ECONOMIC DIMENSIONS OF INLAND FISHERIES OF THE UPPER EAST REGION OF GHANA

by

Maxwell Okrah, B.A Integrated Development Studies (Hons.)

A Thesis submitted to the Department of Planning,

Kwame Nkrumah University of Science and Technology,

in partial fulfillment of the requirements for the degree

of

MASTER OF SCIENCE IN

DEVELOPMENT POLICY AND PLANNING

Department of Planning,

College of Architecture and Planning

OCTOBER, 2010

DECLARATION

I hereby declare that this submission is my own work towards the Master of Science in Development Policy and Planning and that, to the best of my knowledge, it contains no materials previously published by another person nor materials which has been accepted for the award of any other degree of the University, except where due acknowledgement has been made in the text.

MAXWELL OKRAH (PG2334708) …….. ……

(Student) Signature Date

Certified by:

DR. K.O. AGYEMAN ……. …….

(Supervisor) Signature Date

Certified by:

DR. IMORO BRAIMAH …… ……

(Head, Department) Signature Date

ABSTRACT

Aside crop production, the Tono and Vea irrigation dams are to ensure the supply of freshwater fish and regular income as well as create employment for people within and without the riparian communities. However, after 25 years and 30 years of operations of the Tono and Vea reservoir fisheries respectively, the economic benefits of employment, revenue and income generations are at risk as fish catch over the years has been fluctuating. This has been worsening the incidence of poverty among the users of the fishery resources of Tono and Vea. The decline of fish stock threatens the income and employment of fishermen and the multitude of other ancillary services of the fishing industry. Attempts to mitigate the problems facing the fishery subsector witnessed management and government support by way of advocating for enforcement of closed seasons, gear restriction, capacity building of institutions, aquaculture development and strengthening of fishery extension activities. This study was designed to assess the prospects of the countless efforts aimed at improving income, generation of revenue and employment of fishery resource users. The Tono irrigation in the Kassena Nankana District and Vea irrigation in the Bongo District of the Upper East Region were used as a case. Based on the objectives, a case study design approach was employed and both secondary and primary data was collected and analysed. Empirical results revealed that: although the fishery resources in both areas is an open access resource, it requires registration of users; the fishery offered direct employment of only 0.3 percent of the potential labour of the study districts; more fishermen earned high income in 2009 than in 2000; whereas fruitless effort was made by the KNDA to tax fishery resource users, BDA has not exploited that; false condition of economic efficiency, low stakeholder interaction and low priority for the fishery sector. This research asserted that enhanced income, secured employment and improved revenue demands fishery enhancement, specific use rights, effort regulation and gear quota and integrated water use planning. To harness the fishery revenue potentials in a balanced ecological setting, revenue profiling and an ecosystem approach are recommended.

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LIST OF ABBREVIATIONS

BDA	Bongo District Assembly
CBFM	Community Based Fisheries Management
CPUE	Catch Per Unit Effort
DAs	District Assemblies
DoF	Directorate of Fisheries
FADs	Fish Aggregation Devices
FAO	Food and Agriculture Organisation
FMSP	Fisheries Management Science Programme
GDP	Gross Domestic Product
GIHOC	Ghana Industrial Holding Corporation
GNP	Gross National Product
GPRS	Growth and Poverty Reduction Strategy
GTZ	German Technical Cooperation
ICOUR	Irrigation Company of Upper Region
IOC	Intergovernmental Oceanographic Commission
KNDA	Kassena Nankana District Assembly
LMC	Lake Management Committee
MoFA	Ministry of Food and Agriculture
MRAG	Marine Resource Assessment Group
MSY	Maximum Sustainable Yield
PNDC	Provisional National Defence Council
SFLP	Sustainable Fisheries Livelihoods Programme
SPAs	Special Protected Areas
SPSS	Statistical Package for Social Scientist
UN	United Nations
UNCLOS	United Nations Convention of the Law of the Sea
USA	United States of America
WHAT	World Humanity Action Trust
WRI	Water Research Institute

ACKNOWLEDGEMENT

This research would not have been accomplished without the support and encouragement of some individuals and institutions. First of all, I am very grateful to the Almighty God who gave me the grace, energy and wisdom to go through this work. To my wife, Mrs. Juliana Okrah and my daughter Jenifer Okrah, who supported me with prayers and financially to be educated up to this level, I am greatly indebted to them.

With sincere gratitude, I acknowledge the contribution of Dr. K.O. Agyeman who supervised the entire research. He put forward ideas, encouragement and insightful comments that greatly improved the thesis. I owe immeasurable gratitude to Mr. Sebastian Chirasoe Waltia (MoFA District Fishery Officer-KNDA) and Mr. Robert Atinga Baba (MoFA Assistant Chief Technical Officer-BDA) for their technical comments and contributions. The following individuals also deserve specific mention and credit: Alhaji Issah Bukari (Managing Director of ICOUR Ltd), Mr. Gyim Boateng (Chief Monitoring Officer) and Mr. Fred Abakah, all of ICOUR Ltd. They have helped sharpen my analysis and contributed in various ways in making this research a success. I am equally grateful to Mr. Augustine A. Akolgo for hosting me during data collection for this study.

It is not possible to mention all personalities and institutions connected with this work, including my course mates, but let it be known that I appreciate all their encouragement, criticisms and support.

CHAPTER ONE

GENERAL INTRODUCTION

1.1 Introduction

Inland fisheries represent an important contribution towards food security, income and employment in many African countries. In this regard, small-scale fisheries provide people with an important and sometimes crucial form of safety-net that helps protect them against the effects of agricultural product price volatility, macro-economic crises, structural reforms, harvest failures and other factors that threaten rural stability and food security (FAO, 1996; cited in Sarch and Allison, 2000). A major problem is the lack of information about many fisheries, resulting in fisheries that are not well managed. At the same time many fisheries may be threatened by degradation of the environment, loss of habitat and by overexploitation of fishery resources (Sarch and Allison, 2000).

According to Hardin (1968; cited in Hartmann et al. 2004) the users of common-pool resources are caught in an inevitable process that leads to the destruction of the very resources on which they depend. The rational user of a "commons" makes demands on a resource until the expected benefits of his or her actions equal the expected costs. Because each user ignores costs imposed on others, individual decisions cumulate in tragic overuse and potential destruction of the resource in question. This problem of the commons has also been called "the fisherman's problem", because open-access fisheries provided important early illustrations of it.

This old industry of inland fishery in Africa, including Ghana has been operated under the concept of common-pool resource and/or 'tragedy of the commons' which invariably gives way to open access and overexploitation of resources, therefore endangering fishery employment, income and food security (Sarch and Allison, 2000). The perception of common-pool resource and the existence of overexploitation of the inland fisheries in Ghana, including that of Tono and Vea reservoirs threaten the economic opportunities that have been envisioned and offered by policy makers.

According to Seini et al (2003), Ghana has a system of rivers, lagoons and lakes that form the basis of an inland fisheries industry. The fisheries sector has for a long time provided a source of employment for Ghanaians living in close proximity to inland fishery resource bases. Fish supplies naturally augment food availability. Consumption of fish improves on the utilisation of food thereby ensuring good nutritional outcomes particularly of the poor and rural populations. A great number of people engaged in the fishing industry earn an income that improves upon their access to food. With the experience that crop yield has been declining, especially in the savannah region of Ghana, and catch from inland fisheries becoming increasingly a source of food, the concerns of government, civil society organisations and individuals have been directed towards the management and protection of inland fisheries and their habitats (Adua, 2000). This realisation made the government to fund the construction of irrigation projects around the country, which included the Tono and Vea irrigation projects. The choice of Upper East Region for the construction of the Tono dam, Vea dam and other small-scale dams has been influenced by irrigation potentials. The aim was to strengthen the Irrigation Company of Upper Region (ICOUR) in the development of livestock, crops and fisheries (ICOUR, 1995).

According to FAO (1998), employment in the inland fishery sector in Ghana has been decreasing over the years. The number of fishers, processors, traders, boat builders and maintenance personnel declined from 500,000 in 1992 to 400,000 in 1996 (IOC, 1997; cited in FAO, 1998). Thus, employment declined by about 22.3 percent between 1992 and 1996. Although there are no reliable data on the number of persons currently employed in the Sector, one may not be wrong to assume that the numbers have come down due to, among others, dwindling fisheries resources (Antwi, 2006).

According to the Ministry of Food and Agriculture fisheries directorate (MoFA, 2008), the growth rate of fish catches from 1995 to 2004 was just 3.6 percent with some declining trends between 2000 and 2003. Inland fishery employs about 80,000 fishers and some 20,000 fish processors in Ghana but has been recording net losses of employment recently.

The problem of declining incomes is linked with overexploitation, subsequently leading to fishery degradation. In open access fisheries, the Bioeconomic Equilibrium (when the population is at equilibrium, means losses by natural and fishing mortalities are compensated by the population increase due to individual growth and recruitment) is reached with increasing economic inefficiency (Clark, 1985). The pressure to provide employment and opportunities make the inland fisheries of Tono and Vea more prone to overexploitation and subsequently declining incomes, employment and revenue.

1.2 Problem Statement

The construction of the Tono and Vea irrigation dams was seen as a pivot of development, not only in the area of food crop production, but also in the fishery subsector. Freshwater fish was to be supplied not only as an important source of food security, but also a source of employment and income in the catchment areas and beyond. However, the economic benefits of employment, revenue and income generations are at risk as the Tono and Vea reservoirs have been recording declining trends of fish catch. The dwindling fish catch over the years is threatening employment and income opportunities of the Tono and Vea fisheries. This invariably leads to the worsening of the already high incidence of poverty among the fisherfolks in particular and in the Upper East region in general. This assertion has been supported by the analysis of 'Growth and Poverty Reduction Strategy' (GPRS II) that, nine (9) out of every ten people in the Upper East Region are poor (NDPC, 2005).

The institutionalisation of a modern management system over the Tono and Yaritanga rivers did not only offer an interesting insight into people's livelihood but also a gradual transition from subsistence fishery to a quasi-cash economy in the catchment areas of the above rivers. However, from the records of ICOUR (2009), the tonnage of fish catch from the Tono and Vea lakes portrayed a fluctuation trend over the past ten (10) years, spanning from 2000 to 2009. This situation has negative consequences on those whose livelihood depend directly or indirectly on the fishery resource. The concomitant ramification of open access fishery, overfishing and low fish catch is deterioration of

employment and income of fishers and those engaged in ancillary activities as well as revenue to the catchment Assemblies.

Aside the fisher folks, who are involved in the inland fishery industry and are directly affected by under employment, unemployment and low earnings due to overexploitation and depletion, many more who work in processing and trading and in ancillary services such as net repair, supply of fishery inputs, boatbuilding and basket-making has been experiencing a slowdown in profitability. Therefore, the decline of fishery stock and earnings affects the livelihoods of multitude of stakeholders within and around the Tono and Vea irrigation projects. The continuous existence of declining fish catch will adversely affect the school participation rate of the children of fish-dependent households and other stakeholders in socio-economic opportunities. This will further marginalise the inland fishers from political decision making and deprivation in access to social services hence, putting them and their communities into cyclical poverty.

The potential of the fisheries sector to contribute to the economy and development of the country has not been lost on successive governments. As such various government-led efforts have gone into building the institutional capacity to support the Sector. Equally, the above problem witnessed some effort from Ghana's Fishery Sector Development Project (1995 - 2000), where a lot of emphasis was placed on the development of inland fisheries and aquaculture in particular. Efforts were made to strengthen extension activities with the goal of achieving sustainable yields, employment and income. Also, dialogue was established with fishermen and traditional authorities with the aim of controlling fishing activities (Seini et al., 2003). To ensure sustainability of fishery resources and income, the management (ICOUR) of Tono and Vea projects had prescribed the approved methods of harvesting fish, the enforcement of closed seasons on fishing from June to August each year and the formation of Lake Management Committees (LMC).

With all measures in place, the problem of fluctuating income, lost of employment and revenue of fishers and other ancillary service providers persist. The continuous

deteriorating of the economic opportunities, as a result of declining fish catch amid several remedying efforts by government, management and other stakeholders' effort is a threat to livelihood sources of the fishers and mongers hence the need to study the inland fisheries of Tono and Vea reservoirs. The focus of this research is therefore to assess the contribution of the fishery subsector of Tono and Vea irrigation projects to employment, income and revenue generation as well as poverty reduction. In view of the above problems, this study was designed to answer, among others, the following questions:

- How do the catchment communities access the fishery resources of Tono and Vea reservoirs?
- What is the level of inland fishery employment generation in the Tono and Vea reservoirs?
- How has the inland fishery of Tono and Vea contributed to revenue and poverty reduction?
- What is the relationship between the fish catch and income levels of fishers?

1.3 Objectives of the Study

The broad objective of the study is to ascertain how the inland fisheries of Tono and Vea irrigation dams have been contributing to employment and income generation.

1.3.1 Specific Objectives

The specific Objectives of the study are:

- To assess the accessibility of the catchment communities to the fishery stock.
- To examine the level of employment generated by the Tono and Vea reservoir fisheries.
- To analyse the contribution of the fishery to revenue and poverty reduction
- To assess the link between fish catch and income variability of fishers

- To make policy recommendations for a sustainable inland fishery, employment and income in the reservoirs.

1.4 Scope of the Study

The focus of this research is to assess the contribution of the fishery subsector of Tono and Vea irrigation projects to employment, income and revenue generation as well as poverty reduction in the catchment communities. In order to connect the inland fisheries to employment, income and revenue, catch, effort and access variables were assessed. The Region is chosen due to her enormous irrigation potentials as well as the existence of a large size (Tono) and medium size (Vea) dams which can satisfy the fishery demand of the Region and beyond. The time boundary for the investigation spanned from 2000 to 2009. Data on fish catch, employment and income level of the fishers and mongers within this time frame was collated and analysed.

1.5 Justification of the Study

This investigation will generate baseline information that could be useful for the Ministry of Food and Agriculture, those who are managing change and the fishery subsector in particular for planning and monitoring purposes. Attention could be redirected at the economic aspects of managing the two irrigation dams and similar projects to enhance fishery sustainability and reduce poverty. Equally, documentation from this research could serve as a useful source of information for future researchers and organisations involved in fishery development and the provision of irrigation facilities in Ghana.

Findings from this study will make the catchment communities and the peasant fishers in particular more responsible in terms of protection of the lake's ecosystem and self-restraint in the use of the fisheries resources. Thus, the fishing communities will perceive their mutual interests in sustaining fisheries resources hence play a proactive role in regulating fishing efforts themselves.

Recommendations made there-of, if implemented would enhance the level of coordination and cooperation between and among the management of ICOUR, Ministry of Food and Agriculture and the catchment Districts and communities. This will increase the level of trust and the effective integration of economic dimensions of management and utilisation of the irrigated projects.

More importantly, findings from this investigation will add to the existing knowledge on the link between inland fishery on one hand and economic growth and poverty reduction on the other. The study will also facilitate the use of co-management principles in the management and governance of Ghanaian water and other natural resources.

1.6 Organisation of the Study

The study has been organised under five main chapters. Chapter One focuses on the general introduction to the study and defines the research problem, objectives, scope and justification. The second chapter reviews literature on the concept and economics of inland fisheries. This chapter also covers the theoretical and the analytical frameworks for the study. Chapter Three covers the profile of the study Region and Districts as well as the methodology that has been employed to carry out the study. The fourth chapter presents an in-depth analysis and presentation of data. The fifth and final chapter covers the major findings and policy implications of the study, recommendations and conclusion for sustainable utilisation of inland fisheries in Ghana.

CHAPTER TWO
CONCEPTUAL AND ANALYTICAL FRAMEWORK

2.1 Introduction

This chapter presents a critical review of literature relating to the theoretical and the conceptual frames and the meaning of inland fisheries. The study employed theories like the Common-Pool Resource Theory, the Game Theory and the Bioeconomic Model. Bioeconomic model was used as the principal theory because of its link with efficient assessment of fisheries both as an ecological resource and economic activity. It also uses the Common-Pool Resource Theory as it helps to explain factors affecting accessibility of inland fisheries. The Game Theory provided an understanding of the various ways through which the fishers react to changes in cost and catch. Cumulatively, the theories provided empirical insight on how inland fisheries contribute to employment, income, revenue and food security. Also, literature on factors threatening the role of inland fisheries as revenue and employment generation activity and income earning venture was assessed. The Chapter shows how these theoretical issues relate to the provision of a framework from which measures could be derived to guide the inland fishery sector for a sustainable income and employment.

2.2 The Concept of Inland Fishery

There is no consensus by scholars on the definition of the concept 'inland fishery' or 'fishery' in general. But for the purpose of this study and the assessment of varied views about the concept- inland fishery, few definitions have been reviewed. According to FAO (2000), a fishery can be defined as the exploitation of living aquatic resources held in some form of common or open access property regime. Although the current study is concerned not about all living aquatic resources but fish, this definition is useful because it focused on open access fisheries where excludability through restriction cannot be exercised. However, Arlinghaus et al (2002) defined inland fishery as "fishing activities in natural or 'semi natural', limnetic ecosystems, such as rivers, lakes, gravel pits, other manmade standing water bodies and reservoirs, to benefit from the use of fish and other aquatic organisms therein". Allan et al (2005) defined inland fisheries as the capture of

wild stocks of primarily freshwater fish, including migratory species that move between freshwater and the oceans. Although aquaculture significantly augments the supply of certain species and contributes a substantial fraction to the overall harvest, the study of Allan et al focused on capture fisheries of natural stock. This definition is relevant for the current study. However, the objective is not to establish the benefit of other aquatic organisms, but fish in the Tono and Vea reservoirs.

In the view of Arlinghaus et al (2002), inland fisheries systems worldwide comprise four main categories: (i) commercial, capture food fisheries; (ii) non-commercial fisheries exploited for leisure, 'sport' or subsistence; (iii) aquaculture and (iv) upstream or downstream services such as gear manufactures, ownership of water rights, tourism (upstream) and fish processors, transporters and retailers (downstream). Aquaculture is often treated separately from the inland fisheries sector as it is more akin to an agricultural activity. This assertion is in line with the focus of this study as it attempts to assess the economics of wild inland fisheries of the Tono and Vea reservoirs. The study of these reservoirs would fall within the first category of inland fishery (commercial, capture food fisheries). The common features about the three definitions centred on fish and water resources as well as the exploitation activities taking place on these aquatic resources. The nature of fishing activities and the state of the ecological system affect the quality and quantity of water and water resources.

2.2.1 Working Definition of Inland Fishery

Inland fishery is a unit or an entity that is engaged in exploiting and harvesting of freshwater fish. The unit can be treated as the people involved, area of water, methods of fishing and purpose of the activities. Typically, inland fishery is the combination of fish and fishers in a region and the conservation, management and development of fish and water resources.

2.3 Types of Inland Fisheries

There is a large volume of published literature about the nature of fisheries especially inland fisheries. However, there has not been a consensus among authors on the types of inland fishery subsector. Contributing to this dilemma, Van Zalinge et al (2000a), who reported on the Cambodian inland fisheries, divided the sector into two broad categories: Limited Access Fisheries and Open Access Fisheries. In their view, under a well defined limited fisheries regime, the individual fisherman would not exceed the Maximum Economic Yield (MEY - the total amount of profit that could be earned from a fishery if an individual owned it). Béné (2003) noted that institutional restrictions provides some kind of "economic exclusion", where costs of licenses, bribes or fees to government or traditional authorities together with the costs of fishing gear exclude poor households from either all or the best fisheries.

In an open access fisheries, there is the absence of institutional restrictions combined with affordable costs for the purchase or self manufacture of fishing gear and attainable knowledge and skill requirements which clearly results in low barriers to entry to fishing (Smith et al. 2005: 366-7). Open access fisheries and property rights have contributed mainly to the recent increase in fishing pressure and led to a rapid expansion of fishing effort in waters. Under open access fisheries, Van Zalinge et al (2000a) identified the following categories of fisheries:

- Middle-scale Fisheries. A number of gears specified by the fishery law require a license (such as gillnets, seines, arrow-shaped traps, etc.).
- Small-scale or Family Fisheries. The remainder of gears, such as small castnets, small dipnets, small gillnets, certain traps, etc., are free for anyone to use, although not everywhere nor at any time. Rice-field fisheries fall in this category.
- Illegal Fisheries. A number of gears and methods (such as brush parks, explosives, poisons, electric gears, etc.) have been declared illegal.

However, Welcomme (1985) in Koeshendrajana and Cacho (2001) explained that fishers can be divided into three groups: Occasional, Part-time and Full-time. Occasional fishers harvest fish for their own consumption and are comparatively unproductive. Part-time

fishers tend to use a range of fishing gear and usually operate their fishing as a consequence of lack of work in their main occupation. Thus, they use fishing as occupation of 'last resort'. Full-time fishers are more specialised and operate their fishing as a main occupation. The third group of fishers (full-time) will experience the concept of 'economic exclusion' as explained by Van Zalinge (2000a) because the existence of limited access will deny the full-time fishers their livelihood and income sources. This study however, did not recognise that the consideration of only fisheries productivity to the neglect of fisheries ecology lead to Bioeconomic Equilibrium.

Koeshendrajana and Cacho (2001) reported after assessing the management options for the inland fisheries resource in South Sumatra that fishing patterns are significantly affected by fluctuations in seasons and water levels. In this regard, fishing seasons can be distinguished as high water (December to February), receding water (March to May), low water (June to August) and rising water (September to November). So, in a fishery resource, the employment can either be part-time or full-time depending on the consistency or otherwise of seasons and levels of water. The same study added that most river fisheries experience increased fishing during periods of low flow with the greatest Catch Per Unit of Effort (CPUE) often associated with falling or rising water levels.

Fish are more concentrated in low water and tend to become migrationally active during rising and falling water. Hence, they are more susceptible to capture during these times. In this regard, the structure and functional composition, as well as abundance of fish stock, are reflected in the types and intensities of fishing effort operated during this time of the year. Fish stock typically recover from intense low water exploitation during the high water season, when fishing efficiency is low due to dispersion of fish in newly inundated areas (Koeshendrajana and Cacho, 2001). The hypothesis that the productivity of a water body is driven by water level may be seen as related to the "flood pulse" concept which suggest that seasonal flooding is a major driver of the biotic productivity of river-floodplain system (Junk et al. 1989; cited in Béné, 2007). Although the Tono and Vea Lakes are not a river-floodplain system per se, they are characterised by seasonal fluctuations of water levels. The above literature is therefore relevant because the rising

and falling of water levels affects the income as well as revenue of fishers, fishmongers and other ancillary workers whose livelihood depend on inland fishery resources.

For the purpose of this study, access to inland fisheries resource and their economic analysis have been looked at from various theoretical view points and schools of thought of economic dimensions of inland fisheries. The cooperation or otherwise of fish stock users and the decision of entry or exit have been explained by various authors in the fisheries sector.

2.4 Common-Pool Resource

A path breaking work of Gordon (1954) and Scott (1955) in Hess and Ostrom (2001) introduced an economic analysis of a natural resource (fisheries). Their two articles outlined the conventional theory of the 'commons'. They demonstrated that when multiple individuals jointly harvested fish in high demand without a limit on the amount that any fisher could withdraw, the quantity harvested would exceed both the maximum sustainable yield and the maximum economic yield. At that time, the only solution to this problem that they contemplated was private ownership of the fishery or by state control. However, in 1968, the biologist, Garrett Hardin, crystallised this thinking of many social scientists and policy makers with his metaphoric analysis of the 'tragedy of the commons.' Hardin (1968) in Hess and Ostrom (2001) argued that the individuals who jointly use a 'commons' are hopelessly trapped in an immutable tragedy. Given this trap of overuse, the 'only' solution Hardin envisioned was externally imposed government or private ownership.

These theoretical studies, as outline by Hess and Ostrom (2001: 51) analysed simple common-pool resource systems using these assumptions. In such systems, it is assumed that the resource generates a highly predictable, finite supply of one type of resource unit in each relevant time period. Appropriators are assumed to be homogeneous in terms of their assets, skills, discount rates, and cultural views. They are also assumed to be short-term, profit-maximising actors who possess complete information. In this theory, anyone can enter the resource and appropriate resource units. Appropriators gain property rights

only to what they harvest. The harvested resource units are then privately owned and can be sold in an open competitive market. The open access condition is a given and the appropriators make no effort to change it (Hess and Ostrom, 2001). Appropriators act independently and do not communicate or coordinate their activities in any way. This unilateral decision by actors is what Merino et al (2007), citing Nash (1951) referred to as the 'Non-cooperative Solution Concept'.

According to Hess and Ostrom (2001: 51), the unsparing application of this conventional theory to all common-pool resources was challenged by the work of the National Academy of Sciences' Panel on Common Property-USA. They came to the realisation that, there exists the capacity of appropriators to communicate, coordinate their activities, and to create institutions to allocate property rights and make policies related to a jointly owned resource. The growing evidence from many field studies of common-pool resources conducted by anthropologists and historians called for a serious re-thinking of the theoretical foundations for the analysis of common-pool resources. The challenge was not about the empirical validity of the conventional theory (where it is relevant) but rather its presumed, universal, generalisability.

2.4.1 The Application of the Common-Pool Resource Theory to Tono and Vea Fisheries

The applicability of this theory can be observed at the individual, community and management levels. At the community level, the nature of property regime of the water and fishery resources affects the accessibility of each user as well as the benefits to society and the type of management approach for sustainable fisheries. In the situation of open access, the assumption is that no individual user has an incentive to conserve the use of the fisheries or to invest in improvements. In such a situation, a fisher account only his own marginal costs and revenues and ignores the fact that increases in his catch affect the returns to fishing effort for other fishers as well as the health of future fish stock. The consequences will be dissipation of economic rent, economic overfishing, which may also lead to ecological overfishing. The realisation from the theory is that without a sustainable fishery, the living conditions of the fishing communities cannot be improved in the long term. As a solution to the problem of the 'tragedy of the commons', as

envisioned by Hardin (1968) in Hess and Ostrom (2001), informed the institutionalisation of state ownership over the Tono and Vea reservoirs. The overall objective is to create the understanding that property regime under common-pool resource will affect the provision, production, distribution, appropriation and consumption of the fish stock.

2.5 The Game Theory

Exploitation of renewable resources such as fish stocks shared by a limited number of agents introduces the so-called stock externality and the involvement of strategic interactions as a consequence. Game Theory is a formal tool for analysing the strategic interactions between a finite number of agents sharing an exploited resource (Sumaila, 1997; cited in Merino et al. 2007). Strategic interaction in fisheries is interpreted as the way in which the harvest by one agent highly affects the fishing strategy of other agents or fishers (Gronbak, 2000). Game Theoretic models have been applied to different cases in fisheries, such as equilibrium global models with symmetrical agents, dynamic age-structured models in boat conflicts and suitability of cooperative and non-cooperative behaviours in the management of shared fisheries (Hannesson, 1995; cited in Merino et al. 2007).

The Game Theory, as applied to fisheries postulated that the fishers were the main decision makers. The model proposed here aims to determine the effort strategy adopted by each fisher or boat under two assumptions: i) each boat strives to maximise its profits for the non-cooperative solution, and ii) boat maximise overall profits for the cooperative solution. Merino et al (2007) proposed that differences among individual vessels are reflected in their catchability and costs of activity. The profit of each owner depends not only upon his own effort strategy, but also upon the strategies of the other owners. Hence, the players are faced with a non-zero sum game (Basar and Olsder, 1999). The solution concept used is the Nash equilibrium (Nash, 1951; cited in Merino et al. 2007), defined as a set of strategies satisfying that each player's strategy is the best response to the equilibrium strategies of the others. It provides us with strategies such that none of the players will benefit from unilateral deviation.

2.5.1 Application of the Game Theory to Fishers' Income

The Game Theory is helpful in the analysis of income in the Tono and Vea reservoirs. Like any other natural resource, harvesting of fish from the stock reduce the economic return to other users. The strategies of each fisher (which includes the type and quantity of gear, the part of the water resource being harvested and fishing effort) are directly related to cost and catch under the non-cooperative solution. The Theory revealed that the income of each user is not only determined by his/her unilateral strategic decision but that of others. Invariably, no individual user benefit from the situation of uncoordinated strategies. Therefore, for the maximisation of economic returns from a renewable natural resource like fishery, the appropriate solution or sustainable approach for the Tono and Vea reservoirs will be the practicalisation of the equilibrium strategies - the cooperative solution - of each fisher.

2.6 Bioeconomic Model

Gordon (1954) in Mutunga et al (2002) assumed an instantaneous entry of fishers into the fishery in response to profits. Like Gordon (1954), Smith (1969; cited in Mutunga 2002) noted that the change in total effort in a fishery is proportional to the change in the fishery's current profits. Gordon (1954) posited that the fishermen enter the fishery in response to attractive rents, and repeat this until the point is reached where effort earns only its opportunity cost. Following the work of the above authors, the Bioeconomic Modelling has invariably assumed instantaneous adjustment of effort to changing profits. The implicit assumption of this modelling is that management has complete control over effort or that potential entrants into a fishery have myopic, adaptive expectations. The theory of economic management of fishery resources predicts that, if a commercially valuable common property fishery resource is exploited under open access and unregulated as well, the resource will be driven down to a level-conceivably zero-at which the resource rent is fully dissipated. This level as postulated by Gordon (1954) is referred to as the 'Bioeconomic Equilibrium'.

In open access fisheries, the Bioeconomic Equilibrium is reached with increasing economic inefficiency (Clark, 1985). When a fishery is developing, a trend of declining

costs occurs due to an increasing fishing power and efficiency, together with increasing knowledge of the most important fish concentrations. However, these factors tend to reduce stock abundance, increase harvesting costs and diminish net revenues per unit of effort. When this happens, fishing areas closest to the shallow part of the water body are gradually overexploited or even depleted and the areas previously less attractive will tend to be progressively used. Thus, the Bioeconomic Equilibrium will be reached at high levels of stock overexploitation, at which point the lack of profits discourages entry of new fishers.

The study of Beddington and Rettig (1984) also highlighted that a biological approach that does not consider variations in environmental factors will not provide a real representation of the fishery especially for those species that are sensitive to environmental variability. The exogenous environmental factors invariably affect the stock and thus the economic rent derived from the fishery. The economic benefits of income, employment and revenue will be lost by precluding the application of economic criteria for fishery management.

2.6.1 Application of Bioeconomic Model to the Tono and Vea Fisheries

The Concepts of 'Bioeconomic' and 'Bioeconomic Equilibrium' are very useful for the economic analysis of inland fisheries. Through the understanding of the direct relationship between fishery income and change in fishing effort, the Irrigation Company of Upper Region (ICOUR) is able to assist the fishers for a secured supply of fish for the riparian communities and beyond. Although some of the users regard fishing as an occupation of 'last resort' especially for occasional and part-time fishers, the consideration of economic rent attract fishers and other users of the Tono and Vea reservoirs. However, the knowledge of Bioeconomic Equilibrium has made management to institute a management strategy of closed season to prevent the occurrence of dissipation of profit as well as the fishery resources. It could be asserted that apart from the relationship that exist between profit and fishing effort, there is also a connection between and among environmental variability, fishery stock and revenue or income of

resource users. Thus adequate rainfall enhances spawning condition which in intend improves and sustains catch per effort, fishery revenue and employment.

2.7 Summary of Theories

These three theories (Common-Pool Resource, Game Theory and Bioeconomic Model) are important to the study of the economic dimensions of Upper East inland fisheries because they provide an understanding of what roles the fishery resources of Tono and Vea reservoirs play in the areas of employment, income and revenue generation as well as poverty reduction. Before the construction of the Tono and Vea dams, their water and fishery resources were being utilised on the basis of common-pool resource and open access fisheries. The reservoir fisheries offered the users livelihood diversification options. However, due to increasing fishing pressure, the employment of unsustainable fishing methods, ecological degradation, among others are threatening the income, revenue and livelihoods of fishers and other ancillary service providers.

Critically, the assumption under Common-Pool Resource that open access condition is a given has been constrained by modern management practice of controlling access, effort and gear. Also, the Game Theoretic assumption of maximisation of overall profit for the cooperative solution did not consider the type and quantity of gear and the level of investment by the appropriators. The Bioeconomic Model assumptions of instance adjustment of effort to changing profits and absolute control of effort by management are contradicting. The applicability of these theories should give recognition to the type of resource system, the availability of alternative livelihood activities, attitude of resource users and the appropriate incentives and policy environment to control gear, exploiting methods and effort.

2.8 Open Access Fisheries and Common Property Regime

Common property denotes resources that are owned by a community and rules of access to the resource are defined by the community that owns the resource (Heltberg, 2001). A clear example of these resources is fishery stock. According to Baland and Platteau

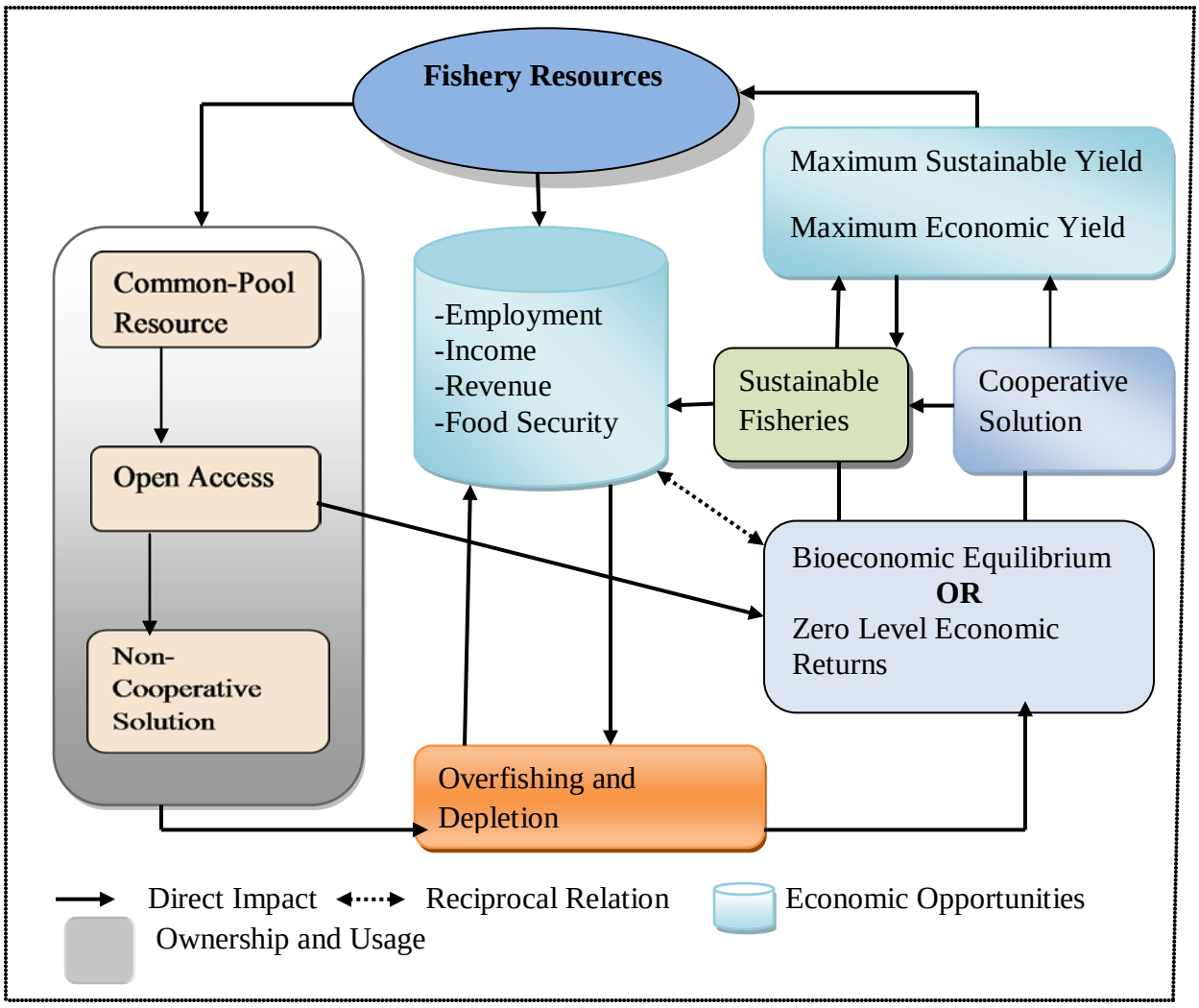
(1996), common property could either be regulated, where the rules governing the resource utilisation are clearly specified, or unregulated (common-pool) where the rules do not exist or are not enforced to limit the use of the resource. These categories of resources are mainly characterised by; difficulty or high cost of excluding potential users, and every user subtracts from benefit to other users (Ostrom, 1990). This can aptly be attributed to fishery stock as a good example of these resources. The above situation gives rise to overexploitation, a phenomenon known as the 'tragedy of the commons'. Open access to a fishery as explained by Béné (2003 p. 951) is the "endogenous origin of poverty in fisheries" as it allows more people to enter, leading to economic (and possibly biological) overexploitation of the resource, eroding profitability and impoverishing the fishing community.

Under conditions of open access and common-pool resources, it is invariably the case that fishermen collectively will have an incentive to invest in capital to an extent that far exceeds the resource regulator's optimum (Mutunga, 2002). In an investigation under open access and common property, Baland and Platteau (2000) aptly illustrated the distinction between the two concepts. In an open access resource, users make a choice of entry or otherwise for the exploitation of the resource base on price of entry and the expected income, which can be negative or positive. As long as the net expected benefit is positive, they decide to enter and exploit the resource. The problem is that their private evaluation of the expected benefits does not take into account the fall in others' incomes, which is caused by their entry. By their action they impose an externality on other agents. Under open access, a right of inclusion is granted to anyone who wants to use the resource (Baland and Platteau, 2000).

Unlike in open access, Baland and Platteau (2000) argued that, the right of exclusion is assigned to a well-defined user group under common property. Hence, the agents are allowed to interact strategically with each other. The users do not any more think that the final outcome is independent of their own individual decisions, as was the case under open access. They actually expect that their action will induce a particular reaction from the other agents and, thereby, affect the collective result (Balnad and Platteau, 2000).

In the case of Tono and Vea, the adoption of the fishery resource management regime that is based on the idea of common property will influence collective decision about sustainable use of the fishery resources as entry criteria would be established to control activities of appropriators. However, in a situation where fishing is seen as the economic activity of 'last resort', the decision of entry is not mostly influenced by the expected outcomes as explained by Baland and Platteau under open access fisheries.

Figure 2.1 Conceptual Framework for Economic Dimensions of Fisheries



Source: Author's Construct, April 2010

Fishery is not only a natural resource but, also renewable. They engage a lot of people, especially rural dwellers and provide a means of income and revenue. The utilisation of

most tropical inland fisheries is perceived as common property in an open access regime, where each user adopts and operates unilaterally (See Figure 2.1). The existence of this gives rise to overfishing and/or depletion of the fish stock, therefore, undermining the economics of inland fisheries. The consequences of open access fisheries are 'zero level economic returns' and Bioeconomic Equilibrium. Since fishery is a renewable resource, sustainable management and the application of 'Nash Equilibrium Strategies' (defined as a set of strategies satisfying that each player's strategy is the best response to the equilibrium strategies of the others) will lead to maximum sustainable yield and maximum economic yield. This will subsequently increase the potentials of the fishery to provide more employment, income, revenue and reduce poverty in fishery resource-dependent households and communities.

2.9 Ghana's Fisheries Resource Management/Production Policy

The management system of fisheries in Ghana has been categorised into freshwater and brackish water systems. Basically, there are two main management systems working towards the achievement of the overall objectives of the Sector. These are the Marine Management System and the Volta Lake Management System. The first category - Marine Management System - is in charge of the marine subsector, with common goals of: enforcing regulations that ensure the escape and survival of juvenile fish from net and the combined use of purse seines and Fish Aggregation Devices (FADs) and ensuring that stocks are not depleted especially demersal fishes through the imposition of closed seasons on trawl fisheries (Tetteh, 2007).

On the other hand, the Volta Lake Management System is responsible for managing the inland sector. This system has the objectives of regulating fish mortality by: declaring Specially Protected Areas (SPAs) as breeding and nursing grounds, enforcing fishery regulations on the use of active gears and undermeshed nets and enforcing licensing systems and entry requirements to avoid influx (Tetteh, 2007). Also, the system aims at encouraging management, development and research on the Volta Lake, encouraging co-management institutions that can sustainably manage territorial use rights regimes through local community structures and mechanisms and improving the socio-economic

conditions of lake-side communities. However, management attention is mainly directed towards the Volta Lake to the neglect of other inland fisheries.

Aside the above systems of management, there is also the traditional method which works through the observation of non-fishing days within the week on which the fishers rest and mend their gears and the imposition of ban on fishing during certain periods of the year or sometimes a total ban on a particular fishery (Tetteh, 2007). However, the overall management of the fishery sector comes under the Directorate of Fisheries (DoF) and all were managed by the defunct Ministry of Fisheries but now Ministry of Food and Agriculture. At the district level, District Assemblies work in collaboration with the district department of Ministry of Food and Agriculture and other administrative bodies for the management of fisheries. Also, Community Based Fisheries Management Committees and Non-governmental Organisations are partners in the management of fishery resources.

Since the ratification of the United Nations Convention of the Law of the Sea (UNCLOS) by Ghana in 1983, five fisheries related laws have been passed to help manage and regulate the Sector. These are:

- Fisheries Regulation 1984 LI 1294;
- Maritime Zones (Delimitation) Law, 1986;
- PNDC Law 256 of 1991;
- Fisheries Commission Act of 1993, Act 457; and
- Fisheries Act 625 of 2002.

The above legislations brought in an increasing awareness of the need for conservation, with later ones going to greater lengths to achieve this objective (Kwajosse, 2009).

The use right of the fish resources of Ghana is enshrined in fishing regulations by government (PNDC law 256 of 1991) to ensure sustainability (Akpalu, 2002). As a dynamic resource, the fisheries sector law of PNDC law 256 of 1991 and other Acts, Decrees and Legislative Instruments has been consolidated by the Fisheries Act, Act 625 of 2002. This is the regulation currently governing the fisheries sector. It amends,

consolidates and attempts to streamline all the existing fisheries laws to address chronic and emerging issues while conforming to national and international fishery resource development and management strategies. The law provided for a regulatory body, the Fisheries Monitoring, Control, Surveillance, and Enforcement Unit as well as a fisheries advisory council (Kwajosse, 2009).

2.9.1 The National Fisheries and Aquaculture Policy

The main goal of the policy is the effective implementation of fisheries management and conservation measures to ensure the long term contribution of fisheries to the national economy and to allow the present generation to meet its needs without compromising those of future generations (Kwajosse, 2009). Hence the objectives set for this area are designed to address the problems of overexploitation, environmental degradation and unsustainable fisheries in general through the strengthening of the regulatory framework to ensure effective implementation of conservation and habitat protection measures (Ministry of Fisheries, 2008). Broadly, the national fisheries and aquaculture policy is structured around four policy areas. These are:

- management of fisheries, conservation of aquatic resources and protection of their natural environment;
- promotion of value addition and improving the livelihood of fisheries communities;
- development of aquaculture; and
- improvement of services provided to the sector by the Ministry and other institutions.

These four policy areas took into consideration the vision of the government of Ghana and that of the then Ministry of Fisheries for the achievement of the strategy of sustainable development and environmental protection of the sector (Kwadjosse, 2009). Despite the fact that the current study is focused on capture fisheries, the national fisheries and aquaculture policies will provide the basis for the assessment of the management and conservational approaches of ICOUR.

2.10 Inland Fisheries and Employment

Allan et al (2005) citing Kura et al (2004), acknowledged that fishing and the activities surrounding it-processing, transport, and retailing-are important at every scale, from the village level to the national economies. As a crucial source of livelihoods in developing nations, inland fishery provides employment of last resort, particularly for low-income families in rural areas where job options are limited. Neiland and Béné (2003) added that the fisheries of river basins of West and Central Africa provide employment for a greater number of households as much as 64,700 and 62,000 in the Niger-Benue system and in the Congo-Zaire respectively. Equally, Jul-Larsen et al (2003) in Béné (2007) described that fishers' density on lakes and reservoirs in Ghana range up to 6 fishers per km of shoreline, which is a relatively high figure compared to what is observed in Southern Africa. FAO (2004) in Tetteh (2007) estimated that the inland subsector of Ghana's fisheries offers job to approximately 30,000 people. The above literature is relevant for this study as it is also trying to establish the link between the inland fisheries of Tono and Vea and employment creation. However, whereas the focus was on direct employment (thus, to fishers), the current study includes indirect or ancillary employment.

2.11 Inland Fisheries and Income

Allison et al (2007) argued that although the fisheries of Lake Chilwa offer an economically unstable environment, determined by the seasonal and long-term fluctuations in lake level, but at high production periods, the fisheries contribute readily-earned cash to the wider rural economy. In supporting this view, Béné (2006) pointed out that a well managed inland fisheries and fish-related activities play a critical role in generating wealth and sustaining economic growth. For example, research in the Zambezi area reveals that inland fisheries generate more cash for households than cattle rearing in most cases and more than crop production in some cases.

According to Lorenzen et al (2000), in Laos, about 30 percent of rural household income is earned through inland fishing. In Sri Lanka, recent economic valuations have put the

value of fisheries at about 18 percent of total economic returns to water in irrigated paddy production (Renwick 2001; cited in Coates, 2007). This issue of income dimension of inland fisheries was supported by a study of World Fish Centre (2008) in West and Central Africa river fisheries. The organisation alluded that inland fisheries is not only labour intensive and artisanal but also a strategy of risk-spreading of the poor rural households. Though relevant, this study did not assess the ability of inland fisheries to generate revenue for the local or regional economies where fishery resources are located. In Ghana, the Ministry of Food and Agriculture (2002) admitted that the fisheries sub-sector contributes 5 percent of the agricultural share of GDP and 3 percent of national GDP.

2.12 Inland Fisheries and Revenue Generation

Scholars in the fisheries sector are of the view that well managed inland fisheries, can provide revenue to both management and local government. A study carried on Lake Chad and other water bodies by Neiland and Béné (2003) pointed out that the inland fishery sector contributes about 10 percent of GNP. Although livelihoods of fisherfolk are known to be adaptive (mobile and diverse), long-term decline in fishing is a wider concern for rural development because fisheries provide one of the few sources of cash revenue and are therefore a local 'engine of growth' in areas otherwise remote from the cash economy (Allison et al. 2004). Also, a study on Lake Chariba by Njaya (2007) supports the revenue attribute of inland fisheries as the collection of taxes from fishers and traders (appropriators of the commons) provided revenue for the common good of all communities around the fishing area.

2.13 Inland Fisheries Crisis

Inland waters and their species experience myriad direct and indirect stresses in addition to overfishing, including altered flows, environmental and ecological pollution or habitat degradation. Intensive harvesting of fish invariably leads to what known as 'fishing down the food web'.

2.13.1 Neglect of Inland Fisheries

Overexploitation of the world's fisheries is the subject of much recent concern both nationally and internationally (FAO, 2002). However, the discussion of the current fisheries crisis has focused nearly exclusively on marine resources, and to some extent on associated threats to marine biodiversity. In the view of COFAD (2002), the neglect of inland capture fisheries of Sub-Saharan Africa is perceived to be in the area of less development assistance from both African governments and development partners as compared with other sectors of primary production. According to this group, low level of socio-political representation and the fact that inland fisheries are mostly part of the informal sector of the economy have accounted for this. Similarly, Neiland and Béné (2006) concluded from their study that, irrespective of the contribution of fishery as a source of food and means of livelihood, national policies on economic development in many developing countries, often fail to recognise these important attributes. The above literature is useful for the study because policy and resource neglect have negative effects on the income and employment generation potentials of inland fisheries.

The fisheries of inland waters have received only minimal consideration within global analyses (FAO 1999; Kura et al. 2004). In effect, the neglect of specific inland fishery policy contributes to the fishery crisis. In assessing the overfishing of inland waters, Allan et al (2005) confirmed the position of the FAO (1999) and that of Kura et al (2004). However, they went further to count the contributory factors of policy neglect as: unreliability of data and scientific literature in the inland fisheries compared with marine fisheries; small-scale nature of majority of freshwater fisheries; spatially diffuse activities; and a significant part of the production is not commercialised or is marketed only through informal channels and is therefore not properly reflected in national economic statistics. As a consequence, these fisheries are often perceived as a low-value activity. According to MoFA (2006) in Béné (2007), fish production records for dams, dugouts and rivers (except Lake Volta) in Ghana are under-estimated. The reason for this statement is that catch data from representative samples of these water bodies are reported directly as total fish production figures without due adjustments to make up for the total number of water bodies concerned. Based on this, an estimate of 319,000 tonnes

(comprising 251,000 tonnes from the Volta Lake and 68,000 tonnes from other sources) has been proposed for the year 2000, making the contribution of inland fisheries equal to nearly 83 percent of the total marine output of 383,000 tonnes for that year Béné (2007), citing MoFA (2006). This hypothesis (which should be considered with great caution), outlines the extent to which the inland fisheries sub-sector may effectively contribute to economic growth and poverty reduction, a consideration that has hitherto not been recognised.

2.13.2 Environmental and Ecological Problems of Inland Fisheries

In an examination of net loss of fish for the poor in developing countries by Panos (1995), a link was established between the general slump in the inland fishery productivity of rivers and lakes of the Sahel region of West Africa with chemical run-off and drought. According to him, low rainfall over the last 20 years has turned rivers into trickles, and caused lakes to shrink. It supports the findings of an earlier study by Devalatha (1994) on the production and the rate of exploitation of inland fishery resources of Kerala which stated that, ecological factors are largely responsible for the depletion of inland fish wealth in the State. The practical solution of this is a widening of the group of stakeholders and setting up the appropriate structures and legal framework (Allan et al 2005).

Neiland and Béné, (2003) also highlighted the role of severe drought around Lake Chad which has induce a decline in inland fish production. This threatened the position of Chad which was one of the five largest producers of inland fish in Sub-Saharan Africa. It supports an earlier study by FAO (1999) cited in Arlinghaus et al (2002) that human-induced eutrophication, degradation of the environment and loss of aquatic habitat still remain the predominant concerns for the sustainability of inland fisheries. FAO (1999) in Allan et al (2005) is of the view that most inland capture fisheries that rely on natural stock reproduction were overfished or being fished at their biological limit, and that the principal factors threatening inland capture fisheries were habitat loss and environmental degradation. The organisation acknowledged that, overfishing, then, may not always be

the sole or even the primary threat, but in conjunction with other stresses which can make the consequences more serious. Though supported the ecological explanation of inland fishery crisis, Béné (2007) who carried out a study on the Volta Lake concluded that, in addition to reduction in total rainfall there existed the problem of increasing fishers' population, illegal methods of harvesting fish as well as farming along the banks of the lake.

2.13.3 Overfishing

A research conducted by Von Sarnowski (2004) on Lake Albert in Uganda revealed that there was a decline in the size of fish harvested. The same study added that, a decrease in the size of fish is a major indicator for biological overfishing. Like other common property resources, the fisheries of Lake Albert are experiencing the tragedy of the commons where "freedom in the commons brings ruin to all" (Hardin 1968, p. 1244; cited in Von Sarnowski, 2004). Whereas in a well defined property regime fishing effort and yield will not exceed the maximum economic yield, an open access situation will not only lead to economic overfishing but also biological overfishing (Von Sarnowski, 2004).

Contributing on the issue of overfishing, Abila (1998) in Mutunga (2002) expressed that overfishing caused by increased fishing pressure is manifested in the use of small mesh sizes and the existence of destructive and non-selective fishing methods, which interfere with the food chain linkages. In another study in the Kuttanad region, the causes of overfishing or biological overexploitation were identified to exist as a result of: excess fishing effort, use of large quantities of nets and over-crowding in the inland fishing sector, resulting into a decline in the average size of fish. Also, Jose (1999) noted that, the ramification of these is the harvesting of the fishery stock beyond the Maximum Sustainable Yield (MSY) stage.

A study by Allan et al (2005) rather established a link between overfishing of inland waters and the health of human populations as the number of predator fish that feed on vectored snails will decline leading to increase cases of schistosomiasis and cholera. The

issue of overfishing attracted the attention of the international community and in the World Summit on Sustainable Development in 2002, there was an international call to reverse its impacts. A clear link was established between overfishing and the reduction in the amount of fish available to fishers, loss of jobs, increase in the cost of fish and reduction in revenue stream to developing countries (FMSP/MRAG, 2006). This supports a report by Brainerd (1995) cited in Oguntade et al (2007) that most fishery resources in Africa are being overexploited due to increase in real prices of fish, conditions of open access and lack of effective management schemes, high demand for products, technological choices promoting more efficient gear, limited alternative opportunities for labour and capital, breakdown of traditional fishery management systems and barriers to entry and high population growth within fishing communities. In another study by Béné (2007) on the Volta Lake, it was revealed that the lake's fishery resources are seriously overexploited for the past 30 years. Similarly, Kofie and Yiborku (2005) confirmed that one of the key problems in the fisheries sector in Ghana is over fishing, which directly impact on fisheries livelihood through income and profit reduction, increasing competition and conflicts over fishing grounds and resources.

The above literature is relevant for the current study because the more fish is exploited, the more the Catch Per Unit of Effort (CPUE) decreases and as a result a fall in fisherman's income. Though Béné, (2007) linked the issue of overfishing to fishers' income, it failed to assess same on inland fishery employment and revenue generation.

2.14 Measures of Sustainable Inland Fisheries

For the inland fishery subsector to continue its support for income, revenue and employment generation as well as the fight against poverty and food insecurity, some researchers in the field has provided sustainability measures. Though they may not be stereotyped antidote to the fishery crisis, selective application in relation to property ownership regime and the policy orientation of management will enhance economic and biological yields from inland fishery resources.

2.14.1 Fishery Management Approach

The United Nations Food and Agriculture Organisation (1997) cited in Neiland and Béné, (2003) stated that: 'Management should be conducted in a climate of compromise with other users and depends as much on regulations governing their activities as those governing the fishery itself. According to Coates (2007), a sustainable inland fishery management based on ecosystem approach is a suitable measure irrespective of the challenge of low-capacity and data-deficiency in developing countries.

There is a mutual dependency between the goals of improved living conditions and the conservation of the fish resources. Without a sustainable fishery, the living conditions of the fishing communities cannot be improved in the long term. And without consideration of the basic needs of the people, the recovery of the fish stocks and a sustainable fishery cannot be achieved (GTZ, 1997; cited in Von Sarnowski, 2004). However, there is a conflict in the short term when reducing pressure on the fish stocks leads to an immediate loss in the fishermen's and fishmongers' income. The conclusion drawn called for the provision of non-fisheries related income activities in an integrated development approach as a mitigation measure

A study by FAO (1999) recommends the use of closed seasons and closed areas as management strategies as they perceived them to have some acceptability among fisheries resource users. The organisation however emphasised that the timing and duration of closed seasons must consider both the needs of fish stocks and users of fishery resources. However, in assessing the functions of inland fisheries in developing countries, Smith et al (2005) argued that the common measure of increasing fisheries productivity by raising the efficiency of fishing effort (for example, through credit provision and technology transfer) will not raise incomes unless the number of fishers is reduced to maintain a sustainable long run catch rate. However, under open access regime, the strategy of reducing the population of the fishers may be expensive to undertake.

On the question of governance in fisheries, WHAT (2000 p. 8) in Béné and Neiland (2006) concludes that 'effective governance of fisheries requires the assignment of enforceable rights to shares of fisheries. The importance of rights has been well known for decades, yet rights are either ineffective or non-existent for most of the world's fisheries. As a result, many fishery resources have been overfished and tens of billions of dollars in economic benefits are wasted annually'. On the contrary, Béné and Neiland (2006) argued that the depletion of economic rent of a fishery culminating from lack of right of enforcement is an economic issue that has little to do with governance. They asserted that if the usual indicators of good governance are 'transparency', 'accountability and 'participation' then it cannot be likened to management which is charged with 'sustainability', 'biodiversity' or 'conservation'. The assessment of Béné and Neiland (2006) however failed to recognise that effective management of fisheries is influenced by governmental policies and actions.

In the view of Chimatiro et al (2008), fishers and other stakeholders' participation can be enhanced for community-based and co-management strategies which should be informed by relevant research. Allison and Ellis (2001) cited in Smith et al (2005) explained that the characteristics of fishers – the desire for immediate returns, lack of social capital and other assets - suggests that attempts at establishing community-based fisheries management may be inappropriate because of weak incentives for collective action and household assets. Aside promoting sustainable fisheries, fisheries co-management has a basic challenge of reshaping the thinking of government to institutionalise collaboration between administration and resource users (Baland and Platteau, 1996). By way of addressing the phenomenon of non-compliance, triggered by inadequate policy in sustainable fishery resources management, according to Akpalu (2002), necessitated the development of Community Based Fisheries Management Programme (CBFM) to strengthen the existing structures to improve the long-term sustainability of Ghanaian fisheries.

2.14.2 Policy Responses

The growing consensus in the literature on climate change is that the poor are more vulnerable and less able to adapt (UN, 2007). This support an earlier study by Smith et al (2005), which revealed that ecological change does not only affect the fishery income of users of fishery resources but also other alternative income sources which often depend on the opportunities offered by natural resource-based production systems. When climate change results in crop failure or livestock deaths, it is the poor who suffer more (Smith et al. 2005). To reverse this situation and increase the economic potentials of inland fisheries, Allison et al (2007), citing FAO SFLP (2007) acknowledged the use of policy impact strategies and pathways and appropriate level of policy support to enhance the adaptive capacity of fishing communities as a whole. According to Coates (2007), effective policies for the conservation and sustainable use of freshwater biodiversity are generally absent, adaptive policy support mechanisms are required to ensure that reforms realise the potential of local economic development and improve food security benefits.

2.15 Summary

The intellectual debates about the contribution of inland fisheries to the development of riparian communities as well as local and national economies centred on the theoretical foundation of the sector. As developing economies are resource-based in general, the inland fisheries subsector occupies an important position if well managed to generate employment, revenue, income as well as supply of fish food. The established fact that, inland fisheries is not just an ecological resource but also an economic resource is being threatened mainly by policy neglect, ecological degradation and overfishing. If sustainable and responsible fisheries are the desired goals, then stakeholders with direct or indirect interest must be prepared to reshape policies. The concepts that have been discussed in this chapter are those considered relevant for the purpose of achieving the objectives outlined in the previous chapter. The preceding chapter gives the profiles of the Upper East Region, Kassena Nankana and Bongo Districts, research design, the instruments for data collection and data analysis design for the whole study.

CHAPTER THREE

PROFILE OF STUDY AREA AND RESEARCH METHODOLOGY

3.1 Introduction

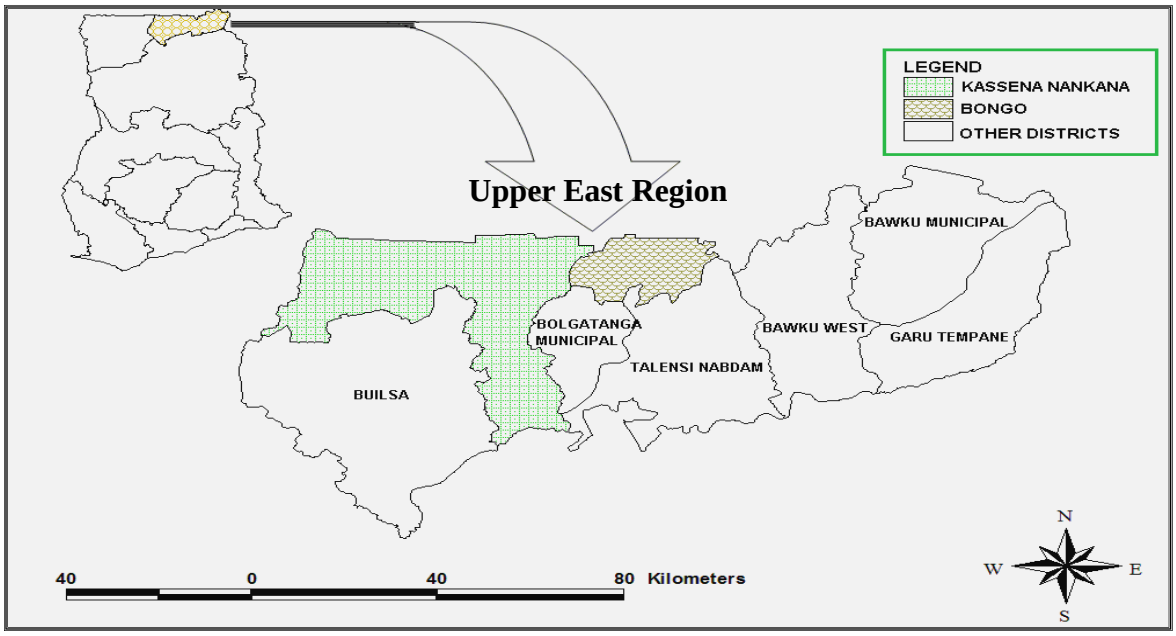
This chapter presents an overview of the profiles of the Upper East Region in general and the Kassena Nankana and Bongo Districts in particular as well as the profiles of the Tono and Vea irrigation projects. It also covers the methodology that has been employed to gather the relevant data for this study. The methodology focuses mainly on the research design, the issue of validity, the concept of population and sampling, sources and methods of data collection and processing, as well as analysis that has been employed to make meaning from the data gathered.

3.2 Profile of Upper East Region

3.2.1 Location and Size

The study region - Upper East Region - is located on the North-East corner of Ghana between latitudes 10º 30′ to 11º North and longitudes 0º to 1º 30′ West within the White Volta River Basin. The Region covers a land surface area of 8,842 kilometres square representing only about 4 percent of the total land mass of the country. It has two international boundaries with the republics of Burkina Faso to the North and Togo to the East. The other boundaries are Northern region and Upper West region to the South and West respectively (Aquastat, 2005).

Figure 3.1 Map of Upper East Region in the National Context



Source: DERF Networks, April 2010

3.2.2 Vegetation and Drainage

The natural vegetation of the Region is that of the savannah characterised by short scattered drought-resistant trees and grass that gets burnt by bushfire or scorched by the sun during the long dry season. The most common economic trees are the sheanut, dawadawa, baobab and acacia. About 85 percent of the entire region fall within the White Volta basin, and the radial drainage system in the Region is produced mainly by the network of the White, Red, and Black Voltas and the Sissile. Also, the Kulpawn River which has its catchment to the south-west of the Region is joined by the Sissile just before its confluence with the White Volta. Besides these, there are other smaller water bodies that give the region a great potential for irrigation development (Aquastat, 2005).

3.2.3 Climate

The climate in Ghana is controlled primarily by the tropical continental air mass and the tropical maritime air mass. The distinct seasons are results of the movement of the Inter-Tropical Convergence Zone (ITCZ) separating these two air masses. The climatic regime

of the study region is influenced by the same air masses. The Upper East Region has a tropical continental or interior savanna climate, mostly influenced by the tropical continental air mass. While the movement of the ITCZ results in two rainy seasons in the southern part of the country, the Upper East Region experience only one, lasting from May to October. As a result, the Region and Northern Ghana receive less rain than the south. The study area receives about 1000 millimetres of precipitation per year (Dickson and Benneh, 1988).

3.2.4 Demographic Characteristics

The structure of the regional population generally depicts a preponderance of females over males. With a growth rate of 2.9, the projected population of the region for 2010 was given as 1,229,595. Out of the Region's total population of 920,089 in 2000, 47.7 percent and 52.3 percent were males and females respectively. Again, going by the 2000 population census, the age structure for the Region shows that 44.7 percent of the Region's population falls under 15 years of age, with 4.4 percent being above 65 years, while 50.8 percent of the rest of the population falls within the 15–64 years group (Ghana Statistical Service, 2000).

3.2.5 Economic Activities

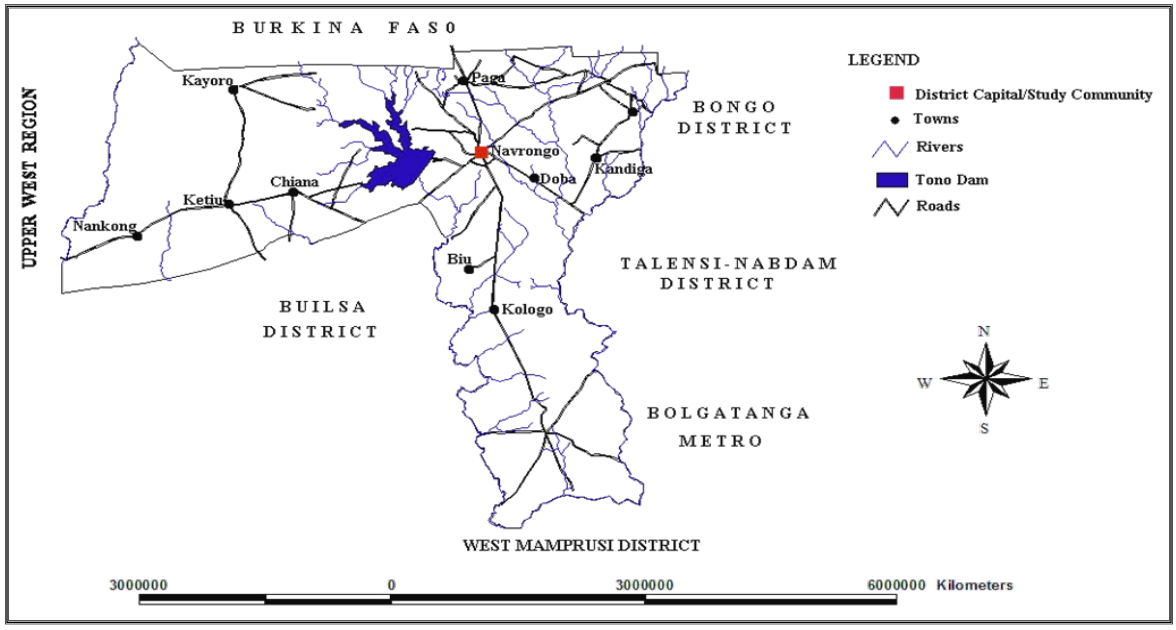
The Region is predominantly agricultural with about 70 percent of the economically active population engaged in livestock rearing, farming or fishing. Having predominantly savanna vegetation, the Region possesses the basic natural requirements for livestock and poultry production. The Region produces about 25 percent of the nation's cattle herd and a sizeable percentage of sheep and goats. There are two major irrigation projects – Tono and Vea - and other 172 dams and dugouts scattered over the region that support agriculture and its related activities. Industrial activity in the region is generally low, with only one industry in operation at the moment. This is the newly built cotton ginnery at Pusu-Namogo (Near Bolgatanga). Others include the erstwhile GIHOC tomato factory (Northern Star Tomato factory) at Pwalugu, the GIHOC Meat Processing factory at Zuarungu and the rice mills at Bolgatanga (Aquastat, 2005).

3.3 Profile of Kassena Nankana and Bongo Districts

3.3.1 Location and Size of Kassena Nankana and Bongo Districts

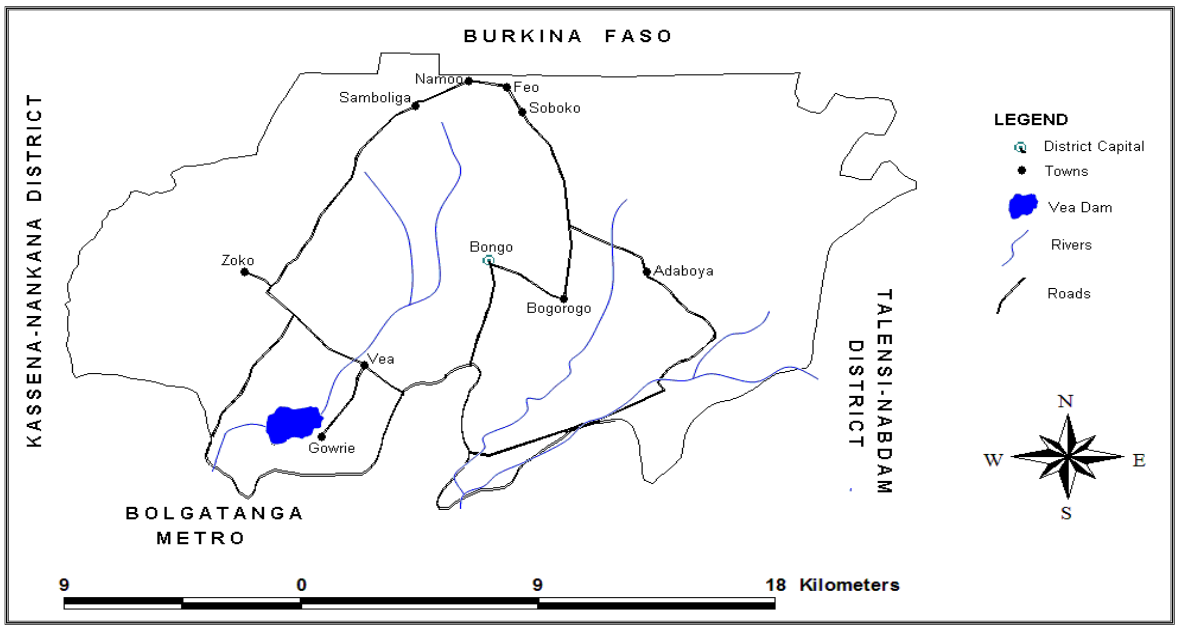
The Kassena Nankana District within which the catchment of the Tono irrigation project is located covers an estimated land mass of 1,674 kilometres square. 80 percent of the land is arable while the remaining 20 percent is covered by forest, rivers, hills and eroded areas. The District falls approximately between latitude 11º10´ and 10º3´ North and longitude 10º1´ West. The District shares boundaries with Burkina Faso to the North, Bongo and Bolgatanga districts to the East, Builsa and Sissala East Districts to the West and West Mamprusi District to the South. On the other hand, the Bongo District under which the Vea irrigation project is located has a land mass of 459.5 square kilimetres and lies between longitudes 0.45º West and longitude 10.50º North. Bongo District shares boundaries to the North with Burkina Faso, Kassena Nankana District to the West and Bolgatanga Municipality and Talensi District to the South (KNDA, 2006; BDA, 2006).

Figure 3.2 A Map Showing Kassena Nankana District



Source: DERF Networks, April 2010

Figure 3.3 A Map Showing Bongo District



Source: DERF Networks, April 2010

3.3.2 Relief and Drainage

With the exception of an inselberg near Bongo (which rises to a height between 92 and 122 metres above the surrounding area), the two study Districts are low-lying with undulating areas and isolated hills, rising up to 300 metres above sea level. The Kassena Nankana District is drained mainly by the tributaries of the Sissile River. In the case of Bongo District, the main drainage system comprises the Atankuidi, Yaragatan-Atanure and the Red Volta. Basically, the District is drained by both the Red and White Volta basins (KNDA, 2006; BDA, 2006).

3.3.3 Climate and Vegetation

The vegetation of the study Districts is classified as a Guinea Savannah Woodland. The vegetation of the two Districts consists of short deciduous trees often widely spaced and a ground flora composed of different species of shrubs of varying heights. However, in the Bongo District, there is a Red Volta Forest Reserve which supports wildlife. Similarly, the Kassena Nankana District has some forest reserves such as Sissile and Asibelika basins and the Kolgo and Naga Forest Reserves (KNDA, 2006; BDA, 2006). The climate

of the study Districts which is not different from that of the Upper East Region is shown in Table 3.1.

Table 3.1 Climatic Characteristics of the Study Districts

Study District	Air Mass	Temperature	Rainfall
Kassena Nankana	Two air masses - North-East Trade Winds and tropical Maritime.	Maximum - 42º Celsius (especially Feb. & March) Minimum - 18º Celsius	Single maxima rainfall (May & October) averaging 950mm per annum
Bongo	Two air masses - North-East Trade Winds and tropical Maritime.	Maximum - 40º Celsius Minimum - 12º Celsius	Single maxima rainfall ranging between 600mm and 1400mm

Source: Author's Construct, April 2010

3.3.4 Soil Characteristics

Two main soil types are recognizable within the Kassena Nankana District. These are the Savannah ochrosols and underground laterite. The Northern and Eastern parts of the District are covered by the Savannah ochrosols, while the rest of the District has underground laterite. The Savannah ochrosols is the most arable site which includes most parts of the Tono irrigation project where both wet and dry season farming activities are concentrated. The underground laterite is estimated to cover 60 percent of the District's land area (KNDA, 2006).

The soil in the Bongo District is developed over Bongo granites which is very productive due to high potash and phosphate content. The two main series of soils in the District are the Yorogo and Zorko series. Generally, the Bongo soils consist of about 3 inches of very slightly human stained, crumbly coarse sandy loam overlying reddish brown, fine blocky, very coarse sandy loam containing occasional incomplete weathered feldspar particles (BDA, 2006).

3.3.5 Demographic Characteristics

The 2000 population and Housing Census gave the population of Kassena Nankana District to be 149,491 with a growth rate of 1 percent. A projection of the District's population from 2000 to 2005 put the population at 157,153 with a male population of 48.1 percent whereas the female population accounted for 51.9 percent of the total. However, in 2010, the population was estimated to be 165,211. On the other hand, the population of Bongo District in 2000 was 77,885 and a growth rate of 2.8 percent. The projected population of Bongo District was 91,949 in 2006. A further projection gave the District's population to be 103,049 in 2010. The male projected population in 2006 was 46.7 percent of the total population while that of the female was 53.3 percent.

3.3.6 Economic Activities

Bongo and Kassena Nankana Districts are predominantly agrarian. In view of this, the construction of the Tono and Vea irrigation dams was to enhance the status of these Districts as food baskets, particularly in the regional context. The main economic activity of the study Districts is agriculture (crop production, animal rearing, fishing and agro-forestry) which provides employment for about 68.7 percent and 58.8 percent of the employable population of the Kassenan Nanakana and Bongo Districts respectively. Public servants, traders, food processors and small-scale artisans account for 31.3 percent of the labour force in the Kassena Nankana District while in the case of Bongo District, it constitute 41.2 percent. The implication of the above situation is that, the income of those in the agrarian sector has a significant influence on the fight against poverty (KNDA, 2006; BDA, 2006).

3.4 Profile of Tono and Vea Projects

The Tono and Vea irrigation projects are some of the strategic investments in the Upper East Region of Ghana. These projects are multi-purpose such that they involve crop production, fish production, tree production, livestock production as well as domestic water supply. The Vea and Tono projects got started in 1960 and 1975 but became fully operational in 1980 and 1985 respectively (Gordon, 2006). Some facts about the irrigation projects are shown in Table 3.2.

Table 3.2 Dams/Reservoir Information of Tono and Vea Irrigations

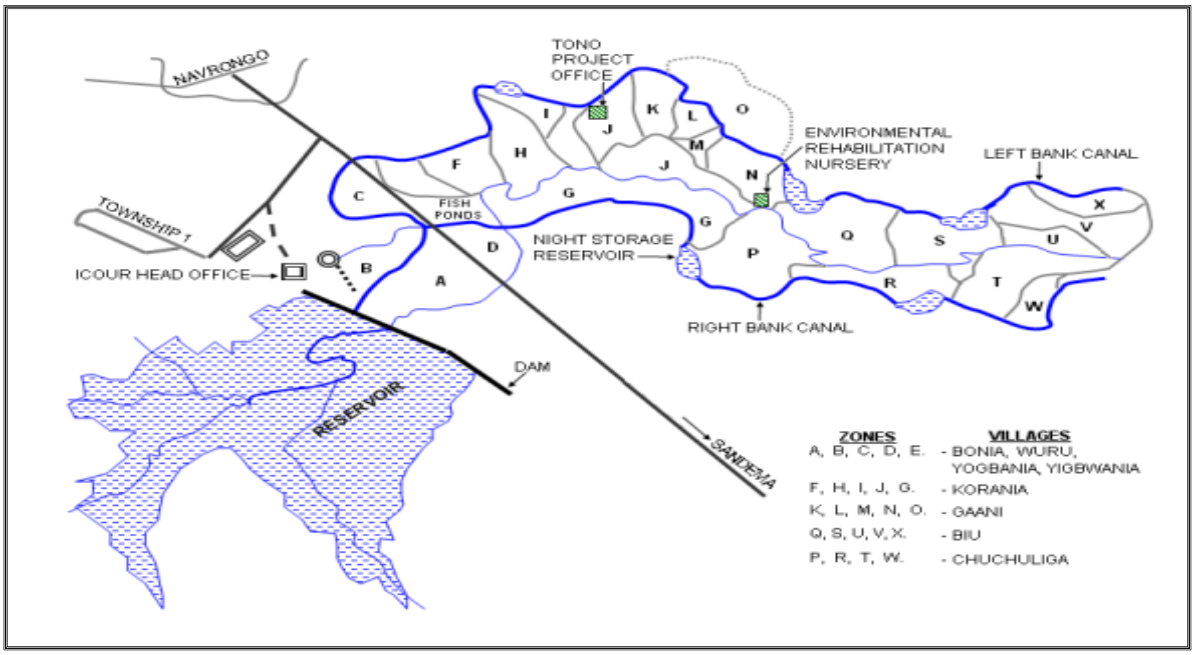
General Information	**Tono**	**Vea**
Catchment Area	650 Km^2	136 Km^2
Reservoir Area	18.6 Km^2	40.5 Km^2
Volume (10^6 m^3)	92.6	17
Gross Project Area	3,860 hectares	1,197 hectares

Source: Adopted from Gordon, 2006

3.4.1 Catchment Communities

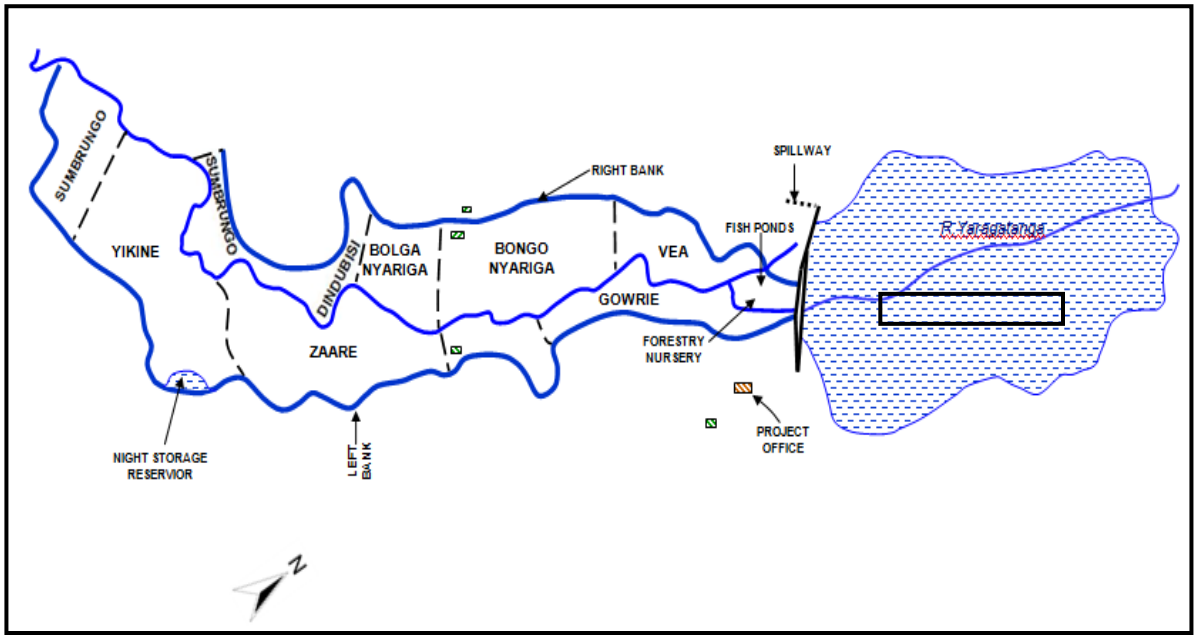
Operating on the idea of common resource, the fisheries of the Tono and Yarigatanga rivers were being exploited by several people and communities. The catchment communities of Tono irrigation are Bonia, Wuru, Yigbwania, Yogbania, Korania Gaani, Biu and Chuchuliga while those of Vea are Vea, Gowrie, Bongo Nyariga, Bolga Nyariga, Dindubisi, Zaare, Yikine and Sumbrungu (See Figure 3.4 and Figure 3.5). However, people from outside these catchment communities have access to the irrigation facilities as well as harvesting of fish (ICOUR, 1995). Appropriate examples are Balunge and Bongo Kukua in the case of Vea project.

Figure 3.4 Map of Tono Irrigation Project Site



Source: DERF Networks, April 2010

Figure 3.5 Map of Vea Irrigation Project Site



Source: DERF Networks, April 2010

3.5 Research Methodology

3.5.1 Research Design

A case study research design was employed for this study to investigate how the inland fisheries of the Tono and Vea reservoirs have contributed to employment, income of fishermen and fishmongers and the revenue of catchment Districts. The case study research design is the blueprint that enables the researcher to come up with solutions to the research problem and provides a guide throughout the various stages of the research. It is seen as the field strategy, procedure and the steps that help the investigator to seek information and analyse his evidence in the scientific way (Yin, 1994, cited in Sharma and Lawrence, 2005).

3.5.2 Case Study Approach

Definition of Case Study: A case study is seen as a systematic way of in-depth collection of information or investigating the circumstances of a person, a group, a community, an institution, or an incident. This requires a comprehensive examination, a critical analysis and interpretation of available data or information on the real situation of a particular issue, event, occurrence or problem (Kumekpor, 2002 p. 100). In contributing to the definition of a case study, Kumar (1999 p. 99) stated that "it is an approach to studying a social phenomenon through a thorough analysis of an individual case". The case may be a person, group, episode, process, community, society or any other unit of social life. A qualitative case study is an approach to research that facilitates exploration of a phenomenon within its context using a variety of data sources (Baxter and Jack, 2008).

Philosophical Underpinning of Case Study: From the work of Yin (2003), a case study approach is based on a constructivist paradigm. Constructivists claim that truth is relative and that it is dependent on one's perspective. This paradigm 'recognises the importance of the subjective human creation of meaning, but doesn't reject outright some notion of objectivity. Pluralism, not relativism, is stressed with focus on the circular dynamic tension of subject and object' (Miller and Crabtree, 1999, in Baxter and Jack, 2008). Constructivism is built upon the premise of a social construction of reality. One of the

advantages of this approach is the close collaboration between the researcher and the participant, while enabling participants to tell their stories. Through these stories the participants are able to describe their views of reality and this enables the researcher to better understand the participants' actions (Robottom and Hart, 1993, cited in Baxter and Jack, 2008).

Rationale behind the Case Study Approach: The case study approach was employed due to the fact that it provided a basis for an empirical enquiry that allows the researcher to investigate and understand the role of inland fisheries in the economic life of the fishers. It created the avenue to use multiple sources of evidence, thus improving the quality of data for the study as it allows triangulation. Also, it afforded the researcher the opportunity to study inland fishery income, employment and revenue within a real life situation (Frankfort-Nachmias and Nachmias, 1996).

A case study provides an opportunity for intensive analysis of many specific details often overlooked by other methods. This approach rest on the assumption that the case being studied is typical of cases of a certain type so that, through intensive analysis, generalisations may be made that will be applicable to other cases of the same type (Kumar, 1999). Again, since the researcher has very little control over the phenomena being investigated- employment, income and revenue - the case study approach is appropriate for the retrospective assessment of the phenomena. This provides precedence, as well as sources of reference for future cases (Kumekpor, 2002). Finally, this approach enabled the researcher to learn from practice that has enhanced a better understanding of the underlying theories of Common-pool Resource, Game Theory and Bioeconomic Model.

Shortcomings of the Case Study Approach: Just like any other research design, the case study design has both advantages and weaknesses in conducting a qualitative research. These shortcomings, if not well managed, can mar the validity, credibility and reliability of observations made from field data. The chosen design (case study) has no control over

extrinsic and intrinsic factors. More so, it does not allow for before-after experimental group comparison. In fact, the case study method is limited by lack of adequate control over rival explanations, therefore weak on internal validity (Frankfort-Nachmias and Nachmias, 1996). Case studies often contain a substantial element of narrative. Accordingly, such narratives may be difficult or impossible to summarise into neat scientific formulae, general propositions, and theories (Mitchell and Charmaz, 1996, quoted by Flyvbjerg, 2004).

3.5.3 Validity

The ability to adequately measure or provide the real meaning of concepts under consideration affects the validity of research findings. Validity, as defined by Smith (1991) in Kumar (1999), is the degree to which the researcher has measured what has been set out to measure. According to Frankfort-Nachmias and Nachmias (1996), validity is the degree to which a measuring instrument measures what it is supposed to measure. A method can be reliable, consistently measuring the same thing, but not valid. The researcher maximised validity by establishing the logical link between the objectives of the study and the questions used. In research, validity has two essential parts - internal and external – for the practical objective of ensuring quality in the research process.

Internal Validity: Internal validity encompasses whether the results of the study (e.g. mean difference between treatment and control groups) are legitimate because of the way the groups were selected, data was recorded or analysis performed (Last, 2001). According to Frankfort-Nachmias and Nachmias (1996), internal validity is established when the researcher is able to explain whether changes in the independent variable did in fact cause the dependent variable to change. A common threat to internal validity is reliability. A typical strategy that was used by the researcher to improve the research findings was triangulation. Golafshani (2003), citing Mathison (1988) elaborates this by saying that triangulation has risen an important methodological issue in naturalistic and qualitative approaches to evaluation as it controls biases and establishes valid propositions.

External Validity: In social research, the concern is not only with the effect of one variable on another but also its effect on other natural settings. External validity, according to Frankfort-Nachmias and Nachmias (1996) is the extent to which the research findings can be generalised to larger populations and applied to different social or political settings. External validity, often called 'generalisability', involves whether the results given by the study are transferable to other groups or populations of interest (Last, 2001). The issue of external validity is compromised by ignoring representativeness of the sample. To ensure that external validity is maximised, random sampling techniques was employed not only to increase the representativeness of the sample size but also to apply the findings from this study to other inland fisheries.

3.5.4 Key Variables and Units of Analysis

According to Kerlinger (1986) in Kumar (1999), 'A variable is a property that takes on different values'. Also, Black and Champion (1976) defined a variable as, 'rational units of analysis that can assume any one of a number of designated sets of values'. In this study, the main variables used include but not limited to gender, tonnes of fish catch, employment created by the fishery subsector, income, revenue, fishing effort, accessibility to fishery stock, vegetation around the dams and off-fishing work and income. The units of enquiry in this research include, District Assemblies, ICOUR, MoFA, Fishermen and fishmongers.

3.5.5 The Concept of Population and Sampling

Methodologically speaking, the entire set of relevant units of analysis or data is called the population. In other words, population is the entire group or set of cases that a researcher is interested in generalising (Frankfort-Nachmias and Nachmias, 1996). In this study the population of interest was all registered fishermen and fishmongers of the Tono and Vea irrigation projects.

Sampling on the other hand is the process of selecting a few (sample) from a bigger group (the sampling population) to become the basis for estimating or predicting a fact,

situation or outcome regarding the population (Kumar, 1999). Sampling is a research technique through which investigators study a manageable number of people, known as the sample, selected from a larger population or group. A sampling procedure that is accurately carried out enhances the external validity of the results. However, error in sampling may compromise the level of accuracy in conclusion or findings of the research. A sample is representative if the analyses made using the researcher's sampling units produce results similar to those of its population. The basic technique that was used to increase the representativeness of the sample was random sampling.

3.5.6 Sampling Design

The scheme employ by an investigator to select a particular sample expresses the sampling design. In this study, a multi-stage sampling technique was adopted for the study at different stages of sampling. Respondents were selected on the basis of probability and non-probability procedures. The two Districts that have Tono and Vea reservoirs within their administrative boundaries, MoFA and ICOUR were purposively selected but the selection of respondents from ICOUR, MoFA and the District Assemblies were based on the willingness to answer the questions. In all, twenty-five (25) agreed to answer the questionnaire. Also, catchment communities were identified purposively (thus communities with three or more registered fishermen and fishmongers) while simple random sampling was used to select four (4) communities each within the catchment of Tono and Vea reservoirs. As sample frame of fishermen and fishmongers was available, a systematic sampling was used to select ninety-two (92) fishermen at Tono and thirty-one (31) at Vea from the frame. The same technique was employed to select fifty-nine (59) and ten (10) fishmongers of Tono and Vea reservoirs respectively. Traditional and specialised knowledge on fishery were tapped from key informants through purposive sampling technique.

3.5.7 Sample Size Selection from the Frame

In selecting the respondents, a proportional stratified sampling was used for the study. To ensure representativeness of each category of respondents, a formula of n/N was used to determine the sample size of fishermen and fishmongers. This constitutes 50 percent of each stratum as indicated in Table 3.3.

Table 3.3 Sample Size Determination for the Study

Category of Respondent	Reservoir	Community	Sample Frame	Sample Determination	Sample Size
Fishermen	Tono	Navrongo	56	½ x 56	28
		Chuchuliga	39	½ x 39	20
		Bonia	50	½ x 50	25
		Wuru	38	½ x 38	19
	Total		**183**		**92**
	Vea	Vea	17	½ x 17	9
		Gowrie	19	½ x 19	10
		Balunge	15	½ x 15	7
		Bongo Kukua	11	½ x 11	5
	Total		**62**		**31**
Sub-Total (A)			245		123
Fishmongers	Tono	Navrongo	32	½ x 32	16
		Chuchuliga	29	½ x 29	15
		Bonia	35	½ x 35	18
		Wuru	21	½ x 21	10
	Total		**117**		**59**
	Vea	Vea	3	½ x 3	1
		Gowrie	7	½ x 7	4
		Balunge	6	½ x 6	3
		Bongo Kukua	4	½ x 4	2
	Total		**20**		**10**
Sub-Total (B)			137		69
Grand Total (A + B)			**382**		**192**

Source: Author's Construct, April 2010

3.5.8 Data Collection Method

A hallmark of case study research is the use of multiple data sources, a strategy which also enhances data credibility. Unique in comparison to other qualitative approaches,

within case study research, investigators can collect and integrate quantitative survey data, which facilitates reaching a holistic understanding of the phenomenon being studied (Yin, 2003). In this study both quantitative and qualitative methods were employed for data collection. This approach was similar to the view of Flyvbjerg (2004) that, more often than not, a combination of qualitative and quantitative methods will do the task best. Logical empiricists also take the position that social scientists can attain objective knowledge in the study of the social as well as the natural world (Frankfort-Nachmias and Nachmias, 1996). To have a comprehensive assessment of inland fisheries of the Tono and Vea reservoirs, the quantitative and the qualitative methods were combined.

Secondary Data Collection: The secondary sources of data created the avenue for the understanding and conceptualisation of the concept, Bioeconomic Efficiency. To do this, text books, articles, reports, magazines and journals, among other sources were analysed. Specifically, secondary data were gathered from the annual reports and records of fish catch of the Irrigation Company of Upper Region (ICOUR) and the District offices of the Ministry of Food and Agriculture (MoFA). The profile of the study Districts and population census data were obtained from District Assembly planning reports while relevant data on inland fisheries were obtained from text books and the internet.

Primary Data Collection: The study basically employs two instruments to carry out the investigation so as to gather the appropriate data. The main primary data collection instruments were observation and interview techniques (structured, semi-structured and unstructured questionnaire) of gathering information. Observation is a purposeful, systematic and selective way of watching and listening to an interaction or phenomenon as it takes place (Kumar, 1999). Specifically, non-participant observation was used in the study to gather information about the vegetation around the dams and the size of fish being harvested from the reservoirs.

The second instrument that was employed to collect data was interview. According to Moser and Kalton (1971) an interview is a conversation between interviewer and the respondent with the purpose of eliciting certain information from the respondent. Cohen (1976) adds that like fishing, interviewing is an activity requiring careful preparation, much patience, and considerable practice if the eventual reward is to be a worthwhile catch. This instrument helped to collect in-depth information about the contribution of the inland fisheries of Tono and Vea to income and employment generation. This approach was also used to elicit information on the accessibility of the fishermen to the fishery stocks. Structured interview was used to collect information on tonnes of fish catch, income of fishermen and fishmongers, employment, fishing effort and off-fishing work. However, unstructured interview was employed to gather information from the staff of KNDA, BDA, ICOUR and MoFA. Focus discussion with fishermen and fishmongers' groups was used to confirm or correct information that was gathered through structured interviews and observation. Also, the semi-structured interview was used to seek specialised information from key informants about the traditional ways of regulating the use of the fishery stock for income, employment and fishery sustainability.

3.5.9 Data Analysis Design

The research employed both descriptive and inferential statistics in analysing both the secondary and primary data. To assess the economic dimensions of the inland fishery of Tono and Vea reservoirs, descriptive statistics was employed to organise and analyse the qualitative data by using tables, graphs and percentages where applicable. The analysis of primary data largely involved data disaggregation, cross-tabulation and time-series analysis. The descriptive statistics covered income, employment, revenue, off-fishing work, access to fishery stocks, and the average tonnes of fish catch per effort. To be able to make valid and reliable inferences from the observation, the researcher employed cross-tabulation to assess catch and income, quantity of gear and catch and fishing effort and catch. In both descriptive and inferential statistics, the Statistical Package for the Social Sciences (SPSS) software was used.

CHAPTER FOUR

ANALYSIS OF INLAND FISHERIES IN THE KASSENA NANKANA AND BONGO DISTRICTS

4.1 Introduction

This chapter presents an analysis of data on inland fisheries of the Tono and Vea reservoirs in the Kassena Nankana and Bongo Districts respectively. The key areas of the analysis covers the type of access to the Tono and Vea fisheries, tonnes of fish catch, the number of fishermen and fishmongers employed, the annual average income, revenue to the catchment Districts, fishing effort, closed season jobs, as well as perception of fishermen and fishmongers on sustainability. The analysis has been categorised into three, with the first section covering the analysis of institutional and specialised views, while the second and the third section present the analysis of data from fishermen and fishmongers respectively.

4.2. Institutional Analysis of Tono and Vea Fisheries

This section presents the issues concerning management of the inland fishery of the reservoirs and the direct and ancillary employment that has been created. This starts with an assessment of the views and perceptions of MoFA, DAs and ICOUR personnel on the management of the Tono and Vea fisheries. The major issues that were identified and examined include access to the reservoir fisheries, tonnes of fish catch, revenue, employment, strategies for participation, effective inland fishery policy, integrating water and land uses and prospects of the fisheries.

4.2.1 The Nature of Access to the Reservoirs

An interview with the District fishery officers of MoFA of the study Districts indicated that fishermen have access to the Tono and Vea either by registering with MoFA or ICOUR. Interaction with revenue collectors and District Finance Officers of KNDA and BDA indicated that they had no idea about the nature of access to the reservoirs. However, the monitoring officer of ICOUR, Mr. Gyim Boateng was of the opinion that the fishery of the Tono and Vea reservoirs is open to the general public. This view is not

different from that of the chief fisherman at Gowrie in the Bongo District. From the view of ICOUR personnel interviewed, fishermen and fishmongers are supposed to register for the purposes of management and monitoring irrespective of the existence of open access. Under such situation no rational fisherman will conserve the fish stocks, as there is no guarantee that his competitors will do the same.

4.2.2 Records of Fish Catch

As part of monitoring measure, daily catch of fish was being recorded by the management of the Tono and Vea irrigation projects. Aside enhancing management decision and controlling overfishing, the daily records of fish catch help to improve on compliance of the use of the right fishing gear and methods. For the past six (6) years, this activity has become a key responsibility of the fishery sector of MoFA in the study Districts.

Table 4.1 Forecast of Fish Catch (Tono and Vea Reservoirs) for 2015

Year	X	Catch (Y) -Tono	X^2	XY-Tono	Catch (Y) Vea	XY-Vea
2000	0	41.01	0	0	25.46	0
2001	1	38.13	1	38.13	24.50	24.50
2002	2	26.50	4	53.00	48.90	97.80
2003	3	43.05	9	129.15	44.50	133.50
2004	4	109.13	16	436.52	36.25	145.00
2005	5	148.75	25	743.75	56.92	284.60
2006	6	38.30	36	229.80	21.35	128.10
2007	7	53.17	49	372.19	33.92	237.44
2008	8	45.94	64	367.52	22.35	178.80
2009	9	79.96	81	719.64	20.76	186.84
∑	**45**	**623.94**	**285**	**3,089.70**	**334.91**	**1,416.58**

Source: ICOUR and MoFA, April 2010

Calculation from Table 4.1 (see Appendix A) gave the values of 'ao' and 'ai' (the constant) for Tono reservoir as 47 and 3.4 respectively. Based on these values, a forecast for 2010 and 2015 was made. The value of the independent variable ('X') would be 11 in 2010 hence, the forecast of tonnes of fish catch (dependent variable) was estimated to be 84.40 while that of 2015 was 98 tonnes (thus, an increase of 16.1 percent).

In the case of Vea, the calculated values of 'ao' and 'ai' are given as 20.3 and 2.9 respectively. Even though there has been a consistent decline in the tonnes of fish catch between 2007 and 2009, forecasting puts fish catch from the reservoir in 2015 to be 63.8 tonnes. Since annual average growth rate of price of fish (13.1 percent) was higher than that of tonnes of fish catch (7.4 percent), create a false condition of sustainable yield (See Appendix H). Within the next five (5) years, catch from the two reservoirs will neither surpass nor equal the peak catch in 2005. The peak was explained by the use of illegal methods of harvesting fish. This will affect both income and employment offered to fishermen and fishmongers. However, between 2000 and 2009, fish catch increased by 51.5 percent. The growth rate of catch was 5.9 percent and 2.5 percent for Tono and Vea reservoirs respectively (See Appendix A).

4.2.3 Contribution toward Institutional Revenue

ICOUR, one of the main stakeholders in the management of the Tono and Vea reservoirs is supposed to generate revenue to supplement government subvention. In the same way, the fishery sector was supposed to earn revenue for the catchment Districts. The opposite was what the study revealed. In the view of Mr. Sebastian Chirasoe Waltia (Acting District Fishery Officer-KNDA), a collaboration between his outfit and the District Assembly to collect tax from the fishermen was resisted. He however added that the fishmongers do pay market tolls. An earlier interaction with The District Finance Officer of Bongo District also revealed that the Assembly has not made any attempt to tax the fishermen of the Vea reservoir. In effect, the catchment Districts have not seen the fishermen as a source of revenue. However, the fisheries has lost potential revenue of about GH¢12,739.45 and GH¢6,911.25 from Tono and Vea reservoirs fishers (See Appendix H). From the perspective of MoFA, political will from the catchment Districts

was one of the reasons for not effectively capturing the fishermen and fishmongers for revenue mobilisation. This revelation was at variance with a study by Njaya (2007), who asserted that taxes from fishers and other traders provided revenue for the common good of all communities around the fishing area of Lake Chariba.

4.2.4 Assessment of Fishery Employment

Drawing from the work of FAO (2004) in Tetteh (2007), the views of management of the inland fisheries of Tono and Vea were analysed. The total number of registered fishermen and fishmongers of Tono and Vea was 382 (245 fishermen and 137 fishmongers). With a projected potential labour force population of 146,607 (BDA = 58,634 and KNDA = 87,973) for the study Districts, the fishery subsector of MoFA and ICOUR offered employment for just 0.3 percent of the labour force. Considering the registered users of the reservoirs, they provide employment to only a small number of the labour force. However, comparing this to the whole country, it was realised that, out of the estimated 30,000 people employed in the inland fishery sector (Tetteh, 2007), 1.3 percent was offered employment by the Tono and Vea reservoirs.

4.2.5 Management System of the Reservoirs

Under Ghana Fishery Resource Management Policy, District Assemblies work in collaboration with the District department of MoFA and other administrative bodies for the management of fisheries. This was not the case in the study Districts. The management system for the Tono and Vea reservoir fisheries involves mainly ICOUR and MoFA of Kassena Nankana and Bongo Districts. Information on closed season and the use of the right mesh size are usually given as annual rituals without the involvement of the registered fishermen and fishmongers. This gave rise to non-compliance and flouting of ban on fishing activities during the closed season. As suggested by the District Fishery Officer of Bongo, one of the measures to curb this phenomenon of non-compliance is community-based fisheries management and increasing the strength of staff of the fishery subsector for effective monitoring. This confirms the view of

Chimatiro et al (2008) that fishers and other stakeholders' participation is significant for community-based and co-management strategies.

Whereas Béné and Neiland (2006) saw depletion of fish stock solely as an economic problem, institutional views from the study revealed that the participation of the fishery resource users have direct relationship with catch and economic rent. This is shown in Table 4.2 as a comparison was made between levels of involvement of fishers and fish catch.

Table 4.2 Fishery Management Approach and Fish Catch

	Category of Cooperation of Fishermen					
	Condition	**Percent**	**Cooperative**	**Poor Cooperation**	**Non-Cooperation**	**Total**
Tonnes of Fish Catch	Increase in catch	Count	5	0	0	5
		% of Total	20	0	0	20
	Increase in size of fish catch	Count	3	1	0	4
		% of Total	12	4	0	16
	Fluctuation in tonnes of fish catch	Count	0	2	1	3
		% of Total	0	8	4	12
	Decline in catch	Count	0	1	3	4
		% of Total	0	4	12	16
	Increase in catch and size	Count	8	0	0	8
		% of Total	32	0	0	32
	Uncertain	Count	0	1	0	1
		% of Total	0	4	0	4
	Total	Count	16	5	4	25
		% of Total	64	20	16	100

Source: Field Survey, May 2010

Apart from the consideration of economic returns from fish, the levels of participation of the primary stakeholders (fishers) influence their cooperation. About 32 percent of the respondents from the institutions supported the idea that when users cooperate in the enforcement of fishing regulation, both catch and size of fish harvested increase. Unilateral decision which violates compliance with restricted mesh size and ban on fishing in the spawning period affect the principle of maximum economic yield. In the

view of ICOUR, the non-payment of fees by the users of the reservoirs was due to inadequate cooperation which often leads to overfishing and decline in returns. Non-cooperation as a challenge was also spurred by lack of alternative income activities and increasing number of fishermen.

4.2.6 Inland Fishery By-laws

The policy objective of national fisheries stresses on addressing the problems of overexploitation and unsustainable fisheries. At the District Assembly level, the study revealed that there were no specific regulations or by-laws to reflect the local reality of the inland fishery resources. This situation was pointed out by Neiland and Béné (2006) that the fishery sector is assigned a marginal role hence, policy failure to recognise its importance. The institutional view was that, Tono and Vea irrigation projects are national projects and as such should be regulated by the general inland fishery regulatory framework in Ghana. However, the territorial use rights and local structures for improving the socio-economic conditions of reservoir-side communities through proper regulations and monitoring by the catchment Districts, MoFA, ICOUR, Fishermen and fishmongers, traditional political institutions as well as other stakeholders have been neglected.

4.2.7 Multiple Use of Water

There was an acknowledgement by the respondent from ICOUR, District Finance Officer and MoFA of Bongo District that Tono and Vea irrigation dams are composite, which provide water for irrigation, domestic use, afforestation as well as fishing. The allocation of water for the multiple uses affects the aquatic life including fish. An interview with the District MoFA officer for Bongo showed that excessive drawing of water for crop production and improper use of the spill ways affect the fishery resources of the reservoirs.

4.2.8 Performance Assessment of the Fishery at the Institutional Level

The performance analysis at the institutional level centred on perception about the fishery on the key variables of the study. The combined effects of non-compliance and rainfall variability played a vital role in fulfilling the objectives of employment and income generation, source of food and fighting against poverty. It was realised that, greater proportion of catch goes into self-consumption while those marketed are mostly through informal commercial channels. These, according to Allan et al (2005) make inland fishery low-value economic activity.

Table 4.3 Institutional Level Performance Matrix of the Fishery

Performance Variable	**Scores of Performance**				
	ICOUR	**MOFA**		**DAs**	
		KNDA	**BDA**	**KNDA**	**BDA**
Fish Catch	2	1	1	2	1
Monitoring	2	2	1	0	0
Employment	1	1	2	0	0
Revenue	0	0	0	0	0
Food Security	2	2	2	1	1
Poverty Reduction	1	1	2	0	0
Total Score	**8**	**7**	**8**	**3**	**2**
Maximum Score	**18**	**18**	**18**	**18**	**18**
Percent Score (%)	**44.4**	**38.9**	**44.4**	**16.7**	**11.1**

Source: Field Survey, May 2010

NOTE: *Satisfactory Performance = 3, Moderate Performance = 2, Low Performance = 1 and Non/poor Performance = 0*

Institutional perceptions of the Tono and Vea fisheries were assessed not only for current performance but also to provide a framework to redirect policy/bye-laws for sustainable management. Across the performance variables of fish catch, monitoring, employment, income and among others, ICOUR and MoFA of Bongo District Assembly rated the

fisheries with a performance score of 44.4 percent. However, respondents from BDA (11.1 percent) viewed the fisheries to be under-performing. It must be acknowledged that although the BDA is a stakeholder in the management of the Vea reservoir fisheries, it had very weak working relationship with the fishermen, ICOUR and MoFA. This was translated into poor performance in revenue generation from the fisheries.

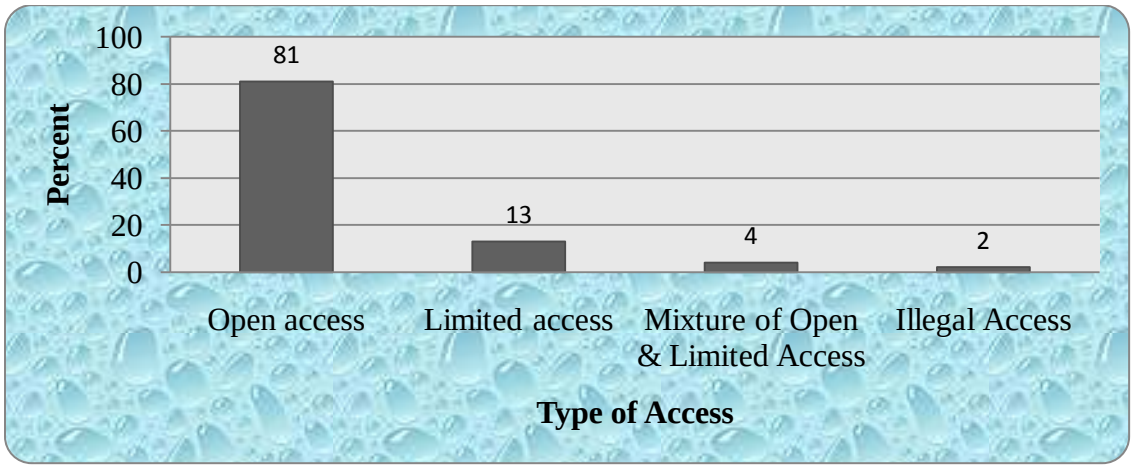
4.3 Analysis of Data – Fishermen

This section presents an analysis of the variables of the study from the perspective of the fishermen. The key variables examined include accessibility, employment, income, fishing effort and Supplementary activities and income. Also, issues of performance, sustainable fishery and the core problems facing the fishermen are presented in this section.

4.3.1 Access to the Fishery

Prior to the construction of the Vea and the Tono irrigation dams, River Tono and Yarigatanga were being used as a common property where the rules do not exist or were not enforced to limit the use of the resource. This is similar to what Baland and Platteau (1996) reported. A discussion with an ex-fisherman in Chuchuliga showed that fishing was seen as the occupation of some particular clans. However, anybody with the skills has access to the fisheries of the Tono reservoir. Similar to findings of Von Sarnowski (2004), some of the fishermen acknowledged the link between open access situation, a reduction in catch and economic inefficiency. The open access condition gave rise to insufficient law enforcement, increase fishing effort and increase investment with a declining economic return.

Figure 4.1 Type of Access to the Reservoir by Fishermen



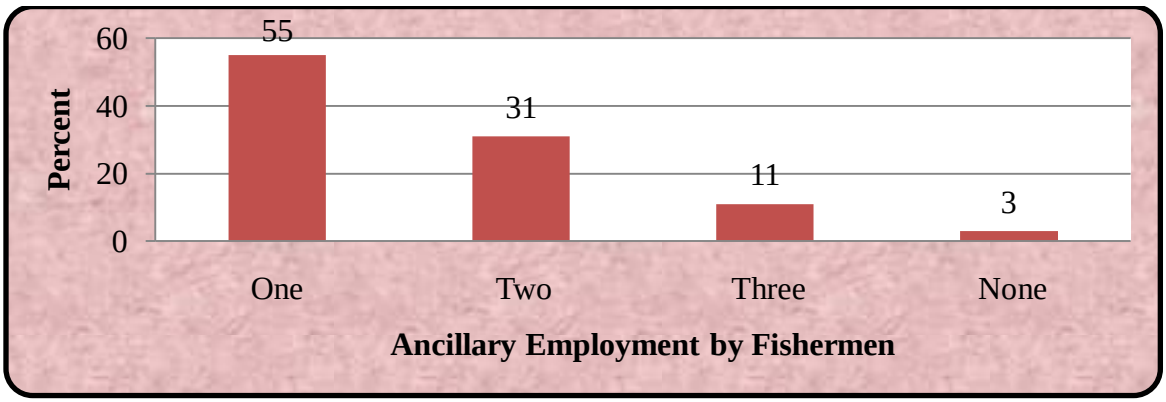
Source: Field Survey, May 2010

The existence of modern system of management over the fishery of Tono and Yarigatanga Rivers has not changed the nature of access to the reservoirs. As high as 81 percent of the fishermen acknowledged that any member of the riparian communities could exploit fish from the reservoirs and that the registration of fishermen is for monitoring purpose. A discussion with fishermen and fishmongers at Bay two (2) of the Tono reservoir (see Plate 4.2) confirmed this assertion. As noted by Ostrom (1990), the existence of open access will not only lead to overexploitation but also "tragedy of the commons". It has been revealed from Figure 4.1 that 13 percent of the fishermen saw the nature of access to be limited for the fact that both ICOUR and MoFA on annual basis implement closed season and monitor the use of under size mesh. However, 2 percent of them access the reservoirs illegally. Though the reservoirs are seen as national assets and can be accessed by every Ghanaian, data collected indicated that harvesting of fish was being carried out by ethnic groups within the catchment of the irrigation facilities. Of the 123 sample registered fishermen, about 60 percent, 25 percent, 11 percent and 4 percent were from the Kassena, Grunsi, Builsa and Nankani ethnic groups respectively. Although national in character, the study indicated that the reservoir fisheries are opened to ethnic groups within their catchment.

4.3.2 Direct and Ancillary Employment

Allan et al (2005) citing Kura et al (2004) stressed the importance of fishing and the activities surrounding it as a means of providing employment. Apart from the 245 fishermen engaged directly in fishing, there are others who are employed in ancillary activities of net repairs, boat making, basket weaving and the sale of fishing gear. In relation to male labour population (as fishing was male bias) of 67,414 in the study Districts, about 0.4 percent had direct employment from the fishery. About 55 percent of the fishermen specified that they provide ancillary employment for one person from the household. Another 31 percent and 11 percent has been engaging two and three people respectively. It was just 3 percent of them who do not offer ancillary employment for any household member (See Figure 4.2).

Figure 4.2 Number of Household Members Indirectly Engaged in the Fishery



Source: Field Survey, May 2010

This implies that the inland fisheries of Tono and Vea reservoirs have ripple effect as far as employment creation was concerned. This promotes the equitable distribution of the benefits of fishery resources. From the point of view of some fishermen at Gowrie, Wuru and Balunge, the employment function of the fishery could even be extended to food sellers who use fish as their input. However, a meeting with fishermen at Bonia revealed that the present and future employment capacity of the reservoir is greatly influenced by rainfall.

4.3.3 Fishing Effort and Income

Drawing from the Bioeconomic model (Gordon 1954), the time spent in fishing and the resultant rent or income of fishermen was analysed. As the time spent on the reservoir is not regulated by management, fishermen would want to maximise their income by spending more time in fishing. Form Table 4.4, about 5.7 percent of the fishermen spent 2 hours or more fishing and earned an annual average income between GH¢900 and GH¢1,099 in 2009. Another 5.7 percent of the respondents spent less than 30 minutes fishing per day and equally earned the least income range of GH¢100 to GH¢299. This confirms the claim by Smith (1969, in Mutunga, 2002) that, change in total effort in a fishery is proportional to the change in the fishery's current profits. Besides the positive correlation between fishing effort and rent, the study equally revealed that the continuous existence of high fishing effort in a bid to earn more income contribute to increasing economic inefficiencies particularly in the month of March and April. This is due to the fact that in March and April, there is an increase demand for the reservoir water for domestic and crop production.

Table 4.4 Income as a Function of Fishing Effort in 2009

			Annual Average Income (GH¢)					
	Fishing Effort	**Percent**	**100-299**	**300-499**	**500 – 699**	**700 - 899**	**900-1,099**	**Total**
Average number of minutes/hour per fishing effort	Below 30 min	Count	7	3	0	0	0	10
		% of Total	5.7	2.4	0	0	0	8.1
	30 - 59 min	Count	0	3	5	1	0	9
		% of Total	0	2.4	4.1	0.8	0	7.3
	1hr - 1:29min	Count	0	21	13	11	2	47
		% of Total	0	17.1	10.6	8.9	1.6	38.2
	1hr:30 min-1hr:59 min	Count	0	0	15	9	13	37
		% of Total	0	0	12.2	7.3	10.6	30.1
	Above 1hr: 59min	Count	0	3	0	10	7	20
		% of Total	0	2.4	0	8.1	5.7	16.3
	Total	Count	7	30	33	31	22	123
		% of Total	**5.7**	**24.4**	**26.8**	**25.2**	**17.9**	**100**

Source: Field Survey, May 2010

The case for the relationship between tonnes of fish catch and quantity or the number of fishing gear used was not different from what has been exhibited in Table 4.4. Like any other economic decision, the decision of users of the Tono and Vea reservoirs to invest in gear was influenced more by high tonnage of fish harvested. Appendix B is a pointer to the fact that the fishermen whose annual catch ranged between ten (10) and twelve (12) tonnes in 2009 were those who used either four (4) or more different sizes of fishing gear. It was obvious from the study that as high income was a key motivation of every fisherman, and that there was a positive relationship between "catch-income" and "catch-gear", the desire to acquire more gear became prominent. This could lead to what Ostrom (1990) referred to as the "tragedy of the commons".

4.3.4 Tonnes of Fish Catch and Income

Fishery mortality as a result of fishing is mostly used to assess the level of fishermen's income and income is normally proportional to the tonnes of fish catch. A range of income and tonnes of fish catch were used to examine how the income (dependent variable) was being influenced by fish catch (independent variable). The analysis of fish catch against income in 2000 showed that about 50.4 percent of the fishermen harvested between one (1) and three (3) tonnes but earned below GH¢399. In the same year, just 3.3 percent of the respondents caused fishing mortality ranging from ten (10) to twelve (12) tonnes but realised economic returns between GH¢500 and Gh¢599 (See Appendix C).

Table 4.5 Relationship between Catch and Income in 2009

Annual Average Tonnes of Catch	Annual Average Income (GH¢)							Total
	Tonnes	**Percent**	**100-299**	**300-499**	**500 - 699**	**700 - 899**	**900-1,099**	
	1-5 Tonnes	Count	8	10	23	33	0	74
		% of Total	6.5	8.1	18.7	26.8	0	60.2
	6-10 Tonnes	Count	0	1	0	0	37	38
		% of Total	0	0.8	0	0	30.1	30.9
	11-15 Tonnes	Count	0	0	0	0	9	9
		% of Total	0	0	0	0	7.3	7.3
	Above 15 Tonnes	Count	0	0	0	0	2	2
		% of Total	0	0	0	0	1.6	1.6
	Total	Count	8	11	23	33	48	123
		% of Total	**6.5**	**8.9**	**18.7**	**26.8**	**39**	**100**

Source: Field Survey, May 2010

Under the income variable of the fisheries of Tono and Vea reservoirs, fishing mortality by majority of the fishermen in 2009 was in the range of one (1) to five (5) tonnes. As indicated in Table 4.5, there was about 60.2 percent of the fishermen whose annual average fish catch ranged between one (1) and five (5) tonnes. Out of this (60.2 percent), no fisherman's income fell between GH¢900 and GH¢1,099. It was only 1.6 percent of them who harvested fifteen (15) tonnes or more and also realised the highest income range of GH¢900 to GH¢1,099 in 2009. Whereas annual growth rate of fish catch was 4.6 percent (51.5 percent from 2000 to 2009), income grew by 5.5 percent (400 percent). According to one key informant, the desire for high income from the fishery has increased fishing effort and the size of gear being used by some fishermen. This is what "The Game Theory" postulated to have a direct relation with non-cooperative solution.

All other factors held constant, Table 4.5 revealed that the higher the tonnage of fish catch, the higher the income. In pursuance of earning more income, fishermen need to increase fishing effort which invariably leads to overexploitation. This is what Gordon (1954) postulated will lead to what he referred to as 'Bioeconomic Equilibrium'. When

this condition exists, the catch per unit effort will be small as depicted at the Vea reservoir in Plate 4.1.

Plate 4.1 Fish Catch per Unit Effort at Vea

Source: Field Survey, May 2010

Plate 4.2 Discussion with Fishers at Tono

Source: Field Survey, May 2010

The income from a fishery is mostly determined by three factors; size of fish catch, tonnes of fish catch and the price of fish (Sarnowski 2004). The assessment of income and tonnes of fish catch between 2000 and 2009 portrayed a condition of sustainable yield. However, a comparison between the two years without reference to the percentage of the respondents within the respective income range will not indicate beneficiaries of the change. Over the period, the highest income range has increased by 81.8 percent with annual growth rate of 5.5 percent while that of beneficiaries was 7.6 percent.

Table 4.6 Comparison between 2000 and 2009 Annual Average Income

Range of Income (GH¢)		Frequency		Percent	
2000	**2009**	**2000**	**2009**	**2000**	**2009**
100-199	100-299	19	8	15.4	6.5
200-299	300-499	18	11	14.6	8.9
300-399	500-699	38	23	30.9	18.7
400-499	700-899	29	33	23.6	26.8
500-599	900-1,099	19	48	15.4	39
Total		**123**	**123**	**100**	**100**

Source: Field Survey, May 2010

Within the period under review, tonnes of fish catch from Table 4.1 increased by 51.5 percent from 2000 to 2009 while income increased by 81.8 percent. This implies that, price either than quantity contributed significantly to the increase. Instances of under-reported landings have a link with the variation between increase in catch and income. As depicted in Table 4.6, those who earned the least income range in 2000 declined from 15.4 percent to 6.5 percent in 2009 while those who earned the highest income increased from 15.4 percent to 39 percent within the same period. As the fishermen perceived access to the fishery to be open access, attractive rent will encourage the entry of more fishermen which will reduce both catch and income in the long run.

4.3.5 Supplementary Activity and Income

As noted by Koeshendrajana and Cacho (2001), fishing seasons determines the type of employment that is being offered to fishermen of inland fisheries - either as part-time or full-time, as Catch Per Unit Effort (CPUE) fluctuates between the rise and fall of water levels. Within the catchment Districts of Tono and Vea reservoirs, the study assessed off-fishing jobs that supplement the income of fishermen as a respond to closed season or as part of livelihood strategy to the rise and fall of water levels (See Table 4.7).

Table 4.7 Fishermen's Supplementary Income Activities

Supplementary Job	Frequency	Percent
Crop Production	29	23.6
Animal Rearing	20	16.3
Petty Trading	4	3.3
Crop Production and Animal Rearing	51	41.4
Crop Production and Petty Trading	1	0.8
Animal Rearing and Petty Trading	4	3.3
Crop Production, Animal Rearing and Petty Trading	3	2.4
No Other Job	11	8.9
Total	**123**	**100**

Source: Field Survey, May 2010

In terms of proportion, about 41.4 percent of the fishermen either do crop production or keep domestic animals. Crop production and animal rearing engaged 23.6 percent and 16.3 percent respectively. However, 8.9 percent of the respondents have no other occupation aside fishing. Petty trading, crop production and animal rearing, crop production and petty trading, animal rearing and petty trading and crop production, animal rearing and petty trading scored below 4 percent. This was supported by one key informant at Bonia who attested that although harvesting of fish is seen as the main income earning activity of most fishermen, it is mostly supported by other primary activities especially during the closed season. Capital was one of the factors that made respondents to favour crop production over petty trading. A discussion with a group of fishermen at Vea community on alternative employment, this is what one of them has to say:

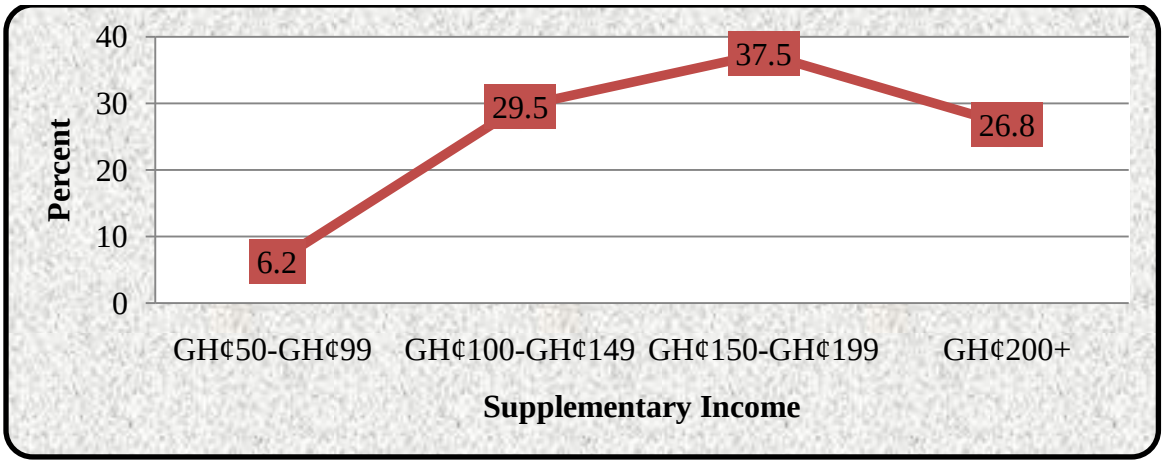
Box 4.1 Fishery Income and Supplementary Income: The Voice of a Fisherman

"I spend more time on crop production and caring for my poultry than I do on harvesting of fish, yet the income from fishing is always higher than that of crop farming and animal rearing". He added that, fishing assures him of not only nutritional diet but also, regular income on daily basis. He however, admitted that it is very difficult to make any savings from the meagre earnings from fishing.

Source: Field Survey, May 2010

This implies that the fishermen have very little capital to invest in fishing gear, equipment and other household expenditure as earning from fishing was rarely saved. From Table 4.6, about 6.5 percent of the fishermen earned an annual average income between GH¢100 and GH¢299. Figure 4.3 established that about 84.1 percent (58) of the fishermen received supplementary income while 15.9 percent (11) do not diversify out of fishing. It was only 8.6 percent whose supplementary earning fell between GH¢250 and GH¢299 in 2009. In comparison with income from fishery, the alternative livelihood options are economically inefficient. In an uncertain climatic environment such as in the study Districts, the reservoir fisheries formed part of a major diversified livelihood option over crop production, animal rearing and commerce. This was similar to what Béné and Neiland (2003) and World Fish Centre (2008) indentified at the Lake Chad basin and the West and Central Africa river fisheries that, fishing provide immediate advantage over farming in a risky environment.

Figure 4.3 Supplementary Income from Off-Fishing Jobs in 2009



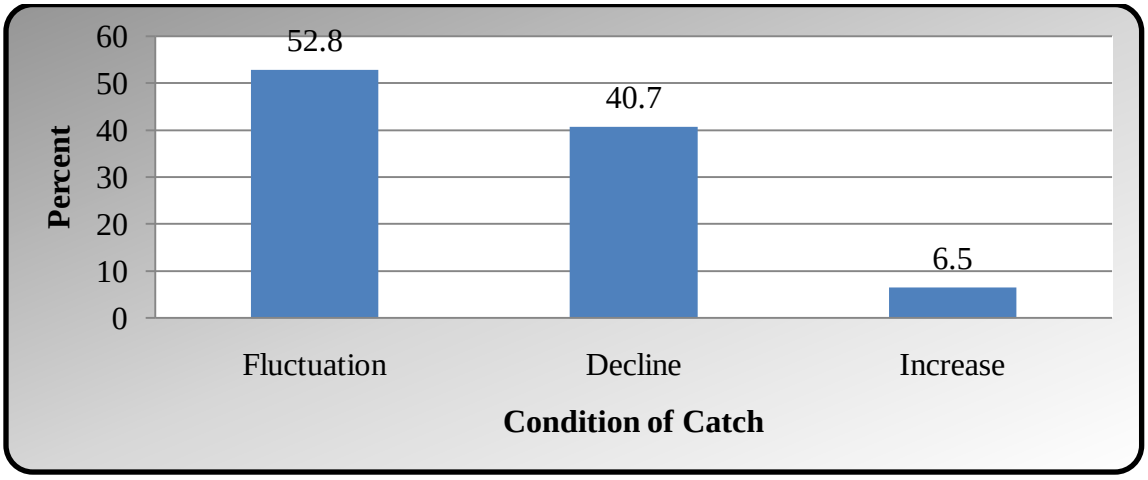
Source: Field Survey, May 2010

Management of population has an influence on both fishery income and supplementary income of fishermen. A large household size will reduce the ability of the fishermen to adequately provide for the household needs and save for investment. With an average household size of 8.1 (KNDA and BDA, 2006) in the study Districts, the supplementary role of the off-fishing activities has been weakened.

4.3.6 Fishermen's Perception about the Fishery

Under the management of the fishery resources, a quasi cash economy was introduced over the non-monetised arrangement in the study communities. Although it was realised that sustainable catch and the existence of economic rent influenced entry into the fishery, some of the fishermen would still be engaged in harvesting fish from the reservoir in a situation of continuous decline in tonnes of fish catch.

Figure 4.4 Condition of the Inland fishery of Tono and Vea in 2009



Source: Field Survey, May 2010

Continuous fishing of a fishery stock beyond the maximum economic yield leads to a decline in users' income and a fluctuation at best. Discussion with fishermen on the status of the fishery indicated that the stock of fish has been fluctuating. Figure 4.4 depicted that 52.8 percent of the respondents acknowledged stock fluctuation from 2000 to 2009. However, 40.7 percent perceived it to have declined while 6.5 percent of the respondents saw the status of the fishery to have appreciated in quantity.

4.3.7 Performance of the Tono and Vea Reservoir Fisheries

Discussion with some fishermen at Navrongo and Bongo Kukua on the trend of catch, ability of the fishery in generating income, employment, food security and poverty reduction showed that the Tono and Vea reservoirs were the centre of economic activities especially in the 1980s and 1990s. There appeared to be a declining trend in the

performance of these reservoirs in relation to the above indicators. However, assessing the performance of Tono and Vea fisheries among eight communities in the study Districts using a matrix, revealed a mixed perception. A nominal scale was employed to do the performance assessment of the fisheries as shown in Table 4.8.

Table 4.8 Performance Matrix of the Tono and Vea Fisheries

Performance Variable	Scores of Performance							
	Tono				Vea			
	Navrongo	Chuchuliga	Bonia	Wuru	Vea	Gowrie	Balunge	Bongo Kukua
Fish Catch	2	1	0	1	1	2	1	1
Monitoring	2	1	2	1	1	2	2	2
Income Generation	2	1	2	2	2	3	1	0
Creation of Employment	2	0	1	2	0	2	1	1
Food Security	1	2	1	2	2	2	3	2
Poverty Reduction	2	2	2	2	2	1	2	0
Revenue Generation	0	0	0	0	0	0	0	0
Total Score	**11**	**7**	**8**	**10**	**8**	**12**	**11**	**6**
Maximum Score	**24**	**24**	**24**	**24**	**24**	**24**	**24**	**24**
Percent Score (%)	**45.8**	**29.2**	**33.3**	**41.7**	**33.3**	**50.0**	**45.8**	**25.0**

Source: Field Survey, May 2010

NOTE: *Satisfactory Performance = 3, Moderate Performance = 2, Low Performance = 1 and Non/poor Performance *

The above scale was used to analyse the performance of the various variables during a focus group discussion at eight communities. Similar to the findings of Brainerd (1995 cited in Oguntade et al. 2007), poor performance of the fisheries are assigned to ineffective monitoring, poor generation of revenue, fluctuating catch and limited alternative labour opportunities in the study communities. The average performance score

for the variables was 38 percent. However, the percentage score of four communities exceeded this average while one of them (Bongo Kukua) has the least performance score of 25 percent. The zero score of the revenue variable across all the study communities confirmed the view of the Acting District Fishery Office (KNDA) that the fishermen have not been paying tax to the catchment District Assemblies.

An interview with the leader of the fishermen at Wuru revealed that ineffective monitoring especially during the closed season by MoFA and ICOUR was the major cause of poor performance in catch and income among the fishermen. Non-cooperation and poor representation of the fishermen in decision making was another reason for poor performance of the above variables.

4.3.8 Proposed Threat to Sustainable Fisheries

As a mechanism for improving the socio-economic conditions of reservoir-side communities, several sustainable and conservational measures were put in place by ICOUR and MoFA. Sustainability of the fisheries of Tono and Vea is a key function of enhanced income, reliable employment and a secured source of food. Except the Vea reservoir which has fishermen's density of 2 fishermen per km, that of Tono was 9 fishermen per km, higher than the national figure of 6 per km as given by Béné (2007). The relatively high density of fishermen on the Tono reservoir has implication for overfishing and fishery depletion, unreliable employment and unsustainable income of users.

Table 4.9 Identified Threat Factors to Fishery Sustainability

Threat Factors	**Frequency**	**Percent**
Population Increase	9	7.3
Use of Chemicals	7	5.7
Use of Under Size Mesh	49	39.8
Poor Protection of Spill Ways	6	4.9
Population Increase and Use of Chemicals	14	11.4
Population Increase and Use of Under Size Mesh	16	13
Population Increase and Poor protection of Spill Ways	3	2.4
Use of Chemicals and Under Size Mesh	3	2.4
Poor Protection of Spill Ways and Under Size Mesh	4	3.3
Environmental Variability	5	4.1
Overfishing	7	5.7
Total	**123**	**100**

Source: Field Survey, May 2010

The study revealed that 39.8 percent of the fishermen considered the use of under size mesh as the more serious threat to the fishery. The use of chemicals and under size mesh amid increasing population of fishermen recorded about 24.4 percent while the threat post by overfishing and the use of chemicals was 5.7 percent each (See Table 4.9). The study indicated that the continuous existence of these threats did not only give rise to small catch per effort but also a decline in the size of fish harvested. This was evidenced after visiting Bay three (3) at the Tono reservoir as most of the catch observed was small in size (See Plate 4.3). The ramification of the above situation has been envisioned to undermine the employment, income and revenue potentials of the fisheries. Although the fishermen did not give much rating for environmental variability, observation revealed poor vegetation around the reservoirs. However, trees have been planted at the Bongo Kukua side of the Vea reservoir.

Plate 4.3 Catch from Gillnetting at Bay 3 of Tono Reservoir

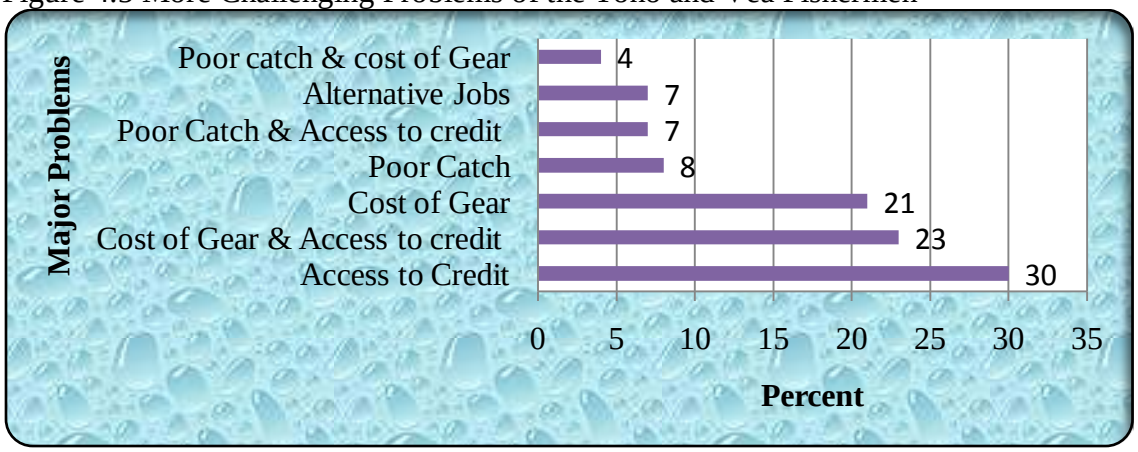
Source: Field Survey, May 2010

The respondents acknowledged the efforts management (ICOUR and MoFA) has made at different levels to conserve the fish stock by causing the arrest of those using under size mesh and chemicals or flouting of the closed season. Registration of fishermen and fishmongers was employed to control population of users. However, much has not been done to protect vegetation around the reservoirs. Management decision to ensure sustainable fishery through closed season affect the income of those who are full-time fishermen. From the perspective of one fisherman at Balunge, economic hardship makes some of the fishermen to flout some of the measures of sustainable fishery.

4.3.9 Assessment of Major Problems of Fishermen

The inland fisheries of Tono and Vea reservoirs had played and continue to play key roles in the local economy of the catchment Districts. In 2009, the two reservoirs produced about 100.72 tonnes of fish thus, 79.96 tonnes for Tono and 20.76 tonnes for Vea (See Table 4.1). The key objective of improving upon the socio-economic conditions of the reservoir-side communities as well as the Catchment Districts has seriously been challenged. From the perspective of the fishermen, the continuous existence of the threats to sustainable fisheries has deepened the problems being confronted.

Figure 4.5 More Challenging Problems of the Tono and Vea Fishermen



Source: Field Survey, May 2010

It is observed from Figure 4.5 that, to a very large extent, the major problems confronting the reservoir fishermen were difficulty in getting credit and cost of gear. At Bonia for instance, the interview revealed that neither management (ICOUR and MoFA) nor fishermen association had ever succeeded in securing a credit facility for them. Poor access to credit was attributed to fluctuating income of fishermen and 'ecosystem-determined' nature of freshwater fishery production. They lamented that since whatever income realised in the fishing season hardly take them through the first month of the closed season, income poverty becomes eminent. Those who could raise their own capital or sell some of their livestock to buy more gear mostly realise high catch. There is a positive correlation between poor access to credit and poor catch. This is supported by Appendix B, as those who possessed more gear equally harvested more tonnes of fish. Additionally, the issue of cost of gear (21 percent) and alternative job opportunities (7 percent) would have been reduced if the interaction and support from the secondary stakeholders was maintained. By way of giving more explanation to the above, a key informant from Gowrie has this to say:

Box 4.2 Withdrawal of Input Supply Credit Intervention

> *"In the past ICOUR used to give input supply credit such as the recommended gear and fishing boats and payment spread over one or two fishing seasons. Equity was the guiding principle in the distribution of the gear which did not only regulate the size of gear but also the effective monitoring and recording of fish catch. I could remember that both ICOUR and MoFA encouraged the fishermen to take up crop cultivation especially during the closed season as off-fishing activity to ensure continuous flow of income".*

Source: Field Survey, May 2010

4.4 Analysis of Data – Fishmongers

This section presents the analysis of data relating to the views and perceptions of the fishmongers of the Tono and Vea reservoirs. The analysis was done in the areas of access to buying the reservoir fisheries, indirect employment created by the fishery, revenue, fishmongers' income as well as their supplementary income activities.

4.4.1 Access of Fishmongers to the Tono and Vea Fisheries

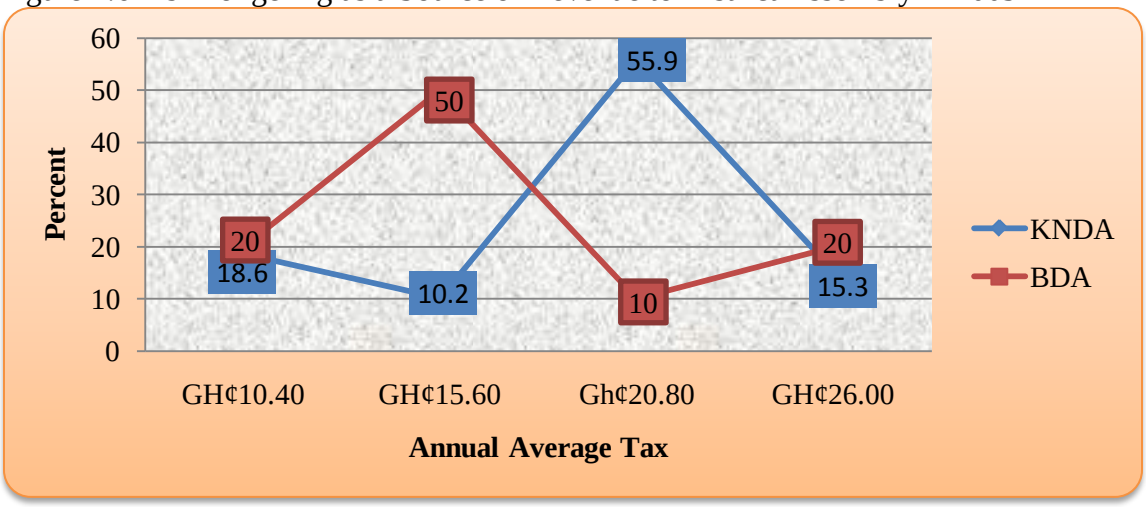
Unlike the fishermen (where about 81 percent have open access to the fishery), fishmongers of the Tono and Vea reservoir fisheries had to register before they are allowed to buy fish. Out of the sample size of 69, it was only 2.9 percent who have not registered before fishmongering. Registration and record of catch were previously done by ICOUR but for the past six years, these responsibilities have been shifted to MoFA. At the time of the study, some of them were not having their records transferred to MoFA. The 97.1 percent of the registered fishmongers however pointed out that they did not pay any fee to ICOUR, MoFA or the District Assembly before or after registration. Similar to the fishermen, the study revealed that it was only fishmongers from the four major ethnic groups (Kassena, Nankani, Grunsi and Builsa) in the catchment of the reservoirs who had access to buying of fish.

4.4.2 Cash Revenue from Fishery

District Assemblies in Ghana are not only charged with the responsibility of ensuring development in their respective areas of jurisdiction but also mobilising local resources in

pursuance of their development agenda. Drawing from the work of Allison et al (2004), fisheries provide one of the few sources of cash revenue and are therefore a local 'engine of growth'. Just like any other person engaged in income earning activity, the fishmongers in the study Districts pay tax as and when they get to market to sell fish. In absolute value, KNDA and BDA received GH¢1,300 (GH¢1,128.40 for KNDA and GH¢171.60 for BDA) as revenue from the fishmongers in 2009. Access to market in the study Districts and the number of registered fishmongers were some of the reasons that made KNDA to receive more revenue from fishmongers than BDA in 2009. The commonest annual average tax paid by fishmongers in the study Districts was GH¢20.80 (See Figure 4.6).

Figure 4.6 Fishmongering as a Source of Revenue to District Assembly in 2009



Source: Field Survey, May 2010

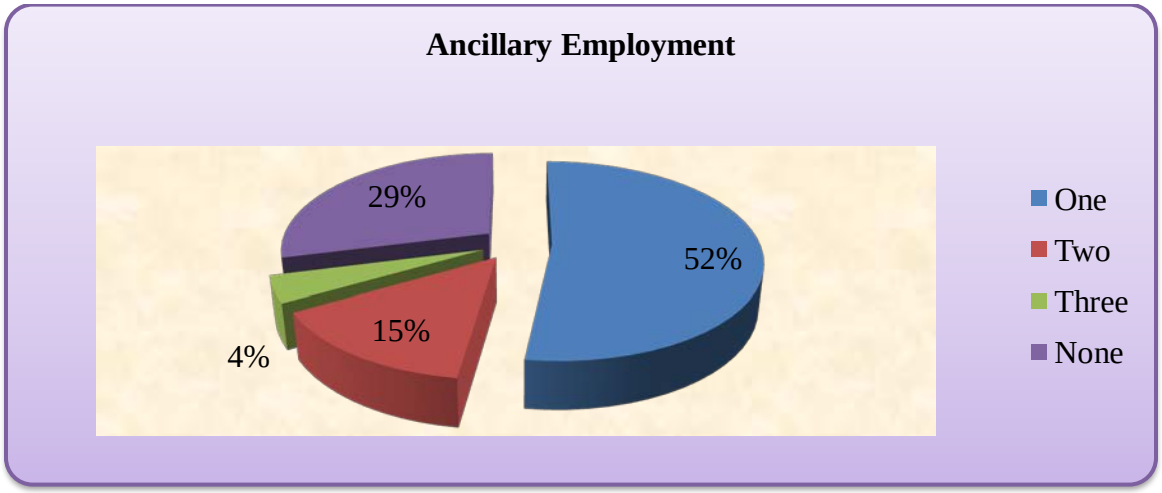
The analysis showed that half of the fishmongers of BDA (50 percent) paid an annual average tax of GH¢15.60 while 55.9 percent paid GH¢20.80 to the KNDA in 2009. It was 20 percent and 15.3 percent of them who paid the highest average tax of GH¢26 to BDA and KNDA respectively. The collection of market tolls was carried out in the market therefore, those who sell their fish within communities where markets do not exist were not captured in the tax net. Some of the fishmongers supply fish direct to food vendors which do not pass through the market to be taxed. The basic implication was that, there was a revenue leakage from the fishmongers. It was thus not by accident that

the District Assemblies did not offer direct assistance or participate in regulating the reservoir fisheries of Tono and Vea.

4.4.3 Provision of Ancillary Employment

This involves employment created for those who indirectly eke out a living from the fisheries of the study reservoirs. The case with the Tono and Vea fisheries so far as ancillary employment was concerned was given a marginal consideration. This was similar to what COFAD (2002) investigation revealed in Sub-Saharan Africa. At the fishmongers' level, about 137 (117 from Tono and 20 from Vea) of them either registered with ICOUR or MoFA to buy fish and were thus given ancillary employment. With a female labour force population of 79,193 in the study Districts, it was only 0.2 percent who engaged in fishmongering. Besides the registered fishmongers, other members of the households, particularly women are offered ancillary employment in the fishery sector.

Figure 4.7 Fishmongers' Ancillary Employment Creation



Source: Field Survey, May 2010

The observation was that, fishmongers offered casual employment to about 65 people. In some communities, the wealthy fishmongers buy boats and fishing nets for fishermen and in that case have absolute access to the catch. They mostly employ other women to either help in fish processing or mongering when catch increase. As high as 71 percent of the

fishmongers provide ancillary employment while 29 percent do not have the capacity to offer employment. It was clear at a discussion that some of the fishmongers did not perceive the engagement of the services of other women as employment. The opposite was revealed at Vea during a focus discussion. On the issue of ancillary fishery employment, this was what one fishmonger from Vea community has to say:

Box 4.3 A View about Ancillary Employment

The services of other women become prominent immediately after the closed season when fish catch is relatively high. She expressed that 'when Vea was Vea' she used to employ more people in the 1980s and early 1990s than now and that was also the time she could also buy more tonnes of fish from the reservoir.

Source: Field Survey, May 2010

Similar to the GTZ (1997; cited in Von Sarnowski, 2004) assertion about the link between improvement in living conditions and fishery resource conservation, the study indicated that the creation of ancillary employment was influenced by tonnes of fish catch at the Tono and Vea reservoirs. It was unequivocal that the ability to create ancillary employment was a direct function of increase in fish catch. However, the goal of providing employment without recourse to maximum economic yield has been dwindling both tonnes of fish catch and income.

4.4.4 Fishmongering as a Source of Income

Allison et al (2007) rightly acknowledged that, "at high production periods, fisheries contribute readily-earned cash". Similarly, from the fishmongers' perspective, the fisheries of Tono and Vea are not only labour intensive but also strategic source of income. With a mean income of GH¢472.33, the fishmongers' annual income for 2009 ranged from GH¢100 to GH¢999. However, analysis of income on District basis revealed that, whereas 20 percent of the fishmongers in the Bongo District earned the highest income range of GH¢850 to GH¢999, those of Kassena Nankana District was only 5.1 percent. On the contrary, 30 percent of the respondents from Bongo District received the least income while those of Kassena Nanakana District was 10.2 percent (See Appendix

D). Using the 2009 daily minimum wage for comparison, about 92.8 percent of the fishmonger from the study communities fell below the minimum wage of GH¢2.65. The remaining 7.2 percent, whose income was more than the minimum wage were identified to be the rich and the powerful individuals with dominant views.

Out of 73.9 percent of the fishmongers who purchased between one (1) and six (6) tonnes of fish per year, it was only 4.5 percent (3 persons) who earned the highest income range of GH¢400 and GH¢499 in 2000 (See Appendix E). From Table 4.1, tonnes of fish catch in 2009 increased by 51.5 percent over that of 2000 but income of fishmongers increased by 428.6 percent. This implies that aside the quantity and quality of fish catch, price of fish was a major determinant of fishmongers' income. Whereas the annual growth rate of price of fish was 12.2 percent and 1.41 percent for fishmongers of Tono and Vea reservoirs, growth in catch was 7.03 percent and -2.15 percent respectively (See Appendix I). As change in fish catch was not proportionate to change in income, demand for fish was identified to be high.

Table 4.10 Tonnes of Fish Bought and Annual Income in 2009

		Annual Average Income in 2009 (GH¢)							
Tonnes of fish bought in 2009	**Tonnes**	**Percent**	**100 -249**	**250 -399**	**400 -549**	**550 -699**	**700 -849**	**850 -999**	**Total**
	1-2 Tonnes	Count	6	9	1	0	0	0	16
		% of Total	8.7	13.0	1.4	0	0	0	23.2
	3-4 Tonnes	Count	2	7	8	3	0	0	20
		% of Total	2.9	10.1	11.6	4.3	0	0	29
	5-6 Tonnes	Count	0	0	8	4	3	0	15
		% of Total	0	0	11.6	5.8	4.3	0	21.7
	7-8 Tonnes	Count	0	0	2	4	3	1	10
		% of Total	0	0	2.9	5.8	4.3	1.4	14.5
	9-10 Tonnes	Count	0	1	0	0	1	1	3
		% of Total	0	1.4	0	0	1.4	1.4	4.3
	11-12 Tonnes	Count	0	0	0	0	3	2	5
		% of Total	0	0	0	0	4.3	2.9	7.2
	Total	Count	8	17	19	11	10	4	69
		% of Total	11.6	24.6	27.5	15.9	14.5	5.8	100

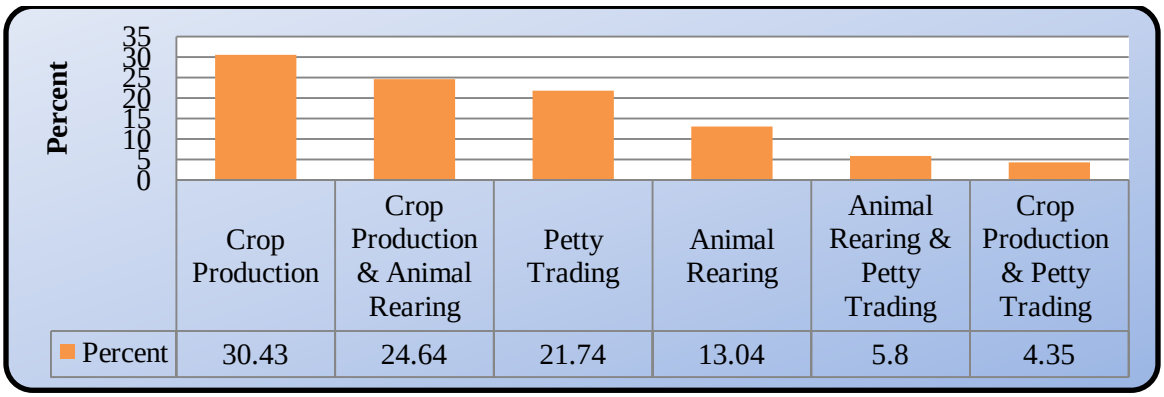
Source: Field Survey, May 2010

Irrespective of the income category of the fishmongers, the study showed that there was a correlation between the quantity or tonnes of fish being purchased by fishmongers of Tono and Vea with their annual income (See Table 4.10). As indicated in Table 4.10, it was only 5.8 percent of the fishmongers who purchased between seven (7) and twelve (12) tonnes of fish and equally earned the highest annual average income range of GH¢850 to GH¢999. A discussion with fishmongers at Chuchuliga indicated that, all those who earned relatively more and purchased the highest tonnes of fish were those who owned and controlled more fishing boats. As expressed by one of the fishmongers, "one earns more income by buying more tonnes, which equally means investing more in fishing gear and equipment".

4.4.5 Assessing Supplementary Job and Income

Apart from fishmongering, some of the fishmongers in the study communities engaged in other income earning activities. Similar to other rural and Guinea Savannah settlements, most of the respondents were eking out a living from vegetable and cereal production, animal rearing as well as petty trading. Unlike the fishermen who had about 8.9 percent (See Table 4.7) solely engaged in fishing, all the fishmongers supplement their fish income in one form of the other. Majority of the fishmongers at a focus group discussion at Navrongo pointed out that the burden of household expenditure has necessitated the engagement in supplementary jobs. This has been a coping strategy especially during the closed season.

Figure 4.8 Supplementary Jobs as a Strategy for Risk Spreading



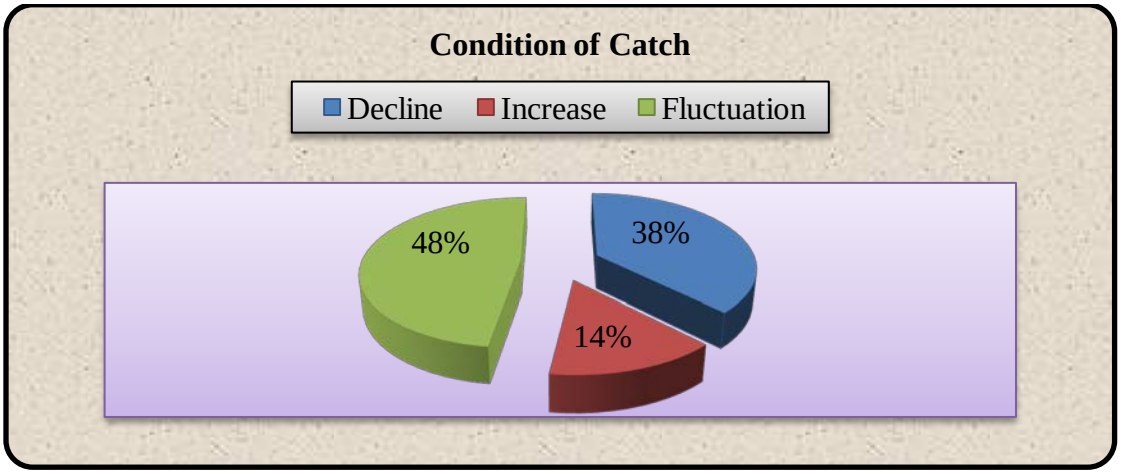
Source: Field Survey, May 2010

Those who supplemented their fishery income through crop production, petty trading and animal rearing constitute 76.81 percent of the fishmongers. However, it was 29 percent of them whose supplementary annual income ranged between GH¢250 and GH¢299 in 2009 (See Appendix G). From the point of view of the fishmongers, income from crop production is difficult to estimate as the yield is mostly used for household consumption.

4.4.6 Fishmongers' Perception about the Fishery

Within the study communities, there are a number of small dams and dugouts for harvesting inland fish. Some of the registered fishmongers do buy fish from these sources. In order not to overestimate the performance of the Tono and Vea fisheries with the entire inland fish catch of the study Districts, fishmongers' views were analysed between 2000 and 2009.

Figure 4.9 Fishmongers' Perception about the Condition of the Fishery



Source: Field Survey, May 2010

The study revealed that fish catch from the Tono and Vea reservoirs rather fluctuates than decline. Form Figure 4.9, 48 percent of the fishmongers perceived the fish stock to be fluctuating over the years. Comparing tonnes of fish bought in 2000 with that of 2009, 38 percent of the fishmongers perceived the fishery to be declining. However, 14 percent asserted that the fishery has shown an increasing trend. This view was not completely wrong as record of catch revealed that there was an increase of 51.5 percent in 2009 over

2000 (See Table 4.1). However, tonnes of fish catch have indicated a fluctuating trend between 2000 and 2009 (See Appendix F).

4.4.7 Factors Affecting Sustainability of Fishmongers' Income

Knowledge about common problems of the fishmongers precedes efforts of stakeholders in addressing them. There seem to be some kind of symbiotic relationship between the fishermen and fishmongers and thus will all be affected by similar problems. From the perspective of the fishmongers, any issue that hinders the attainment of the desired income and keeping them employed was a problem.

Table 4.11 Perceived Problems of the Fishmongers of Tono and Vea

Major Problem	**Frequency**	**Percent**
High Cost of Gear	11	16
Transportation	2	3
Poor Catch	8	12
Storage Facilities	7	10
Access to Credit	14	20
High Cost of Gear & Transportation	5	7
High Cost of Gear & Poor Catch	8	12
High Cost of Gear & Storage Facilities	1	1
Cost of Gear & Access to Credit	6	9
Transportation & Access to Credit	4	6
Alternative Jobs	3	4
Total	**69**	**100**

Source: Field Survey, May 2010

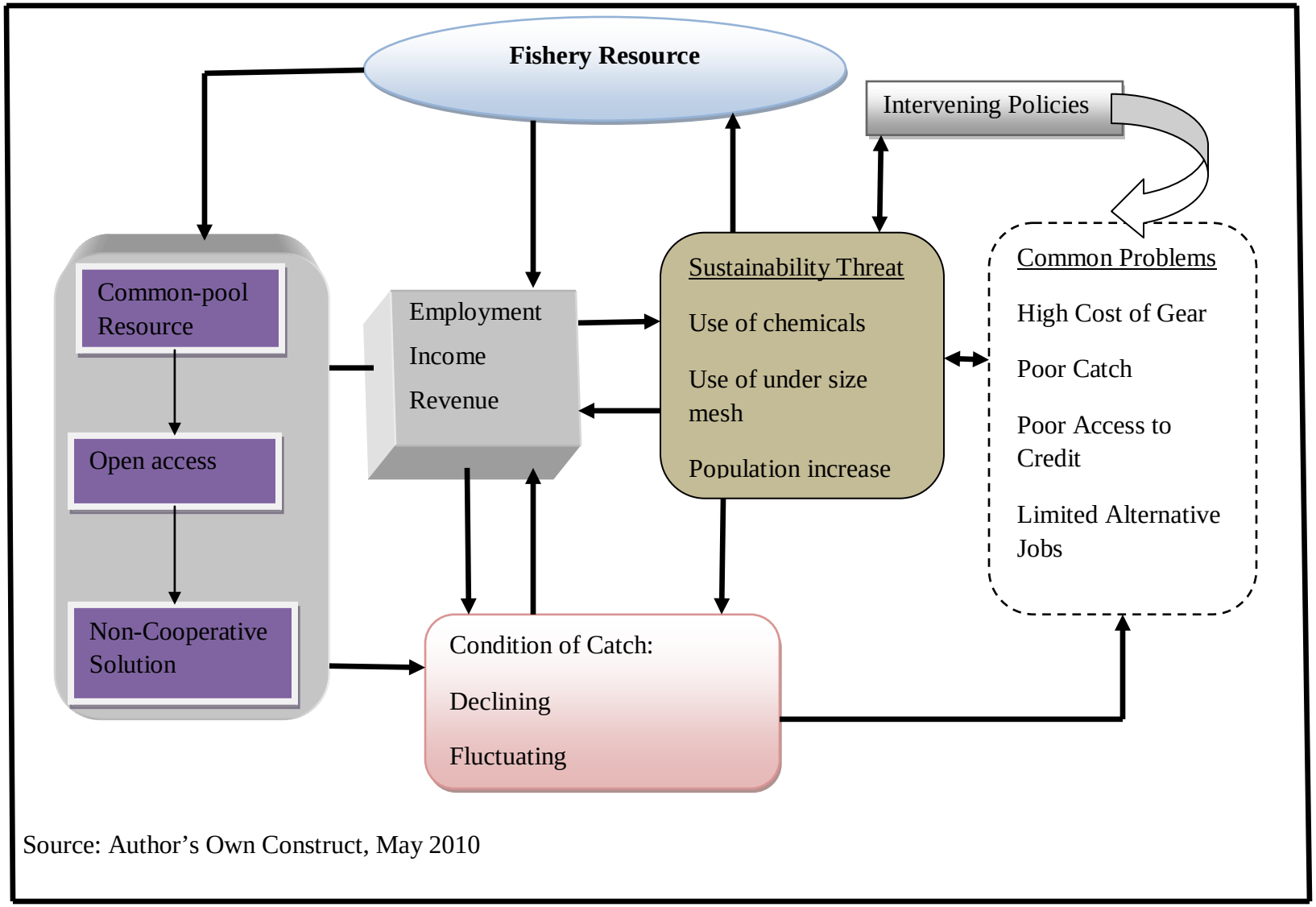
The first three top problems of the respondents were access to credit facilities, price of input and poor fish catch. These problems as depicted in Table 4.11 were not significantly different from those of the fishermen. What appeared unique to the fishmongers was the issue of storage. At a meeting in the Vea community, the women asserted that Tilapia which is the commonest fish species of the reservoir loses its market value when smoked. This realisation made 10 percent of them to consider storage of fish as a major problem. Low access to credit and difficulties in storing fish in the peak of fishing mortality affect the price and income of fishmongers of Tono and Vea reservoirs.

4.5 Summary of Data Analysis

The significant principle of economic dimensions of a fishery resource is to ensure continuous and reliable income, employment and the generation of revenue for local and national development. The type of ownership and the nature of institutional arrangement have direct and indirect relationship with accessibility and the level of cooperation among the users. As depicted in Figure 4.8, the desire to provide employment and income under non-cooperative solution or usage of the fishery either contributed to decline or fluctuation in the annual tonnes of fish catch.

Since the common denominator in assessing the economic dimensions of fishery is fish, a decline in fish stock will reduce the employment, income and revenue potential of the fishery. Conversely, the desire to earn more income and revenue through unsustainable means (the use of chemicals and under size mesh) have been recognized to be contributing to both decline and fluctuation in catch. It was gathered from the field that, the performance of the fishery resources of Tono and Vea in creating employment and generating income to fight poverty has not received any specific local policy or bye-laws. Policy neglect at the local level provided the impetus for overfishing and degradation of the inland fishery resources. The maximisation of the full potentials of the inland fisheries of the studied reservoirs requires policy interventions to address the common problems of high cost of gear, poor catch and access to credit and limited alternative livelihood activities facing fishermen and fishmongers (See Figure 4.8).

Figure 4.10 Framework for Economic Analysis of Tono and Vea Fisheries



Source: Author's Own Construct, May 2010

CHAPTER FIVE

SUMMARY OF MAJOR FINDINGS, RECOMMENDATIONS AND CONCLUSIN

5.1 Introduction

This chapter presents the major findings of the study derived from data analysis, policy implications for enhancement of income and employment generation, recommendations and conclusion. The key findings take cognizance of the objectives of the study.

5.2 Summary of Major Findings

The analysis of the views of institutions, fishermen and fishmongers gave insight on economic dimensions of the inland fisheries. This section covers findings which require attention, resources and pragmatic policy interventions towards sustainable and maximum yield.

5.2.1 Access to the Reservoir Fisheries

The study revealed that both open access and limited access exist at the reservoirs. Unlike what was postulated by Hess and Ostrom (2001) that common-pool resources are equally open access, the fisheries of Tono and Vea exhibit the characteristics of common-pool resource, yet registration is required by users. In reality, management of the inland fishery resources of the study Districts has a monitoring system aimed at regulating catch, effort and population. While effort was made initially at registering users, the children of most retired fishermen engaged in fishing as an inherited occupation.

It was quite obvious from the study that the existence of both open and limited access gave rise to a misconception about the type of access users have into the fishery resource. As many as 81 percent of the fishermen perceived their entry to the fishery to be open access. However, about 97.1 percent of the fishmongers saw their entry as being limited by MoFA and ICOUR.

5.2.2 Employment Capacity

In Ghana, inland fisheries engaged about 30,000 people in various dimensions FAO, 2004 (cited in Tetteh 2007). Just like most informal activity, the accurate number of people employed in the inland fishery subsector of the study communities was difficult to assess. The employment effect of the two reservoirs in relation to the potential labour was marginal yet the ripple effect in creating ancillary jobs was significant. Apart from the registered fishermen and fishmongers (0.3 percent of labour force of the study Districts) employed in the fishery, it generated an ancillary employment for about 0.4 percent of the potential labour force of the study Districts. However, the employment potential of the Tono reservoir was being threatened as it recorded fishermen density of 9 per km. of the reservoir which was higher than the national average of 6. In the case of Vea, the density was 2 per km. of the reservoir.

5.2.3 Status of Fishery Revenue

In spite of the fact that the study Districts are among the poorest local administrative domain in Ghana, their revenue base has not fully covered those employed directly in the fishery sector of Tono and Vea reservoirs. Whereas resisted effort was expended by the KNDA in the past to collect tax from the fishermen, BDA has no idea about the revenue potentials of the Vea fisheries. The inability to tax the fishermen was one of the sources of indifferent attitude by the catchment Assemblies which intend gave the impetus for non-cooperative approach adopted by the fishermen. Indeed, fishmongers have been paying market tolls but institutional effort has not specifically targeted the users of the fisheries as far as revenue was concerned. Unlike the findings of Allison et al (2004), the study revealed a situation of revenue leakage which is a sign of inadequate revenue profiling of the Districts.

5.2.4 Interaction between Effort and Income

The essence of investment decision is to earn more profit with the least input. This transcends the industrial level into the analysis of inland fishery resources. In their bid to maintain the size of the daily catch, the fishermen work for long hours and use large quantities of net and other fishing gear. The study further indentified that the time spent in fishing and the number of

fishing gear have a direct relation with economic returns from the fishery. The relatively high fishery income earners were those who spent at least 2 hours per day in fishing. Since growth in price of fish had more influence for increase in income than growth in catch, a false condition of economic efficiency was exhibited. A similar trend was identified between tonnes of fish catch and investment in the area of fishing gear. This presented three parallel vertical processes, viz; from large quantity of gear to increase in fishing effort, and subsequently to improve economic profit.

5.2.5 Income and Income Distribution

In the study communities, fishermen's income in 2009 has fairly been improved over that of 2000. More fishermen (about 39 percent) in 2009 received higher income range than in 2000. In the case of the fishmongers, the recipients of the higher income declined from 18.2 percent in 2000 to 5.8 percent. As revealed by the analysis, income of fish processors and buyers appreciated in percentage terms than that of the fishermen. Since fishermen have constant and regular processors to sell to, demand triggered price increase in the open market reflect directly in the income of fishmongers than fishermen. Generally however, the income distribution pattern among fishermen was contrary to that of fishmongers as only a small percent of them earned fishery income within the highest income range in 2009. Those fishmongers who owned and controlled more fishing gears were those with relatively high income.

5.2.6 Stakeholder Integration

Fishery policy objective of solving the problems of the environment and overfishing through pragmatic policy framework were neither fully enforced nor bye-laws enacted to regulate the fisheries of Tono and Vea reservoirs. Low priority was given to the fishery subsector as compared to the crop subsector. Although there is a national fishery policy, the catchment Districts have no regulatory framework that reflected unique local needs and condition of the reservoirs. The study revealed that the level of institutional interaction in the management and governance of the inland fishery resources was low. Contrary to the findings of Tetteh (2007) and Chimatiro et al (2008), co-management strategy in a multi-stakeholder resource such the Tono and Vea fisheries was missing.

5.2.7 Threats to Economic Opportunities

Three critical sustainability misnomers identified by the study were the use of under size mesh, chemicals fishing and increasing population of fishermen. The issue of population pressure on the fisheries was peculiar in the Tono reservoir fishery where density was as high as 9 fishermen per km of shoreline of the reservoir. The use of chemicals and under size mesh posed a threat to biological and environmental sustenance as well as economic potentials offered by the fisheries. The desire to provide employment for people with a stake in the fishery has been a source of threat. The concomitant ramification of these threats to the fishery was the fluctuation and decline in catch as indicated by the three categories of respondents.

5.2 8 Performance of the Fishery

Fish and fishing is recognised as an important source of livelihood in Ghana and the fisheries of the study reservoirs is not an exception. The importance lies in the potential for cash revenue, income and fish food. One of the purposes of the fishery component of the two irrigation schemes was to turn around the economic fortunes of the riparian communities. As portrayed by the analysis, aggregate performance of less than 50 percent was a clear vista of underperforming fisheries. This was the culmination of the threat to the fishery habitat as a result of economic consideration over biological sustainability. This exhibits a direct contradiction of the theoretical properties of Bioeconomic Equilibrium as applied to fisheries.

5.3 Policy Implications

Base on the issues of declining catch and the use of under size mesh, pragmatic policy interventions are required to promote the use of appropriate economic strategies that balances the economic dimensions with ecological settings of the fisheries. Since institutional regulation are becoming difficult to strictly enforce, a policy regime that will re-visit the previous strategy of credit supply of gear will regulate mesh size and fishing methods. Also, the existence of low stakeholder integration, threat to the economic opportunities of the fisheries and non-specific use right is an indication of weak community based fishery management. This implies that fishery development policies should be well integrated into the decentralisation framework. Also,

innovative policy planning should be implemented if income and employment maximisation is to be achieved through inland fishing on the Tono and Vea reservoirs.

5.4 Recommendations

Using inland fishery as a catalyst for reducing unemployment and poverty, livelihood enhancement, as well as ensuring food security should be done in an economically and environmentally friendly fashion within the carrying capacity of the fishery resource. Based on the above discussions of the research findings, some key areas have been selected for direct policy intervention, regulatory enforcement and review of the inland fishery sector by MoFA, ICOUR, DAs and catchment communities of the reservoirs.

5.4.1 Specific Use Rights

In small-scale fisheries, the allocation rights or access rights is fundamental in controlling effort and in determining who benefits from the fisheries. For the fishery resources of Tono and Vea to be protected for prosperity, an enhanced collective action from the resource users is required. Access to the fishery should not be seen as a given but regulated through the blending of open and limited access regimes to reflect local reality that suit the socio-cultural milieu of the beneficiary communities. Since the type of ownership affect the stream of benefits to users, the use right should be well defined. Although open to the public, the appropriators of the reservoir fishery should be charge a fee of utilisation on annual basis.

5.4.2 Fishery Enhancement

As the natural recruitment of the fishery is fluctuating as a result of intensive harvesting, it is more appropriate to focus on fishery enhancements as a means of income improvement. Effort should be modified to reposition the fishermen for the adoption of enhancement technologies that will improve on the environmental carrying capacity of the reservoirs. Since culture-based fisheries give some form of private ownership over natural captured fisheries, the challenge of non-cooperation would be controlled.

5.4.3 Revenue Potential Profiling

The strategy of profiling the revenue sources in the catchment Districts will give a fair knowledge about revenue potentials of the fishery and what could be done to harness the potential for sustainable revenue collection. The pursuit of sustainable fishery revenue should fall within the principles of co-management for unanimous collection support from the appropriators of the fishery resources. The profiling should also capture the needs of catchment communities for appropriate bye-law formulation to prevent revenue leakages.

5.4.4 Integrated Water Use Planning

In terms of continuous use of the reservoir water for crop production, domestic water supply and fishery production among others, there should be multidimensional water use planning that has to balance human requirements against protection of the environment and biodiversity. This will require the integration of ICOUR, MoFA, WRI and catchment District Assemblies to capture fishery resources into their development agenda for long-term improvement of the living conditions of the fishing communities. The effective way to produce appropriate, workable and enforceable plans is to get fishing communities to participate in writing and enforcing the regulations.

5.4.5 Effort Regulation and Gear Quota

The appropriation of the fishery resources should be regulated in terms of effort and quantity of gear. The incentive provided by more effort should be discouraged alongside gear quota. This will lead to a significant recovery in the population level of the fish stock. Another area that can facilitate effective monitoring of quantity of gear is the provision of right and recommended fishing gear by management of the fisheries. Reduction in fishing effort would increase landings, enhance fishery employment capacity and economic profitability, fair distribution of income and bioeconomic surplus in the long term.

5.4.6 Regeneration of the Vegetation

Aside the wider indicators of rainfall and pollution that may affect fish population, the vegetation surrounding the reservoirs also influence spawning, recruitment and genetic diversity of the stock. The study therefore proposed that extensive education on tree planting along the banks of the reservoirs would protect and regulate the physical and biological conditions of the fishery.

5.5 Recommendations for Further Research

To make a sustainable use of the fishery, as indicated from the findings, the following areas are recommended for further research.

- Economic Sustainability of Inland Fishery in the Context of Private Ownership
- Management Challenges for the Implementation of Co-management Inland Fisheries

5.6 Conclusion

In many respect, the fisheries of Tono and Vea have made some strides on the path of employment and income generation and the provision of fish food for the fishing communities as well as catchment Districts. It is however, worth noting that much of the efforts have seemingly resulted into uncoordinated stakeholder action and decision making due to limited alternative jobs.

This research has gone a long way to illuminate some of the core hindrance to income and employment maximisation of the fisheries. It was noted that without a clear and concrete integrated development focus, action taken to pursue maximum economic and sustainable yields will not contribute to the desired improvement in livelihood. It has been established that a lot of efforts and energies have been expended by management under the canopy of creating more economic opportunities for fishermen and fish processers. To a greater extent, an appreciable proportion of the users earned below the daily minimum wage in 2009. This makes the fishermen and other ancillary workers take desperate action of increasing size of gear and fishing effort to increase catch and income. The research revealed that there is a decline and fluctuation in catch as a result of unilateral decision of more effort in the bid to earn high economic rent.

Based on the key challenges outlined in this paper, especially in relation to dwindling catch, lack of collective action, less than average performance in income, employment, and poor revenue generation, several strategies are proposed. These include shifts from instructive to consultative forms of management, integrative planning, fishery enhancement and the formulation of clear objectives and roles of actors at both the community and the District Assembly levels.

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Appendix A Forecast of Fish Catch from Tono and Vea Reservoirs

Tono Reservoir

Let Y = ao + aiX

Then the normal equations are:

$\Sigma Y = Nao + ai\Sigma X$

$\Sigma XY = ao\ \Sigma X + ai\Sigma X^2$

623.94 = 10ao + 45ai …….. (1)

3,089.70 = 45ao + 285ai…….. (2)

Multiply equation (1) by 9 and equation (2) by 2

5,615.46 = 90ao + 405ai …….. (3)

6,179.40 = 90ao + 570ai …….. (4)

Substract equation (3) from equation (4)

$\frac{563.94}{165} = \frac{165ai}{165}$

ai = 3.4

Put ai = 3.4 into equation (3)

5,615.46 = 90ao + 405 (3.4)

5,615.46 – 1,384.29 = 90ao

$\frac{4,231.17}{90} = \frac{90ao}{90}$

ao = 47, Y = 47 + 3.4 X

Forecast of Fish Catch in 2015

In 2010, the value of 'X' will be 11 hence, the estimated tonnes of fish catch will be given as:

Y = 47 + 3.4 (11) = 84.40/ Y = 84.40 tonnes

In 2015, the value of 'X' will be 15 hence, the estimated tonnes of fish catch will be given as:

Y = 47 + 3.4 (15) = 98/ Y = 98 tonnes

Vea Reservoir

Let Y = ao + aiX

Then the normal equations are:

$\Sigma Y = Nao + ai\Sigma X$

$\Sigma XY = ao\ \Sigma X + ai\Sigma X^2$

334.91 = 10ao + 45ai…….. (1)

1,416.58 = 45ao + 285ai …….. (2)

Multiply equation (1) by 6 and substract 15 from equation (2)

2,009.46 = 60ao + 270ai …….. (3)

1,401.58 = 30ao + 270ai …….. (4)

Substract equation (4) from equation (3)

$\frac{607.88}{30} = \frac{30ao}{30}$

ao = 20.3

Put ao = 20.3 into equation (4)

1,401.58 = 30 (20.3) + 270ai

1,401.58 – 609 + 270ai

$\frac{792.58}{270} = \frac{270ai}{270}$

ai = 2.9, Y = 20.3 + 2.9 X

Forecast of Fish Catch in 2015

In 2010, the value of 'X' will be 11 hence, the estimated tonnes of fish catch will be given as:

Y = 20.3 + 2.9 (11) = 52.20/ Y = 52.2 tonnes

In 2015, the value of 'X' will be 15 hence, the estimated tonnes of fish catch will be given as:

Y = 20.3 + 2.9 (15) = 63.80/ Y = 63.80 tonnes

Calculation of Growth Rate of Fish Catch

$$R = \frac{Ln\left(\frac{P1}{Po}\right)}{t}$$

Where Ln is the natural log (2.718), Po is the first catch figure, P1, the second catch figure and 't' the time between the two years.

Tono: $r = 2.718^{\frac{\left(\frac{79.96}{41.01}\right)}{9}} = 5.9\%$

Catch growth from 2000 -2009 is 5.9% per annum

Vea: $r = 2.718^{\frac{\left(\frac{20.76}{25.46}\right)}{9}} = 2.5\%$

Catch growth from 2000-2009 is 2.5% per annum

Tono and Vea: $r = 2.718^{\frac{\left(\frac{100.72}{66.47}\right)}{9}} = 4.6\%$

Appendix B Comparison between Fish Catch and Number of Fishing Nets in 2009

Annual Average Tonnes of Fish Catch	Number of Fishing Nets Used					Total
	Tonnes	**Percent**	**1-2 Gear**	**3-4 Gear**	**Above 4 Gear**	
	1-3 Tonnes	Count	59	15	0	74
		% of Total	48	12.2	0	60.2
	4-6 Tonnes	Count	2	29	7	38
		% of Total	1.6	23.6	5.7	30.9
	7-9 Tonnes	Count	0	0	9	9
		% of Total	0	0	7.3	7.3
	10-12 Tonnes	Count	0	0	2	2
		% of Total	0	0	1.6	1.6
	Total	Count	61	44	18	123
		% of Total	**49.6**	**35.8**	**14.6**	**100**

Appendix C Catch as a Function of Income of Fishermen in 2000

Annual Average Income	Tonnes of Fish Catch						Total
	Income Range	**percent**	**1-3 Tonnes**	**4-6 Tonnes**	**7-9 Tonnes**	**10-12 Tonnes**	
	GH¢100-199	Count	19	0	0	0	19
		% of Total	15.4	0	0	0	15.4
	GH¢200 -299	Count	18	0	0	0	18
		% of Total	14.6	0	0	0	14.6
	GH¢300-399	Count	25	14	0	0	39
		% of Total	20.3	11.4	0	0	31.7
	GH¢400-499	Count	0	19	9	0	29
		% of Total	0	15.4	7.3	0	23.6
	GH¢500-599	Count	0	0	15	4	19
		% of Total	0	0	12.2	3.3	15.4
	Total	Count	62	33	24	4	123
		% of Total	**50.4**	**26.8**	**19.5**	**3.3**	**100**

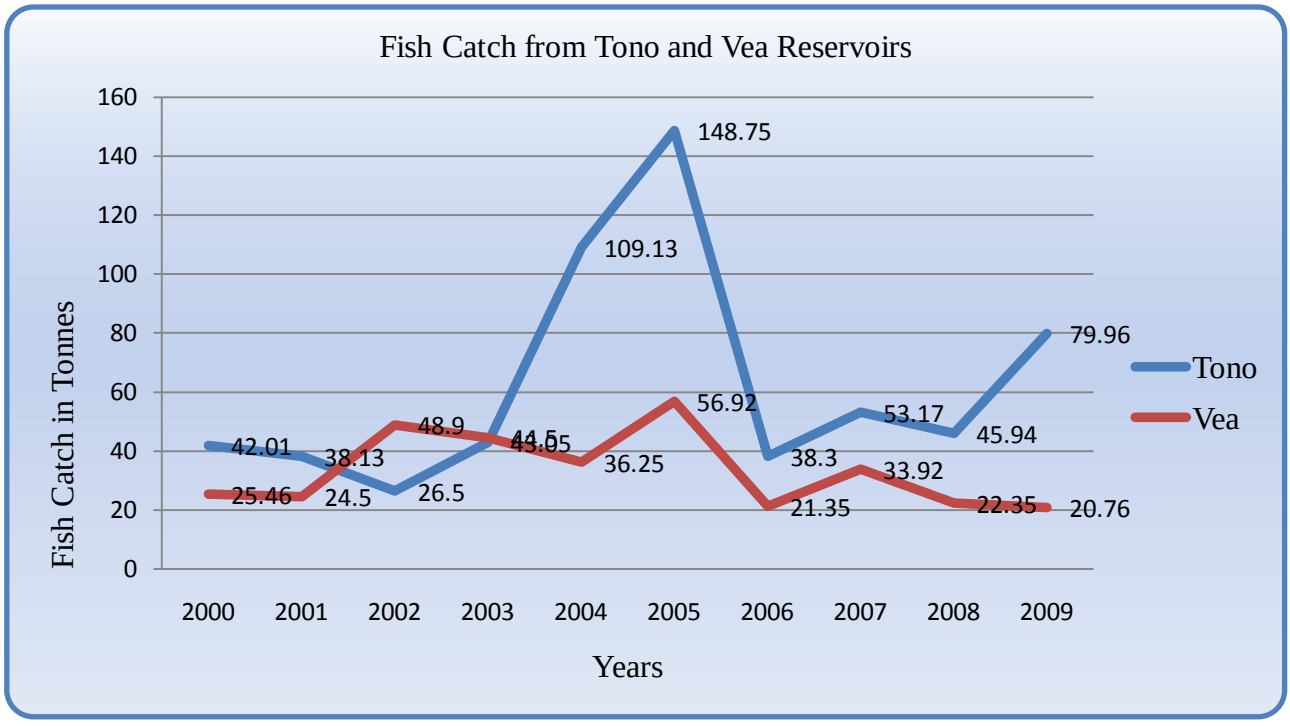
Appendix D Income Levels of Fishmongers in the Study Districts

		Annual Average Income in 2009 (GH¢)								
		Percent	District	100-249	250-399	400-549	550-699	700-849	850-999	Total
Tonnes of fish bought in 2009	1-2 Tonnes	Count	KNDA	5	8	1	0	0	0	14
			BDA	1	1	0	0	0	0	2
		% of Total	KNDA	8.5	13.6	1.7	0	0	0	22
			BDA	10	10	0	0	0	0	20
	3-4 Tonnes	Count	KNDA	1	7	7	3	0	0	18
			BDA	1	0	1	0	0	0	2
		% of Total	KNDA	1.7	11.9	11.9	5.1	0	0	30.5
			BDA	10	0	10	0	0	0	20
	5-6 Tonnes	Count	KNDA	0	0	5	4	2	0	11
			BDA	0	0	3	0	0	1	4
		% of Total	KNDA	0	0	8.5	6.8	3.4	0	18.6
			BDA	0	0	30	0	0	10	40
	7-8 Tonnes	Count	KNDA	0	0	1	4	3	1	9
			BDA	1	0	0	0	0	0	1
		% of Total	KNDA	0	0	1.7	6.8	5.1	1.7	15.3
			BDA	10	0	0	0	0	0	10
	9-10 Tonnes	Count	KNDA	0	1	0	0	1	0	2
			BDA	0	0	0	0	0	1	1
		% of Total	KNDA	0	1.7	0	0	1.7	0	3.4
			BDA	0	0	0	0	0	10	10
	11-12 Tonnes	Count	KNDA	0	0	0	0	3	2	5
			BDA	0	0	0	0	0	0	0
		% of Total	KNDA	0	0	0	0	5.1	3.4	8.5
			BDA	0	0	0	0	0	0	0
	Total	Count	KNDA	6	16	14	11	9	3	59
			BDA	3	1	4	0	0	2	10
		% of Total	KNDA	10.2	27.1	23.7	18.6	15.3	5.1	100
			BDA	30	10	40	0	0	20	100

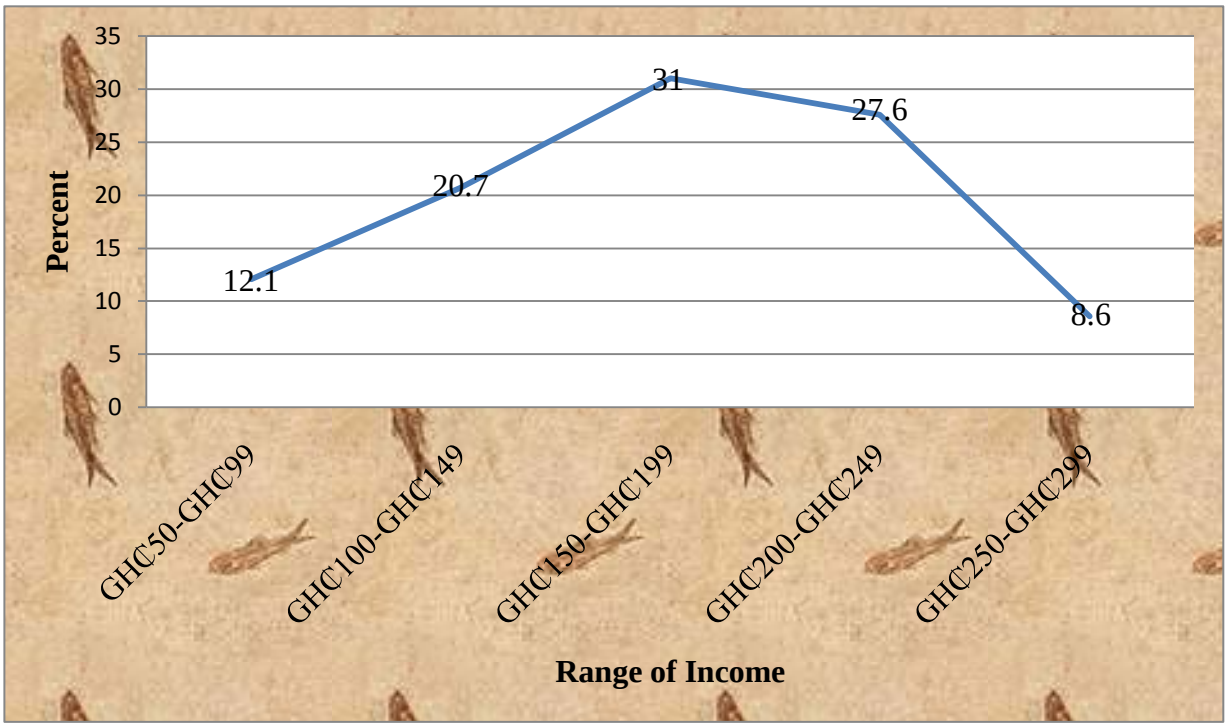
Appendix E Tonnes of Fish Bought and Annual Income in 2000

Annual Average Tonnes of Fish bought	Annual Average Income (GH¢)						
	Tonnes	Percent	100 - 199	200 – 299	300 - 399	400 - 499	**Total**
	1-3 Tonnes	Count	2	16	12	0	30
		% of Total	3	24.2	18.2	0	45.5
	4-6 Tonnes	Count	0	3	15	3	21
		% of Total	0	4.5	22.7	4.5	31.8
	7-9 Tonnes	Count	0	0	6	5	11
		% of Total	0	0	9.1	7.6	16.7
	10-12 Tonnes	Count	0	0	0	3	3
		% of Total	0	0	0	4.5	4.5
	13-15 Tonnes	Count	0	0	0	1	1
		% of Total	0	0	0	1.5	1.5
	Total	Count	2	19	33	12	66
		% of Total	**3**	**28.8**	**50**	**18.2**	**100**

Appendix F Trend of Fish Catch from Tono and Vea Reservoirs



Appendix G Supplementary Income of Fishmongers


35
30
25
20
15
10
5
0
Percent
12.1
20.7
31
27.6
8.6
GH₵50-GH₵99
GH₵100-GH₵149
GH₵150-GH₵199
GH₵200-GH₵249
GH₵250-GH₵299
Range of Income

Appendix H Catch-Price and Price-Income Relationship (Fishermen)

TONO RESERVOIR - FISHERMEN							
Year	Catch-Tono (Tonne)	Annual Growth of Catch	Price/Kilogram (GH¢)	Price/Tonne (GH¢)	Annual Growth of Price	Total Income (GH¢)	Annual Growth of Income
2000	41.01	0	0.20	200	0	8,202	0
2001	38.13	(7.3)	0.35	350	55.9	13,345.50	48.7
2002	26.50	(36.4)	0.35	350	0	9,275	(36.4)
2003	43.05	48.5	0.40	400	13.4	17,220	61.9
2004	109.13	93.0	0.35	350	(13.4)	38,195.50	79.7
2005	148.75	30.9	0.40	400	13.4	59,500	44.3
2006	38.30	(135.7)	0.45	450	11.8	17,235	(123.9)
2007	53.17	32.8	0.50	500	10.5	26,585	43.3
2008	45.94	(14.6)	0.55	550	9.5	25,267	(5.1)
2009	79.96	55.4	0.65	650	16.7	51,974	72.1
Total	**623.94**	**66.6**	**4.2**	**4,200**	**117.9**	**254,789**	**184.5**
Average	**62.4**	**7.4**	**0.42**	**420**	**13.1**	**25,478.90**	**20.5**
VEA RESERVOIR - FISHERMEN							
Year	Catch-Vea (Tonne)	Annual Growth of Catch	Price/Kilogram (GH¢)	Price/Tonne (GH¢)	Annual Growth of Price	Total Income (GH¢)	Annual Growth of Income
2000	25.46	0	0.25	250	0	6,365	0
2001	24.50	(3.8)	0.35	350	33.6	8,575	29.8
2002	48.90	69.1	0.40	400	13.4	19,560	82.5
2003	44.50	(9.4)	0.30	300	(28.8)	13,350	(38.2)
2004	36.25	(20.5)	0.40	400	28.8	14,500	8.3
2005	56.92	45.1	0.42	420	4.9	23,906.40	21.7
2006	21.35	(98.1)	0.50	500	17.4	10,675	(80.6)
2007	33.92	46.3	0.50	500	0	16,960	46.3
2008	22.35	(41.7)	0.55	550	9.5	12,292.50	(32.2)
2009	20.76	(7.4)	0.58	580	5.3	12,040.80	(2.1)
Total	**334.91**	**(20.4)**	**4.25**	**4,300**	**84.1**	**138,225**	**35.5**
Average	**33.5**	**(2.3)**	**0.43**	**430**	**9.3**	**13,822.47**	**3.9**

5% of catch used as fish food* *5% of Income assumed to be taxable: Tono= GH¢12,739.45 & Vea= GH¢6,911.25

Appendix I Catch-Price and Price-Income Relationship (Fishmongers)

TONO RESERVOIR - FISHMONGERS							
Year	Tonne	Annual Growth of Catch	Price/Kilogram GH¢	Price/Tonne (GH¢)	Annual Growth of Price	Total Income (GH¢)	Annual Growth of Income
2000	38.96	0	0.30	300	0	11,688	0
2001	36.22	(6.93)	0.40	400	28.8	14,488	21.5
2002	25.17	(34.58)	0.45	450	11.8	11,326.50	(24.6)
2003	40.90	46.07	0.55	550	20.1	22,495	68.6
2004	103.67	88.35	0.55	550	0	57,018.50	93.0
2005	141.31	29.35	0.60	600	8.7	84,786	39.7
2006	36.38	(128.91)	0.70	700	15.4	25,466	(120.3)
2007	50.51	31.16	0.75	750	6.9	37,882.50	39.7
2008	43.64	(13.87)	0.80	800	6.5	34,912	(8.2)
2009	75.96	52.63	0.90	900	11.8	68,364	67.2
Total	**592.72**	**63.27**	**6**	**6,000**	**110**	**368,427**	**176.4**
Average	**59.27**	**7.03**	**0.60**	**600**	**12.2**	**36,843**	**19.6**
VEA RESERVOIR - FISHMONGERS							
Year	Tonne	Annual Growth of Catch	Price/Kilogram GH¢	Price/Tonne (GH¢)	Annual Growth of Price	Total Income GH¢)	Annual Growth of Income
2000	24.19	0	0.30	300	0	7,257	0
2001	23.27	(3.61)	0.40	400	28.8	9,308	24.8
2002	46.45	65.64	0.45	450	11.8	20,902.50	80.9
2003	42.27	(8.9)	0.50	500	10.5	21,135	1.1
2004	34.44	(19.47)	0.55	550	9.5	18,942	(11)
2005	54.07	42.84	0.55	550	0	29,738.50	45.1
2006	20.28	(93.19)	0.65	650	16.7	13,182	(81.4)
2007	32.22	43.98	0.70	700	7.4	22,554	53.7
2008	21.23	(39.61)	0.75	750	6.9	15,922.50	(34.8)
2009	19.72	(7.03)	0.85	850	12.5	16,762	5.1
Total	**318.10**	**(19.35)**	**5.70**	**5,700**	**93.69**	**175,700**	**83.5**
Average	**31.81**	**(2.15)**	**0.57**	**570**	**10.41**	**17,570**	**9.2**

5% of income assumed to be taxable: Tono = GH¢18,421.35 & Vea = GH¢8,785

Appendix J Questionnaire for Fishermen of Tono and Vea Irrigation Projects

DEPARTMENT OF PLANNING
Faculty of Planning and Land Economy
College of Architecture and Planning
Kwame Nkrumah University of Science and Technology

Research Topic: Economic Dimensions of Inland Fisheries in the Upper East Region of Ghana.

Community/Place of resident: …… Date: ……

Name of respondent: ……..

1. Sex: Male [ ] Female [ ]

2. Age: Below 18 [ ] 18 – 24 [ ] 25 – 50 [ ] 51 and above [ ]

3. How would you describe your current marital status? Not married [ ] Married [ ]

4 a. How many dependants do you have? [ ]

4 b. What is the size of your household? [ ]

5. What is your ethnicity? Nankani [ ] Kassena [ ] Grunsi [ ] Builsa [ ]

6. Does every member of this community have access to exploiting fish from the Tono reservoir? Yes [ ] No [ ]

7. What are the means for gaining access to harvest fish from the reservoir? …….

8. How would you describe the type of access you have to the fisheries?
Open access [ ] Limited access [ ] Mixture of open & limited access [ ] No idea [ ]

9. Do you pay some fee before having access to the reservoir? Yes [ ] No [ ]

10. If yes to question 9, how much do you pay per annum? [GH¢ ……]

11. What are some of the regulations put in place to regulate fishing activities?
a)…… b)…… c)……

12. Which organization(s) is/are responsible for enforcing the regulations?
a)…… b)…… c)……

13. How many members of your household are indirectly engaged in the following fishery related activities? Fish mongering [ ] Boat repairs [ ] Net repairs [ ]

Sale of inputs [ ] Any other (specify)……

14. Have you observed any change in the tonnes of fish you catch? Yes [ ] No [ ]

15. What is the nature of change of fish catch? A decline [ ] An increase [ ]
A fluctuation [ ]

16. What was your annual average income in 2000 and 2009?

2000		**2009**	
GH¢100-GH¢199	[ ]	GH¢100-GH¢299	[ ]
GH¢200-GH¢299	[ ]	GH¢300-GH¢499	[ ]
GH¢300- GH¢399	[ ]	GH¢500-GH¢699	[ ]
GH¢400-GH¢499	[ ]	GH¢700-GH¢899	[ ]
GH¢500-GH¢599	[ ]	GH¢900-GH¢1,099	[ ]

17. Have you noticed a change in the tonnes of fish catch? Yes [ ] No [ ]

18. If yes to question 17, what were the tonnes of fish catch in 2000 and 2009?

2000		**2009**	
1-3 tonnes	[ ]	1-5 tonnes	[ ]
4-6 tonnes	[ ]	6-10 tonnes	[ ]
7-9 tonnes	[ ]	11-15 tonnes	[ ]
10-12 tonnes	[ ]	15+ tonnes	[ ]

19. What was the average time you spent in fishing in the reservoir?
Below 30mins [ ] 30mins-59mins [ ] 1hr-1hr: 29mins [ ] 1hr:30mins-1hr:59mins[ ]
Above 1hr: 59mins [ ]

20. What was the average number of fishing gear used in fishing in 2009?
1-2 gear [ ] 3-4 gear [ ] Above 4 gear [ ]

21. Do you engage in any income supplement activity? Yes [ ] No [ ]

22. If yes to question 21, which of the following supplement your income from fishing?
Crop production [ ] Animal rearing [ ] Petty trading [ ] Others (specify)……

23. How much do earn from your supplementary income activity per year?

GH¢50-GH¢99	[ ]
GH¢100-GH¢149	[ ]
GH¢150- GH¢199	[ ]
GH¢200+	[ ]

24. Do you pay tax to the District Assembly as a fisherman? Yes [ ] No [ ]

25. If yes to question 24, how much tax do you pay per annum? [GH¢ ……]

26. Apart from you, are some members of your household engaged directly in exploiting fish? Yes [ ] No [ ]

27. If yes to question 26, how many have you employed? One [ ] Two [ ] Three [ ] None [ ]

28. How will you describe the performance of the fishery in the following variables?

Variable	Performance			
Fish catch	Satisfactory	Moderate	Low	Poor
Monitoring				
Income generation				
Creation of employment				
Food security				
Poverty reduction				
Revenue generation				

29. What factors pose a threat to sustainability of the fishery? Population increase [ ] Use of chemicals [ ] Use of under size mesh [ ] Poor protection of spill ways [ ] Environmental variability [ ] Overfishing [ ]

30. What are some the major problems you encounter as a fisherman?
a)…… b)…… c)…… d)……

Appendix K Questionnaire for Fishmongers of Tono and Vea Irrigation Projects

DEPARTMENT OF PLANNING
Faculty of Planning and Land Economy
College of Architecture and Planning
Kwame Nkrumah University of Science and Technology

Research Topic: Economic Dimensions of Inland Fisheries in the Upper East Region of Ghana.

Community/Place of resident: …… Date: ……

Name of respondent: ……..

1. Sex: Male [ ] Female [ ]

2. Age: Below 18 [ ] 18 – 24 [ ] 25 – 50 [ ] 51 and above [ ]

3. How would you describe your current marital status? Not married [ ] Married [ ]

4. What is your ethnicity? Nankani [ ] Kassena [ ] Grunsi [ ] Builsa [ ]

5. Did you register before buying fish from the reservoir? Yes [ ] No [ ]

6. If yes to question 5, did you pay any fee before registration? Yes [ ] No [ ]

7. If yes to question 6, how much did you pay? [GH¢……..]

8. Have you observed any change in the tonnes of fish you buy? Yes [ ] No [ ]

9. What is the nature of change of fish catch? A decline [ ] An increase [ ]
A fluctuation [ ]

10. What was your annual average income in 2000 and 2009?

2000		**2009**	
GH¢100-GH¢199	[ ]	GH¢100-GH¢249	[ ]
GH¢200-GH¢299	[ ]	GH¢250-GH¢399	[ ]
GH¢300-GH¢399	[ ]	GH¢400-GH¢549	[ ]
GH¢400-GH¢499	[ ]	GH¢550-GH¢699	[ ]
		GH¢700-GH¢849	[ ]
		GH¢850-GH¢999	[ ]

11. Have you noticed a change in the tonnes of fish you used to buy? Yes [ ] No [ ]

12. If yes to question 11, what were the tonnes of fish bought in 2000 and 2009?

2000		**2009**	
1-3 tonnes	[ ]	1-2 tonnes	[ ]
4-6 tonnes	[ ]	3-4 tonnes	[ ]
7-9 tonnes	[ ]	5-6 tonnes	[ ]
10-12 tonnes	[ ]	7-8 tonnes	[ ]
13-15 tonnes	[ ]	9-10 tonnes	[ ]
		11-12 tonnes	[ ]

13. How many members of your household do you offer casual employment?
One [ ] Two [ ] Three [ ] None [ ]

14. What other factor(s) can you identify to cause a decline in your income than a fall in catch? Price of fish [ ] Price of Input [ ] Interest on loan [ ] Others (specify)……

15. Do you pay tax to the District Assembly as a fishmonger? Yes [ ] No [ ]

16. If yes to question 15, what is the period of payment? Weekly [ ] Monthly [ ]

17. If yes to question 15, how much tax do you pay per annum? [GH¢ ……]

18. Apart from fishmongering, what other income earning activity do you engaged in?
Crop production [ ] Animal rearing [ ] Petty trading [ ] Others (specify)……

19. What was your supplementary income in 2009?
GH¢50-Gh¢99 [ ] GH¢100-GH¢149 [ ] GH¢150-GH¢199 [ ]
GH¢200-GH¢249 [ ] GH¢250-GH¢299 [ ]

20. What are some the problems you face as a fishmonger?
a) ……b) …… c) ……

21. What measures can be put in place to solve the identified problems?
a) ……..
b) ……..

Appendix L Survey Checklist for Catchment District MoFA

DEPARTMENT OF PLANNING
Faculty of Planning and Land Economy
College of Architecture and Planning
Kwame Nkrumah University of Science and Technology

Research Topic: Economic Dimensions of Inland Fisheries in the Upper East Region of Ghana.

Community/Place of resident: …… Date: ……

Name of respondent: ……..

---

1. Does MoFA take part in managing the fish stock of the reservoir? Yes [ ] No [ ]

2. If yes to question 1, what other organisations or agencies are involved in managing the fishery of the reservoir? a) ……

3. What role(s) does MoFA play in managing the fishery of the reservoir? a) ……

4. How do the fishermen get the opportunity to harvest fish from the Vea reservoir?
   a) ……
   b) ……

5. Do you have an idea about the number of people employed in the fishery sector?
   Yes [ ] No [ ]

6. If yes to question 5, how many of them are engaged in;
   (a) Fishing [ ]
   (b) Fishmongering [ ]

7. What was the condition of fish catch in the reservoir five years ago? ……

8. Do you think there is an overfishing of the fish stock of the reservoir?
   Yes [ ] No [ ]

9. If yes to question 8, what are some the causes of overfishing in the reservoir?
   a)……
   b)……
   c)……

10. What can be done to make the fish stock of the reservoir/lake more sustainable?
    a) ……..
    b) ……..
    c) ……...
11. What measures have MoFA put in place to regulate excessive fishing effort?

Closed season [ ] Closed area [ ] Selective mesh size [ ] Others (specify)……

12. How will the above chosen measure(s) improve upon the income of fishermen and fishmongers?

a) ……..
b) ……

13. What potentials exist in the fishery subsector of the irrigation?

a) ……
b) ……

14. What has been the attitude of fishermen and fishmongers towards the enforcement of fishing regulations?

15. What are some the challenges MoFA faces in the fishery subsector?

a) ……
b) ……

16. What do you suggest can improve on the income of the fishermen and fishmongers?

a) ……
b) ……

Appendix M Survey Checklist for Personnel of Catchment Districts

DEPARTMENT OF PLANNING
Faculty of Planning and Land Economy
College of Architecture and Planning
Kwame Nkrumah University of Science and Technology

Research Topic: Economic Dimensions of Inland Fisheries in the Upper East Region of Ghana.

Community/Place of resident: …… Date: ……

Name of respondent: ……..

---

1. Do you have fishermen in this district? Yes [ ] No [ ]
2. If yes to question 1, what are the sources of harvesting fish? ……

3. Does the Assembly play a role in how fishermen gain access to harvesting of fish from the reservoir? Yes [ ] No [ ]

4. If yes to question 3, what specific role is being performed? ……

5. Does the district have regulations/bye-laws governing the activities of fishermen?
   Yes [ ] No [ ]

6. If yes to question 5, which kind? ……

7. If no to question 5, what reason(s) can you give? …….

8. How will you describe the fishery sector of the reservoir?
   Good source of employment [ ] Good source of income [ ]
   Good source of revenue [ ] Others (specify): ……

9. Does the Assembly collect tax from the fishermen and fishmongers? Yes [ ] No [ ]

10. If yes to question 9, what is the mode of collecting the tax? ……

11. How much is being paid per person?
    Fishermen [GH¢ ……..]
    Fishmongers [GH¢ ……...]

12. What potentials do you think exist in the fishery sector of the reservoir?
    a) ……

16. How can the harvesting of fish be made more sustainable?
    a) ……

Appendix N Survey Checklist for Personnel of ICOUR

DEPARTMENT OF PLANNING
Faculty of Planning and Land Economy
College of Architecture and Planning
Kwame Nkrumah University of Science and Technology

Research Topic: Economic Dimensions of Inland Fisheries in the Upper East Region of Ghana.

Community/Place of resident: …… Date: ……

Name of respondent: ……..

---

1. What are the main functions of your company?
   a) ……

2. Which of the above functions rank high to the company?
   a) ……

3. How do the fishermen gain access to harvesting fish from the Tono and Vea reservoirs? ……

4. Does the company charge the fishermen any fee for exploiting fish from the reservoirs? Yes [ ] No [ ]

5. If yes to question 4, what is the mode of payment? Weekly [ ] Monthly [ ]

6. If yes to question 4, how much do they pay as:
   Fishermen (GH¢……)
   Fishmongers (GH¢……)

7. If yes to question 4, what are the criteria for charging the fees? ……

8. If no to question 4, give reason(s) for not charging a fee. ……

9. Do you have an idea about the number of people employed in the fishery sector of Tono and Vea irrigation projects? Yes [ ] No [ ]

10. If yes to question 9, how many are employed as:
    a) Fishermen [Tono ……] and [Vea ……]
    b) Fishmongers [Tono……..] and [Vea …….]

11. Do you think there is an overfishing in the Tono and Vea reservoirs?
    Yes [ ] No [ ]

12. If yes to question 11, what are some the causes of overfishing?
    a)……
    b)……

13. What measures have the company put in place to regulate excessive fishing effort?
    Closed season [ ] Closed area [ ]
    Selective mesh size [ ] Others (specify)……

14. Do you manage the fish stock with other organisations or agencies?
    Yes [ ] No [ ]

15. If yes to question 14, list them. ……

16. What do you think is happening to fish stock in the Tono and Vea reservoir?
    Declining fish catch [ ] Declining in size of fish catch [ ]
    Fluctuation in size and catch [ ] Stability in size and catch [ ]

17. What are some the challenges of the fishery subsector of the Tono and Vea irrigation?
…….

18. What can be done to improve upon the income of fishermen and fishmongers?
    a) …….
    b) ……
    c) ……

Appendix O Interview Guide for Fishermen' Group

DEPARTMENT OF PLANNING
Faculty of Planning and Land Economy
College of Architecture and Planning
Kwame Nkrumah University of Science and Technology

Research Topic: Economic Dimensions of Inland Fisheries in the Upper East Region of Ghana.

Name of Community: ……

No. of fishermen present: …… Date: ……

1. What history do you know about the reservoir?

2. What is your main source of income?

3. Explain the procedure for accessing the fisheries.

4. What motivated you to be engaged in the reservoir fishing?

5. What is the average price per a tonne of fish catch?

6. Do you think it is necessary to regulate fishing activities on the reservoir?

7. Does the administration of closed season have any benefit to you?

8. How better are you than those who solely engaged in irrigation farming?

9. Have you observe any change in management approach to the fishery?

10. What role do you play in managing the fisheries?

11. Do you receive cash or input credit from any institution?

Appendix P Interview Guide for Fishmongers' Group

DEPARTMENT OF PLANNING
Faculty of Planning and Land Economy
College of Architecture and Planning
Kwame Nkrumah University of Science and Technology

Research Topic: Economic Dimensions of Inland Fisheries in the Upper East Region of Ghana.

Name of Community: ……

No. of fishmongers present: …… Date: ……

1. When did you become a fishmonger?

2. What are the opportunities offered by the reservoir fisheries?

3. Do you buy fish from a specific fisherman or from any fisherman?

4. What is the average price per a tonne of fish catch?

5. How do you preserve fish in the boom season?

6. Have you observed a change in the tonnes of fish you used to buy?

7. Do you foresee a situation where there will no more be fish in the reservoir?

8. What can be done to ensure sustainable supply of Fish?