectives one, three and four. The data presentation was done using tables, graphs and charts of different kinds.

Inferential statistics was analyzed using t-test of mean difference analysis to establish the grazing effects on the vegetation structure, and Paired Samples T-test was used for variation of seasonal livestock grazing effects on riparian vegetation structure. For the socio economic effects of grazing along river Benue. ANOVA, and Pearson coefficient correlations were used to test the null hypothesis at level of significance 0.05. The null hypotheses tested included: grazing has no effects on the vegetation structure in riparian area along river Benue; variation of seasonal livestock grazing has no effects on riparian vegetation structure along river Benue; and there is no socio economic effect of grazing along river Benue.

3.9. Ethical consideration

This study observed the following ethical considerations: The research ensured quality and integrity by reporting only what he found in the field and following a scientific and generalized report writing for academic research.

The study sought for informed consent from the respondents. This was done by requesting them to sign the informed consent form before participating in the study.

The research respected the confidentiality and anonymity of the research respondents by involving them in the study in their own terms and place of convenience and coding their names in the final report of the study.

The study ensured that participating in the research was voluntary, no one was coerced, forced or bribed in order to be part of the study, research also ensured voluntary withdrawal from the study in case of change of mind of the respondent.

The study ensured that there was no harm to the participants in anyway, also ensured that the final reporting was impartial and independent of his personal opinion, rather it was the opinion of the respondents that were used in the final analysis of the research.

3.10. Limitation of the study

The reliability of the results (test-retest) was not adequate enough to provide a better explanation for the consistency of the results of this study instruments. There is need to set up a control group as to substantiate the reliability of the study.

However, the study tried to address this weakness by using Cronbach's alpha that measured the internal consistency of the items, with the intent of finding out how closely related a set of items are as a group.

The study was limited by financial constraint since the researcher was using his personal money to finance the study. It was not adequate to facilitate him throughout the course of the research. However, he mitigated this challenge to an extent by borrowing money.

Furthermore, given the academic nature of the study, time constraint was a limiting factor, which was not enough to provide substantive results in this kind of research. The study needed a longitudinal study that covers at least a period of 10 years and above so as to substantiate the effect of over grazing on the riparian area of river Benue.

CHAPTER FOUR

PRESENTATION OF RESULTS

4.1 Response rate

The research distributed 232 questionnaires to staff and members of River Basin Development Authority, State Environment Management Agency, Non-governmental organizations; Community based organizations and the Local community members. However, the research managed to retrieved 222 questionnaires which were successfully completed by the respondents. This gave the study a response rate of 96 percent. According to Amin (2005), if the response rate is greater or equal to 70 percent, the data can be analyzed. The study used the responses of the 222 respondents whos questionnaire were retrieved as in table 5 below.

Table 5: Response rate

Category of respondents	sample size	retrieved	response rate (%)
River Basin Development Authority	27	24	89
State Environment Management Agency	23	20	87
Non-governmental Organizations (NGOs)	5	5	100
Community Base Organizations(CBOs)	15	15	100
Local community members	162	158	98
Total	**232**	**222**	**96**

4. 2 Demographic characteristics of the respondents

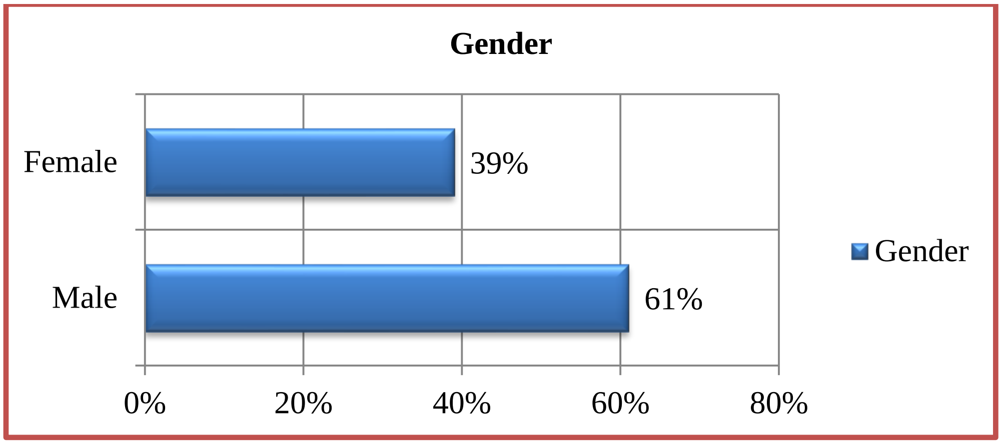


Figure 4: Gender of the respondents

The results presented in Figure.4 unveiled that, 61 percent of the respondents were male while 39 percent were females. Therefore, this means that there was more male respondent than female respondents. The dominance male respondents are mostly house hold heads. They represent families' and own properties such as domestic animals of the family compared to their female counterparts. The difference in property ownership is attributed to culture in African tradition setting where Nigeria is no exception. However, with increased civilization and women emancipation women are becoming property owners, especially the educated, politicians and business women.

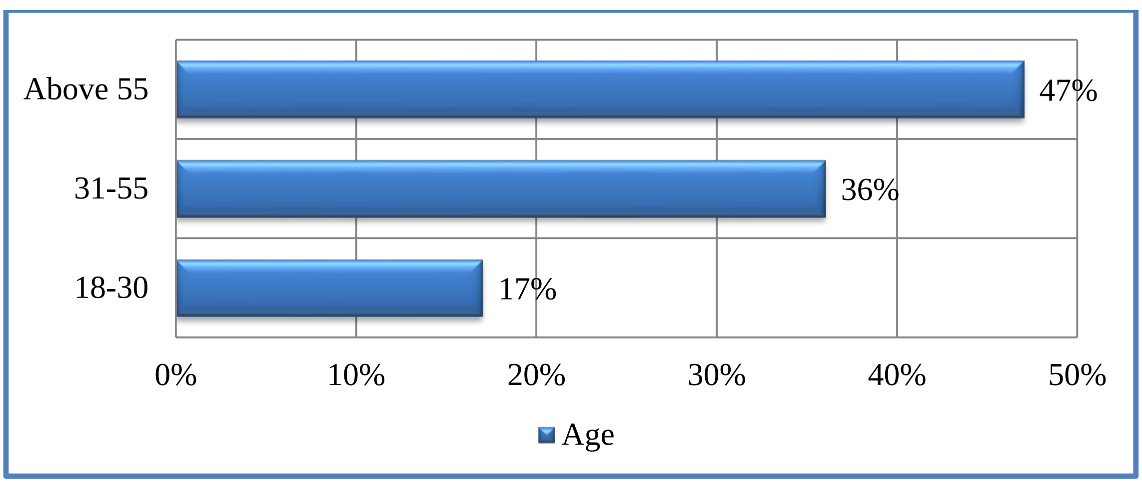


Figure 5: Age of respondents

The results presented in Figure 5 reveals that, 47 percent of the respondents were above 55 years of age, followed by 36 percent of age group (31-55) years while 17 percent of the respondents were within the age group of 18-30 years. The dominance of the respondents above 55 years of age signifies that elders were available during the study period. The study also revealed that elders were found to be family heads and owning properties along the riparian. as most of them hustle to maintain family livelihood, since those that would support them could have been away on Government service and education.

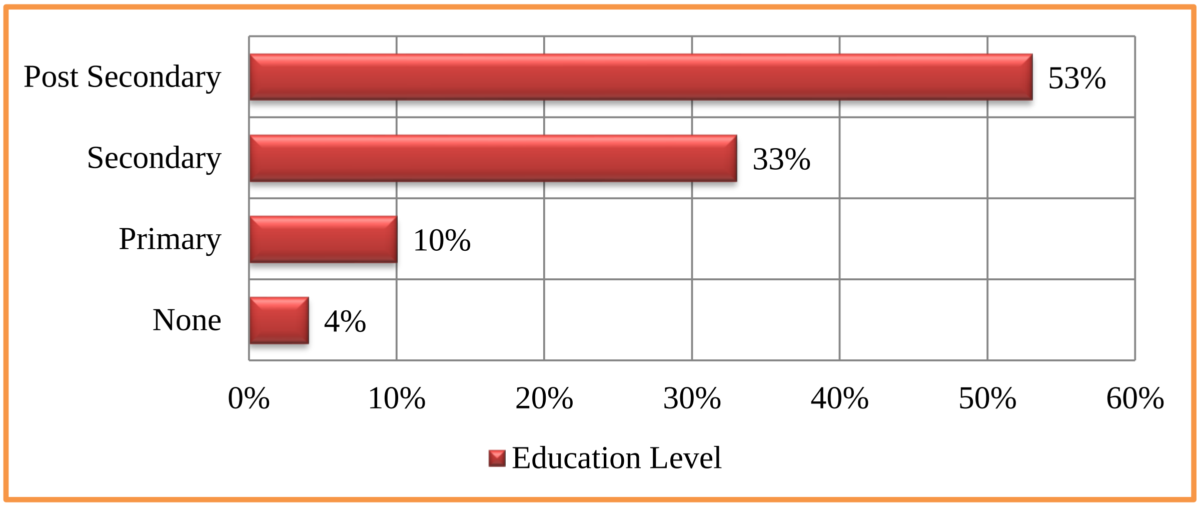


Figure 6: Education level of respondents

The findings presented in Figure 6 affirms that, 53 percent of the respondents had post-secondary education, 33 percent had secondary education, while primary and no formal education were represented by 10 percent and 4 per cent respectively. The dominance of the respondents who had post-secondary education could be because majority 65 percent of Nigerian population above the age of 20 years are educated (Nigeria Bureau of Statistics, 2012). Post-secondary education levels include those who went beyond the secondary level in their educational pursuit. They include holders of Diploma, Bachelors, Master's degree, and PhD.

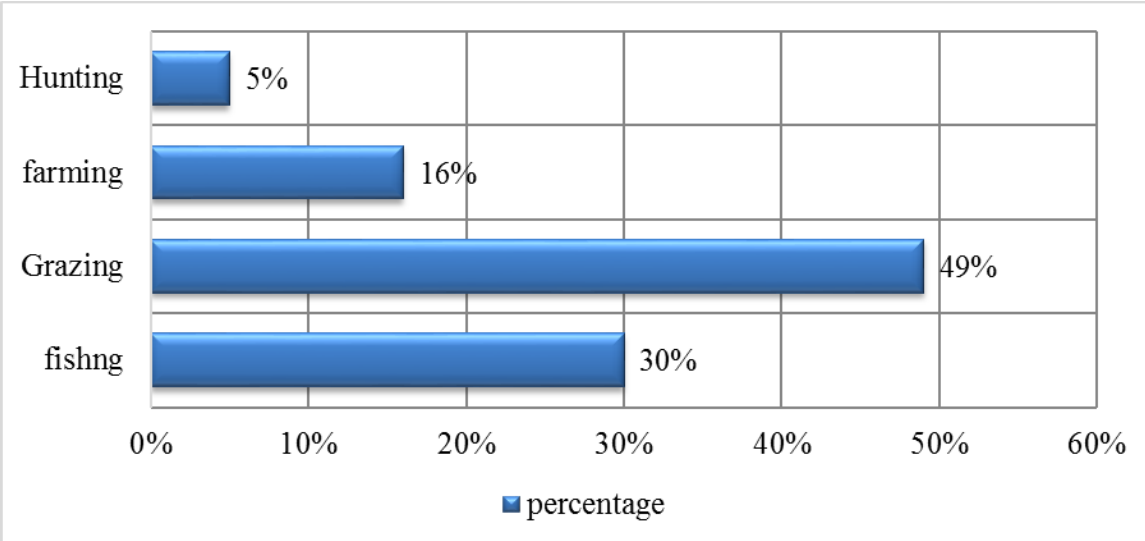


Figure 7: Occupation of respondents.

The information in Figure 7, established the occupation of the local community members along the riparian, 49 percent of the respondents are grazers, while 30 percent are those engaged in fishing as means of earning a living in the area. Farmers 16 percent of the respondents and those in hunting occupation are 5 percent of the respondents. Grazing as occupation become predominance in the community because, culturally, animals are properties or assets which every family should have. In addition to the nomadic pastoralists in the area who has large number of herds, there are many who are in the practice of agro-pastoralists and they graze throughout the year unlike the nomadic pastoralists who are seasonal.

4. 3 Grazing effects on vegetation of riparian area along river Benue

The goal of vegetation survey is to compare plant cover, distribution, and species composition of the quadrats in group A and disturbance comparable less frequently grazed reference site quadrats in group B. Observation method was used to collect data on grazing effects on the flora community composition in the riparian area, and variation of seasonal livestock grazing effects on riparian vegetation structure along river Benue.

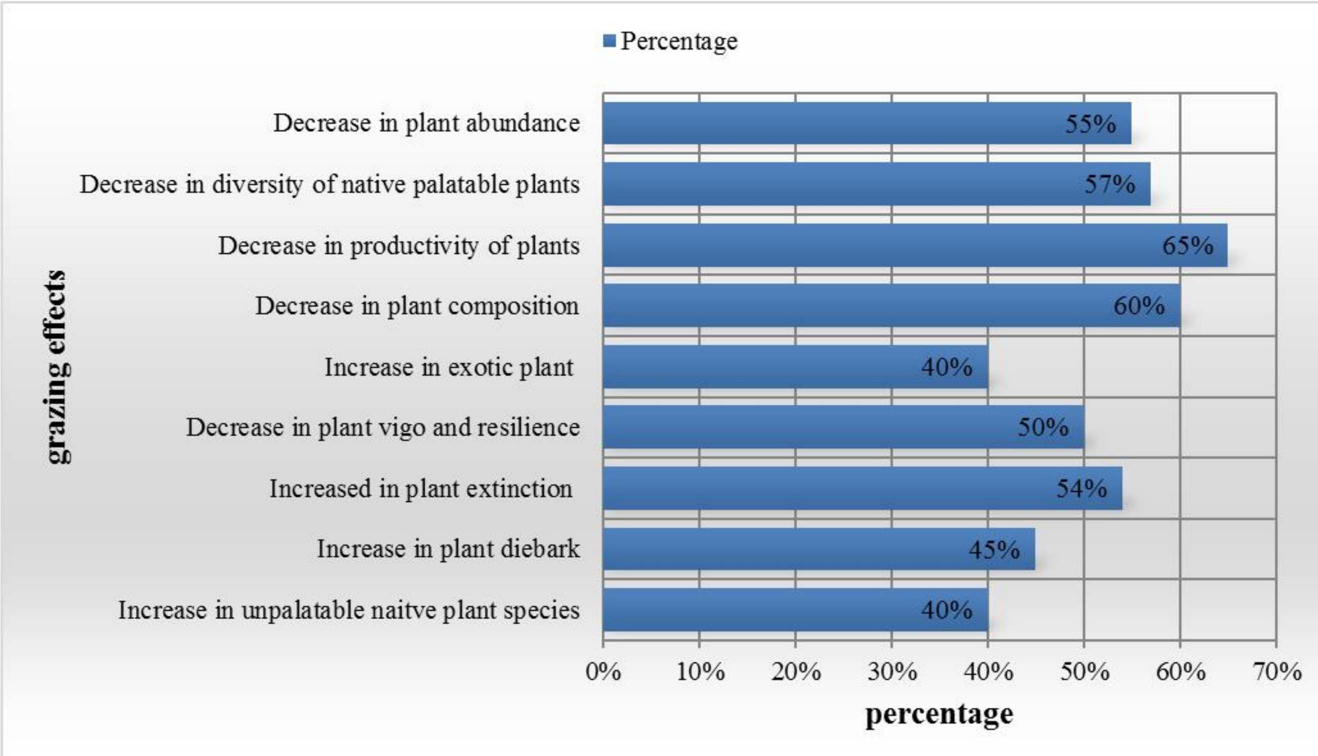


Figure 8: Percentage of grazing effects on plant species along riparian area

The information in Figure 8, indicate the adverse of grazing effects on plant species in the riparian. There is a general decrease in the growth of plant species 55 percent of the respondents consented to that. A general decreased in the diversity of the native edible species (e.g. *Aristida mutabilis*, *Themeda triandra* and *Cynodon dactylon*, *p, africana*) cited by 57 percent of the respondents and decrease in plant productivity (e, g *Celtis Africana*) mentioned by 65 percent of the respondents. Others consist of overall reduction in composition (heterogeneity) 60 percent of the respondents affirmed and increase in exotic weeds variety in the riparian (e.g. *Learsia Hexandra*, *algae*) mentioned by 40 percent of the respondents.

A decreased in plant vigor/resilience (e.g. *Carissa spinarum*(shrub) and *Cynodon dactylon* (grass) 50 percent of the respondents advanced it.

Increase in death of sensitive plants to grazing (e.g. *Vangueria infausta*, *clausina anisata*) was cited by 54 percent of the respondents; increase in the widespread of diebark (e.g. *Eucalyptus spp*) 45 percent and finally increase in the diversity of inedible native (e.g. *Imperata Cylindrica-spear grass) Aristida mutabilis*, *Chlorophytum dalziere and Rucinus cominunis*) due to ebb of edible vegetation covered as mentioned by 40 percent of the respondents in the area.

The decline in the plants growth was due to intensities grazing mechanisms (defoliation, browsing and trampling) of foraging livestock which leads to decrease in perennial palatable native tussock grasses family such as, *Andropogon spp* (*e. g Andropogon tectoreum*,) on the grazed sites. Shrubs such as (*Angylocorlyx Oligophyllus* and (*Chytranthus Macrobotrys)* were also affected through similar processes. Decline in diversity of native palatable were due to selective foraging effect palatable grass species like (*Sorghum Vulgare* and *Nymphoea lotus*) among others due to its aperitive which attract stock frequent foraging. This caused reduction in diversity of native palatable and increase diversity in native unpalatable species like (*Penniretum purpuseum*).

Some of the exotic weeds like *Cenhrus cilliaris* was identified to have a deleterious effect on native species, this increases the diversity level of unpalatable species in the grazed site. The decline in the productivity of plants was due to selective foraging on the productive parts (flowers and nodes), on both *Monocotyledonous* and *Dicotyledonous* families like; (*Euphorbiaceae and Mumosaceae*). Although, grazing activities promote diversity in plants (exotic and unpalatable native species), it reduces plant vigor and resilience through the grazing mechanisms. Widespread of diebark plant especially the tree life-form was observed in the site amidst families of *Rucinus cominumis* and *Sterculiaceae* including tree like *Eucalyptus*.

Diebark is a severe problem on plants in the riparian grazing regimes, the large trees were found to be more susceptible to the diebark than the small saplings. On the grazed sites decrease in vigor and resilience amidst plants were mostly associated with species like (*Carissa spinarum* and Senecio *abyssinica*) which are much resilient to grazing disturbances. Plant species like (*Celtis africana, Vangueria infausta* and *Hypoestes arisata*) are only found in the ungrazed site of the study area, such plants are completely in extinction in the grazed area.

Increase in plant species diversity in the grazed area associated with plants that unpalatable (e.g. *Cynodon dactylon, Rucinus cominunis*), such plants has tannins that are disturbing to grazing animals.

There are several other factors that interplay with ecosystems resources particularly the riparian ecology. The presences of such factors and their influence on the ecosystems may generate a doubt of whether livestock grazing is fully accountable for such effects in the riparian.

The current study identified grazing effects on riparian vegetation after subjecting it to principal components analysis (factor analysis) to determine the true loading of the effects on grazing activities in the riparian as in Table 6.

Table 6: Principal components analysis of grazing effect on riparian vegetation

Rotated Component Matrix[a]		
	Component	
	1	2
Decline in plants growth	.759	
Decrease in diversity of native palatable plants	.748	
Decrease in productivity of plants	.668	
Increase in diversity of unpalatable native plant	.638	
Increase in die bark of plant	.583	
Reduction in plant composition.		.711
Increase in diversity of exotic weeds		.629
Increase extinction of plants		.594
Decrease in vigor/resilience of plant		.584
Total of Eigenvalue	**2.910**	**1.762**
% of variance	**29.102**	**17.621**
Cumulative %	**29.102**	**46.723**

The information in Table 6 show that the most loaded grazing effect in the riparian were; decline in plant abundance (0.759), decrease in diversity of native palatable plants (0.748), and decrease in productivity (poor yield) of plant (0.668).

While reduction in plant composition (0.711), and increase diversity in invasive weeds (0.629) had large loadings on factor 2.

Together, factor 1 and factor 2 explain 29.102 percent and 17.621 percent of variation in the data respectively. In other words, it implies that factor 1 and factor 2 are the eminent contributors of grazing effects on the plant community in the riparian area.

Nevertheless, the variables loaded on the factor 1 and factor 2 are accountable for the massive environmental variations in the riparian along the river. The eigenvalue of 1.762 for the effect of grazing shows a large difference in plant species abundance and variety deterioration of edible native from the rest of the effects. It is satisfactory to describe a significant control of grazing pressure on the riparian plant community species; this shows plant species are delicate to upset of grazing activities. The cumulative Eigenvalue of 46.723 is a strong evidence of livestock influence in the riparian, that grazing of vegetation accounts for 46 percent of vegetation decline in the riparian.

4. 3.1 Variation in grazing effects between upper and lower riparian sections

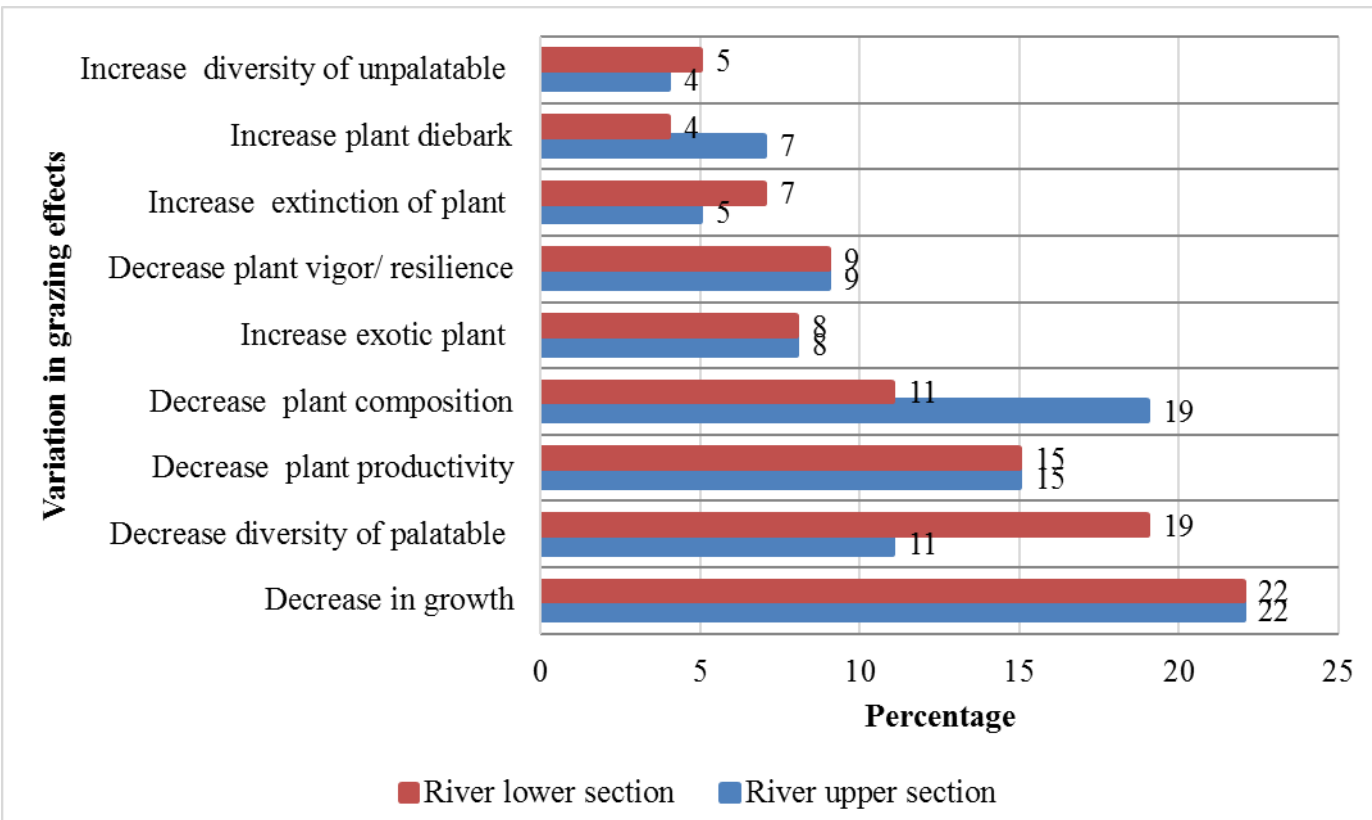


Figure 9: Percentage of grazing effects on plant species along riparian area

The information in Figure 9, reveals difference in effects of grazing on the plant community amidst the upper and lower section of the riparian. Grazing effect on the plant species in both section differed slightly among species categories.

Decrease in plant abundance 22 percent, decline in the diversity of native palatable 19 percent, decrease in the plant productivity 15 percent, increase in the diversity of invasive species 8 percent. Others are; increase in extinction of grazing –sensitive plants 7 percent, decrease in the vigor and resilience of plants 9 percent; increase in the diebark of plant 4 percent and finally increase in the diversity of native unpalatable plants 5 percent.

In the upper section, as in Figure 8, grazing effect on the plant community has no difference compared to the lower section. However, differences only exist on the severity on each attribute in same section: decrease in plant abundance 22 percent; decline in plant composition 19 percent; diversity decline in the native palatable plant 11 percent; decrease in the productivity of plants 15 percent, while increase in the diversity of exotic (invasive) species 8 percent and increase in the diversity of unpalatable native 4 percent.

Others are: increase in the diebark of tree plants 7 percent; decrease in the vigor and resilience of species 9 percent; decrease in the composition of plant percent and finally the extinction of grazing sensitive plant 5 percent.

Variation in the effects amidst the riparian sections were due to factors like: difference in vegetation type, riparian gradients and width, frequency and intensity of grazing herds such factors are strong determinant of species types, variability and attributes. Vegetation of the upper section is dominated mostly by evergreen trees such as;(*Clutia abyssinia, Achyranthus aspera, and Cassipourea malosona*). Also tussock grass species such as; (*Penniretum purpuseum and Andropogan tectorum*). These are found in the under growth of the vegetation which has numerous shrubs like (*Potentilla fruiticosa* and *Arterrisa tridentata)* families and climber plants like; *Passiflora foetida* (*Wild passion fruits*). The landscape of the upper riparian section is rocky and undulating plateau with little riparian width along the river gradients especially around the Gotel high land. There are lesser grass species but much tree plants that are palatable for animals than most of the shrubs and the fewer weeds grasses dominated by Nogoora *burr* (e.g. *Xanthium strumarium*).

Vegetation of the riparian lower section is a great Savanna grassland with few scattered trees like *Parkia spp* and *Rubiaceae* family (*e.g. Xeromphis nilotica*), *Calatropics procera* and the *Phoenix dactylifera* (*date palm*) families.

The lower riparian vegetation also has numerous shrubs and herbaceous layers which includes; *Angylocorlyx oligophyllus* and *Chytranthus macrobotrys* as shrubs and *Cyperus papyous* as sedge. The grassland nature of the riparian section expedited the wide riparian width and the availability of both perennial and annual shrubs, herbaceous and grasses.

The most common families of the grasses are dominated by *Imperata spp*, *Hyparrhenia spp*, others are *Ctenium newtonii* and *Monocymbium ceresiitorns* class, which made the attractive to large influx of grazing herds.

The influx of grazing herds into the lower section of the riparian is at high frequency that encourages grazing intensity also, creating diversity in the unpalatable native and exotic species due to discriminate grazing. The problem of plant diebark is less pronounced in the lower section of the riparian, then the upper having more diverse tree community (forest). Overgrazing is eminent with pronounced bare ground due to much death of juvenile plant and grass through trampling, defoliation and uprooting in the lower section. High plant species diversity in the lower section of the riparian may be due to the intensity of grazing. Resulting in opening of vegetation with numerous scattered patches of trees, grasses and shrubs residual of native palatable species, with abundant presences of both native unpalatable and exotic species.

4. 3.2 Observation of vegetation density of the riparian sections

Table 7: Observed mean density of plant species covers (paired t –test)

Species life form	Grazed	Nongrazed	*P*
Canopy cover (trees)	13.20	26.25	0.002
Under storey cover	8.05	31.10	0.003
Tussock grass cover	5.23	14.14	0.002
Shrubs cover	6.01	10.30	0.004
Forb cover	8.21	10.01	0.001
Herbaceous/ cryptogam cover	2.15	7.32	0.004

*significance at p value = 0.05

The information in Table 7 reveals the results of livestock grazing influence on the plant cover density. The tree plant life-form covers dominated by *Caesalpiniaceae* (e.g. *Cynometra*) and *Sapotaceae* family (e.g. *Lophira alata*) was greater (p=0.002) in the ungrazed area compared to the grazed area.

The small tree/climbers plant life-forms of the understorey cover dominated by *Zygophylluaceae* (e. g *Balanites aegyptiaca*) and Epiphytes (e. g *Loranthus*), were much larger (p=0.003) in the ungrazed as per what was found in the grazed site of the study. The shrub life-form covers dominated by families of *Papilionaceae* (e.g. *Angylocorlyx oligophyllus*) and Sapindaceae (e.g. *Chytranthus macrobortys*) species was larger (p=0.026) on the ungrazed area compared to the grazed area in the riparian.

Total herbaceous / cryptogams plant life-form covers dominated by *Alectra virgotanherns* and Aeschynonse *neglectra* were much larger (p=0.004) in the ungrazed compared to the grazed area of the riparian. The tussock grasses life-form covers of the riparian dominated by Tridx *combretum, Helichsysum cameroonense* and *Panniiretum purpuseum* (*Elephant grass*) families were much larger (p=0.004) in the ungrazed compared to the grazed area.

The forb plant life-forms cover in the riparian dominated by *Rytzynica aryantea* and Rubiaceae families (e.g. *Moralia senegalensis* and *Apocynceae* (e.g. *Saba florida*) were as much larger (p=0.001) in the ungrazed area compared to the grazed area of the riparian.

Base on the observation there were more woody species in the ungrazed compared to the grazed this indicate that, woody species breakthrough very quickly under a riparian condition free from grazing disturbances. The existence of the woody species structural components of the riparian vegetation will be a cardinal sources of habitat for the wildlife, as well important for boosting the management of traditional herbal medicine. On the contrast, there were more diverse non-native (invasive) species like (e.g. *Learsia hexandra* and *water hyacinth*) and native unpalatable species like (*Chlorophytum dalziere* and *Rucinus cominunis*) in the grazed site of the riparian compared to the ungrazed site. The presences of such species like, *Tuft Damaliligel* and *Commelina beughalensis* (grass life-form) contribute immensely to species diversity in the grazed area. The deficient in diversity of plant species in the ungrazed areas can be due to the dominant tree stands that highjack the largest allotment of the habitat resources (nutrients sunlight).

Paired t-test used indicate the difference in the responses of the plant species heterogeneity amidst the non-grazed and the grazed areas of the riparian, which was found significant at p=0.05 greater than p=value of each in Table 7. The resultant effect was due to pressures from the grazing processes on the grazed site.

However, the difference in the response of plant life forms cover in the grazed sites did not occur only by chance, but rather due to several pressures from grazing which is highly significant. Conclusively, there is overwhelming evidence to affirm that, the research hypothesis which state that “livestock grazing has no effect on the plant community of the riparian” is rejected and the alternative hypothesis which state that “grazing has effect on the vegetation” is accepted. The effect on the individual plant life-form communities is a challenge to other components such as soil, wildlife and fishery productivity and water in the riparian area.

Table 8: Observed most affected and resilience species along riparian of river Benue

Riparian plant species affected	Potential effects			
	Vigor/Resilience	Productivity	Diversity	Extinction
Stream bank species				
Lophira alata	decrease	decrease	decrease	increase
Cynometra ananta	decrease	decrease	Decrease	increase
Diospyris Spp	decrease	decrease	Decrease	increase
P, Africana	decrease	decrease	Decrease	increase
Celtis Africana	decrease	decrease	Decrease	increase
Carissa spinarum	Increase	increase	increase	decrease
Imperata cylindra	increase	increase	increase	decrease
Aristida mutabilis	increase	increase	increase	decrease
Themeda triandra	decrease	decrease	decrease	increase
Cynodon dactylon	increase	increase	Increase	decrease
Cenhrus cilliaris	increase	increase	Increase	decrease
Hyparrhenia spp	decrease	decrease	Decrease	decrease
Xanthium	increase	increase	Increase	decrease
Penniseum spp	increase	increase	Increase	decrease
Chlorophytum dalzieri	increase	increase	Increase	decrease

The study information in Table 8 indicates the most sensitive and resilient species to grazing in the riparian area along river Benue.

The productivity of some of the stream bank vegetation species were in terms of vigor and biomass declined due to grazing effect. Such plants like *Themeda triandra* (Plate 1) *Cynodon dactylon* (Plate 2) *Prunus africana* and *Celtis africana* are sensitive to grazing lesser number were found in the grazed if grazing persist in the riparian such species will completely disappear. Similarly, plant species such as (*Monocymbium ceresiiforms* and *Araceae* (*Pistia stratiles*) and tree species such as Erythrophleum ivorense belongs to the class of most disturbed species vulnerable as stock feeds on the bark, (Diebark).

Grazing in riparian caused a decline in grazing-sensitive plant species like *(Ctenium newtonii*) and scarcity in native palatable vegetation species like *Themeda triandra, Cynodon dactylon grass Chlorophytum dalzieri* and *pennisetum Spp*. This had led to reduction and loss of complex vegetation structure.

However, grazing through selective foraging had improves the diversity and dominance of grazing resistance or resilient of some native unpalatable (*grasses such as Imperata cylindrical-spear grass* (plate 4) and *Aristida mutabilis* (Plate 3) Carissa *spinerum, Cynodon dactylon* and *Cenhrus cilliaris*) Such a situation leads to great decrease in the diversity of the native species and increase in the dominance of the invasive species. The disappearing of the grazing sensitive creates a bare ground where found to be dominant.

4.3.3 Comparison of Palatable and Non-Palatable Grass Cover

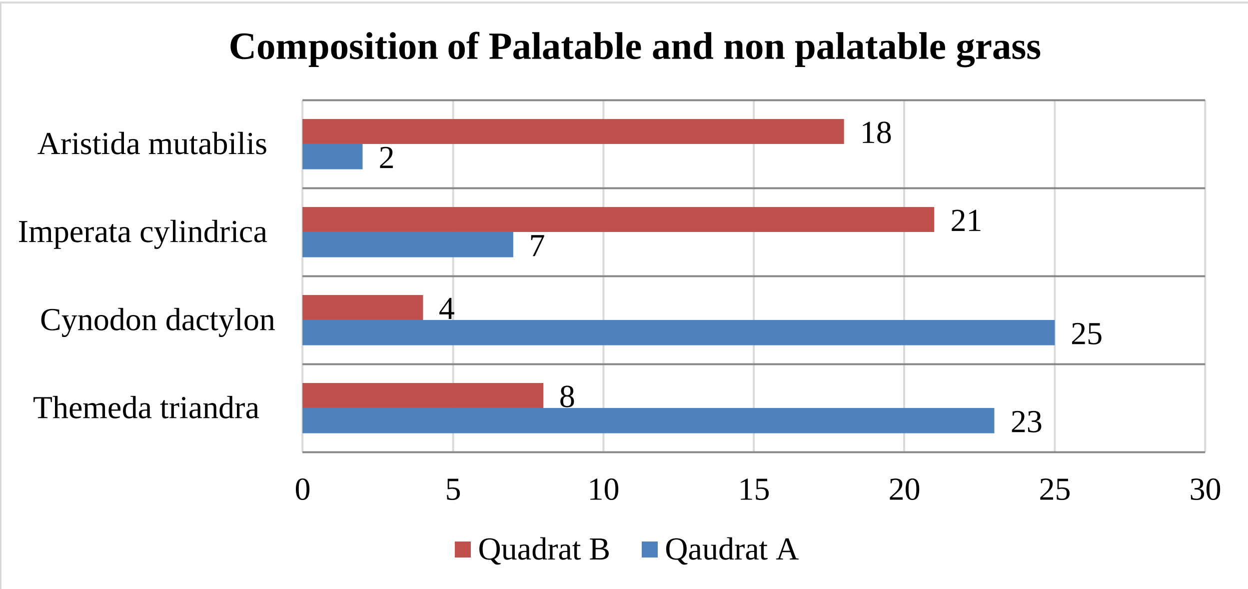


Figure 10: Comparison of Palatable and Non-Palatable Grass Cover

Sampling with quadrats plots of a standard size was used for comparison of palatable and non – palatable grass cover in accordance with Cox 1990 method in both the grazed and non-grazed areas. The results of the study indicated in Figure 10 showed that palatable grass that is *Themeda triandra* (Plate 1) and *Cynodon dactylon* (Plate 2) reduce in the overgrazed area quadrats group A and unpalatable grass that is *Imperata Cylindra- (spear grass)* (Plate 4) and *Aristida mutabilis* (Plate 3) dominate in the overgrazed area quadrat group A. The result of the study also indicated that palatable *Themeda triandra* (Plate 1) - and *Cynodon dactylon* (Pate 2) are abundant in the non- grazed area quadrats group B and unpalatable that is Aristida mutabilis (Plate 3) and Imperata cylindra- spear grass (Plate 4) are fewer in the non-grazed areas.

Plate 1: Palatable species *Themeda triandra*

Plate 1, A native palatable *themeda triandra* grass one of the mostly affected in both upper and lower sites of the grazed area due to its palatability, it can resist drought for a short period, predominant in the non-graze as one of the tussock grass but found in scattered patches in the grazed area. The most predominant species toward the earth landscape of the riparian along the lower riparian section.

Plate 2: Palatable species *Cynodon dactylon*

Plate 2 a native palatable *Cynodon dactylon species* one of the sensitive species with less diversity across the sections grazed sites of the riparian but, abundant in the non-grazed areas (a rear species in the intensively grazed areas) its absences create a large bare ground as it regulates water velocity being a good ground covers.

Plate 3: Non-palatable species Aristida mutabilis

Plate 3 Non-palatable species of *imperata cylindra* class on the bank sandy soil of the river one of the most diverse species in both lower and upper section of the riparian due its unpalatability. available in Dundu Yola south and Dem in DemsaThis was observed in the early wet season.

Plate 4: Non- palatable species Imperata cylindra

Non- palatable species *Imperata cylindra* along the lower section of the riparian in Lamurde during wetseason, one of the predominant species of the stream buffer in all the sections of the riparian areas along the river.

Plate 5: Plant browsing and tramping

Plate 5 shows the effect of grazing through browsing and defoliation on the vegetation during late wet season. The plate indicates effects of grazing on plant species (*Commiphira africana* and *Acacia senegalensis).* These plant species were cut down by herds men to feed stocks. Grazing causes bare groud, decrease productivity in biomass and migration of wild life due to none existence of vegetation cover along the river Benue riparian in Numan.

Plate 6: Soil tramping

Plate 6 shows the effect of animal hoofs and trampling on plant cover, soil texture of the topsoil during late wet season. This is the cause of plant loss and soil vulnerability to erosion during the rainy season. In Plate 6 above, it is clear that, the vegetation that is likely to withstand such conditions are shrubs of non-palatable quality (*Cratter sahel)* along the river Benue riparian in Yola south

Plate 7: Decrease in stream bank vegetation, urine and feces deposited in water

Plate 7 shows the effect of grazing in the early dry season where animal concentrate in the riparian for water and lounging. This process lead to tramping and breaking stream bank, overhanging plants, depositing feculence thus affecting quality and quantity of downstream water, soil and flora such as (*Nymphaea lotus*, *Vossia cuspidate* and *Cyperus papyrus*) along river Benue in Lamurde.

Plate 8: Soil compaction during dry season

Plate 8 shows the effect of grazing on the vegetation. The resultant effect is bare ground due to early dry season grazing leading to soil compaction and the spread of invasive species like (*Deschanpsia caespitosa*) a less palatable species. Also one of the most dominance along the river riparian in Yola North and Yola South.

Plate 9: Effect of hoofing

Plate 9 shows appearance of an overgrazed riparian in middle dry season, with a vast hoofed bare ground, less habitat for wildlife along river Benue riparian in Girei.

4. 4. Socio-economic effect of grazing on human communities along the riparian area

The socio-economic effect of grazing is discussed separately in this study in order to have a broad view of the consequences of grazing on the socio- economic transformation and livelihood patterns of the communities along riparian of river Benue.

The study revealed that besides grazing Cows, Goats, and Sheep, Fishing, dry season farming (irrigation), hunting, herbal medicine practicing, sand selling, boating business, mat making (weaved materials) and Wild fruits/ vegetable selling are some of the local community livelihood activities.

4.4.1 Social effect of grazing on the communities along riparian area

The study findings in Table 6 indicate grazing social effects that have a profound effect on quality of life of the communities along the area of river Benue. During the study, it was revealed that grazing results into insecurity, destruction of water sources, leads to poor quality of life and poor health care.

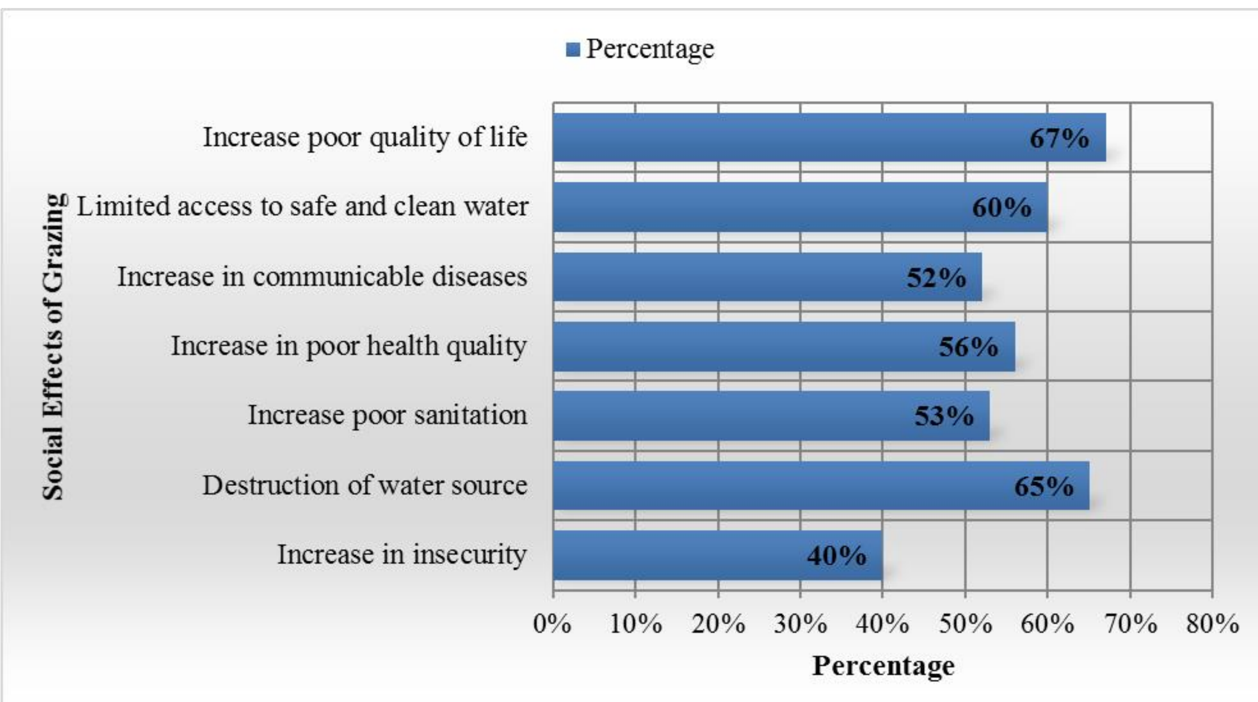


Figure 11: Social effects of grazing on the communities along the riparian

Research findings as indicated in Figure 11 signify that grazing results into social effects to the communities along the riparian of the river Benue. These social effects include insecurity cited by 40 percent the respondents, destruction of water sources 65 percent of the respondents mentioned it, poor quality of life was advanced by 67 percent of the respondents and poor health quality was consented by 56 percent of the respondents.

Others are increase in communicable diseases 52 percent of the respondents mentioned, poor sanitation as mentioned by 53 percent of the respondents and limited access to safe and quality water 60 percent of the respondents advanced it up as one of the challenges. All challenges are compounded by the tough economic conditions which threaten livelihoods of the communities along the riparian area.

The prevalence and severity of these challenges were affirmed by reasonable percentage of the respondents as in Figure 10. For instance, during the study, a sizeable number of the respondents approved the preponderance of poor quality of life and destruction of water in the communities in both the upper and lower section. Clashes among the pastoralists and the riparian dwellers on resource was reported to be the major cause of insecurity in the area.

The study also revealed the situation of water scarcity in the riparian. This problem emanates from uncontrolled grazing activities by the pastoralists along the riparian. A sizeable section of respondents 65 percent revealed that destruction of water sources is as a result of vegetation decline due to grazing. Grazing is responsible for the destruction of farm and non from activities along river Benue. It leads to decline in water quantity and quality downstream which is potential for irrigation and non-farm activity such as swimming. In addition, the distortion in the vegetation composition by grazing results into environmental contamination by pollutants as a result of flooding. This leads to vulnerability to disease and poor quality of life.

Grazing has negative effect on the communities along riparian. It is responsible for deteriorating quality of sanitation and health. Grazing livestock pollutes water, land and air through defecation and urine in the water source and land cover which leads to limited safe and clean water. Activities of grazing can go a long way to destroy the clean water sources for domestic use, industrial and social units such as schools, health centers and sports arenas.

These challenges as analyzed in (Figure 11) are compounded by human needs which increases drivers and pressures on the vegetation which directly or indirectly transformed into secondary problems such as water scarcity, poor sanitation and vulnerability or communicable diseases and a decline in the ecological functions which is a threat to livelihood and quality of life.

4.4.2 Variation in social effects of grazing amidst the communities

The study findings, identified difference in the social effects of grazing on the communities along the riparian area. That is, social effects of grazing are more severe on some of the communities than others amidst the riparian sections of the river (Figure 11)

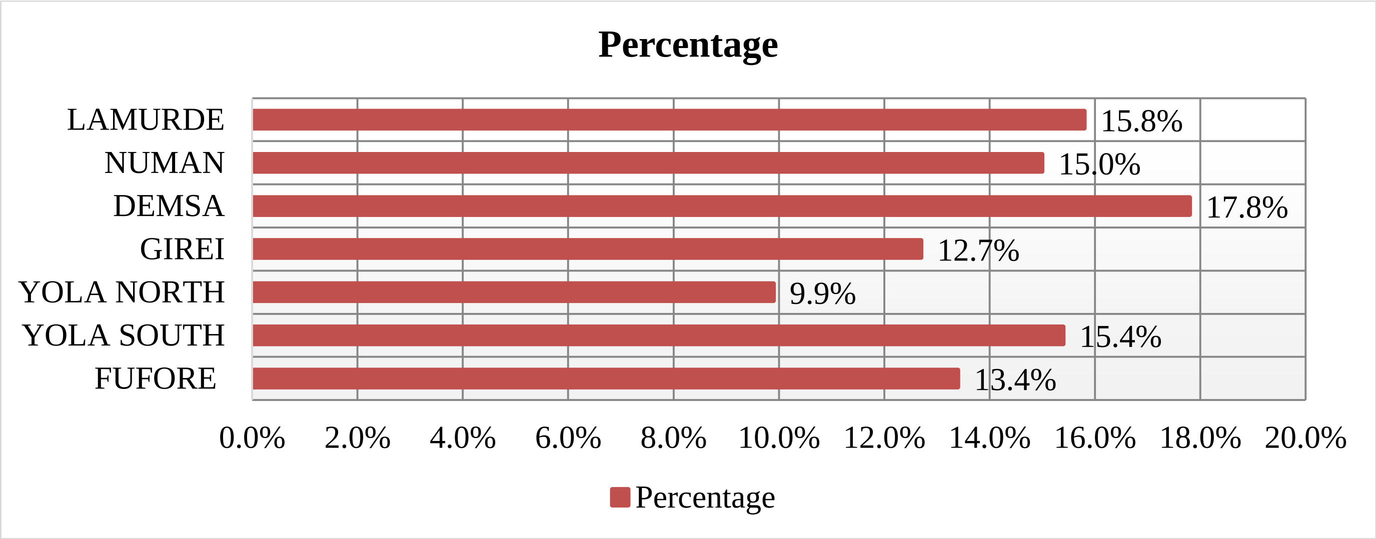


Figure 12: Variation in social effects of grazing amidst the communities

The information in figure 12 above, indicate clearly that there is a great variation in the social consequences of grazing amidst the communities along the riparian of river Benue. The communities along the lower section of the riparian has more severe weight of the social effects compares to those in the upper section of the riparian. Demsa is mostly affected with 17.8 percent of asperity of all the challenges, followed by Lamurde area as 15.8 percent crabbiness of the effects and Numan areas with 15 percent tartness to the prevalence respectively. In the upper section, Yola South is most affected socially as mentioned by 15 percent sourness of the challenges, Fufore 13.4 percent astringency of the effect on community and Girei with 12.7 percent experiences of challenges bitterness to the actuality of effects and Yola North with 9.9 percent less experiences of challenges severity.

The intensity of grazing along the lower section being a flood plain area with far-reaching pasture variability, is a factor that attracts many herds men with large number of herds. The influx of large numbers of herds leads to a competition amidst the herds men themselves and the local community dwellers on the available riparian resources. The conflicts amidst them mainly occurs in the dry season when plants and other resources are scarce, and towards beginning of the wet season when crops are still on farm.

During such periods, the grazing livestock affects the farm and non-farm economic activities of the local community. Such a situation leads to a clash intensifying pockets of insecurity which is principally responsible for the decline in the social facilities in the area. The armed herds men sometimes destroy life and social facilities of people in the local communities along the river Benue.

In a related development, the degraded vegetation exposes the community to floods during wet season which contaminate the environmental creating potential for communicable diseases. It also destroyed their social and economic functions and this is more severe in rural communities of Bworang, Gerang, Gwewana and Dem. Such areas usually have their dwellings and livelihoods activities, social facilities, health centers, social viewing centers, clubs, sports and cultural /spiritual activities affected along the river riparian. In most cases, those facilities are usually destroyed by the armed herds men who frequently attack the communities along the riparian over riparian resources control. The lower section of the riparian where social effects of grazing are more severe is also an area liable to floods in the wet season and wild fire in the dry season, which limits their social gathering and other social benefits.

The communities along the upper section of the riparian have fewer percentages of grazing effects compared to the communities in the lower section. The social effects are mostly felt by the people residing on the fringes of the riparian in the rural area of Girei, Yola South and Fufore. Social effects of grazing in the upper section of the riparian are not severe compared to the lower section. Most of the people engaged in the social actives in the riparian dwell in the citified areas.

The riparian in the upper section specifically in Fufore are predominantly woody, with trees and shrubs that are not much palatable in addition to the rocky nature of the gradient which do not encourage grazing intensity.

Again, the riparian along river Benue in Yola South, Yola North and Girei are mostly preoccupied by frontiers development, being citified areas. These areas have much of the social amenities, security, which creates the variation in the effects amidst the communities along the riparian. But Girei and Fufore have vast rural settlements like Labodo, Dundu, Boroje and Dasin along the river with their entire social activities concentrated on the riparian sites.

However, communities along the riparian are under the stress of grazing effects due to a decline in socio- economic activities leads livelihood run-down. But the lower section of the riparian is considered the worst depressed by grazing effect and more devastating on both social and economic activities of the communities.

However, it is evident that improper grazing result in adverse effects on the physical and biological components of riparian resources and can reduce the resources benefits or the value of riparian resources. That is the contribution of riparian products to the rural social livelihood, health security and quality of life was well acknowledged and beneficiary unlike the situation after grazing.

As there are some issues which the respondents could not express on the questionnaire, the study had a face to face interview with the local population along the riparian area of river Benue for opinions expression.

> *"……before grazing drifted into riparian, the river areas have good quality water, plants and fish, but now these resources are not there……"* (Fisherman, age 45).
>
> *"………the environment before this problem of grazing was nice but now everywhere, hot and dry, wildlife animals, good water and plants all are degraded …….."* (Herdsman, age 56).
>
> *"………. before this time of riparian grazing river plants were good, people were living in peace, but since grazing drifted these things are history. …………."* (Woman, age 39).

"………. the presence of grazing along the river has created many problems, no good fruits, water and other functions as usual, only pollutants and diseases………" (Old man, age 78).

"………. we use the river for transporting people and goods before, but now grazing had destroyed the river and other resources……." (Community Association Member, age 59).

"…………we were living peacefully before this time of grazing, but now conflicts the herds men are killing with guns' social activities down………." (Elderly woman, age72).

Convincingly from the responses, it can be deduced that grazing along riparian of river Benue has affected the social life of the riparian communities.

This is because, riparian resources and other physical social and health facilities have been destroyed by floods, drought and soil erosion as a result of vegetation degradation due to uncontrolled intensive grazing. Grazing activities also affect social life of the communities where security in the area has been compromised through a skew attitude by the Government to deal with herdsmen.

4. 4.3 Economic effect of grazing on the communities along the riparian area

The study findings indicate that grazing has economic effects on the communities along the riparian of river Benue. Most common and severe economic effects that are upsetting the communities along the riparian of River Benue include inter Lia; decrease in wild foods (fruits/vegetable) and medicinal plants, destruction of habitat and Fishery productivity, and decrease in the navigability of riparian water for transportation and other functions, (Table 12).

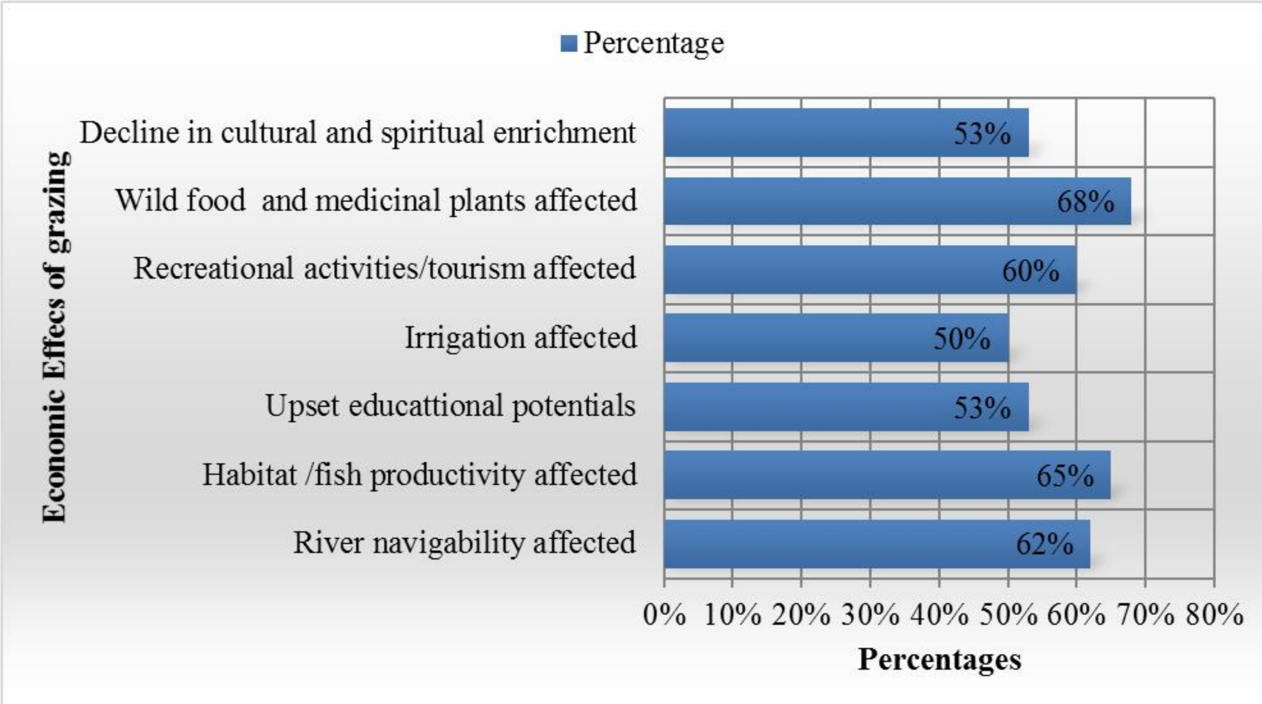


Figure 13: Economic effects of grazing on communities along riparian areas

The study findings as in Figure 13 indicate that grazing has economic backlash on the communities along the riparian area. The economic effects are expressed in the negative terms which grazing contributes towards economic decline in benefits derived by the communities along the riparian areas.

Such economic problems as in figure 13 includes destruction of habitat and decrease in fish productivity 65 percent of the respondents acknowledged it, decrease in wild foods (e.g. *Hack berry, Anacardium occidentale*) and medicinal plants *(Leonurus sibiricus, lactuca salinga*) prevalence was mentioned by 68 percent of the respondents; decrease in the navigability level of riparian water (boating business) 62 percent of the respondents advanced it ; destruction or upsetting of riparian educational potential 53 percent of the respondents affirmed. Others which are not compromising are; destruction of recreational activities 60 percent of the respondents mentioned; decline in irrigation 50 percent of the respondents consented and destruction of spiritual and cultural enrichment 53 percent of the respondents advanced the challenge.

Reasonable size of the respondents concurred with the prevalence, and discomforts caused by each of the challenges to the economy of the community, state and by extension the Nation. Decline in the habitat availability and decrease in fishery productivity are due to degradation of vegetation cover of river bank which have been widened by continue hoofing. As a result of grazing there is a drop in the water level and an increase in the stream temperature, as well the tannins hence fishing activates have slowed down due to fish migration and low fishery productivity.

There is a poor navigability along the river Benue due to sediment deposition, widening of stream channel and decrease in water volume downstream due to grazing. This have affected businesses associated with water (e.g. boating, swimming) amidst the communities. Decrease in wild foods, fruits and vegetable such as *Robusta coffee, Anacardium occidentale,* medicinal plants, (of the Lettuce genus), tourism, and recreational potential were as a result of decrease in plant growth and composition. Decrease in native species diversity and species extinction along the riparian have affected the value of trees like *Parkia spp* and *Hevea biasilliensis* (Rubber plants) in the area.

4.4.4 Variation in economic effects of grazing amidst the communities

According to the research findings there is a variation in the economics effects of grazing on the communities along the riparian area, that is, the economic effects of grazing are more severe on others than some of the communities in the upper and lower section of the riparian (Figure,13).

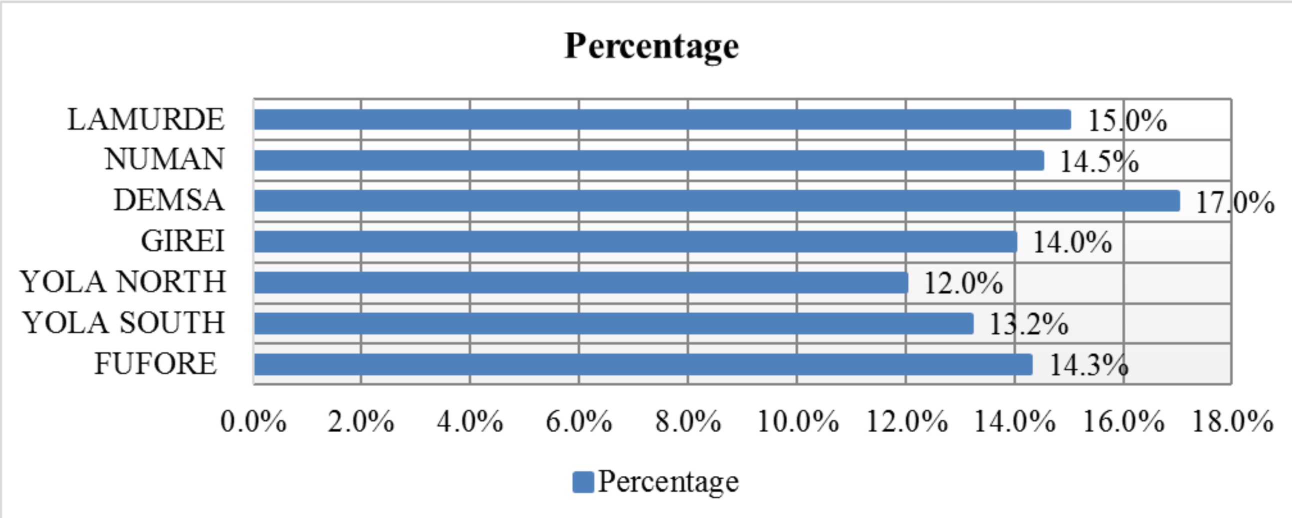


Figure 14: Variation in economic effects of grazing amidst the communities

According to the analyzed result in Figure 14 there is a great difference in the economic consequences of intensive grazing amidst the communities along river Benue. The communities in the lower section of the riparian are more affected than those in the upper section; Demsa is most affected 17 percent astringency; followed by Lamurde 15 percent asperity and Numan 14.5 percent bitter experience. In the upper part or section of the riparian Girei is most affected with 14 percent severity, while Yola North 12 percent sourness, Yola South 13.2 percent asperity and Fufore within the range of 14.3 percent of the challenges astringency respectively.

Large numbers of livestock grazing are evident in the lower section of the river being a larger and richer flood plain (grass land), where there is variability of sufficient succulent species of native palatable pasture. It is the largest source of pastures for grazing herds in the dry season period. Coupled with that, most of the people dwelling in the rural areas along the river have most of their basic economic activities barely dependent on the riparian natural resources.

Fishing, dry season farming (irrigation), hunting, herbal medicine practicing, sand selling, boating business, mat making (weaved materials) and wild fruits/vegetable selling are some of their livelihood patterns. Principally, the river is the only source of water, and aquatic foods for the communities and where most of their business transactions are done along river banks.

The economic effects of grazing are less pronounced among the communities in the upper section of the riparian. For instance, the percentages in the upper section are comparatively low 14 percent as in (Figure 13). Therefore, the consequences are relatively low among the communities on the fringe of the towns along the riparian. This is evidenced among the communities along the riparian in the upper section such as Yola north, where most are civil servants and business men and women, who are less dependent on the riparian natural resources as their basic means of livelihood. This is because the riparian bank of Yola North and Yola South are peril-urban.

But Girei community seem to be different from other communities in the upper section because of her closeness with Demsa along the vast flood plains of Lobondo and Wurobwukke, where most of the people share similar economic activities. These activities include irrigation, fishing and fruit gathering. The pre-urban nature of Yola north and Yola south provides more employment and business opportunities for the communities. Only very few people along the river are dependent on the riparian resources for their livelihoods as most of them are unskilled migrants from the rural. Again, even the herds men with large number of herds hardly graze longer within the fringe of the citified areas. Nevertheless, economic activities like swimming, boating, transportation, fishing festival, and other recreational potential are also affected in the upper section through sedimentation and weeds.

The study findings as well indicated that grazing has socio- economic effects on the communities including decrease in wild foods like wild fruits such as *hackberry* and *cashew apple* (Plate.10) produced naturally by cashew tree (*Anacardium occidentale*). Nigerian leafy vegetables such as *Wild Lettuce* locally known as (**Efo** Yarin –Yoruba) and *Crassocephalum rubens* locally known as the (*Yoruban* bologi Ebolo). Sold after the arrival of the new yam, deep into the rainy season such are traditional medicinal plants that form some considerable economic assets of most human communities.

Some of these considerable plants include; *Vernonia amygdalina* the Edo call it oriwo*;* Hausa, *chusar doki (a horse**tonic** food containing the **leaves**), fatefate/mayemaye (a food prepared from the **leaves**);* Ibibio atidot; Igbo, ***onugbu****;* Tiv, ityuna; and Yoruba, ***ewuro***. (Plate14). *Moringa oleifera, Garcinia kola, and Anacardium occidentale*., destruction of habitat and the reduction Fishery activities and productivity (Plate 10), and decrease in the navigability of riparian water for transportation and other functions

Sincerely, as felt, riparian supply variety of non-timber and bio-fuel products of significant to the riparian community livelihood economy. These products in addition to the wild foods, include handicrafts made from riparian floristic species, largely by sailors and children which support significantly source of household income.

Plate 10: Anacardium occidentale

Plate 10 One the economic trees along the riparian *(Anacardium occidentale)* the tree is not native of the riparian plant life forms but, one of the several valuable trees introduced by the communities to the riparian environment due to its economic and medicinal values. It produces fruits late wet season around October when this picture was spant.

Plate 11:Hackberries

Plate 11 Hackberry one of the native tree found commonly on river terraces and flood plain in Lamurde, Demsa Dong in the lower riparian area and Vunoklong, jobubloyo, and Damare along the upper section of the Benue river. One of the useful economic plant used as fruits and juice by the children herding along the riparian, also picked by people for sale to earn money most especially children of school age. Usually produces fruits twice in a year at the mid dry season and ending of the wet season.

Plate 12: Wild Lettuce (Efo Yarin)

Plate 12 Wild lettuce this specie is many in the (lettuce genus) family such as; *Lactuca virosa, Lactuca salinga and Leonurus sibiricus* they are native of the riparian use as food and medicinal herbs for centuries in the area. This plant start t the beginning of wet season up till the end of the season.

Some of these lettuce species (*e.g. Lactuca virosa and Lactuca salinga*) are very palatable for human and grazing animals. There are found along the riparian but with variation in species kind influenced by soil type and nutrients, the palatable species are more in the non-grazed site of the study area.

Plate 13: : Crassocephalum rubens (the Yoruban bologi Ebolo)

Plate 13, *Crassocephalum rubens* is one of the *Crassocephalum genus* family members include *rag leaf*, *Thickhead* and he *Bologi*. There are several in the vegetal family which are edible and consumed by many tribes across Africa. There are native of the riparian species some like *Crassocephalum crepidiodes* and *Mannii* are shrubs which are ornamental and toxic. Ther are used as medicinal herbals, *Crassocephalu genus* is one of the most economic species in life forms of herbs and shrubs. Every community value it for foods and medicine, both animal like it much and can be source of conflicts amidst grazing herds and human mostly grown in the beginning of the rain season and some few towards the end of the wet around November when this picture was snaped.

Plate 14: Vernonia amygdalina

Plate 14 is *Vernonia amygdalina* a native plant of the riparian species, a member of the *Asteraceae* family a small shrub of different class. Grows mostly on sandy soil of riparian stream bank in the beginning of wet season and last to the mid and late time of the around October. It looks like the drumstick (*Moringa oleifera*) and is one of the most economic plants in the riparian used for vegetable soup and medicinal herbs like the *Moringa oleifera*.

It is mostly found in the non-grazed areas as it is one of the palatable species sensitive to grazing, it is found in a scattered residual patches along the grazed site of the riparian.

Plate 15: Fishing site on River Benue at Wurobukke

Plate 15 This is one of the fishing sites along the river Benue, this specific one was taken in themed time of the wet season in Wurobukke in the upper section of the riparian area.

Fishing sites are areas of economic activities along the riparian where most youth and adults earn their livelihood. Many of these fishing sites in the lower and upper sections where varieties of aquatic foods were obtained for consumption have been degraded. As a result, it affected supply of fish for domestic and commercial purposes.

The research hypothesis which states that “grazing has no effects on the socio-economic activities of the communities along river Benue has been tested using “a Pearson correlation analysis.

Table 9: Pearson correlation analysis of socio-economic effects of grazing on the communities' livelihoods

		Socio-economic effects of grazing	People's Overall livelihood
Socio-economic effects of grazing	Pearson Correlation	1	.852*
	Sig. (2-tailed)		.000
	N	230	230
Deterioration in People's livelihood	Pearson Correlation	.852*	1
	Sig. (2-tailed)	.000	
	N	230	230

According to the analyzed result of Pearson correlation (Table 10), the findings revealed that there exists a strong negative relationship at ($r=0.852^*$, $p<0.05$). That grazing has negative implications on the sustainability of socio-economic activities among the communities along river Benue.

The result further impliesthat the relationship was not merely by chance but reasonably a true representation of their true interplay phenomenon. This signifies that the various socio economic effects of grazing like poor navigability, fishing, poor quality of life, insecurity and vegetables harvesting have a profound effect on the overall livelihood of the riparian communities. Consequently, the result indicates that, as grazing increases in the riparian, there is more deterioration of the socio-economic activities and livelihoods of the communities along the riparian area.

The Pearson correlation coefficient result is sufficient and significant for rejecting the null hypothesis at P-value ($P = 0.00$) which is significantly lower than the $\alpha = 0.05$ level of significance. Pearson correlation states that, when the P-value is less than the level of significance, then the null hypothesis is rejected. Therefore, the research null hypothesis which stated "livestock grazing has no effects on socio-economic activities of the communities along the riparian" is rejected and the alternative hypothesis that; (there is a significant inverse or negative correlation between grazing and socio-economic livelihoods of the communities is accepted at ($r=0.852$, $p< 0.05$).

The study had a face to face interview with the local population living along the riparian area of river Benue, to solicit for some hidden opinions the questionnaire could not have taken care of, as cited below;

> *"…….in 70s and 80s our fishing business was booming, but since grazing drifted in 90s things changed, productivity declined……."* (Fisherman, 68)
>
> *"…………. we used to enjoy many cultural and religion functions but now the vegetation destroyed, gods and shrines disappeared………"* (Elderly man, age 78).
>
> *"……………. all the medicinal plants available in those days are no longer there, grazing had destroyed most…….".* (Local community woman, age 61).
>
> *"………………… in 80s many functions like fishing festival, swimming competitions were good, we earn moneys but those functions collapsed …………"* (Local trader (woman), age 57).
>
> *"………………. those good tress and grasses along the river habitat to birds and animals are destroyed by overgrazing, food source gone………"* (Hunter (male), age 54).
>
> *"……………. our parent use to tell us stories on the river, traditional values, now the resources are destroyed by grazing, traditional education gone………"* (Young man, age 34).
>
> *"…………our parents sell bush fruits, sugarcane etc. from the riverine, but now the economic activities are collapsed………."* (Farmer (male), age 42).

The voices signified that grazing has greatly affected the economic life of the local community dwelling along the riparian area of river Benue. Their non-farming economic activities such as hunting, fishing, cultural festivals, religious facilities and educational potentials have been damaged as a result of uncontrolled intensive grazing. Furthermore, ecotourism has also been affected and therefore, affecting revenue generation or earnings from tourists by the communities, state and the federal government.

4.5 Effective management strategies for vegetation conservation and sustainability in the riparian

The research findings, reveals that a number of strategies have been adopted to control grazing activities in the riparian. These include inter Lia; fencing, alternative watering points away from riparian and the use of shade and shelter upland are the most the prevalence, adoptability, effective and efficiency management strategies for riparian conservation in the area (Fgure,12).

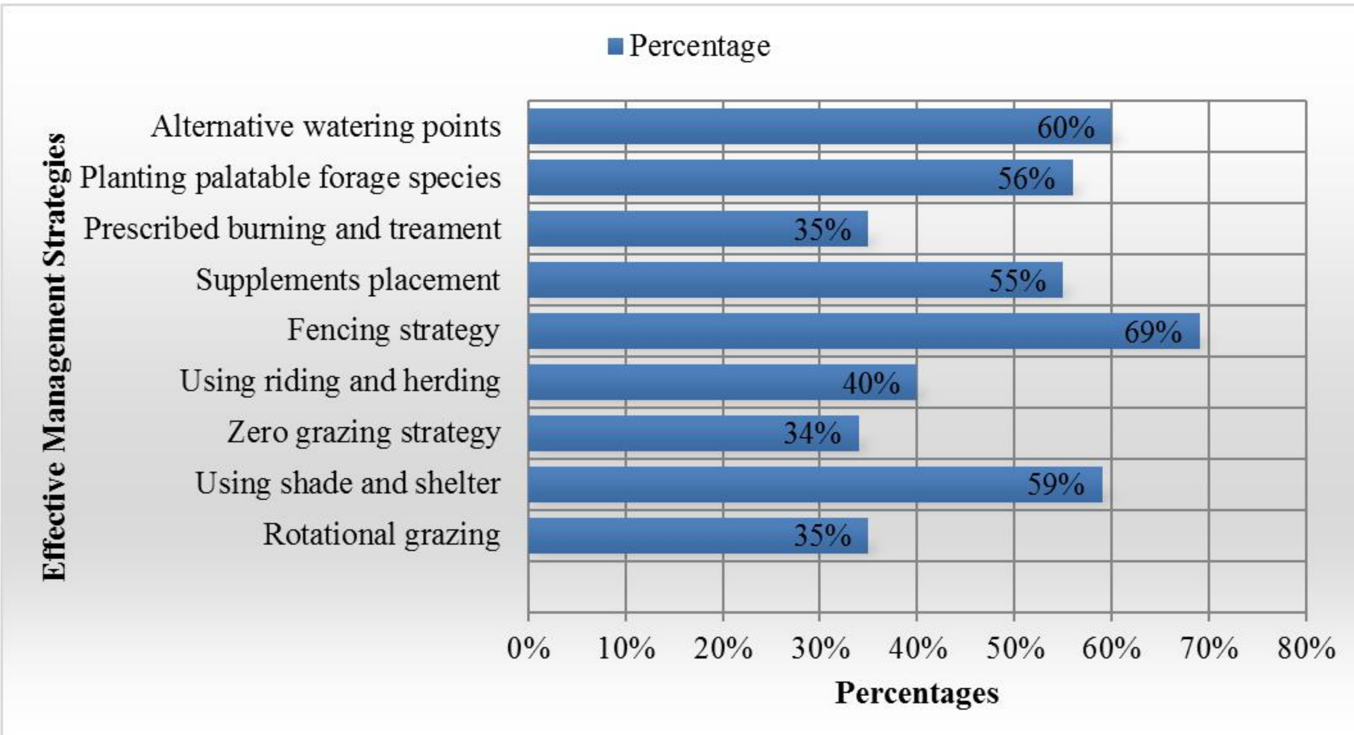


Figure 15: Effective management strategies for conservation and sustainability of riparian

According to the study findings, the analyzed result in (Figure 15) are the common and most used managing strategies in the area. The percentage against each strategy reflect the strength of its prevalence, adoptability, effectiveness and efficiency as a strategy for riparian conservation and sustainability in the area. Fencing strategy with 69 percent; Alternative Watering points upland 60 percent provision of Shade and Shelter strategy upland 59 percent and supplements placement upland 55 per cent.

Other strategies which are limited in application are; planting forage upland 56 percent; the use of riding and herding 40 percent; rotational grazing strategy 35 percent zero grazing strategy 34 percent and prescribed burning and treatment 35percent are the minimal preferred strategies for adoption.

These strategies in the upper rank were found to be adopted by most people in the community but using local materials like wood poles for fencing. This was affirmed by a sizeable section of the respondents who revealed that most people along the riparian area practiced these strategies during the dry season. During dry season period, temporal shade and shelter as well as alternative watering points are being provided by the agro-pastoralists in the area, to keep livestock away from the riparian.

The study also revealed that some of the strategies in terms of prevalence and adoptability like rotational grazing management strategy; prescribed burning and treatment strategy and Zero grazing 35 percent. These strategies are identified as new management strategies that are not commonly found in the area. The limitedness in adaptation and application of these strategies could be probably associated with the expensiveness of such strategies, coupled with lager numbers of livestock's, scarcity of pasture land and land tenure system in the area.

The most commonly adopted and practiced management strategies in the Nigerian setting revealed by the study include but not limited to: fencing strategy, alternative watering point strategy. Others are: shade and shelter grazing strategy, supplement placement (salt, hay, grain, molasses) in upland areas away from riparian areas, and planting palatable forage species in the upland. All these strategies have been cited as effective which attract livestock away from riparian areas.

The research had a face to face interview with some respondent's including officials of River Basin Development Authority (RBDA) (4 officials), State Environment Management Agency (SEMA) (3 officials),

> *"…………. there are policies regulating cattle grazing along the river or stream bank riparian, government should re-enforced those policies………."* (RBDA official).

> *"…………. I think it is better when government stopped people from grazing in the riparian, and should encourage the zero grazing management strategy to conserve vital floristic resources……….".* (SEMA official).

"…………. provision of water and hay for the cattle up land should be enforced by policy among the grazers to save the river riparian vegetation and other resources………….." (SEMA official).

"……………cattle are too much, number and distribution should be controlled by the authority to avoid wasting our river resources……….". (RBDA official).

"…………………in those many years of our grandparents there were common areas reserved for grazing. Those herds' men or cattle owners are rich they should buy lands for grazing……………." (SEMA official).

"…………government should educate people on the importance of such resources to our life, and the need not to graze in such areas………" (RBDA official).

"…………. people should cultivate hay in the upland and store them to feed their cattle.........." (RBDA official).

These responses specified the most effective management strategies for controlling grazing along riparian area of river Benue; these include law enforcement on the side of the government, environmental conservation awareness, grazing in upland area, adopting zero grazing and cultivation of hay in the upland areas.

CHAPTER FIVE

DISCUSSIONS AND RECOMMENDATIONS

5.0 Discussions

5.1. Grazing effects on riparian vegetation along river Benue

The study results reveal that grazing was found to negatively affect plant communities along the riparian of river Benue. The study observed larger density and richness of plant life-form species in ungrazed area in the upper and lower section of the riparian compared to the grazed areas in the sections. The ungrazed areas in the sections were distinguished by old growth stands of plants life-form of tree, shrub, forb, tussock grass and cryptogams/herbaceous. On the contrast, the ungrazed areas were deficient in diversity of some plant life-form like the Cryptogams and grass. The low diversity was attributed to the dominant tree stands that highjack the largest allotment of sunlight and nutrients. Indeed, numerous research had recorded that, an inconsiderable plant species privileged by absences of grazing could go up against small and juvenile plants (Brinson. *et al.*, 2013; and Dobson, 2013).

On the other hand, lesser density and richness of plant life-form were recorded in the grazed areas of both sections of the riparian. But, a great decrease in the diversity of the palatable native species amidst the plant life-form were recorded in the grazed areas along the riparian. Similarly, a diversity of native unpalatable (e.g. *Phonix dactylifera* and *Cenhrus cilliaris*) and invasive species (e.g. *Learsia hexandra*) were recorded. This indicate that intensification of grazing in riparian lead to reduction in the palatable native species and promoting the dominance of the native unpalatable and invasive species (Glinski, 2011). Livestock grazing in the riparian had affected the competition ability of the native species among others by way of discriminate foraging as well trampling.

Subsequently, as a result of grazing intensity, a decrease in species growth, decline in heterogeneity, diebark, productivity and diversity in unpalatable were recorded as effects (Figure 6 and Table 6). This finding is in line with the mechanisms that veiled the central distraction assumption of complex interplay amidst needs drivers and resources pressures responses (EEA,2005). Some plant species along the riparian were found to be intolerant to grazing (e.g. P africana) which was found in the ungrazed area but missing in the grazed site.

However, the species that was found sensitive to grazing and only available in the ungrazed area is *Cassipourea malosona*. Therefore, it can be richly argued that livestock grazing greatly affects plant species density, diversity and richness of the life- form on grazed area along the riparian. This is because the evidence of lesser woody species, palatable tussock grass and shrub in the grazed area indicate effect of grazing on the riparian vegetation of river Benue in Adamawa.

In affirmation to the above findings, a study by Adefioye (2013) revealed that, variation in the grazing effects amidst the riparian sections were due to factors like; the vegetation type which determined plant species availability and variability. Riparian gradients and width was found to be influential also on the vegetation viability of the section as it determines the habitat size and stream bank size. Large size of herds grazing on the riparian enhance overgrazing. Adefioye (2013) further observed that herds size was a strong facilitating factor in grazing effects on the plant community. Due to the undulating nature of riparian landscape around the Gotel hill in the upper course, forest vegetation dominated by *Banbacaceae* and *Vetbanceae* families of trees were predominant.

The vegetation of such kind favoured the availability and variability of edible bark trees and shrub, though grasses were mostly unpalatable to the grazing livestock. Climbers species like *Caesalpiniaceae* (*Dialup guineense*) and *Apocynaceae* are some of resilient species whose presence have often limited the grazing habits of livestock. Lower riparian has a savanna grassland vegetation which expedited wide riparian width with numerous perennial and annual plant species. Most of the predominant grass include; (e.g. *Cyperus papyous*) and shrub (*Anglocorlyx nilotica*) with several patches of Raphia palm (Phonix *dactylifera*). The lower riparian became attractive to large herds grazing due to presence of more palatable native grass and shrub of the grassland vegetation, in addition to the availability of water and shades. This finding agrees with that of Sherman. *et al*., (2013) who found that livestock preferred foraging, drinking and lounging on the grassland riparian especially in the dry season.

In addition to the above, the upper section of the riparian, grazing processes like defoliation and browsing were found to be more active on the plant species while uprooting, defoliation, and trampling were found to be more active and severe on the plant species in the lower section (grassland).

The selective foraging behaviors of the local breeds was also found to be a contributing factor to the much damage done on the lower section. This is because most of the local breeds dislike grazing on the undulating hills especially, the Gotel hill and its surrounding.

This finding consented with Chaney. *et al*., (2010) and Fleischner, (2014), that livestock prefer grazing in the water shade stream channel to hills because of difficulties in going up the slope under gravity influence and sharpness of the riparian stream bank.

Despite the fact that grazing seems to be more severe in the lower section, the study found that plant species sensitive to grazing (e, g *Prunus africana* and *Carissa spinarum*) were severely affected in both upper and lower riparian buffers. This was significant on the density and diversity of riparian vegetation, enhancing decrease in the ecological functions. It was found by the study that, livestock grazing had damaged the riparian vegetation along river Benue. However, it should be noted that, the vegetation conditions can be kept good and stable with efficient ecological services as riparian. Therefore, the rights of use of "common land" in Nigeria which were and still been unregulated and traditional grazing practices should be re-examined and other areas relatively from human activities.

An extensive literature search did not locate peer-reviewed, empirical papers reporting a positive impact of grazing on riparian areas when those areas were compared to non-grazed sites, but some studies reported no statistical significant effects due to riparian grazing (Buckhouse and Gifford 2010; Samson. *et al.*, 2012). The authors of these papers usually explain this absence of statistically significant impacts due to stochastic or design problems associated with their research, rather than to grazing having no effect on vegetation, fish, and soil. They described such problems as: i) high variability among treatment plots, which masked treatment effects (Sarr. *et al*., 2009); ii) insufficient recovery periods after protection from grazing (Sedgwick and Knopf, 2012, Sarr. *et al.*, 2009); iii) heavy browsing and grazing by native herbivores (or trespassing cattle) on supposedly non-grazed sites plots (Clary. *et al.*, 2011); iv) unplanned disturbances such as flooding (Sedgwick and Knopf, 2012, Clary. *et al.*, 2011); iv) the unknown effects of a prior history of heavy grazing, which may have permanently altered stream vegetation function and prevented recovery of control plots (Tiedemann and Higgins, 2013). The absence of significant effects may also be due to investigators setting statistical significance at arbitrarily low levels (i.e. at $P<0.05$).

Marlow (2015), argues that many studies, such as those with few treatment replications or high spatial variability, have low power (i.e. poor ability) to detect environmental change.

Because of the possibility, that already depleted fish stocks could become endangered or important habitats become permanently altered, he argues that higher probability levels (i.e., P<0.1) are appropriate to test significance of hypotheses.

Authors have also attributed non-significant results to supplemental feeding of livestock (Sedgwick and Knopf, 2012), which resulted in lower forage consumption levels than originally prescribed, and to high recreational fishing, which obscured the negative effects of vegetation degeneration by grazing on fish population and other aquatic life. Therefore, it can be argued that severe vegetation damage such as loss of native plant species or extinction in palatable and medicinal plants cannot be reversed in just a few years of protection. This implies that stream vegetation can recover slowly or only over geological time scales.

In agreement to the findings of this study, the studies by Chaney. *et al.*, (2010); Platts, (2011), Elmore and Kauffman (2011); McIntosh. *et al.,* (2013); Fleischner, (2014); and Oholmart, (2011), all found that livestock grazing in riparian areas affect watershed plant community attributes, stream channel morphology, wildlife, fish and other vegetation-dependent organisms and water quality at both local and large scales through damaging of riparian vegetation.

In addition, Clary. *et al.*, (2011) also found that stock foraging strongly influences the stability and shape of the stream bank vegetation through its influence on ground cover species like cryptogam rates. This is because grazing can detrimentally influence the plant regeneration. They can both accelerate stream bank vegetation degradation, decrease stream bank buffers during flood events, largely due to excessive removal of vegetative ground cover. The consequence of both increase extinction and decreased diversity along the stream bank, can influence water temperature through decrease overhang plants. It can also increase in-channel deposition of sediments due to vegetation heterogeneity fragmentation. Both results can greatly degrade aquatic habitats. Moreover, transport of soils and fine organic materials from the site decreases the fertility of the soils and can reduce capacity to support vegetation of any type.

Furthermore, grazing alters the structure and function of riparian plant communities in several ways. Grazing, browsing, defoliation, and trampling can change the quantity and composition of plant species, as well as the quantity and depth of plant roots. Livestock can also change the vertical structure and distribution of vegetation.

Moreover, selective removal, and/or trampling damage, can alter the age structure of plant communities, this concurred with the observation of Clary, (2010).

Therefore, controlling frequency of grazing is an important tool for minimizing the effect of defoliation. Proper frequency of grazing allows for a sufficient rest period for plants to recover from the defoliation event and prevent 'overgrazing'. If grazing is too frequent, overgrazing occurs and vigor and abundance of grazed plants can be reduced. If overgrazing persists, desirable forage species could be replaced by weedy annuals that have little or no forage value and the functioning of the plant community may be altered.

In conclusion, grazing in riparian area can potentially influence it in various ways: defoliation of plants; trampling of plants; trampling and compaction of the soil; redistribution of nutrients through depositing urine and feces in areas away from grazing sites, including water bodies; and redistribution of plants by transporting seed and other propagules from one location to another.

The null hypothesis' states, that livestock grazing is not associated with the degradation of riparian vegetation structure. From the analysis the variations in the mean of vegetation structure in the non-grazed and grazed sites in (Table 6), unveiled a significant difference with a relatively average Eigenvalue of 1.762 and large cumulative value of 46. 762 loaded on factor 1 and 2 holding grazing accountable. It also shows difference at P value < 0.05 which is greater than the paired t-test values in Table 6 which affirmed that grazing is strongly associated with riparian vegetation degradation. this is being determine by the difference in plant density between ungrazed and grazed areas. Therefore, the null hypothesis is rejected in favor of the alternative hypotheses. As such, differences in the vegetation structure is not by chance but rather due to grazing. And of which the little or minimal disturbance in the vegetation of the non-graded sites was due to other factors like bush fire, drought, dissertation, bio- fuel harvest and others. Rather than grazing associated processes in the riparian.

5.2. Socio- economic effects of grazing along the riparian area

The social and economic consequences of grazing on the livelihood of the riparian community was determine through respondents' opinion, which were analyzed using descriptive techniques simultaneously with the correlation techniques. The descriptive analysis was on both social and economic effects.

5.2.1 Socioeconomic effects of grazing along the riparian area

The study found that the social effects commonly cited by the respondents included; prevalence of insecurity, increased risks of contracting communicable diseases, destruction of water source for drinking. Others are increased poor health quality due to flood and open defecation by herdsmen, and limited access to safe / clean drinking water. In other words, by degrading water supplies and reducing the health of riparian habitat, livestock fragment landscape-level connections. They also damage the connection between natural and human communities, since degraded streams and plant community reduce the potential for recreational, fishing, swimming and boating in the area. Degrade riparian vegetation influence precipitation amount, provide less water for reservoirs, as well damage coastal sporting and fishing festival are some of the social implications of grazing, being experience by the communities (Linus, *et al.*, 2014).

Some of the social implications with less prevalence in the communities as affirmed by the respondents are: poor sanitation, and poor quality market, school and sports infrastructures due to the insecurity and destructions of social amenities. Effects of intensive grazing in riparian is not only on the plant community resources, but it creates conflicts between the communities and herdsmen which generate huge social implications (Meagher and Yunusa, 2012; Linus. *et al.*, 2014). There is a great variation in the social effects across the communities along the river Benue, communities along the lower section of riparian are mostly faced with severe social problem. The effect is more disastrous in Demsa which has the highest percentage, followed by Numan and Lamurde respectively. Categorically, settlements are rural in these communities with most of their social livelihood activities rely heavily on the riparian along the river.

The study found that the most common economic effects biting livelihood of the communities, accepted by the respondents included among others; destruction of fish habitat and decrease in fish productivity and wild life which is another source of protein for the community.

Destruction of recreational potentials such like pools and ponds, boating and sand mining. Others are; decline in eco-tourism activities, destruction of medicinal plants and the decline in navigability of the river which affected transport business, practices of herbal medicine and even vegetable.

Livestock grazing can affect the riparian environment by changing and reducing vegetation or by actual elimination of riparian areas by channel widening, channel aggradation, or lowering of the water table through plant degradation (Macleod. *et al.*, 2014). Along the riparian the communities, the most apparent effects are on fish habitat due to vegetation degradation which reduces shade cover, and influx of food supply. Others are resultant increases in stream temperature, decline in wild fruits along stream, decrease of debris cover through plants degradation. The result complement the study of Armour. *et al.*, (2011), that stream-channel vegetation degradation has long been recognized as a major watershed-fisheries problem, not only to fisheries but it is even general to ecological services. The elimination of stream bank vegetation due to acute livestock grazing is a serious negative development to all vegetative dependent riparian components. In the grazed site of the riparian, stream banks eroded because livestock congregate along streams for shade, succulent riparian vegetation and drinking water. The collapse of overhanging banks due to livestock grazing is one of the principal factors contributing to the decline of native trout in the Western Australia (Jansen and Robertson, 2012).

Furthermore, the importance of riparian vegetation to the life support function begins in the aquatic communities of headwater streams and rivers. Studies have linked the importance of riparian plant cover to fish populations. McIntosh. *et al.*, (2013), for example, found that populations of brown trout (*Salmo trutta*) were reduced by 27 per cent when riparian vegetation was removed by grazing cattle.

Waterholes are often favoured locations for camping, picnicking, swimming and fishing. These values can be lessened by reduced fish populations, loss of aesthetic appeal, poorer water quality, increased weeds and reduced number of shady trees and native couch grass on riverbanks. The water quality of the water holes may also exceed Nigeria health guidelines for secondary contact (e.g., swimming), especially with regard to indicators such as faecal coliforms deposits by stocks which encourages predominance of algae invasive.

The descriptive simple percentages explanation of the respondents responds and the correlation statistical analysis were simultaneously used to determine the relationship, between grazing consequences and the degrading socio-economic activities on community livelihood. The coefficient results of person correlation indicate that there was association between the grazing socio-economic effect and livelihood of the communities along the river. The high and significant Pearson correlation coefficient provides sufficient evidence for the research null hypothesis rejection. The P-value ($P = 0.00$) was significantly lower than the $\alpha = 0.05$ significance level Table 8.

Therefore, the high and significant Pearson correlation coefficient analysis provides sufficient evidence for the rejection of the Null hypothesis, which states that there is no socio- economic effect of grazing in the riparian along river Benue. As the p- value calculated at, (P=0.000) is significantly lower than (r=0.852) at(α=0.05) significance level, Pearson correlation state that, when P-value calculated is less than critical level of significance, Ho, should be rejected. Conclusively, the P-value (0.000) is less than α=0.05, therefore, Null hypothesis is rejected in favor of the alternative.

5.3. Management strategies for conservation and sustainability of the riparian area

Of all the effective management strategies identified from the reviewed literatures which are widely used across the globe, for riparian natural resources conservation and sustainable very few are obtainable in Nigeria. Those identified in the study are but with variation in their prevalence, applicability and effectiveness are: fencing strategy; alternative watering point strategy; shade and shelter grazing strategy; and placing supplement upland e.g. salt, hay, grain, and molasses).Other are: planting of palatable forage upland, rotational grazing strategy, range riding and herding, incorporating different kinds of livestock, cross breeding), prescribed burning vegetation treatment and zero grazing strategy.

There is considerable debate on the most effective methods of grazing management, as the evidence is uncertain regarding the benefits of various strategies (Miners. *et al.*, 2012).

This may reflect the inclusive deficit of research on the issue but is more likely to reflect the diversity of conditions under which the various studies have been undertaken. That is, the appropriate regime will vary between different regions.

Fencing strategy

As environmental awareness increases in our society, the need to protect our natural environments against further deterioration and in some instances to undertake habitat restoration and conservation is increasing. One of the major tools for enhancing environmental condition of riparian zones in grazing areas is to exclude cattle (Sattler, 2012). The investigation unveiled that fencing is adopted as one of the strategies which enables control over stock access to the riparian. The prevalence and effectiveness of this approach is 25 per cent as affirmed by almost respondents and the most used strategy in the area, as most of the non-grazed parts of the riparian were fenced. It received a wide acceptance across the community probably it is the simplest, and cheapest practical approach. Study identified it as the most common means of achieving riparian sustainability, a management tool that achieved through local materials (Miners. *et al.*, 2012; Ganskopp, 2014).

The frequency and intensity of stock access to fenced riparian zones in the control non-grazed site has been insignificant therefore fencing was of critical importance. Access route of livestock across the grazed vary considerably between different communities along the riparian but, it is unfortunate that there are no management strategies that will enable the maintenance of flora productivity and profitability. Essentially restoring and even improving riparian environmental values in the area is cardinal which attracted the use of fencing. Livestock should be excluded completely from sensitive environment like riparian, and the common approach is fencing (Tiedman and Higgins 2013). The fenced non-grazed site has healthy vegetation compare the grazed site; the processes are important in stimulating seed release and germination in riparian communities and are opportunities for the riparian vegetation community to renew itself (Adefioye, 2012; Herbel and Nelson, 2014).Protecting of riparian environment from grazing were found to be significant in the area, as cattle were also found a more likely to avoid riparian areas during and shortly after the wet season as forage in the watercourses were fenced.

Riparian zones are often used by cattle as preferred resting and feeding locations and can thus be expected to be most affected from cattle and to be able to benefit most from the introduction of more pro-active management (egg riparian fencing). It is much more environmentally sound and cost-effective to protect areas now than to rehabilitate them when they become degraded.

Successful example of the use of riparian fencing in grazing areas is that of the Victoria River in the Northern Territory (Sattler, 2012).

Extensive fencing was undertaken along a 250km river frontage. The fencing is up to 1km from the river in places, in order to avoid erosion gully heads. Off-river watering points were also established. The fenced riparian zones utilized for relief grazing during times of need. Despite the initial costs, the fencing has been reported to be cost neutral due to savings from less bogged cattle, less time checking the river for stock, easier mustering and improved grass growth within the fenced zone.

Study found fence strategy to improve distribution of livestock by excluding or including of stock. In the area, fences around riparian areas in the non-grazed site were used to exclude livestock, essentially during periods when there is high potential for damage or when other suitable forage is available in the upland. On the other hand, a riparian fence can be used to include livestock when riparian areas are less susceptible to physical damage or when quality of upland forage has diminished late in the growing season, in other words, fencing, when properly located, well-constructed, and maintained, can be an effective tool for controlling distribution of livestock. This is because it facilitates management of riparian areas by either including or excluding livestock use, depending on management objectives (Brinson. *et al.*, 2013 and Heady and Child,2014). Sometimes exclusion fencing may be the most practical approach for initiating rapid riparian recovery or improving highly sensitive areas. It can also be a temporary measure for initiating recovery. The loss of forage from exclusion fencing may be inconsequential on streams in poor condition that lack vegetation.

Alternative watering point strategy

Alternative watering sites can be developed in upland locations for encouraging livestock to utilize vegetation away from riparian areas. The positive effects of this technique may include: better utilization of upland vegetation, decreased amount of time livestock spend in the riparian area, and better quality water developed away from riparian areas, especially if natural water bodies are prone to algae blooms, salinity, or nitrate accumulation.

Prevalence and effectiveness of this management strategy is not well known across the community, used by few individual. Approach is practice by agro-pastoralist with less number of cattle, reasonable number of the respondents approved the practice. It reduces livestock concentration in the riparian, improves water quality and plant vigor (Howery. *et al.*, 2011).

Therefore, water development in upland areas that lack water is often a key factor in reducing livestock concentrations in riparian areas. Ganskopp (2014), found that moving portable stock tanks or closing access to specific watering points within pastures is very effective at altering the distribution patterns of beef cattle on arid rangelands in Oregon. A south-central South Dakota rancher found that distributing water tanks throughout a large pasture and having the ability to turn the water on and off at each tank worked well to distribute livestock to various parts of the pasture and decreased the amount of interior fence needed in rough terrain.

Shade and shelter grazing strategy

Livestock are often attracted to riparian areas if riparian vegetation creates a favorable microclimate. For example, during dry season when temperatures are highest, riparian areas are often cooler than uplands (Channey and Platts,2010). To help decrease the time livestock spend in riparian areas, producers can erect shelters that provide shade and cover in upland environments. In the study area the prevalence and effectiveness of this stagey was affirmed and rated 15 per cent by good number of the people. This technique may be especially effective when combined with off-site water, salt, minerals, rubbing posts or oilers. This approach can have a profound influence on riparian plants regeneration and conservation when properly employed. In Yola North and Yola South, being citified areas, along the fringe riparian, a frontier, shade and sheltered of exotic plants are being intensively practiced by the Agro-pastoralists.

Using shade and shelter was effective on Wyoming nature conservation, which promotes long term conservation (Gripne, 2015), it was also found effective in fringe of some reserved frontier developed along the riparian.

Supplements placement in upland areas away from riparian areas

Strategically placing salt, grain, hay, or molasses in uplands may help improve livestock distribution by luring them away from riparian areas, Bailey and Welling, (2011).

Since livestock typically move from water to feeding areas and then to salt or mineral sources, it is not necessary to place these supplements near water. Thus, desirable areas for locating feed supplements include ridges, uplands and other areas easily accessed by livestock that have sufficient forage to make increased livestock use advantageous. Such a stagey was acknowledged with fewer practice, although it is an effective measure which was rated 10 per cent prevalence and adoptability in use by the people who up held its significant.

Provenza (2013) found that placing salt, hay, grain, molasses, and other supplements only in upland areas away from riparian improves livestock distribution. However, he argues that supplements ought to be placed no closer than four hundred meters, and preferably five hundred meters or more (depending on the topography), from riparian areas and intermittent drainages, except where salt and supplements are used deliberately to restrict animal impacts. If supplements are placed near riparian areas, livestock use of vegetation and other riparian fodder may increase and needs to be closely monitored to avoid misuse.

Furthermore, some of the management strategies with fewer percentages of the participants are very much relevant in the management of riparian environment resources. The less percentages of the respondents below 50 per cent is not on their significance ineffectiveness, but rather on the adoptability and prevalence of these techniques in the area. Rotational grazing strategy, incorporating different kinds of livestock or cross-breeding, prescribed burning vegetation treatment and the zero grazing were not seen either been practiced in the research area. These are management strategies widely practice across the globe, due to the facts that they are effective and efficient in restoration and conservation of both upland and riparian environment (Sherman. *et al.*, 2015).

These approaches encourage a complete restriction of stock movement and foraging time. The absences of these methods on the research sites could be explain in association to their expensiveness. Rotational grazing requires a much reasonable land mass for adequate pasture and foraging plots. Zero grazing demands a ranch or reserved site or firm, although it allows plant community species to meet their growing period, seed development and saplings vigor development, it expensive for large her holders (Glimp and Swanson,2014; Sherman. *et al.*, 2015).

5.4 Conclusion

Livestock grazing effects in riparian vegetation is correlated predominantly to the following processes: plant defoliation, animal traffic and redistribution of nutrients and plant propagules. Otherwise, poor livestock management affects riparian vegetation and stream habitats by reducing riparian vegetation cover, altering its structural composition and distribution which diffusely alter soil properties. Such changes result in adverse effects on hydrologic functioning of the riparian area. There is enough documented evidence from literature that inappropriate or unrestrained grazing can adversely affect the riparian plant and wildlife communities as well as the physical environment and the general ecosystems services. Nevertheless, with appropriate evaluation, satisfactory planning and implementation of rightful grazing management approaches and strong use of environmental laws, the health of riparian areas can be improved and maintained.

Main conclusions from the findings in the objectives of the study i) Riparian areas are complex, diverse and dynamic ecosystems, ii) Grazing in riparian areas have significant effect and include decline in plant community species, water quality, fish productivity and wildlife habitat and population, forage production and overall site ecological value and sustainability, iii) Different seasons of grazing effects on riparian vegetation structure occurred different significantly more severe on the plant community in the dry season, iv) Choosing and using the suitable grazing management methods, techniques and practices can help prevent or minimize the negative effect of livestock grazing in riparian areas. This was observed clearly on the where some of the strategies were used, such as fencing along some of the pravite plots along the ripain. Some strategies like alternative watering points and Stuff placement upland were measured through sites observation (site seeing) by the researcher were available on the riparian sites, v) Grazing in the riparian area possess considerably adverse socio-economic force on the livelihood of the communities, state and national economy.

5.5 Contribution to knowledge

Several of the previous studies have looked at the interplay between livestock and riparian vegetation, and found a mixed result in the advanced countries, for example the work of Belsky. *et al.,* (2009); Schulz and Leininger, (2010); VanWoudenberg (2010); Bohn and Buckhouse (2012); McCalla. *et al.,* (2012); Von Behren, Dietrich and Yeakley, (2013); Richardson. *et al.*, (2014) and Tara and Possingham, (2015). However, the current study investigated grazing effect on vegetation of riparian area along river Benue, Adamawa State, Nigeria, and its findings contributed to the body of knowledge.

The study found that grazing contributes tremendously towards the degradation of vegetation along the riparian area of river Benue. Livestock grazing is a strong contributor to negative socio-economic life of the local communities dwelling along the riparian of rive Benue. In addition, the most effective management strategies for riparian conservation and sustainability in African and especially in Nigerian setting included: fencing strategy, alternative watering points strategy, shade and shelter strategy, and supplements' placements (hay, molasses, salt.) upland during dry season.

5.6 Recommendations

Under this sub-unit, recommendations are made according to the objectives of the study, reflecting on the findings of the research work. Some other recommendations were also made on the general scene as regards the research work. Objective one of the research is on the grazing effects on the riparian vegetation, findings revealed that grazing has negatively influenced the vegetation leaving the riparian with degenerated vegetation residuals.

Therefore, there is need to work towards reclaiming the riparian vegetation. In this regard, community leaders, community base organizations in collaboration with NGOs should embark on tree planting campaign. Planting trees and grasses of riparian characteristics along the river fringes will furnish habitats and other functions to safe guard the riparian.

Also, the local community's leaders, traditional councils, stakeholders and stakeholders in livestock management, should advocate for the use of appropriate grazing management strategies like alternative watering points, fencing as a shift from the traditional strategies.

On the problem of plant extinctions more especially that of vital medicinal plants, there is need for collaboration between local communities, CBOs, NGOSs and State Agronomies to develop ways forward for domesticating essential plants.

Under objective two of this work, livestock grazing was found to have affected the socio-economic functions in the riparian. Therefore, there is need for the Local community leaders, CBOs, to collaborate with union leaders e.g. Sports Fishermen's Association of Nigeria (SFAN) and other relevant bodies to, embark on sensitization of stake holders and general public. This should be through environmental education and other related programmes for riparian rehabilitation of the degraded ecosystem. This will improve productivity of fishes, wildlife and other potentials like recreational, aesthetic and other valuable functions.

Community leaders, CBOs, Traditional councils and stakeholders of riparian environment should advocate and campaign for a cutting edge cultural values embedded in unified management approaches of environmental education into school curriculum. This can help in rejuvenating the degenerated socio-economic opportunities to improve on the livelihood of the communities.

Traditional councils, community leaders and Union leaders e.g. Farmer Development Union of Nigeria (FDAN), Mi-yetti Allah Cattle Breeders Association of Nigeria (MACBAN) and Nigeria Conservationist Foundation(NCF) should develop a forum for sensitizing the pastoralists, agro-pastoralists and farmers to get the values of riparian sustainability. Also the need for resources sharing and respect for human life.

In objective three, Environmental friendly grazing management strategies were found to have improve riparian vegetation by keeping livestock away from the area. Therefore, adapting such measures will obviously help in regenerating the degraded riparian vegetation.

There is also the need for community leaders, Traditional council, CBOs and other Union leaders e.g. Foundation for Environmental Development in Nigeria(FEDEN) to advocate for a shift from riparian utilization for grazing. This is achievable through environmental education programmes, enlightening the grazers and stakeholders on the need for sustainable grazing through environmental friendly management strategies e.g. supplement placement upland and pasture cultivation.

There is need for proper documentation of grazing management strategies and information that is successful in improving the state-of the-art. Therefore, community leaders and state agencies of relevant ministries, should form some supervisory units for check mating the implementation of the management strategies.

On the general scene, the following recommendations will enrich general public and community leaders in the restoration of the degenerating vegetation and socio-economic activities along the riparian areas. Therefore, there is need to support grass-root community participation in the development and implementation of environmental programmes and policy for tenable achievements of the goals.

Community leaders, CBOs, NGOs should ally with relevant Union leaders e.g. Nigeria Conservationist Foundation (NCF) and State authorities to advocate and support universities to embark on environmental programmes to get the general public informed of the relevance of having a healthy riparian environment.

Community leaders, Traditional councils, CBOs, NGOs, and Environmental Activists to support in the development of livestock grazing ranches across the state. This will enable sustainable grazing environment and riparian vegetation, will also facilitate peaceful co-existence among the communities and the pastoralists in the areas.

Finally, community leaders, stakeholders in environment, CBOs and general public should advocate for a strong reinforcement of the existing environmental laws in the state.

5.7 Areas for further research

The study cannot claim to have exhausted all about grazing and vegetation interplay and its effect on the human community in the riparian area. Therefore, studies relating to grazing and vegetation need to be conducted in other parts of the state, similar studies need to be conducted in the North West, North Central, and North proper where grazing shouts threats. The research suggested the following topical areas for further study: (i) Grazing and variability of palatable plant species productivity in the riparian ecology, ii) Grazing induced invasive species and the resilience of native medicinal species in the riparian, iii) Seasonal variation grazing and variability of short root herbaceous plant species in the riparian, iv) Grazing and climber's species regeneration at the understorey cover of riparian vegetation, v) Seasonal grazing and farming activities in the riparian of river Benue.

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APPENDIX I:

QUESTIONNAIRE FOR RIVER RASIN DEVELOPMENT AUTHORITY (RBAD)

Dear respondents,

I am a student of Kampala International University conducting a research on the problem "**grazing effects on the riparian vegetation and human community along river Benue, Adamawa State, Nigeria**". The intention of this questionnaire was to solicit for an information from you to be used for this research.

The research is one of the requirement for the award of Doctor of philosophy degree in Environmental Management Sciences of Kampala International University. The research is purely academic, any information provided by you will be use for the academic purpose only.

I solicit for your cooperation and your sincere views and response to the items on the questionnaire which will be useful to the research. Thank you so much

Madube Tumba Kwabe

(Student)

SECTION A:

Demographic characteristics of the respondents

Instruction: Please tick the option that best describes your personality

1. Gender

a) Male ☐ b) Female ☐

2. Age

a) 18-30 ☐ b) 31-55 ☐ c) Above 55 ☐

3. Education Level

a) None ☐ b) Primary ☐ c) Secondary ☐

d) Post-secondary ☐

4. Office rank……………………….

Section B: Grazing effects on riparian area

This questionnaire is intended to capture information about the grazing effects on riparian area along river Benue. Please indicate your level of agreement or disagreement by ticking the options presented using the scales below: 5=strongly agree; 4=agree; 3=not sure; 2=disagree; and 1=strongly disagree.

#	**Grazing effects on riparian area**	**5**	**4**	**3**	**2**	**1**
	As a result of grazing in the riparian area over the years there was…					
1	Decrease in plants growth					
2	Decrease in diversity of native palatable plants					
3	Decline in plant productivity (poor yield)					
4	Decrease in plant composition					
5	Increase in exotic species diversity					
6	Increase in diversity of non-native plants					
7	Increase in extinction of grazing-sensitive plant					
8	Increase in plants(tree) diebark					
9	Decrease in plants vigor /resilience					

Section C: Effective management strategies for riparian conservation and sustainability

Please use the following scales to indicate your level of agreement or disagreement the statements. Scale: 5=you strongly agree, 4=you agree, 3=you are not sure, 2=you disagree, and 1=you strongly disagree.

#	**Management strategy for riparian conservation**	**1**	**2**	**3**	**4**	**5**
	Effective management strategy for riparian conservation used in this area include…..					
1	Alternative watering point strategy					
2	Planting palatable forage species upland areas or cropland to attract livestock away from riparian areas.					
3	Prescribed burning and vegetation treatments to enhance forage production.					
4	Supplements placement in upland areas away from riparian areas					
5	Using fencing strategy					
6	Using rotational grazing strategy					
7	Using zero grazing strategy					
8	Using shade and shelter grazing strategy					
9	Use of frequent range riding and herding to control livestock distribution in many situations.					
10	Incorporating different kinds of livestock to affect both the distribution pattern and forage preference					

Section D: Socioeconomic effects of grazing along river Benue

Please use the following scales to indicate your level of agreement or disagreement the statements. Scale: 5=you strongly agree, 4=you agree, 3=you are not sure, 2=you disagree, and 1=you strongly disagree.

#	Social economic effect of grazing along river Benue	1	2	3	4	5
A	**Social effect of grazing along river Benue has caused…..**					
1	Increased poor quality of life					
2	Limited access to clean and safe water.					
3	Increase risk to communicable diseases.					
4	Destruction of water source					
5	Increase in poor health quality					
6	Increase in insecurity of life and properties					
7	Increase poor environmental sanitation					
B	**Economic effect of grazing along river Benue include……**	**1**	**2**	**3**	**4**	**5**
1	Destruction of fish habitat and decrease in productivity.					
2	Reduction in the availability of medicinal plants					
3	Decline in tourism activities in the community.					
4	Destruction in recreational potentials in riparian area.					
5	Upset of educational potential of the community.					
6	Destruction of cultural/spiritual enrichment of the community.					

APPENDIX II:

QUESTIONNAIRE FOR STATE ENVIRONMENTAL MANAGEMENT AGENCY (SEMA)

Dear respondents,

I am a student of Kampala International University conducting a research on the problem "**grazing effects on the riparian vegetation and human community along river Benue, Adamawa State, Nigeria**". The intention of this questionnaire was to solicit for an information from you to be used for this research.

The research is one of the requirement for the award of Doctor of philosophy degree in environmental management sciences of Kampala International University. The research is purely academic, any information provided by you will be use for the academic purpose only.

I solicit therefore, for your cooperation and your sincere views and responses to the items on the questionnaire which will be useful to the research. Thank you so much

Madube Tumba Kwabe

(Student)

SECTION A:

Demographic characteristics of the respondents

Instruction: Please tick the option that best describes your personality

1. Gender

a) Male ☐ b) Female ☐

2. Age

a) 18-30 ☐ b) 31-55 ☐ c) Above 55 ☐

3. Education Level

a) None ☐ b) Primary ☐ c) Secondary ☐

d) Post-secondary ☐

Section B: Grazing effects on riparian area

This questionnaire is intended to capture information about the grazing effects on riparian area along river Benue. Please indicate your level of agreement or disagreement by ticking the options presented using the scales below: 5=strongly agree; 4=agree; 3=not sure; 2=disagree; and 1=strongly disagree.

#	**Grazing effects on riparian area**	**5**	**4**	**3**	**2**	**1**
	As a result of grazing in the riparian area over the years there was…					
1	Decrease in plants growth					
2	Decrease in diversity of native palatable plants					
3	Decline in plant productivity(poor yield)					
4	Decreased in plant species composition					
5	Increase in diversity of exotic species					
6	Increase diversity of –native unpalatable plants					
7	Increase in extinction of grazing-sensitive plant					
8	Decline in plant vigor /resilience					
9	Increase in plants (trees) diebark					

Section C: Effective management strategies for riparian conservation and sustainability

Please use the following scales to indicate your level of agreement or disagreement the statements. Scale: 5=you strongly agree, 4=you agree, 3=you are not sure, 2=you disagree, and 1=you strongly disagree.

#	Management strategy for riparian conservation	1	2	3	4	5
	Effective management strategy for riparian conservation used in this area include…..					
1	Alternative watering point strategy					
2	Planting palatable forage species upland areas or cropland to attract livestock away from riparian areas.					
3	Prescribed burning and vegetation treatments to enhance forage production.					
4	Supplements placement in upland areas away from riparian areas					
5	Using fencing strategy					
6	Using rotational grazing strategy					
7	Using zero grazing strategy					
8	Using shade and shelter grazing strategy					
9	Use of frequent range riding and herding to control livestock distribution in many situations.					
10	Incorporating different kinds of livestock to affect both the distribution pattern and forage preference					

Section D: Socioeconomic effects of grazing along river Benue

Please use the following scales to indicate your level of agreement or disagreement the statements. Scale: 5=you strongly agree, 4=you agree, 3=you are not sure, 2=you disagree, and 1=you strongly disagree.

#	Social economic effect of grazing along river Benue	1	2	3	4	5
A	**Social effect of grazing along river Benue has caused…..**					
1	Increased poor quality of life					
2	Limited access to clean and safe water.					
3	Increase risk to communicable diseases.					
4	Destruction of water source					
5	Increase in poor health quality					
6	Increase in insecurity of life and properties					
7	Increase poor environmental sanitation					
B	**Economic effect of grazing along river Benue include……**	**1**	**2**	**3**	**4**	**5**
1	Destruction of fish habitat and decrease in productivity.					
2	Reduction in the availability of medicinal plants					
3	Decline in tourism activities in the community.					
4	Destruction in recreational potentials in riparian area.					
5	Upset of educational potential of the community.					
6	Destruction of cultural/spiritual enrichment of the community.					

APPENDIX III:

QUESTIONNAIRE FOR NON-GOVERNMENTAL ORGANIZATIONS (NGOs)

Dear respondents,

I am a student of Kampala International University conducting a research on the problem "**grazing effects on the riparian vegetation and human community along river Benue, Adamawa State, Nigeria**". The intention of this questionnaire was to solicit for an information from you to be used for this research.

The research is one of the requirement for the award of Doctor of philosophy degree in environmental management sciences of Kampala International University. The research is purely academic, any information provided by you will be use for the academic purpose only.

I solicit for your cooperation and your sincere views and responses to the items on the questionnaire which will be useful to the research. Thank you so much

Madube Tumba Kwabe

(Student)

SECTION A:

Demographic characteristics of the respondents

Instruction: Please tick the option that best describes your personality

1. Gender

a) Male ☐ b) Female ☐

2. Age

a) 18-30 ☐ b) 31-55 ☐ c) Above 55 ☐

3. Education Level

a) None ☐ b) Primary ☐ c) Secondary ☐

d) Post-secondary ☐

Section B: Grazing effects on riparian area

This questionnaire is intended to capture information about the grazing effects on riparian area along river Benue. Please indicate your level of agreement or disagreement by ticking the options presented using the scales below: 5=strongly agree; 4=agree; 3=not sure; 2=disagree; and 1=strongly disagree.

#	**Grazing effects on riparian area**	**5**	**4**	**3**	**2**	**1**
	As a result of grazing in the riparian area over the years there was…					
1	Decrease in plants vigor/ resilience					
2	Decrease in productivity of plants (poor yield)					
3	Decline in diversity of the native palatable plants					
4	Decreased in plant species composition					
5	Increase in diversity of native unpalatable species					
6	Increase in diversity of non-native plant species					
7	Increase in extinction of grazing-sensitive plant					
8	Increase in tree plants diebark					
9	Decrease in plants growth					

Section C: Effective management strategies for riparian conservation and sustainability

Please use the following scales to indicate your level of agreement or disagreement the statements. Scale: 5=you strongly agree, 4=you agree, 3=you are not sure, 2=you disagree, and 1=you strongly disagree.

#	**Management strategy for riparian conservation**	**1**	**2**	**3**	**4**	**5**
	Effective management strategy for riparian conservation used in this area include…..					
1	Alternative watering point strategy					
2	Planting palatable forage species upland areas or cropland to attract livestock away from riparian areas.					
3	Prescribed burning and vegetation treatments to enhance forage production.					
4	Supplements placement in upland areas away from riparian areas					
5	Using fencing strategy					
6	Using rotational grazing strategy					
7	Using zero grazing strategy					
8	Using shade and shelter grazing strategy					
9	Use of frequent range riding and herding to control livestock distribution in many situations.					
10	Incorporating different kinds of livestock to affect both the distribution pattern and forage preference					

Section D: Socioeconomic effects of grazing along river Benue

Please use the following scales to indicate your level of agreement or disagreement the statements. Scale: 5=you strongly agree, 4=you agree, 3=you are not sure, 2=you disagree, and 1=you strongly disagree.

#	**Social economic effect of grazing along river Benue**	**1**	**2**	**3**	**4**	**5**
A	**Social effect of grazing along river Benue has caused…..**					
1	Increased poor quality of life					
2	Limited access to clean and safe water.					
3	Increase risk to communicable diseases.					
4	Destruction of water source					
5	Increase in poor health quality					
6	Increase in insecurity of life and properties					
7	Increase poor environmental sanitation					
B	**Economic effect of grazing along river Benue include……**	**1**	**2**	**3**	**4**	**5**
1	Destruction of fish habitat and decrease in productivity.					
2	Reduction in the availability of medicinal plants					
3	Decline in tourism activities in the community.					
4	Destruction in recreational potentials in riparian area.					
5	Upset of educational potential of the community.					
6	Destruction of cultural/spiritual enrichment of the community.					

APPENDIX IV:

QUESTIONNAIRE FOR COMMUNITY BASE ORGANIZATIONS (CBO)

Dear respondents,

I am Madube Tumba Kwabe a student of Kampala International University conducting a research on the problem "***Grazing effects on the riparian vegetation and human community along river Benue, Adamawa State, Nigeria***". The intention of this questionnaire was to solicit for an information from you to be used for this research only.

The research is one of the requirement for the award of Doctor of philosophy degree in environmental management sciences of Kampala International University. The research is purely academic, any information provided by you will be use for the academic purpose only not for any other reasons.

I am delightful to have you as my respondent, i solicit for your cooperation and your sincere views and responses to the items on the questionnaire which will be useful to the research. Thank you so much.

SECTION A: Demographic characteristics of the respondents

Instruction: Please tick the option that best describes your personality

1. Gender

a) Male ☐ b) Female ☐

2. Age

a) 18-30 ☐ b) 31-55 ☐ c) Above 55 ☐

3. Education Level

a) None ☐ b) Primary ☐ c) Secondary ☐

d) Post-secondary ☐

Section B: Grazing effects on riparian area

This questionnaire is intended to capture information about the grazing effects on riparian area along river Benue. Please indicate your level of agreement or disagreement by ticking the options presented using the scales below: 5=strongly agree; 4=agree; 3=not sure; 2=disagree; and 1=strongly disagree.

#	**Grazing effects on riparian area**	**5**	**4**	**3**	**2**	**1**
	As a result of grazing in the riparian area over the years there was…					
1	Decrease in plants vigor/resilience					
2	Increase in diversity of native unpalatable plants					
3	Decline in diversity of native palatable plant species					
4	Increased in diversity of non-native (exotic) plant species					
5	Decrease in plant species composition					
6	Decrease in plant growth					
7	Increase in extinction of grazing-sensitive plant					
8	Decline in productivity of plant (poor yield)					
9	Increase in tree plant diebark					

Section C: Effective management strategies for riparian conservation and sustainability

Please use the following scales to indicate your level of agreement or disagreement the statements. Scale: 5=you strongly agree, 4=you agree, 3=you are not sure, 2=you disagree, and 1=you strongly disagree.

#	Management strategy for riparian conservation	1	2	3	4	5
	Effective management strategy for riparian conservation used in this area include…..					
1	Alternative watering point strategy					
2	Planting palatable forage species upland areas or cropland to attract livestock away from riparian areas.					
3	Prescribed burning and vegetation treatments to enhance forage production.					
4	Supplements placement in upland areas away from riparian areas					
5	Using fencing strategy					
6	Using rotational grazing strategy					
7	Using zero grazing strategy					
8	Using shade and shelter grazing strategy					
9	Use of frequent range riding and herding to control livestock distribution in many situations.					
10	Incorporating different kinds of livestock to affect both the distribution pattern and forage preference					

Section D: Socioeconomic effects of grazing along river Benue

Please use the following scales to indicate your level of agreement or disagreement the statements. Scale: 5=you strongly agree, 4=you agree, 3=you are not sure, 2=you disagree, and 1=you strongly disagree.

#	**Social economic effect of grazing along river Benue**	**1**	**2**	**3**	**4**	**5**
A	**Social effect of grazing along river Benue has caused…..**					
1	Increased poor quality of life					
2	Limited access to clean and safe water.					
3	Increase risk to communicable diseases.					
4	Destruction of water source					
5	Increase in poor health quality					
6	Increase in insecurity of life and properties					
7	Increase poor environmental sanitation					
B	**Economic effect of grazing along river Benue include……**	**1**	**2**	**3**	**4**	**5**
1	Destruction of fish habitat and decrease in productivity.					
2	Reduction in the availability of medicinal plants					
3	Decline in tourism activities in the community.					
4	Destruction in recreational potentials in riparian area.					
5	Upset of educational potential of the community.					
6	Destruction of cultural/spiritual enrichment of the community.					

APPENDIX V:

QUESTIONNAIRE FOR LOCAL COMMUNITY MEMBERS

Dear respondents,

I am Madube Tumba Kwabe a student of Kampala International University conducting a research on the problem "**grazing effects on the riparian vegetation and human community along river Benue, Adamawa State, Nigeria**". The intention of this questionnaire was to solicit for an information from you to be used for this research only.

The research is one of the requirement for the award of Doctor of philosophy degree in environmental management sciences of Kampala International University. The research is purely for academic exercise any information provided by you will be use for the academic purpose only.

I am delightful to have as one of my respondents, i solicit for your cooperation and sincere views and responses to the items on the questionnaire which will be useful to the research.

Thank you so much.

SECTION A:

Demographic characteristics of the respondents

Instruction: Please tick the option that best describes your personality

1. Gender

a) Male ☐ b) Female ☐

2. Age

a) 18-30 ☐ b) 31-55 ☐ c) Above 55 ☐

3. Education Level

a) None ☐ b) Primary ☐ c) Secondary ☐

d) Post-secondary ☐

Section B: Grazing effects on riparian area

This questionnaire is intended to capture information about the grazing effects on riparian area along river Benue. Please indicate your level of agreement or disagreement by ticking the options presented using the scales below: 5=strongly agree; 4=agree; 3=not sure; 2=disagree; and 1=strongly disagree.

#	**Grazing effects on riparian area**	**5**	**4**	**3**	**2**	**1**
	As a result of grazing in the riparian area over the years there was…					
1	Decrease in plants vigor/ resilience					
2	Decrease in productivity of plant (poor yield)					
3	Decline in diversity of native palatable plant					
4	Increased in diversity of native unpalatable plant					
5	Reduction in plant species composition					
6	Increase in diversity of non-native (invasive) plants					
7	Increase in extinction of grazing-sensitive plant					
8	Decline in plant species growth					
9	Increase in tree plants diebark					

Section C: Effective management strategies for riparian conservation and sustainability

Please use the following scales to indicate your level of agreement or disagreement the statements. Scale: 5=you strongly agree, 4=you agree, 3=you are not sure, 2=you disagree, and 1=you strongly disagree.

#	Management strategy for riparian conservation	1	2	3	4	5
	Effective management strategy for riparian conservation used in this area include…..					
1	Alternative watering point strategy					
2	Planting palatable forage species upland areas or cropland to attract livestock away from riparian areas.					
3	Prescribed burning and vegetation treatments to enhance forage production.					
4	Supplements placement in upland areas away from riparian areas					
5	Using fencing strategy					
6	Using rotational grazing strategy					
7	Using zero grazing strategy					
8	Using shade and shelter grazing strategy					
9	Use of frequent range riding and herding to control livestock distribution in many situations.					
10	Incorporating different kinds of livestock to affect both the distribution pattern and forage preference					

Section D: Socioeconomic effects of grazing along river Benue

Please use the following scales to indicate your level of agreement or disagreement the statements. Scale: 5=you strongly agree, 4=you agree, 3=you are not sure, 2=you disagree, and 1=you strongly disagree.

#	Social economic effect of grazing along river Benue	1	2	3	4	5
A	**Social effect of grazing along river Benue has caused…..**					
1	Increased poor quality of life					
2	Limited access to clean and safe water.					
3	Increase risk to communicable diseases.					
4	Destruction of water source					
5	Increase in poor health quality					
6	Increase in insecurity of life and properties					
7	Increase poor environmental sanitation					
B	**Economic effect of grazing along river Benue include……**	**1**	**2**	**3**	**4**	**5**
1	Destruction of fish habitat and decrease in productivity.					
2	Reduction in the availability of medicinal plants					
3	Decline in tourism activities in the community.					
4	Destruction in recreational potentials in riparian area.					
5	Upset of educational potential of the community.					
6	Destruction of cultural/spiritual enrichment of the community.					

APPENDIX VI:

LIST OF PLANT LIFE-FORM SPECIES IN THE STUDY AREA (MOST DOMINANT SPECIES)

Species Name	Life form	Frequency
Virtex Doliana	Tree	10
Bataytics sperman	Tree	11
Eucalyptus spp	Tree	20
Ziziplus spinadinsti	Tree	9
Balanites aegyptiaca	Tree	10
Acacia ivarensis	Tree	10
Acacia senegalensis	Tree	16
Termarindus indica	Tree	13
Tricalysia negerica	Shrub	10
Tarupin	Shrub	16
Tricalysia wrahaniana	Shrub	12
Tricalysia abanensus	Shrub	10
Sabicea langinosa	Shrub	16
Rytizynia aryantea	Shrub	21
Allophysus nigericus	Shrub	30
Prunus Africana	Shrub	31
Sansevera liberica	Shrub	14
Acacia nilotica	Shrub	10
Mimosa pudica	Shrub	10
Carculinta moschola	Shrub	7
Solanum nigeum	Shrub	9
Lecnurus sibiri	Shrub	11
Annoria spp	Shrub	9
Grater sahel	Shrub	25

Asptenium comutuma istan	Shrub	21
Indegofera lotisepola	Shrub	23
Alectra virgata herns	Shrub	19
Chlorphytum dalzieri	Grass	11
Aeschynarnene neglecta	Grass	13
Hepper	Grass	12
Labiates spp	Grass	20
Tridx combretum	Grass	37
Pacunium spp	Grass	27
Sorghum Vulgare	Grass	39
Panicum maximum	Grass	9
Floating grass	Grass	11
Tuft Damaliligel	Grass	17
Strychirus nuxvorica	Grass	20
Gynandopsis synandra	Grass	24
Nymphoea lotus	Grass	30
Pristia stratiotes	Grass	9
Commelina Beughalensis	Grass	40
Ipomoea spp	Grass	15
Hyparrhenia spp	Grass	30
Anogneissus spp	Grass	31
Ipomea acquatic	Grass	13
Maginfera indica	Grass	20
Walitenbergiara mosissima	Grass	18
Thulin sibspprа mosissima	Grass	13
Batulia termulcaulis	Grass	31
Helich sassy Comerica nines	Grass	25
Stiches pseudohamritusa	Grass	16
Nymphaelotus haolatus	Grass	14
Satribia molesta	Grass	16

Hibiscus sineoculeotus	Grass	10
Indigefera hutchinsoniana	Herb	13
Raphia mambillenisis	Shrub	25
Azolia African	Grass	27
Commelina benghalensis	Forbs	16
Cypenus spp	Forbs	14
Leersia hexandra	Grass	13
Water hyacinuth	Grass	10
Raphia sudanica	Tree	35
Phonix dactylifera	Tree	11
Xeromphis nilotica	Shrub	26
Khaya senegalensis	Tree	9
Adansonia digitata	Tree	11
Azadiracta indica	Tree	20
Asperula canferta	Forbs	16
Boerhavia dominii	Forbs	15
Salsola tragus	Shrub	13
		1235

APPENDIX VII:

TRANSMITTAL LETTER

KAMPALA
INTERNATIONAL
UNIVERSITY
EXPLORING THE HEIGHTS

Ggaba Road, KansangaPOBOX 20000Kampala, Uganda
Tel: +256(0) 41-266813 * Fax: +256 (0) 41-501 974
E-mail: admin@kiu.ac.ug *website: http: // www.kiu.ac.ug

School of Engineering and Applied Sciences (SEAS)
Office of the Dean

July 15th, 2016

Dear Sir/Madam, registration

RE: TRANSMITTAL LETTER FOR DATA COLLECTION

This is to introduce to you **MUDUBE TUMBA KWABE (PhD EM/39730/131/DF)** who is a student in the Department of Biological and Environmental Sciences at the School of Engineering and Applied Sciences, Kampala International University. He is expected to produce his student card, which carries a photograph, as proof of identity.

Kwabe is undertaking a study leading to a Thesis titled **"Overgrazing Impacts in Riparian Ecosystem along River Benue, Adamawa, Nigeria"** as a partial fulfillment for the requirement of Doctorate of Philosophy in Science: in Environmental Management, of Kampala International University.
By this letter, we request you to grant him permission to undertake his study in your industry/organization. All information provided to him shall be treated with utmost confidentially.

Any assistance rendered is highly appreciated.

Sincerely,

KAMPALA INTERNATIONAL UNIVERSITY * SCHOOL OF ENGINEERING & APPLIED SCIENCE
15 JUL 2016

Mundu M. Mustafa
Associate Dean, SEAS
Contact: +256 773 247 249, +256 751 914 614
Email: mundu.mustafa@kiu.ac.ug or mundumustafa@yahoo.com

"Exploring the Heights"

ADAMAWA STATE GOVERNMENT OF NIGERIA

MINISTRY OF ENVIRONMENT

P.M.B. 2170 Yola TEL 075-626920 624853

Our Ref: ASG, MOE, R216

Your Ref:

Date 20th July 2016

Office of the Director
Department of Natural Resources

The Dean ,
School of Engineering and Applied Sciences (SEAS)
Kampala International University

Dear Sir/Madam

RE: INTRODUCTION LETTER IN RESPECT OF MR MADUBE TUMBA KWABE (Ph.D/EM/39730/131/DF

I write to acknowledge receipt of your letter dated 15th July, 2016, introducing the above named Ph.D student to the Riparian area of Benue to conduct his Ph.D research

I am directed to inform you that, the Management has approved your request for Madube Tumba Kwabe to interact with the communities along the Riparian of the river, and observe the flora and other components of the physical Environment for his Ph.D Research data collection.

The concerned units of the Communities are by this letter duly informed to guide/assist him accordingly

MINISTRY OF ENVIRONMENT
DEPARTMENT OF NATURAL RESOURCES

Tha[illegible]

20/07/2016

Usman Abba, Madagali
Director Natural Resources

ADAMAWA STATE WATER BOARD

P.M.B. 2088, YOLA

Telegram: WATER
Telephone: 624814
626807
624552
Fax: 624771

Ref. No: wat/166B

Date: 20 July 2016

Jimeta Water Plant Resources Unit
Adamawa state Water Board, Yola
Nigeria

The Dean
School of Engineering applied Science (SEAS)
Kampala International University

Dear Sir/Madam

RE: INTRODUCTION LETTER IN RESPECT OF MR. MADUBE TUMBA KWABE (PhD/EM/39730/131/DF)

I write to acknowledge the receipt of your letter date 15th July, 2016 introducing the above named PhD Student to carry out research in the Riparian Area of River Benue.

I am directed to inform you that the Management has approved your request for the said student, and to interact with the Vegetation and Communities along the river riparian .

Adamawa State Water Board P.M.B 2088 YOLA

20/07/2016

Gabriel Kwada
Asst. Chief Water Sci.
A.S.W.B, Yola.

APPENDIC VIII:

INFORMED CONSENT

I am giving my consent to be part of the research study of Mr. Madube Tumba Kwabe on **"Grazing effects on riparian vegetation along river Benue, Adamawa State, Nigeria".**

I have been assured of privacy, anonymity and confidentiality and that I will be given an option to refuse participation and right to withdraw my participation any time.

I have been informed that the research is voluntary and that the result will be given to me if ask for it.

Initial …………………………………Date ……………………………………….

APPENDIX IX:

OBSERVATION CHECK LIST

Field observation recording sheet for rapid appraisal of riparian condition

Vegetation structure assessment

Sub index	Indices	Range	Method of scaring observations (score)					Quadrant No.	Season	Canopy	Mid-layer	Ground cover	Grazing processes (actions)			
Vegetation structure	Residual of tree stacks and poles	score	0 mark	1 mark	2 mark	3mark				Scores	Scores	Scores	Grazing	Trampling	Browsing	Defoliation
		0-3	Absent	1-30 %	31-60 %	>60 %										
	Residual of shrubs and forb	0-3	Absent	1-5%	6-30 %	>30 %										
	Residual of grasses,	0-3	Absent	1-30 %	31-60 %	>60 % cov										

	saplings					er										
	Residual, patches of herbs/cryptogams	0-3	Absent	Ground	Mid-layer	canopy										

Source; Adapted from: Jensen etal, 2005

Rainy/Wet Season

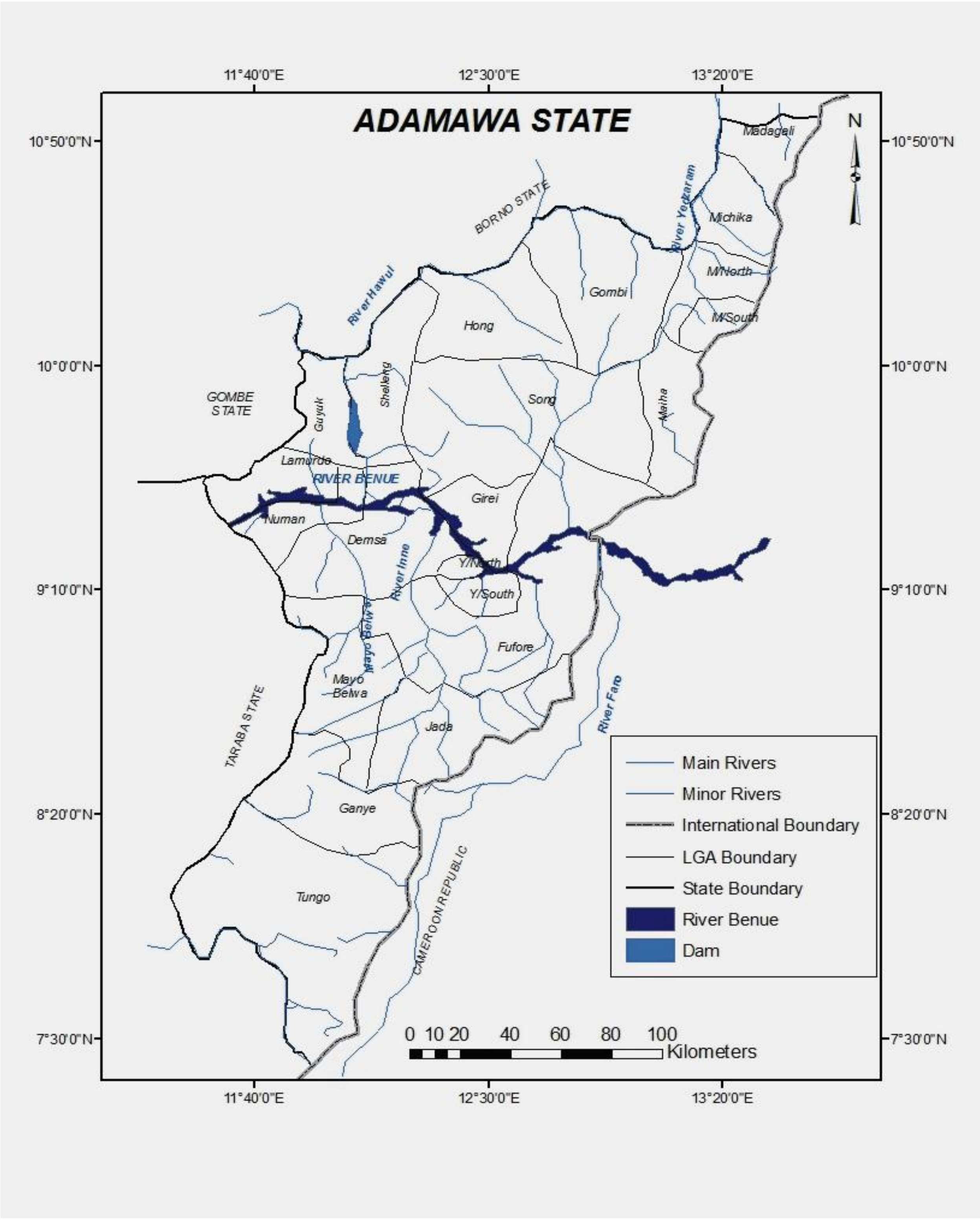
Riparian components affected	**Potential effects**			
	Defoliation		**Animal traffic**	
	Vigor, biomass	**Vegetation cover**	**Plant tramping**	**Soil tramping, compaction**
Stream bank vegetation				
Productivity	Decrease [ ] Increased [ ]	Decrease [ ] Increased [ ]		
Vegetation overhang		Decrease [ ] Increased [ ]	Decrease [ ] Increased [ ]	
Riparian zone soil				
Soil moisture				Decrease [ ] Increased [ ]
Erosion				Decrease [ ] Increased [ ]
Infiltration rate				Decrease [ ] Increased [ ]

<u>Dry Season</u>

Riparian components affected	**Potential effects**			
	Defoliation		**Animal traffic**	
	Vigor, biomass	**Vegetation cover**	**Plant tramping**	**Soil tramping, compaction**
Stream bank vegetation				
Productivity	Decrease [ ] Increased [ ]	Decrease [ ] Increased [ ]		
Vegetation overhang		Decrease [ ] Increased [ ]	Decrease [ ] Increased [ ]	
Riparian zone soil				
Soil moisture				Decrease [ ] Increased [ ]
Erosion				Decrease [ ] Increased [ ]
Infiltration rate				Decrease [ ] Increased [ ]

APPENDIX X:

MAP OF ADAMAWA STATE



APPENDIX XI:

RIPARIAN AREAS ALONG RIVER BENUE