

UNIVERSITY OF EDUCATION, WINNEBA

COLLEGE OF TECHNOLOGY EDUCATION, KUMASI

ASSESSING THE IMPACT OF BAGRE DAM SPILLAGE IN THE PRU EAST DISTRICT
OF BRONG AHAFO REGION



DANIEL KWASI MANU

APRIL, 2019

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OF BRONG AHAFO REGION



A Dissertation in the Department of Mechanical and Automotive, Faculty of Technical Education submitted to the School of Graduate Studies, University of Education, Winneba in the partial fulfilment of the requirement for the award of Master of Technology (Mechanical Technology Education) Degree

APRIL, 2019

DECLARATION

STUDENT'S DECLARATION

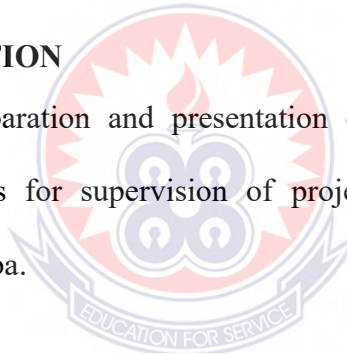
I, DANIEL KWASI MANU do declare that this project report, with the exception of quotations and references contained in published work which have all been identified and duly acknowledge, is entirely my own original work, and it has not been submitted, either in part or whole, for another degree elsewhere.

SIGNATURE:

DATE:

SUPERVISOR'S DECLARATION

I hereby declare that the preparation and presentation of this work was supervised in accordance with the guidelines for supervision of project report as laid down by the University of Education, Winneba.



NAME OF SUPERVISOR: DR. ENOCK A. DUODU

SIGNATURE:

DATE:

DEDICATION

I dedicate this project to my dear wife, Madam Sylvia Abasey.



ACKNOWLEDGEMENT

My first and foremost thanks go to God Almighty for granting me strength and knowledge to come up with this research work. I am also grateful to Dr. Enock A. Duodu for his immense contribution whose spent time off his busy schedule in making the necessary corrections, guidance and a pieces of advice in making this research work a success.

Not forgetting my spiritual father, Rev. Prophet Emmanuel Opoku who assisted with prayer to make this work fruitful.

Last but not the least, I would like to acknowledge Mr. Bright Kesse who also assisted in the research work.



ABSTRACT

According to the World Commission on Dams (WCD, 2000) the global debate about dams is overwhelmingly complex and at the same time fundamentally simple. It is complex because the issues on dams are not limited to, design, construction and operation of dams themselves, but give support to a range of social, economic, environmental and political choices on which the human aspiration to development and improved well-being depend on. The purpose of this study is to assess the impact of Bagre dam spillage along the on the Volta Basin in the Pru East District. The study identifies environmental, health and economic implications among others on the spillage of Bagre Dam in the Pru East District. The qualitative design of case study was used for the study. Respondents were selected using the purposive sampling technique and sample size of seventy-three (73) was chosen. Data collected for the study were mainly through primary and secondary sources. Statistical tools such as the Statistical Package for Social Sciences (SPSS) were used to gather and generate data, and data were presented in the form of charts, tables and graphs. Results show that the spillage of dam destroys afforestation in the affected communities, and also has significant impact on the social and economic livelihood of the inhabitants. From the findings, it was observed that ten (10) respondents representing 13% showed that the dam spillage has caused a lot of erosion and has forced the land or the soil to lose its structural of nutrients. It was observed that 23 (31%) respondents have lost their place habitat which threatened the natural existence of inhabitants rest due to the Bagre Dam spillage. It was observed that, the environment suffers most whenever, there is the spillage of the dam.

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CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

According to the World Commission on Dams (WCD, 2000) the global debate about dams is overwhelmingly complex and at the same time fundamentally simple. It is complex because the issues on dams are not limited to, design, construction and operation of dams themselves, but give support to a range of social, economic, environmental and political choices on which the human aspiration to development and improved well-being depend on. In the future, as population increases and water consumption rise, many people believe there will be a need for more dams. Dams fundamentally alter rivers and the use of a natural resource, frequently entailing a reallocation of benefits from local users to new groups of beneficiaries at a regional or national level.

Dams transform landscapes and create risks of irreversible impacts. Clashes between dam proponents and critics have brought the dams issue into focus as one of the most intensely debated issues in sustainable development.

In the late 1980s, Burkina Faso, indicated its intention to construct a dam for the purposes of irrigation and the generation of electricity. The country eventually built the Bagre Hydro Dam in 1992 on the White Volta sub-basin of the Volta Basin, without any consultation with Ghana which is downstream of Burkina Faso.⁶ The White Volta is a tributary of the Volta River Basin which is the ninth largest Basin in Africa, encompassing approximately 400,000 km² in area and generates more than 32,000 million cubic meters of water in mean annual runoff. The trans-boundary water basin which is located in West Africa is the principal water source for millions of people in six (6) riparian states. It lies mainly in Ghana (40%), and Burkina Faso (43%), with the remaining 17% in Benin, Cote d'Ivoire, Mali and Togo. The Volta River is indispensable in the relations of Ghana and Burkina Faso as one state is

upstream (Burkina Faso) while the other is downstream (Ghana) and the activities by the upstream state directly or indirectly affect those of the downstream state.

Ghana benefits immensely from the Volta River. In 1966, Ghana built the Akosombo Dam, which is a 912-megawatt hydropower plant and the most significant hydraulic structure on the Volta River. Ghana built another hydropower plant in 1982 in Kpong, and in August 2008, again started the construction of a 400-megawatt hydropower dam at Bui on the Black Volta. Ghana also uses the Volta River for transportation and tourism purposes. The Dodi Princess, for example, is used for tourism from Akosombo to the Dodi Island. The Bulk Oil Storage and Transportation Company Limited (BOST) of Ghana transport petroleum products from Tema to Buiepe in Northern Ghana through the Volta River, for distribution and for further transportation to Burkina Faso by road.

However, the construction of the Bagre Dam by upstream Burkina Faso and the recurrent annual flooding it causes in downstream Ghana, as a result of its spillage, could constitute an immense source of potential tension between the two countries. The Bagre Dam has a water holding capacity of 235 meters, beyond which extra water must be let out. Due to increased rains over the years since 2007, possibly resulting from the effects of climate change, the Dam has always received more water that threatens to exceed its capacity, thereby compelling its managers to spill excess water to avoid it breaking its banks.

In August 2007, the government of Ghana had to declare a state of emergency in the Upper East, Upper West and Northern Regions due to the devastating impact of floods on Ghanaians living on the banks of the White Volta River susceptible to the effects of the opening of the Bagre Dam. This was a unilateral decision taken by Burkina Faso thereby giving Ghanaians no chance to prepare and evacuate from the affected areas. The affected communities became inaccessible because roads and bridges were destroyed. Many lives,

both human and livestock were lost, large areas of farmlands were destroyed and businesses were swept away by the floods. Unfortunately, grappling with the impacts of the spillage from the Bagre Dam has become an annual affair with its associated devastating consequences on these vulnerable populations thereby exacerbating their already precarious socio-economic conditions.

According to Niasse (2005), the alleged water releases from dams in Burkina Faso (particularly the Bagre Dam) resulting in floods in Northern Ghana in 1999 was a potential source of conflict between Ghana and Burkina Faso. Even though this situation has not resulted in any major conflict between the two countries, it could be a potential source of tension if appropriate agreements are not properly respected and the situation should escalate.

1.2 Problem Statement

Over the past few decades, construction of dams for water supply around the world has attracted much attention concerning the social and environmental impacts that have arisen from such developments. Construction and operation of dams have always been associated with changes in the physical and biological environment as well as effects on the social and economic aspects of the surrounding community including exploration of the land. The health, economic and environmental changes coming out of the dams are in various amounts and in different importance degrees (Boycen, 2012). Report indicates that spilling of excess water in the Bagre Dam has become an annual affair (Mathews, 2012). It affects the livelihood of the people along the White Volta Sub-Basin of the Volta Basin, especially, communities in the Talensi, Bawku East, Binduri Districts and the Pru East District in the Brong Ahafo Region of Ghana. Thus the problem of this study is to assess the effects of the spillage in the communities along the Volta Basin.

1.3 The Purpose of the Study

The purpose of the study is to assess the impact of the Bagre dam spillage in the Pru East District of Brong Ahafo Region.

1.4 Objectives of the Study

The objectives of the study were to

1. Identify environmental implication of the spillage of Bagre dam in Pru East District.
2. Identify the health and sanitation implications of the spillage of Bagre dam in Pru East District.
3. Identify the economic implication of the spillage of Bagre dam in Pru East District.

1.5 Research Questions

The research seeks to answer the following questions

1. What are the environmental implication of the spillage of Bagre dam in Pru East District?
2. What is the health and sanitation implications of the spillage of the Bagre dam in Pru East District?
3. What is the economic implication of the spillage of the Bagre Dam in Pru East District?

1.6 Significance of the Study

The construction of dams in the country is given too much of structural or engineering consideration with little or no environmental, health and economic impact assessment of the operations after the design and construction. The environmental, health and economic impacts as a result of operation are usually devastating, thus there is a need for impact

assessment. The dam is only interested in the supply of water without due consideration of environmental, health and economic impacts to the community as a result of the spillage. This study is significant as it identifies these impacts & examines implementation of mitigation measures.

The research would serve as a useful reference for policy-makers in both Ghana and Burkina Faso with regards to issues arising from the management of the trans-boundary river basin.

1.7 Limitation of the Study

In spite of the expedient findings of this research, there are several limitations which must be acknowledged. Findings of this research relies on respondents' honesty. Respondents would agree further on socially required answers and disagree towards the opposite before fully and truly expressing their feelings and sentiments. Another limitation of this study is the collection of data through the surveys, as a result, the inaccuracy of information gathered stands probably high. Furthermore, the small sample size keeps a tight rein on the reliability as well as the generality of the research.

1.8 Scope of the Study

The study was carried out in Pru East District in the Brong Ahafo Region and it focused on the impacts of the Bagre dam spillage in the Pru East District. Other effects of the dam where tourism, which was not considered because it did not fall within the subject matter of the study.

1.9 Organisation of Chapters

In order to provide sequential flow of ideas to the study, the study has been divided into five (5) main chapters.

The First Chapter contains the introduction which introduces background to the study, problem statement, purpose of the study among other issues with regards to Bagre dam spillage. Review of relevant related literature forms the Second Chapter. Thirdly, the method used in gathering the data forms the Third Chapter. Chapter Four contains the data analysis, presentation and discussion of the findings. The conclusion and recommendations form the Chapter Five of this study.



CHAPTER TWO

REVIEW OF LITERATURE

2.1 Introduction

This chapter presents the background to the study which illuminates the subject matter in a way which easily leads to defining the problem to be investigated in this research work. The chapter ends with the structure of the study which gives an overview of the research work and which seeks to reviews relevant related literature geared towards achieving the stated objectives.

2.2 The Volta River Basin

The Volta River Basin is located in West Africa and occupies about 400,000km². It is shared between six riparian nations: Burkina Faso (43%); Ghana (40%); Togo (6%); Benin (4%); Mali (4%) and Cote d'Ivoire (3%) (Tall et al., 2012). The Basin stretches from approximately latitudes 5° 30"N and 14° 30"N and longitudes 2° 00"E and 5° 30"W in Mali. Ghana occupies the lower half of the basin and the point at which the three principle tributaries (Black Volta, White Volta and Oti River) join the main Black Volta to form the Akosombo Dam. The basin extends over at least four climatic regions, from Rainforest in the south to the Sahel in the north, with Guinea and Sudan Savanna in between (Rodgers et al. 2007). Each climatic zone is strongly influenced by the movement of the Inter-Tropical Convergence Zone (ITCZ), which is responsible for both rainfall regimes (Sultan et al. 2004; Rodgers et al. 2007).

Southern zones exhibit one peak in June/July and another in September/October, within an overall moist season stretching from April to mid-November. In the uni-modal north, the rainy season persists from May to October with a peak in August/September. The basin experiences high degrees of spatial and temporal variability in rainfall, making it unreliable

for agricultural production resulting in diminishing food security. Irrigation is limited to the more arid Northern Regions especially in Burkina Faso. In Ghana the water is utilized mainly for power generation and domestic consumption. Three quarters of Ghana is drained by the Volta River, which enters the country's Northern Regions from Burkina Faso, and flows more than 1400 km before reaching the Gulf of Guinea near the town of Ada in the Volta Region. In addition to three quarters of Ghana, it also drains approximately two thirds of Burkina Faso, a large part of Togo and small slices of Côte d'Ivoire, Benin, and Mali. The basin can be subdivided into smaller basins belonging to its three major tributaries, the Black Volta, the White Volta, the Oti, and the Lower Volta, referring to the river downstream of the confluence of the Black and White Volta. The Black Volta flows from Burkina Faso, along the border of Ghana and Côte d'Ivoire, through the Bui Gorge into the Voltaian Basin. To the east, the White Volta also flows south from Burkina Faso. When it encounters the Gambaga escarpment it turns in a westerly direction traversing the foot of the escarpment until it reaches the end where it continues southward into the Voltaian basin. Further east, the Oti River flows below the western slopes of the Buem Ranges before joining the Volta. The river flows through the Voltaian sandstone basin occupying an area of 112,768 km² in the heart of the north-central region of Ghana. In this basin are Paleozoic formations of sandstone, shale and mudstone and pebbly conglomerate beds. These materials are easily eroded and gently dipping or flat bedded. The basin is bounded on the south by the Southern Voltaian Plateau and in the northeast by the Gambaga escarpment. The river exits the basin through a narrow gorge at Akosombo, offering the opportunity to dam the river with a relatively small structure (Andreini et al., 2000).

Transboundary water resource management has been nonexistent within the basin until recently. In 2007, the Volta Basin states signed and subsequently ratified a convention, the purpose of which is to promote social and economic growth within the region and to

effectively manage the Volta River and its tributaries. This instrument was the first and most important step in creating a cooperative effort for the basin's water resource management. Unfortunately, the treaty is severely lacking in many of its substantive and procedural obligations (Mathews, 2012). A series of memoranda of understanding has existed between countries through the initiative of the World Bank. The most profound is the one which requires that a country "proposing to execute any project which will regulate, abstract or otherwise change river flow must notify co-riparian states of its intentions so that each state may consider whether it wishes to lodge an objection" (World Bank 1995 & Mathews, 2012). In the building of the Ziga Dam, Burkina Faso actually followed this protocol and invited a Ghanaian delegation to sign a non-binding agreement in order to satisfy the World Bank (GNA, 2016). Intense negotiations have failed to yield a firm agreement; a failure which reemerges when reservoir levels sink so low that energy crises and power rationing arise as they did in 1983, 1998, and 2007. In 1998, exacerbated by drought in the basin, Ghana accused Burkina Faso of causing low water levels by increased withdrawals and obstruction of flow (Ghana Business News, 2016). Andreini, et al. (2000) showed that withdrawals in Burkina Faso have very little impact on lake levels in Ghana. At the same time, Burkina Faso has opted to produce its own power because it considers Ghana's power production capacity as highly uncertain (Owusu, et al., 2008).

The basin region has recently been plagued with devastating parasitic diseases, floods, droughts, and water shortages. As the global temperature begins to shift, the rainy seasons in the basin have become more sporadic and intense, leading to both flooding and droughts. Recent deluges have spurred conflicts between states, springing from accusations of dam letting without prior notification. The inundations left thousands homeless and destroyed thousands of hectares of farmland. These extreme weather events are projected to increase in

occurrence and severity in the basin due to climate change, which would result in increased tension between riparian states (Mathews, 2012), especially upstream Burkina Faso and downstream Ghana.

2.3 Construction of Bagre Dam

The Bagre Dam is a multipurpose dam built on the White Volta and located near Bagre Town in Burkina Faso on the coordinates: 11°28'36.78"N 0°32'48.10"W. The Dam was started on 1989 and completed in 1992 at a cost of 67 million CFA from the World Bank. It has a total capacity of seven billion cubic meters of water (7,000,000m³) or 5,700,000 acres: ft., with maximum length of 400km (250mi). It is the biggest dam in Burkina Faso with 40 meters deep, 400km long and 90km wide and has 40,000 to 80,000 hectares of arable land (Gao et al., 2009). Currently, only 4,000 hectares is being utilized, and produces 450,000 tons of agricultural produce of cereals of various kind benefiting 3,325 families of farmers aimed at fighting food insecurity (FAO, 2014).

The dam has two turbines with installed capacity of 16mw and operated by Société Nationale d'Electricité (SONABEL) of Burkina Faso. It provides 10 percent of the country's electricity needs. The dam impounds into the White Volta, and enters Ghana through the village of Sapielga in the Upper East Region, which is situated about 60km from the dam.

2.4 Dam Flooding

During the monsoon or flood season, dam operation facing conflict objectives like flood control, irrigation, power generation and conversation at the end of the period (Bai & Tamjis, 2007). At the same time, dam water levels are often lowered in order to avoid dam flooding or overtopping and maintain the dams' safety (Chongxun et al., 2008). Both (Liu et al., 2012) and (Valdes & Marco, 1995) acknowledged that the key difference between dams and all

other flood protection measures lies in the fact that dams introduce a new risk of dam flooding which usually results in dam flooding is one of major factors of dam failure. Several researchers such as (Hsu & Kuo, 2004, Kuo et al, 2007, Chongxun et al., 2008 and Chanson, 2009) stated that the chance of a dam (Columbia hydro power dam) break from the world record due to flooding is about one-third or 35% (International Commission on Large Dams, ICOLD, 1973).

Though, Chanson, 2009, opinionated that dam flooding is relatively slow process compare to failure of a dam (Bagre dam), he also agreed with (Benoni, 2016 & Ataie-Ashtiani, 2008) that the risk of dam flooding during extreme floods has become a primary concern for hydraulic engineers, emergency planners and responders. In recent years, the design floods of a number of dams were re-examined and discovered that the revised flows were often exceeded than the allowable designs flows, which would result in dam flooding due to insufficient existing storage and spillway capacity (Axelrod, 2016).

During intense rainfall also, it is known to cause massive flooding, a damaging natural hazard faced by society (Asante, 2015), as water entering the residences and commercial buildings. Even worse, where large parts of areas are facing prolonged flooding that lasted for several days or months (Ankiilu, 2016).

Due to the reason above, dams should be closely monitored during periods of heavy rainfall, especially dams with large numbers of people immediately downstream (Andon, 2015) because dam flooding poses a public health threat in terms of the prolonged flooding at the downstream.

This paper presents the preliminary study of potential dam flooding caused a prolonged flooding. Although warnings are issued for heavy rains and flash flooding, no warnings were issued for potential dam flooding (Amenuveve, 2015). Evaluation the impact of dam flooding

enables the regulatory authorities to analyse the downstream human safety, especially where no dam flooding and prolonged flooding histories are documented (Cleary et al., 2010).

2.5 Impact of the Water Spillage from the Bagre Dam

Reports show that in previous years, the opening of the flood gates of the Bagre Dam has always contributed to floods in Northern Ghana with attendant consequences, especially in the immediate communities around the White Volta River banks and its tributaries, including communities in the Talensi, Binduri, Bawku West Districts and the Bawku East Municipality with attendant effects on the people (Aljezea, 2016).

The Integrated Regional Information Network (IRIN, 2007) report indicates that Ghana experienced one of the most widespread and devastating floods in recent times. Ghana's National Disaster Management Organization (NADMO) report indicates that nearly 266,000 inhabitants in the Northern, Upper East, Upper West and Brong Ahafo Regions of Ghana were affected, with 22 people reported dead in the Pru East District. Over 11,000 homes were destroyed and more than 12,000 hectares of farm lands were destroyed in the Pru District alone (Akapule & Achonga, 2012). The threat to human health through pollution of portable water sources such as boreholes, hand-dug wells as well as destruction of livestock has equally been significant.

Floods in the Northern part of Ghana due to heavy rains and most often worse by the opening of the Bagre Hydro Dam, which inundated several communities sited along the banks of the Volta Basin. Report shows that at least 5,104 houses collapsed, 13 public schools and 30,000 acres of farm land were destroyed. The floods also rendered 24 communities inaccessible (Ankiilu et al, 2009).

The floods in the Northern part of Ghana caused by the annual opening of the Bagre Dam in Burkina Faso and their disastrous consequences continued in 2010, 2011, 2012, 2013, 2014

and 2015. In 2015, more than 650 hectares of farmlands in the Bawku West District of the Upper East Region were reported to have been submerged as a result of the spillage from the Bagre Dam in Burkina Faso. About 1,200 farmers in the District had their farmlands and crops destroyed by the excess water from the spillage. Some farmers in the District contemplated commit suicide as a result of the damage. Some of the crops destroyed were maize and sorghum, in some communities in the district, including Zongoyire, Sakpare, Gozongo and Galaka (Amenuveve, 2015).

According to Hastrup & Rubow (2014) the livelihood of the youth along the White Volta is strongly determined by the Bagre Dam. The floods affect their boat transport business as well as fishing in the river for a long time as community residence are warned to desist from going close to the river. This has led to food security problems and induced rural-urban migration, as the youth who lost their farms and other sources of livelihood departed from the communities to cities and neighbouring countries. This migration effects have the potential of impacting negatively on the general security and especially food situation in the country.

2.5.1 Environmental Impact of the Water Spillage from the Bagre Dam

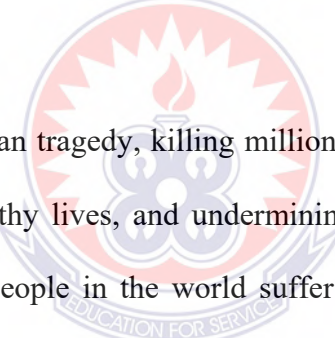
Dam has potential environmental nightmares (Basiru, 2016). One of the most immediate environmental effects of the dam has been an increase in landslide activity. This results primarily from erosion caused by the drastic increases and decreases in reservoir water levels, which, when at their peak, create a body of water almost as long as Britain (Watts 2010). Another major issue with the dam is the ways in which it is affecting biodiversity in the area. Animal and plant life has been greatly threatened due to flooding in some habitats and water diversion in others. Furthermore, fragmentation of habitat may lead to heavy losses of biological diversity (Akapule & Achong, 2012). As one author compellingly shows,

fragmentation leads to species insularization by creating virtual islands, which confound processes of ecosystem stability and biological enrichment (Owusu, 2011). Fragmentation of habitat, moreover, is disturbing the reproduction patterns of many species, suggesting that if they haven't disappeared yet, they soon may. Whether one agrees that this means a loss of spiritual and cultural wealth, it undoubtedly means a loss in resources that might otherwise have been tapped. Examples might include medical plants, among others. Decreases in freshwater flow have meant that more saltwater is creeping up the Yangtze, endangering fish populations already threatened by overfishing (Mathews, 2012). This again signifies a loss of valuable resources. There has also been a 50% loss in sediment and nutrients downstream, a common issue with most dams, which will cause erosion to river systems, wetlands, and seacoast ecosystems, leading to adversely impact fisheries and wetland watersheds (Tall et al., 2012). Lastly Dam may have been tied to major earthquakes, including the one in May of 2008 which killed 87,000 people (Adama, 2016). By placing tremendous pressure and fluctuation (by rapidly raising and dropping water volume) on the underlying geological plates, TGD arguably increases seismic activity. Proving that this leads to increased earthquakes, however, is more difficult (Akapule & Achong, 2012).

2.5.2 Health and Sanitation Impact of the Water Spillage from the Bagre Dam

Environmental change and social disruption resulting from large dams and associated infrastructure developments such as irrigation schemes can have significant adverse health outcomes for local populations and downstream communities. The issue of equity - in terms of pre-existing nutritional and health conditions of the population and the capacity to resist new health problems is at the root of the adverse health impacts of dams (Mathews, 2013). Among the resettled communities, access to drinking water, health services and ability to cope with new social and physical environment determines health conditions. Numerous

vector borne diseases are associated with reservoir dam development in tropical areas. Schistosomiasis (Bilharzia) spread through snails breeding in still or slow moving waters was a significant public health problem that emerged from many early projects, such as Akosombo (Singer & Watanabe, 2014). The sporadic outbreak of the Rift Valley Fever has also been associated with the Aswan and Kariba dams and irrigations systems undertaken along the Blue Nile in Sudan. Most reservoir and irrigation projects undertaken in endemic areas increase Transmission and diseases (Mathews, 2013). In new dams tropical, subtropical, and arid and semi-arid regions is rapid eutrophication resulting in problems of excessive aquatic weed growth or blooms of toxic cyanobacteria. This is reinforced by enhanced nutrient pollution through the growth of towns, agriculture and mining operations in the catchment.

The logo of the University of Education, Winneba, is a circular emblem. It features a central sunburst or flame-like symbol in white and red, set against a blue background. Below the sunburst is a blue shield with a white cross. The text 'UNIVERSITY OF EDUCATION, WINNEBA' is written in a circular path around the emblem, and 'EDUCATION FOR SERVICE' is written at the bottom.

Water-related diseases are a human tragedy, killing millions of people each year, preventing millions more from leading healthy lives, and undermining development efforts (Stronl & Blan, 2013). About 2.3 billion people in the world suffer from diseases that are linked to water (Tajziehchi et al., 2014) Some 60% of all infant mortality is linked to infectious and parasitic diseases, most of them water-related (Plat, 2015). In some countries water related diseases make up a high proportion of all illnesses among both adults and children. In Bangladesh, for example, an estimated three quarters of all diseases are related to unsafe water and inadequate sanitation facilities. In Pakistan one quarter of all people attending hospitals are ill from water borne related diseases (Vanclay et al., 2015) Effects of diseases associated with water bodies can be classified into three categories: waterborne diseases, including those caused by both faecal oral organisms, and those caused by toxic substances; water based diseases; and water related vector diseases (Tullos et al., 2013). Waterborne diseases waterborne diseases are “dirty-water” diseases- those caused by water that has been

contaminated by human, animal, or chemical wastes. Worldwide, the lack of sanitary waste disposal and clean water for drinking, cooking, and washing is to blame for over 12 million deaths a year (Plat, 2015). Waterborne diseases include diarrhea, cholera, typhoid, Shigella, polio, meningitis, and hepatitis A and E. Human beings can act as hosts to the bacterial, viral, or protozoal organisms that cause these diseases. Millions of people have little access to sanitary waste disposal or to clean water for personal hygiene. An estimated 3 billion people lack a sanitary toilet, for example. Over 1.2 billion people are at risk because they lack access to safe, fresh water (Qi & Altinakar, 2012). Diarrhoea, the major waterborne disease, is prevalent in many countries where sewage treatment is inadequate. Instead, human wastes are disposed of in open latrines, ditches, canals, and water courses or they are spread on cropland. An estimated 4 billion cases of diarrhea disease occur every year, causing 3 million to 4 million deaths, mostly among children (Plummer & Guthrie, 2015). Toxic substances that find their way into fresh water are another cause of waterborne diseases. Increasingly, agricultural chemicals, fertilizers, pesticides, and industrial wastes are being found in freshwater supplies. Such chemicals, even in low concentrations can build up over time and, eventually, can cause chronic diseases such cancers among people who use the water (Plummer, 2013). Health problems from nitrates in water sources are becoming a serious health problem almost everywhere. In over 150 countries nitrates from fertilizers have seeped into water wells, fouling the drinking water (Vanclay et al., 2015). Excessive concentration of nitrates causes blood disorders (Vanclay, 2015). Also, high levels of nitrates and phosphates in the water encourage the growth of blue-green algae, leading to deoxygenation (eutrophication). In tropical, sub-tropical and arid regions of the world, it is almost inevitable that new dams will become atrophied (nutrient enriched) rather quickly, often within the first few years of filling and operation. Eutrophication brings with it problems of excessive aquatic weed). Arid zones of the world are particularly at risk, where the artificial

impoundment of water in the growth or blooms of toxic cyanobacteria (cyanobacteria are a type of microscopic algae hot climate creates the perfect ecological environment for the growth of toxic cyanobacteria. Added to this natural climatic effect is the enhanced rate of nutrient pollution that accompanies the growth of towns and agriculture in the catchment around a dam, often with inadequate effluent collection and treatment facilities. Blooms of freshwater algae and cyanobacteria have always occurred in eutrophied waterways, but the toxicity of these organisms has only been elucidated in recent years (Wanga et al., 2013). The most severe and well documented case of human poisoning due to cyanobacterial toxins occurred in the Brazilian city of Cururu in 1996. Inadequately treated water from a local reservoir was used for patients in a local kidney dialysis clinic. As a consequence, more than 50 people died due to direct exposure of the cyanobacterial toxin to their blood stream during dialysis. Elsewhere in South America, in 1988, more than 80 deaths and 2,000 illnesses due to severe gastroenteritis have also been linked with toxic cyanobacteria in a newly constructed dam (Wanga et al., 2013). In China, a high incidence of primary liver cancer has been linked to the presence of cyanobacterial toxins in drinking water (Schneider, 2013). The lessons learnt from these cases are that drinking raw water from a dam is dangerous to health and can lead to disease outbreaks. This study will document the disease situation that can be linked use of untreated water.

Waterborne diseases are caused by aquatic organisms that spend part of their life cycle in the water and another part as parasites of animals. These organisms can thrive in either polluted or unpolluted water. As parasites, they usually take the form of worms, using intermediate animal vectors such as snails to thrive, and then directly infecting humans either by boring through the skin or by being swallowed (Schneider, 2013). Water based diseases include guinea worm (*dracunculiasis*), paragonimiasis, clonorchiasis, and schistosomiasis

(bilharzias). These diseases are caused by a variety of flukes, tapeworms, roundworms and tissue nematodes, often collectively referred to as helminthes that infect humans (Plummer & Guthrie, 2015). Although these diseases usually are not fatal, they can be extremely painful, preventing people from working and sometimes even making movement impossible. The prevalence of water-based diseases often increases when dams are constructed, because of the stagnant water behind dams is ideal for snails, the intermediary host for many types of worms. For example, the Akosombo Dam, on a Volta lake in Ghana, and the Aswan High Dam, on the Nile in Egypt, have resulted in huge increases of schistosomiasis in these areas (Mathews, 2013). Also, in Mali a survey conducted in 225 villages in different ecological settings found that the prevalence of urinary schistosomiasis was five times greater in villages with small dams (67%) than in the drier savanna villages (13%) (Plummer & Guthrie, 2015). Millions of people suffer from infections that are transmitted by vectors- insects or other animals capable of transmitting an infection, such as mosquitoes and tsetse flies- that breed and live in or near both polluted and unpolluted water. Such vectors infect humans with malaria, yellow fever, dengue fever, sleeping sickness, and filariasis. Malaria, the most widespread is endemic in about 100 developing countries, putting some 2 billion people at risk (Scudder, 2012). In sub-Saharan Africa, malaria costs an estimated US\$1. 7 billion annually in treatment and lost productivity (Singer & Watanabe, 2014). Lack of appropriate water management, along with failures to take preventive measures, contributes to the rising incidences of malaria, filariasis, and onchocerciasis. Dam construction projects often increase the mosquito population due to stagnant water (Kurniati et al., 2013). For example, in West Africa an epidemic of Rift valley fever in 1987 has been linked to the Senegal River Project. The project, which flooded the lower Senegal River area, enabled the type of mosquito that carries the virus to expand so much that the virus was transmitted to humans rather than remaining in the usual animal hosts (Henning et al., 2013).

2.5.3 Economic Impact of the Water Spillage from the Bagre Dam

Generally, the immediate impacts of the flooding include loss of human life, damage to property, destruction of crops, loss of livestock, and deterioration of health conditions owing to waterborne diseases. Communication links and infrastructure such as schools, roads and bridges are usually temporarily damaged and members of affected communities forced to leave their homes which are usually submerged to leave in safe havens, and normal life becomes disrupted as many become homeless (Kibler et al., 2012).

The disruption to the agricultural industry which is the main stay of the rural community, in particular, and Ghanaian economy, as a whole, leads to loss of livelihoods and affects the food security situation of the communities and the country by extension (Kurniati et al., 2013). Damage to infrastructure also causes long-term impacts, such as disruptions to access to clean water, electricity, transport, education and health care. Loss of livelihoods, reduction in purchasing power leaves communities economically vulnerable. Trade between the communities and their Burkinabe counterparts is normally affected by the floods as traders in the communities are unable to cross the river by canoes to trade (Strobl & Blanc, 2013).

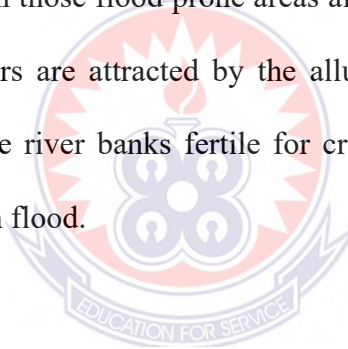
The floods have cost the Ghana government a lot of money in relief and emergency responses which comes at a heavy cost to the people and government and can impact on a country that is already struggling financially to make ends meet within the domestic economy thereby exacerbating economic hardships.

According to Strobl & Blanc (2013) widespread of unemployment due to destructions of crops, farmland, livestock and roads as a result of flooding. The rural economies are not diversified and are mainly dependent on agriculture, they are more sensitive to income effect, and therefore suffers from major loss of income due to the flooding, Loss of household

income from agriculture results in increased poverty and misery. Despite the negative economic impact from the floods, a positive impact is also reported from the residents of the affected areas that the soil becomes more fertile for their crops after the floods (Tajziehchi et al., 2014).

Flooding deposits fine silt (alluvium) onto the floodplain, making it very fertile and excellent for agriculture. This attracts people to live on or near floodplains so that they can cultivate the land to help support their farming and therefore provide food. When the flood waters recede, enough water is left in their rivers which is used to sustain irrigated farming in the dry season, thereby raising the economic wellbeing of the residents (Tajziehchi, 2014).

The negative effects of settling in those flood prone areas along the banks of the White Volta outweighs the gains. The farmers are attracted by the alluvial deposits of previous floods which make farmlands along the river banks fertile for crop production only to have their farms destroyed by the next flash flood.



2.6 Operational Framework

The environmental and social consequences of the dam have several dimensions that are worth considering in the conceptual framework designed for this study. Reservoirs projects are considered to be major assets in terms of the quality and quantity of water they generate for industrial, domestic, irrigation, and the tourist attraction. Notwithstanding these benefits, there are many deleterious social and environmental impacts which have been considered to be adverse on humans and the natural environment. Whenever dams are constructed, multiplicities of actions, both natural and artificial are set in the process. These include; loss of land and vegetation, which translates to the net loss of habitat for plants, animals and human beings. Another impact is the increasing rate of river/lake sedimentation. Usually

human activities within dam catchment areas have accelerated the sedimentation process through farming, human attachment, etc. Due to inundation of the habited areas, by the lake water there is the urgent necessity to resettle the local inhabitants. It is important to note that resettlement and compensation generally constitute the greatest socioeconomic cost of water Dam project development. Furthermore, several aspects of the socio-cultural as well as environmental health related problems have to be considered for redress.



CHAPTER THREE

METHODOLOGY

3.0 Introduction

This chapter examines the research methodology, the approach adopted for sourcing information in order to achieve the study objectives. The chapter contains the study design, target population, sample size and analysis technique.

3.1 Study Area

The Pru East District is one of the 29 districts in the Brong-Ahafo Region with its administrative capital at Yeji. The district was created out of the then Atebubu District by Legislative Instrument (L.I) 1778 in 2004. It has a land size of about 1,782.2sq.km. (690.781sq. miles). The population of Pru East District is about 61,076 representing 2.6 percent of the region's total population. Females constitute 47.3% and males represent 52.7%. The District is wholly rural, implying that the total population of each of the localities is less than 5,000. The main occupation of the district are farming and fishing.

On employment, about 66 percent are engaged as skilled agricultural, forestry and fishery workers, 11.7% in service and sales, 14.1% in craft and related trade, and 4.3% are engaged as managers, professionals, and technicians. Within this category, males account for 65.3% while their females' counterpart contributes 62.2%. Overall, men constitute the highest proportion in each employment category except apprentices. The private informal sector is the largest employer in the district, employing 95.1 percent of the population followed by the public sector with 4.5%.

3.2 Research Design

Research design is a strategic framework that guides research activity to ensure that sound conclusions are reached. This involves plans for data collection, the instrument for gathering information, how information gathered would be processed and analyzed to give meaning to the research findings. The research was carried out in multiple and carefully sequenced phases. It began by exploring the magnitude of the problem which served as a basis for the formulation of objectives and research questions.

A qualitative data collection and analysis approach was used in this study. The qualitative approach offers a systematic subjective way of describing and giving meaning to life experiences and contextual situations (Gray & David, 2013). The qualitative design of the study is the use of case study. According to Zucker (2009), a case study is “a systematic inquiry into an event or a set of related events which aims to describe and explain the phenomenon of interest.” It is a form of qualitative descriptive research that allows for an intensive study of individuals and situation concerned. This is relevant to the study as it provides room for the researcher to seek the right answers to the research questions.

3.3 Population

The entire population of Yeji, Kobre, Parambo, Kajai and Kadue communities along the Volta river basin in the Pru East District were selected for the study.

3.4 Sampling Size and Sampling Technique

This involves the statistical method of obtaining representative data or observations from a group. This was done in a predetermined manner (Gray & David, 2013). Sampling technique provides a range of methods that enables you to reduce the amount of data you need to collect by considering only data from a sub group (known as a sample), rather than all possible cases

or elements (Gray & David, 2013). According to Johnson and Christensen (2014), sampling is the process of drawing a sample from a population.

Respondents were selected using the purposive sampling technique. Purposive sampling is when a researcher chooses specific people within the population to use for a particular study or research project on the basis of one's own knowledge of the population (Johnson & Christensen, 2014). This technique allows the researcher to identify key stakeholders useful for the study. The sample size of sixty-three (63) respondents drawn across the four (4) communities in the Pru East District of Brong Ahafo Region was sampled for the study. Also three focus groups of 10 members each drawn from four (4) communities were identified and selected.

3.5 Source of Data

Data collected for the study were mainly through primary and secondary sources. Secondary sources of data were obtained from books, journals and internet to support the critical analysis of the data obtained from the field. The method of collection of primary data was through an interview, observation and questionnaire.

3.6 Data Collection Instruments

According to Creswell (2005) no single technique may be considered to be adequate in itself in collecting valid and reliable data. Interview guide and questionnaire were the tools used to obtain adequate and reliable information for this study.

3.6.1 Questionnaire

The questionnaires were personally administered by the researcher to encourage the respondents to participate and allow probes and clarification. The questionnaire was used to

gather information on the location and background of the respondents, environmental health issue, social, economic and cultural issues.

3.6.2 Focus Group Discussion

Focus group discussions were conducted in the selected sub-location representing one location. The focus groups comprised 10 participants who selected with consideration of all social group representations; men, women, youth, aged people, influential people in the community and community leaders. From focus group discussions, qualitative information such as general opinion, awareness and attitude towards dam spillage will be collected. The checklist was the basic tool for conducting focus group discussions. Participants responses were recorded in a notebook during the discussions or immediately thereafter.

3.6.3 Field Observation

Field observation was used to verify some issues such as encroachment, flooding, fishing activities, crop destruction by wildlife as well as recreational activities in the study area.

3.7 Data Analysis Procedure

The first stage was the manual editing of the collected data to detect errors and omissions that would compromise low quality standards. This was also to check whether all the questions requiring answers had been answered to ensure accuracy, consistency and completeness of the responses. The next task involved the coding of the questionnaires by assigning numbers to them. Variables were defined for each of the questions on the questionnaire. After the data had been entered, there was the electronic editing of the data where descriptive data analysis was used to check whether all the data sets were valid. Finally, as a descriptive survey, a statistical tool of the Statistical Package for Social Sciences (SPSS) was used to gather and

generate data. Data obtained from the field were displayed in the form of charts, tables and graphs.

3.8 Ethical Consideration

As this study requires the participation of human respondents, certain ethical issues were addressed. The consideration of these ethical issues is necessary for the purpose of ensuring the privacy as well as the safety of the participants; this is because in Ghana most information that comes to the public is different from what is actually happening on the ground. Among the significant ethical issues that were considered in the research process included consent and confidentiality. In order to secure the consent of the selected participants, the researcher relayed all-important details of the study, including its aim and purpose. By explaining these important details, the respondents were able to understand the importance of their role in the completion of the research. The confidentiality of the participants was ensured by not disclosing their names or personal information in the research. Only relevant details that helped in answering the research questions were included.

CHAPTER FOUR

ANALYSIS OF RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents analysis of results and discussion of the findings in the course of the study. The results of the data obtained were presented analytically in the form of tables and charts.

4.2 Responds Rate of Respondents

The researcher was based on the effects of the spillage of the Bagre Dam on the inhabitants of Pru East District. The respondents were eager to understand the concept and the issue being studied on. Because they had experienced it for the past decade, they were eager to help the findings become a success. The researcher, put all of factors before approaching the respondents because, the researcher wanted to engage all the respondents put in place and avoid any error with regards to respondents completing and returning all the questionnaires. The respondents were able to complete and returned all the questionnaires issued to them. Seventy-three (73) questionnaires were issued out and the responds rate was 100%. This implied that, the respondents understood the issue presented to them and they wanted their concerns and ideas known with regards to the problem that has confronted them for the past decade.

With regards to the focus group, the researcher engaged all of his check list. These are the people who have actually experienced the impact of the dam spillage in the Pru District. These focus group included farmers, fishermen and property owners. The responds rate was very significant since their input made the findings very precise and accurate.

4.2 Environmental Issues

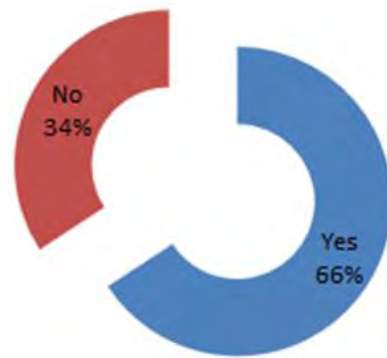


Figure 4.1 Distribution of the Forest due to the spillage of the dam

Source: Field Result, 2018

The spillage of the dam over the past decade has been very impactful on the people along the Volta Basin. The spillage has caused dissatisfaction among the people in the Pru District since the flood damages the forest and farm products. From fig. 4.1, it was observed that forty-eight (48) respondents representing 66% provided evidence that the spillage has caused deforestation. Twenty-five (25) respondents representing 34% believe that, even though, it has destroyed the forest, its effect is not significant on their livelihood. These are likely to be the inhabitants who live a bit far from the water basin.

Table 4.1 Some Environmental Issues Emanating from the Spillage of the Bagre Dam

Environmental Problems	Frequency	Percentages (%)
Flood	23	31.5
Erosion	10	13.7
Loss of Habitat and Sedimentation	23	31.5
Loss of Vegetation	10	13.7
Increase Degradation	7	9.6
Total	73	100.0

Source: Field Result, 2018

The impact of the dam spillage is very devastating and their effect on the inhabitants is always negative. As indicated in Table. 4.1, it was observed that flooding is one of the major effects dam spillage brings. When the dam is spilt, those on the basin and along the basin lose their lives and properties through flooding. Twenty-five (25) respondents representing 31% believe that the effect of flooding as a result of dam spillage is very significant.

Erosion is a continuous soil structure loss due to excessive force from down pour of water. Since this area is major farming community, the land is always subjected to excessive pressure from human and natural activities. Due to this, any form of spillage from the dam can cause the land or the soil to lose its fertility. Also, from the findings, it was observed that ten (10) respondents representing 13% showed that the dam spillage has caused a lot of erosion and has forced the land or the soil to lose its structural of nutrients.

The spillage of the Bagre Dam has caused inhabitants of along the Volta Basin in the Pru East to loss lives as well as the properties. Plummer (2013) reaffirms the data that in 2012, hundreds of inhabitants along the Volta Basin especially in the Pru East District lost their place of abode due to the spillage. Again, it was observed that 23 (31%) respondents have lost their place habitat which threatened the natural existence of inhabitants rest due to the Bagre Dam spillage. Table 4.1 further shows that 10 (13%) of the respondents indicated that the natural vegetation is lost due the Bagre Dam spillage. This assertion reaffirms the findings obtained from (Vanclay, 2015).

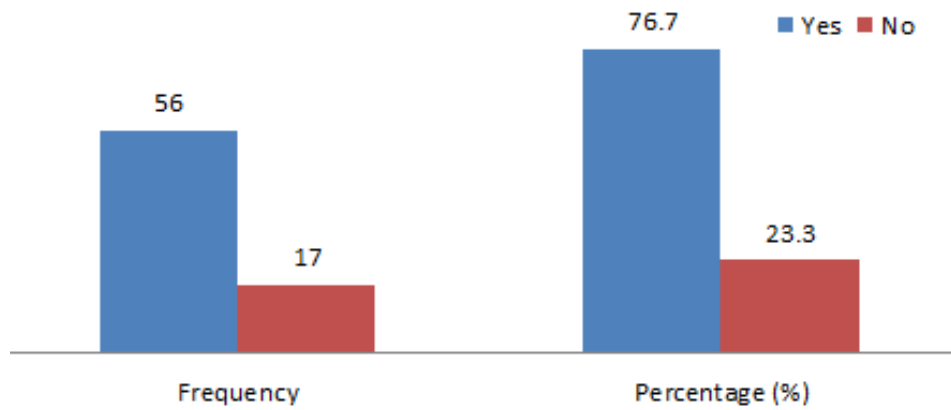


Figure 4.2 Environmental changes in the affected area for the past years of spillage

Source: Field Result, 2018

The impact of the Bagre Dam spillage is enormous resulting in significant effects. From Fig. 4.2, it was observed that, the environment suffers most whenever, there is the spillage of the dam. These environmental changes range from soil erosion, loss of habitats, deforestation, flooding and loss of vegetation. These environmental changes have caused a lot of livelihood dissatisfaction among the inhabitants of Pru District along the Volta Basin. From the expression of Musah et al. (2012), most of the inhabitants of the Pru District living along the Volta Basin have suffered a lot on environmental issues due to the spillage of the Bagre Dam. Fig. 4.2 shows that fifty-sixty (56) respondents representing 76.7% strongly agree with Musah et al (2012).

Table 4.2 Effect of Flood on the Environmental Condition of the Inhabitants in Pru East

District			
	Environmental Condition	Frequency	Percentages (%)
	Very Bad	37	50.0
	Bad	33	44.6
	Not Sure	4	5.4
	Total	74	100.0

Source: Field Result, 2018

The spillage of the dam is a distraction to environmental effectiveness. The communities in the Pru East District are along the Volta Basin and are always at the receiving end of the destruction. Basiru (2016) observed that communities along a particular river basin always destructed when a spillage of the dam is subsiding. This subsiding movement of the water drastically destroys the environment. When the environment is destroyed, the living condition of the inhabitants becomes very unbearable (Tall et al., 2012). Results from Table 4.2 shows that when the dam is spilled, the environment gets destroyed. Thirty-seven (37) respondents representing 50% believe that the environment gets destroyed when the dam is spilled while four (4) representing 5.4% are not sure of the situation.



Figure 4.3 Some of the Effect of Flooding in the Pru East District

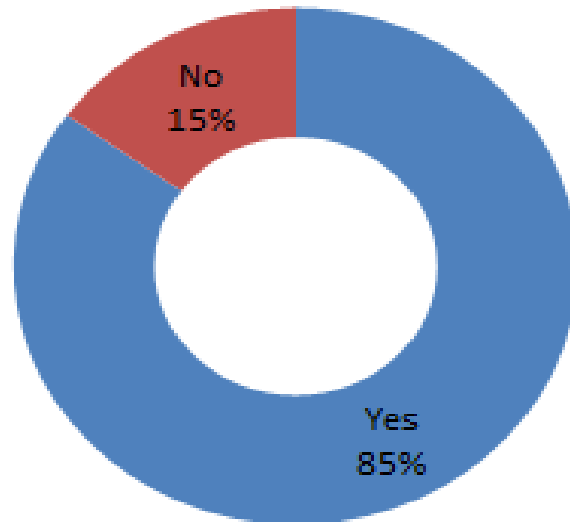


Figure 4.4 Environmental Degradation on the living standard of the inhabitants of Pru East District

Source: Field Result, 2018

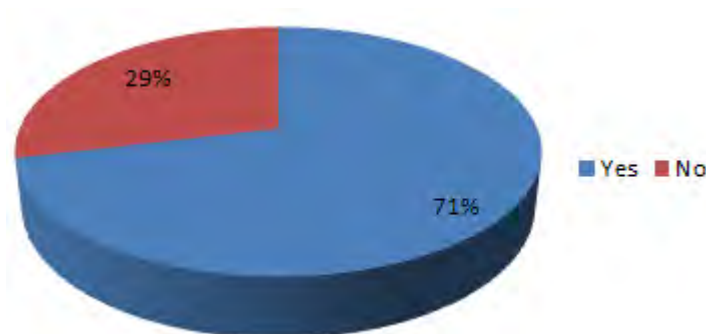
The living condition of any inhabitant in a spilled dam zone is always critical. This affects the housing situation of the inhabitants. People are left homeless and find it very difficult to provide security for themselves. They become very vulnerable to the environmental challenges (Akapule & Achong, 2012). From Fig. 4.4, it was identified that sixty-two (62) respondents representing 83% believe that environmental degradation has contributed to poor living conditions of the inhabitants.

Table 4.3 Effect of Soil Erosion on the Farming Activities in Pru East District

Effect	Frequency	Percentage (%)
Very Bad	52	71.2
Bad	16	21.9
Not Sure	5	6.8
Total	73	100.0

Source: Field Result, 2018

Erosion is an environmental effect which destroys the environment of its quality. Erosion is a continuous soil structure loss due to excessive force from down pour of water. Since this area is major farming community, the land is always subjected to excessive pressure from human and natural activities (Musah et al., 2012). Due to this, any form of spillage from the dam can cause the land or the soil to lose its structure (Etwire et al., 2013). From Table 4.3, it was observed that fifty-two (52) respondents representing 71.2% indicated, the dam spillage has caused a lot of erosion and has made the land or the soil infertile.

**Figure 4.5 Living Standard of the inhabitants along the Volta Basin in Pru East District**

Source: Field Result, 2018

The living standard of the people in the Pru East District has been basically subsistence indicating that they live on what they produce and sells few to the market. Living along the

Volta Basin has been very challenging to their living standards and has affected their productivity. Findings from Harvey et al (2014) and IFAD (2012), the living standards of the farmers living along the Volta Basin keep on deteriorating due to poor management of the Bagre Dam spillage both during and after the spillage. Their livelihood is always at risk because their farming activities are mostly on a small scale and so whenever, there is the spillage, they suffer since they lose all their farms. Fig. 4.5 observed that fifty-two (52) respondents representing 70.3% shows that their standard of living as a result of the dam spillage is poor.

4.3 Health and Sanitation Issues

Table 4.4 Common Diseases in the Spillage Areas

Disease	Frequency	Percentage (%)
Bilharzia	20	27.4
Cholera	27	37.0
Schistosomiasis	11	15.1
Malaria	11	15.1
River Blindness	4	5.5
Total	73	100.0

Source: Field Result, 2018

From the findings, it was observed that a health issue in relations to the dam spillage is inhuman. This is due to the fact that, most of their river bodies become contaminated and affect them. The effect of this is that, they get contaminated too when the use such river bodies. Basically, these effects are related to drinking and using the water to bath. Such river bodies contaminated breeds mosquitoes which in turn affect their health. When used to bath,

it affects their blood system. From table 4.4, it was observed that twenty (20) respondents representing 27.4% experienced symptoms of bilharzia since most of the inhabitants' bath in these river bodies. Twenty-seven (27) respondents representing 37.4% experienced cholera which is related to ad hoc stool running whenever drinking of contaminated water. Eleven (11) respondents representing 15% affirm schistosomiasis and malaria are common among them due to the contaminated water bodies. This assertion affirms IFAD (2012) findings on the aftermath of the Bagre Dam Spillage effect on the people living along the Volta Basin. Four (4) respondents representing 5.5% expressed that river blindness is common among residents.

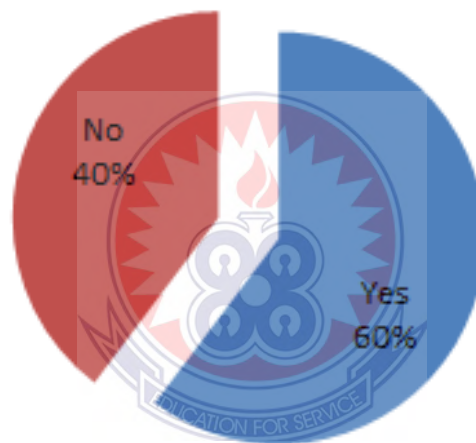


Figure 4.6 Health Education on Bilharzia and River Blindness

Source: Field Result, 2018

Health education is not common among them since the population is commonly known to underdeveloped community. A health service in this district is very less, therefore, extensive of health education before, during and after the spillage is very minimal. Most of them are properly introduced into the actual situation after the spillage. From the findings (Fig 4.6), it was observed that forty-four (44) respondents representing 60 % assert that health education is very insignificant. This affirms what Etwire et al (2013) expressed in his paper, concerning health matters of the inhabitants along the Volta Basin after the spillage of the Bagre Dam.

Table 4.5 Effect of the Spillage of the Bagre Dam on the Water Treatment Plant in the District

Effects	Frequency	Percentages (%)
Very Bad	53	71.6
Bad	20	27.0
Not Sure	1	1.4
Total	74	100.0

Source: Field Result, 2018

The water treatment plant is the only plant supplying water to the community and during the spillage the entire treatment plant is destroyed inhabitants in the affected communities in the Pru East District finds it very difficult to get portable treatment water to drink which is critical to their health in terms of quality of water to drink. From Table 4.5, it was observed that the entire community where the treatment plant was sited got destroyed and water supply has been cut for the past five years. Fifty-three (53) respondents representing 71.6% showed that the spillage has affected the treatment water plant.



(a) Plate 1



(b) Plate 2

Figure 4.7 Effects of Bagre Dam Spillage on Water Treatment Plant in the Pru East District

In 2008, during the spillage the entire treatment plant got destroyed and water supply has been very critical. Inhabitants in the various communities in the Pru East District find it very difficult to get a treatment water to drink. This has been critical to their health in terms of quality water to drink. From the finding (Fig. 4.6), it was observed that the entire community where the treatment plant was sited got destroyed and water supply has been cut for the past five years.

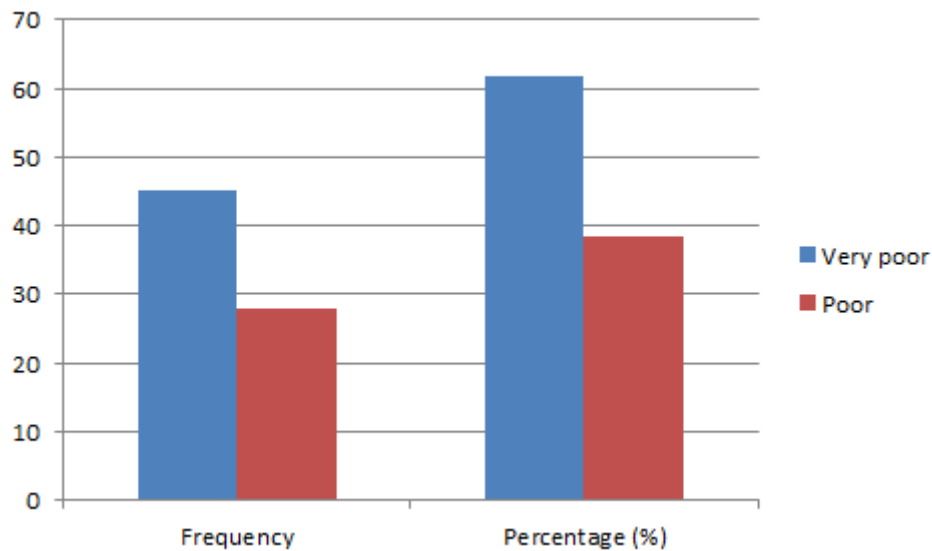


Figure 4.8 Sanitation situation in the Pru East District

Source: Field Result, 2018

Sanitation in the Pru East District for the past decade has been of a major concern to the inhabitants. The environment gets contaminated during and after the spillage. This contamination affects their health and animal survival. Some inhabitants end up diagnosed with cholera and bilharzia. From the findings, it was observed that, after the spillage some individual lives are lost and animal are lost. In Fig. 4.8, it was observed that forty-five (45) respondents representing 60.3% agreed that sanitation situation after the spillage has been very poor.

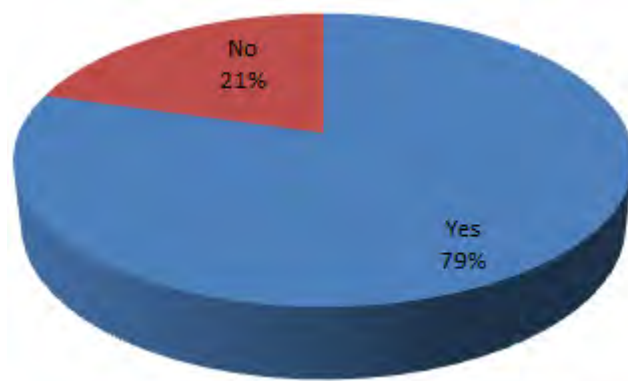


Figure 4.9 Health Situation in the Pru East District after the Bagre Dam Spillage

Source: Field Results, 2018

Health authorities in our communities are meant to orient and transform the community through their sustainable development agenda. This situation is in contrast with Musah et al (2012). From the study in Pru East District, it was identified that health authorities have contributed very little to the health situation in the district. The figure (Fig. 4.9) shows that fifty-eight (58) respondents representing about 79% shows that health authorities have contributed poorly to the sanitation situation in the district.

4.4 Socio-Economic Issues on Water Spillage from the Bagre Dam

Table 4.6 Occupation in the Affected Area

Occupation	Frequency	Percentage (%)
Farming	52	71.2
Fishing	21	28.8
Total	73	100.0

Source: Field Result, 2018

The Pru East District basically engages in agricultural farming both subsistence and commercial farming and few in fish farming. Table 4.6 observed that fifty-two (52) respondents representing 71% basically engage in farming whiles twenty-one (21) respondents representing 28.8% engage in fishing. This description was reaffirmed by Musah et al (2012) who had worked extensively on the people living along the Volta Basin especially those in the Pru East District.

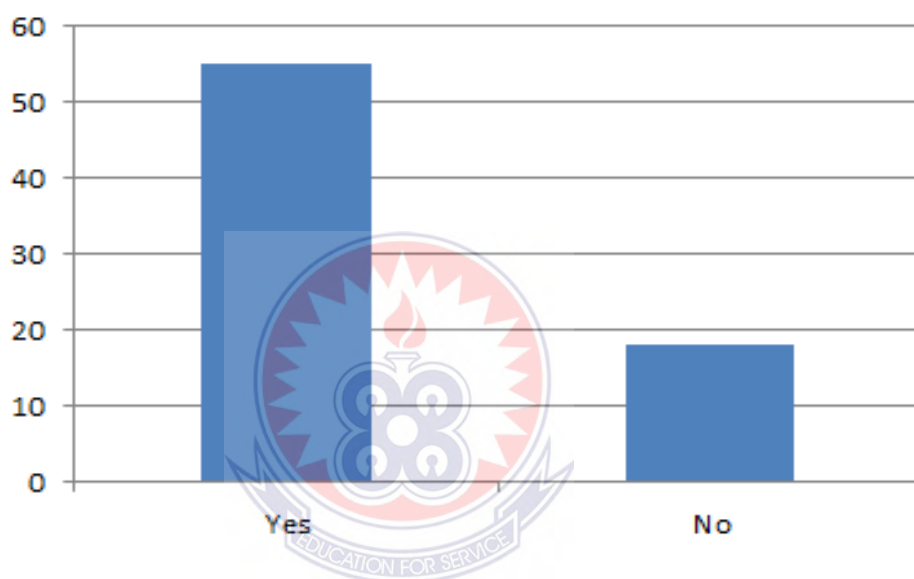


Figure 4.10 Damage to properties during and after the Bagre Dam Spillage

Source: Field Results, 2018

Most of the farmers during and after the spillage lose their properties and are not compensated. These properties included human lives, houses, farmlands, animals among others. According to Strobl & Blanc (2014), most of these farmers after the dam spillage become economically vulnerable since all of their hard earned properties are lost. Most in turn commit suicide and this affect family who depend on this hard working individual. From Figure 4.10, it was observed that fifty-five (55) respondents representing 75% asserted that their properties are lost due to the Bagre Dam spillage.

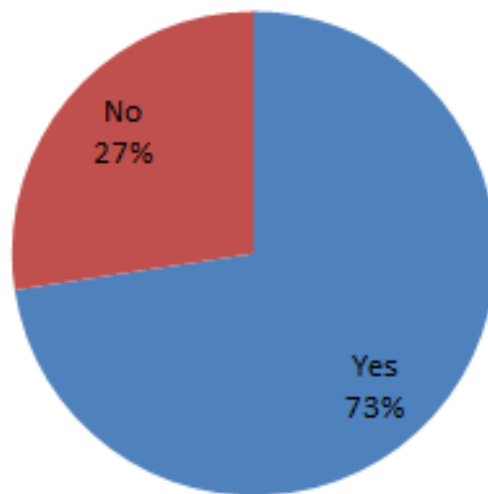


Figure 4.11 Economic Effect on the Inhabitants after the Spillage of the Bagre Dam

Source: Field Result, 2018

The spillage of the dam in the Pru East District has significantly affected the economic situation. Farming activities in the district has reduced to a level forcing majority of the farmers engage in other economic venture and has significantly reduced farmers' productivity in the district. In agreement with Musah et al (2012), the study revealed that a rice farmer lost his entire rice farm due to the spillage of the Bagre Dam. From figure 4.11, it was observed that fifty-three (53) respondents representing 73 % believe that economically, the spillage has been very devastating.

4.5 Focus Group Discussion

The researcher engaged certain group of people selected based on certain criteria such as age, gender, position held in the community. In all ten (10) people were engaged and these members were selected from four (4) communities namely Yeji, Parembo-Sawaba, Kadue and Kajai. These are the communities that are mostly affected by the spillage. They were engaged on a specific number of issues relating to the spillage of the Bagre Dam. These

issues include, health, environmental and socio-economic. They helped in translating the actual issues on the ground aside of collecting and collating data to effect the findings. Some of the members in the focus group have had to suffer to from the effect of the spillage of the Bagre Dam.

4.5.1 Health and Sanitation Issues

Most of the concerns are related to the aftermath of the spillage. Their water bodies including streams, rivers and lakes are contaminated with the debris and other toxic substances. This contamination of the water bodies affect their health and later causes mass death in the community. Their concerns were in confirmation with work done extensively by Mathews (2012) on the aftermath conditions of the spillage of the Bagre Dam. These conditions relating to the health matters of the spillage of the dam include malaria, cholera, river blindness, bilharzia and schistosomiasis. From the group discussion, it was observed that quite large number of the inhabitants suffer from malaria and bilharzia as well as river blindness and cholera. From the discussion one opinion leader reiterated how those who lived close to the Volta Basin experienced excessive cholera outbreak immediately after the spillage. This became an important health issue because the health facility in the community is not up to standard to handle such chronic health matters which resulted in mass death. It reported that quite number of residents in the Pru East District have suffered from health issues relating to malaria, river blindness, cholera, schistosomiasis as a result of the dam spillage (GNA, 2016).

4.5.2 Socio-Economic and Sanitation Issues

Regarding the impact of the spillage on the socio-economic effect, members in the community have suffered a lot in terms of loss of farmlands, animals, houses and human resources. From the group discussion, it was observed that members in the group have suffered economically relating to the spillage. According to Amenuveve (2015), residents

along the Volta Basin lose thousands of worth of properties relating to farmlands, houses, animals and human resources. One group member maintained that the Bagre Dam spillage is yearly issue but nothing reliable has been put in place to avert the challenge as some of the small scale farmers in the Pru East District had to go through. Majority of the members in the group maintained that the only benefit after the spillage is just an intervention and not compensation.

4.5.3 Environmental and Sanitation Issue

Dam has potential environmental nightmares (Basiru, 2016). One of the most immediate environmental effects of the dam has been an increase in landslide activity. This results primarily from erosion caused by the drastic increase in reservoir water levels, which, when at their peak, create a body of water spillage. Another major issue with the dam is the ways in which it is affecting biodiversity in the area. Animal and plant life has been greatly threatened due to flooding in some habitats and water diversion in others. Furthermore, fragmentation of habitat may lead to heavy losses of biological diversity (Akapule & Achong, 2012). As indicated in the literature, fragmentation leads to species insularization by creating virtual islands, which confound processes of ecosystem stability and biological enrichment (Owusu, 2011). Fragmentation of habitat, moreover, is disturbing the reproduction patterns of many species, suggesting that if they haven't disappeared yet, they soon may. Whether one agrees that this means a loss of spiritual and cultural wealth, it undoubtedly means a loss in resources that might otherwise have been tapped.

From the focus group discussion, it was observed that most of farm lands lost their natural content and it will take time to replenish.

4.6 Discussion of the Findings

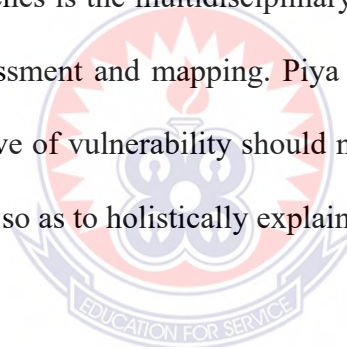
Instead of allowing the impact of the floods to degenerate into a source of conflict between the communities along the White Volta and sharing boundaries with Burkina Faso which can lead to conflict between the two countries, the governments of Ghana, Burkina Faso and some international organisations, have put in place some measures to reduce the effects of the floods compounded by the spillage from the Bagre Dam on the communities that have always been affected (Aduk-Apam, 2016).

Smallholder agriculture is often used to represent rural producers predominantly in developing countries where farming is done on small parcels of land of three ha or less per farmer (IFAD, 2012). This type of farming is usually done with family labour for consumption purposes and also serves as a main income source for farmers which they use to meet their basic needs (Etwire et al, 2013). This system is generally characterized by low level of technology with small farm holdings often practiced under traditional land tenure. Much of farmlands owned by smallholder farmers are on marginal or climate risk-prone environment (Musah et al., 2014). Apart from crop farming, smallholders are also engaged in livestock rearing and practice hunting and gathering of wild resources. They are also mostly involved in non-farm economic activities and income generated is used to supplement farm income for their livelihood activities (Etwire et al., 2013). Worldwide, smallholder farmers' population is estimated to be about 450 to 500 million farmers which accounts for 85% of world's farms (Harvey et al., 2014). Farmers with small farm holdings also represent about half of the hungry in the world and close to three-quarters of the hungry in African. According to IFAD (2012), about 50% of less developed countries (LDC) rural population are smallholders (cultivating on a crop land of 3 ha or less per farmer). The proportion of smallholder farmers in sub-Saharan Africa is higher at 73%. Rural smallholder farmers

produce 80% of food locally consumed in Asia and Sub-Saharan Africa with women farmers constituting a significant percentage (Musah et al., 2014). Ironically, smallholder farmers have been discovered undoubtedly to have an important role in producing adequate food for present and future generations, and yet are also the ones that suffer most from flooding and other climate change induced disasters as a result of their exposure to climate risk and limited adaptive capacity (Harvey et al., 2014). Extreme weather events are expected to disproportionately affect smallholder farmers especially in the tropical regions (Hertel & Rosch, 2010). This is because; households in the same community can experience the same type of hazards and yet have varying vulnerabilities due to the differences in exposure, sensitivity and adaptive capacity. Exposure to floods for instance may differ depending on the location of households in relation to floodplains, steep slopes, low-lying areas or ravines. In most cases poorer households are those that inhabit these locations (Harvey et al., 2014). Smallholder farmers who rely directly on agriculture for their livelihoods are highly sensitive to climate induced disasters like flooding especially if the household does not have diversified resources (Nyong et al., 2008). Flood sensitivity extends to include a large portion of household income from farming used to purchase food and other necessities. It also includes crop damage and land degradation caused by flood events. Climate change studies using simulation models have showed that even moderate rise in temperature will affect rice, wheat and maize production negatively (Morton, 2007). Increase in the frequency and severity of floods are expected to cause poor yields, crop failure, and livestock mortality which is likely to affect smallholder farmers' livelihood gravely. Low agricultural yields can consequently impact on food security, nutrition, income and wellbeing of smallholder farmers (McDowell & Hess, 2012). Strobl & Blanc (2014) illustrated that having a strong adaptive capacity to climate change disasters reduces their impact. But underdevelopment and poverty fundamentally constrains adaptive capacity, especially because of a lack of

resources to adjust to extreme but expected events. They expounded that, “It is not that the risk is unknown, not that the methods for coping do not exist rather inability to cope is due to lack of or systematic alienation from resources needed to guard against these events” (Strobl & Blanc, 2014). Adaptive capacity is therefore defined as the ability of social systems to sustain impacts from flood disasters and minimize potential damage using available resources and techniques (IFAD, 2012). Broadly speaking, adaptive capacity can be explained as a net product of a social system’s stability to climate stresses, and access to key resources. According to McDowell & Hess (2012), farmers’ capacities to absorb climate change impacts depend on ownership or access to a wide range of resources such as credit and insurance, education and age, technical assistance and access to information, social networking, and government and external support programs. Hence, when there is limited access to these resources, the probability of farmers becoming defenseless is very high or farmer become incapacity of avoiding risks they are exposed to (Piya et al., 2012). Households with diversified resources have the ability to cope with or adapt to increased level of risks. These households will have more options to engage in other alternative livelihood activities during the times of climate disaster, hence having more adaptive capacity. For example, smallholder farmers’ household with a lot of savings (financial assets), or memberships in saving and credit institutions (social assets) and have access to loans from rural financial institutions have greater capability to minimize livelihood risks brought about by crop failure due to climate induced disasters. In a similar way, households involved in some off-farm livelihood activities generate additional income to supplement income from farming. This enhances the adaptive capacity of the households through risk sharing across different livelihood sources (Piya et al., 2012).

Integrated approach is rooted in geography as “human ecology”. The key feature of the integrated approach is the amalgamation of the natural-hazard and social vulnerability considerations (Strobl & Blanc, 2014). It entails conceptualizing and analysing elements from the biophysical and social vulnerability perspectives in a single study with the aim of using both to complement each other and to improve the information provided (Mastrandrea et al., 2010). The World Food Programme (2015) defines integrated vulnerability in the context of food insecurity as “being composed of two principal components, namely: (i) risk of exposure to different type of shocks or disaster event... (ii) Ability of population to cope with different type of shocks or disaster event. These definitions are generally used in the area of environmental and climate change studies in a particular region or community. Another key feature of the integrated approaches is the multidisciplinary approach in selecting vulnerable societies for Vulnerability Assessment and mapping. Piya et al (2012) have argued that the biophysical and social perspective of vulnerability should not be mutually exclusive and that their concepts should be merged so as to holistically explain the vulnerability of a group.



CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter presents the major findings of the study in relation to the analysis performed in the previous chapters. It is made up the summary, conclusions and the recommendations for the study.

5.2 Summary

This section presents the summary of the study with respect to the research objectives

5.2.1 Environmental Issues

The spillage of the dam over the past decade has been very disimpactful on the people along the Volta Basin. The spillage has caused dissatisfaction among the people in the Pru District since it has had to damage their forest reserve. From the findings, it was observed that forty-eight (48) respondents representing 65% maintained that the spillage has caused deforestation. Twenty-five (25) respondents representing 34% show that the spillage has affected the livelihood of the inhabitants. These are the people who live a bit far from those who live along the basin. This is understood by what (Mathews, 2013), expressed that dam spillage has a greater impact on the livelihood on the people and its effects is very significant. From the findings, it was observed that flooding is one of the major effects dam spillage brings. When the dam is spilt, those on the basin and along the basin lose their lives and properties through flooding. Twenty-five (25) respondents representing 31% indicated that the effect of flooding as a result of dam spillage is very significant.

Erosion is a continuous soil structure loss due to excessive force from down pour of water. Since this area is major farming community, the land is always subjected to excessive

pressure from human and natural activities. Due to this, any form of spillage from the dam can cause the land or the soil to lose its structure. From the findings, it was observed that ten (10) respondents representing 13% believe, the dam spillage has caused a lot of erosion and has forced the land or the soil to lose its structure of nutrient.

From the finding, it was observed that majority of the inhabitants lost their habitats due to the Bagre Dam spillage.

Also, it was observed that ten (10) respondents representing 13% maintained that the natural vegetation is lost due to the Bagre Dam spillage. Most of the inhabitants of the Pru District living along the Volta Basin have suffered a lot on environmental issues due to the spillage of the Bagre Dam. Results from the findings indicated that fifty-six (56) respondents representing 76.7% strongly agree with findings in literature. It was observed that the environmental issue facing those living along the Volta Basin is very significant which poses inhabitants in a risk platform. Whenever, the dam is spilt, these environmental factors are affected and most of the inhabitants suffer as the population is dependent on rivers, trees, houses among others for survival.

From the studies, it was observed that, the environment suffers most whenever, there is the spillage of the dam. These environmental changes range from soil erosion, loss of habitats, deforestation, flooding and loss of vegetation. These environmental changes have caused a lot of livelihood dissatisfaction among the inhabitants of Pru District along the Volta Basin.

When the environment is destroyed, the living condition of the inhabitants become very unbearable. From the findings, it was observed that when the dam is spilled, the environment gets destroyed. Again the research indicates that when the dam is spilled, the environment is destroyed.

The living condition of any inhabitant in a spilled dam zone is always critical. This affect the housing situation of the inhabitants. People are left homeless and find it very difficult to provide security for themselves which makes them very vulnerable to the environmental challenges.

Since this research area is a major farming community, the land is always subjected to excessive pressure from human and natural activities and due to this, any form of spillage from the dam can cause the land or the soil to lose its structure.

The living standards of the farmers living along the Volta Basin keep on deteriorating due to poor management of the Bagre Dam spillage both during and after the spillage. Their livelihood is always at risk because their farming activities are mostly on a small scale and so whenever, there is the spillage, they suffer since they lose all their farms.

5.2.2 Health and Sanitation Issues

Result from the findings indicated that health issues in relations to the dam spillage are inhuman. This is due to the fact that, most of the river bodies become contaminated with toxic waste. Basically, these effects are related to drinking and bathing. Such river bodies contaminated breeds mosquitoes which in turn affect their health. When used to bath, it affects their blood system.

Inhabitants in the various communities in the Pru East District find it very difficult to obtain good treated water to drink. This has been critical to their health in terms of quality of water to drink. From the finding, it was observed that the entire community where the treatment plant was sited got destroyed and water supply has been cut off for the past five years.

This contamination affects their health and animal survival. Some inhabitants end up diagnosed with cholera and bilharzia. From the findings, it was observed that, after the spillage some individual lives are lost and animal are lost.

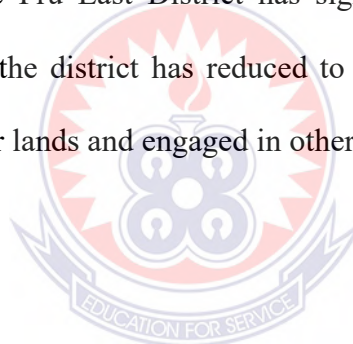
5.2.3 Socio-Economic Issues

The living standards of the farmers living along the Volta Basin keep on deteriorating due to poor management of the Bagre Dam spillage both during and after the spillage. Their livelihood is always at risk because their farming activities are mostly on a small scale and so whenever, there is the spillage, they suffer since they lose all their farms.

From the finding, it was observed that properties are lost due to the dam spillage and these farmers are left with nothing for survival.

Farmers who lose their items get no compensation from the government or any agency. What they get is a relief items from NADMO. It was observed that most of these relief items are not up to what these farmers have lost.

The spillage of the dam in the Pru East District has significantly affected the economic situation. Farming activities in the district has reduced to a certain level which has forced majority of the farmers lose their lands and engaged in other economic activities.



5.3 Conclusions

The purpose of the study is to assess the impact of the Bagre dam spillage in the Pru District. The objectives of the study were to identify environmental implications of the spillage of Bagre dam on Pru District, identify the health implications of the spillage of Bagre dam on Pru District and identify the economic implications of the spillage of Bagre dam on Pru District.

5.4 Recommendations

Based on the findings, the following recommendations were given

- Authority should also put in place a health awareness team and introduce health education in the catchment areas which is a vital measure to control common diseases.

- There is a need to increase research funding for sustainable development and management of water resources in the field of water supply in order to generate useful information for planning, design and decision making.
- Authority should put in place a computer-based technology system to assist in combating the problems by providing reliable, up-to- date and comprehensive data on land use change and other environmental variables.
- It is recommended that a dam is constructed to take excess spillage for irrigation and power purposes.

5.5 Further Researches

- Further Research is necessary as the findings were based on a relatively small sample that may have influenced the nature of the results that were obtained. There is need to expand on the sample size and carry out similar research in other location.
- The analysis that was used is always not sufficient to draw conclusions on a phenomenon, and to provide adequate information that can be used for policy development. Further research focus accessing the perception of catchment community in strategy implementation is recommended.
- The research recommends the establishment of continuous water quality monitoring and mapping at strategic areas along the reservoir to alert policy makers on possible reservoir contamination.

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APPENDIX

QUESTIONNAIRES

UNIVERSITY OF EDUCATION-KUMASI CAMPUS

***THE MAIN OBJECTIVE OF THE STUDY WAS TO ASSESS THE IMPACT OF
BAGRE DAM SPILLAGE IN PRU EAST DISTRICT IN THE BRONG AHAFO
REGION.***

This research is aimed at assessing the impact of Bagre Dam spillage in Pru East District in the Brong Ahafo Region. Your response will help in identifying some of the constraints faced by the community. This can be used for future policy improvements in the area. The research is a nonprofit assignment. All the answers provided are confidential and will not be used to disclose any person's identity without their knowledge.

SECTION A: DEMOGRAPHIC PROFILE

1. Sex
 - a) Male
 - b) Female
2. Age bracket
 - a) 18-25
 - b) 26-33
 - c) 34-41
 - d) 42-49
 - e) 50-57
 - f) 58-65
 - g) 66 and above
3. Level of education
 - a) None



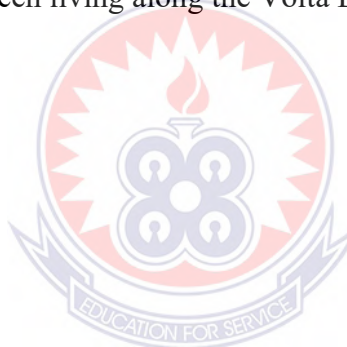
- b) Primary
- c) Secondary
- d) Tertiary
- e) University
- f) Others (Specify).....

4. Indicate the source of your income

- a) Fishing
- b) Farming
- c) Trading
- d) Others (specify).....

5. For how long have you been living along the Volta Basin?

- a) Less than 1 year
- b) 1-10 years
- c) 11-20 years
- d) 21-30 years
- e) 31-40 years
- f) 40 years and over



SECTION B: ENVIRONMENTAL ISSUES

6. Do you think the spillage of the dam has led to deforestation?

- a) Yes
- b) No

7. What do you consider to be the most important environmental issues emanating from the spillage of the Bagre Dam?

- a)
- b)

- c)
8. Do you see any environmental changes in your area during the past year's spillage?
- a) Yes
 - b) NO
9. **If YES**, what has changed?
- a) Increased degradation
 - b) Decrease of degradation
 - c) Loss of habitat and sedimentation
 - d) Soil erosion
 - e) Loss of vegetation
 - f) flood
10. What has been the effect of flood on the environmental condition on the people of Pru East District?
- a) Very bad
 - b) Bad
 - c) Good
 - d) Very good
11. Has environmental degradation contributed to poor living habitat to the inhabitants of Pru East District?
- a) Yes
 - b) No
12. What has been the effect of soil erosion on the farming activities on the people of Pru East District?
- a) Very bad
 - b) Bad



- c) Not sure
- d) Good
- e) Very good

13. Have the inhabitants of Pru East District been affected economically by the spillage of the Bagre Dam?

- a) Yes
- b) No

SECTION C: HEALTH AND SANITATION ISSUES

14. What are the common diseases/ illnesses in the area in this area?

- a) Bilharzia
- b) Cholera
- c) Schistosomiasis
- d) Malaria
- e) River Blindness



15. Do you have any health education about Bilharzia and river blindness?

- a) Yes
- b) No

16. What has been the effect of the spillage of the Bagre dam on the water treatment plant in the district?

- a) Very bad
- b) Bad
- c) Not sure
- d) Good
- e) Very good

17. Has water supply been effective ever since the spillage of the Bagre Dam?

- a) Yes
- b) No

18. What has been the sanitation situation in the district?

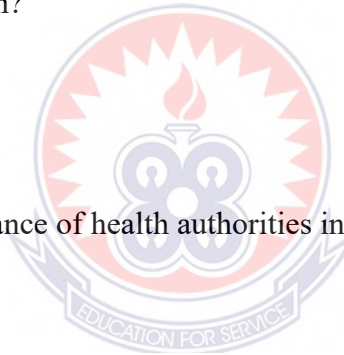
- a) Very poor
- b) Poor
- c) Not sure
- d) Good
- e) Very good

19. Has health authorities in the district contribute to the health and sanitation after the spillage of the Bagre Dam?

- a) Yes
- b) No

20. How do rate the performance of health authorities in their responds to the spillage of the Bagre Dam?

- a) Very poor
- b) Poor
- c) Very good
- d) Good
- e) Excellent



SECTION D: SOCIO-ECONOMIC IMPACT

21. What are the main forms of livelihood in this area?

- a) Farming
- b) Fishing
- c) Trading

d) Others (Specify).....

22. Since the spillage of the Bagre dam, have your living standard improved?

a) Yes

b) No

23. Did you lose any property during or after dam spillage?

a) Yes

b) No

24. If yes, have you gotten any form of compensation for the properties lost?

a) Yes

b) No

25. What has been the economic effect on the people after the spillage of the Bagre Dam?

a) Very bad

b) Bad

c) Not sure

d) Good

e) Very good



26. Have you obtained any financial support from any organisation in the district after the spillage?

a) Yes

b) No

27. If yes, what has been the effect of the financial support given to you by organisations in the district after the spillage?

a) Significant

b) Insignificant