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MSc DISSERTATION ON:

IMPACTS OF RURAL WATER SUPPLY SYSTEMS IN FARMING COMMUNITIES

A CASE STUDY OF THE SABOBA-CHEREPONI DISTRICT

BY

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DECLARATION

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

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ABSTRACT

Several issues may affect the impact of rural water supply systems in the beneficiary communities, including engineering and socio-cultural factors, geological limitations, poverty, ignorance, poor management and lack of sustainability. These, coupled with poor sanitation and hygiene practices may impede the intended socio-economic benefits. The study aimed at examining how these factors manifest in the beneficiary communities in the study area as well as determine the potential of these water systems for small scale irrigation as a means of income generation especially for repairs and maintenance cost. To achieve this, questionnaires and interviews, meteorological data, information on available yields of the water supply systems, crop data and infiltration data were collected. Besides, a case-control method was used where the same questionnaires were administered to equal number of both communities with interventions and those without.

Results of the study revealed that the operational sustainability of the rural water systems in the District was a serious problem. This was due to many factors including inconvenient siting of water-points, poor design and construction of water systems, geological limitations, lack of spare parts, and lack of support to communities and monitoring role from the service providers, District Assembly and other stakeholders. Others included inactive Water and Sanitation Committees at community level, failure to account transparently for funds generated, lack of preventive maintenance, and the community's lack of sense of ownership and apathy, inability to generate sufficient income, lack of community cohesion and lack of capacity.

The prevalence of water related diseases except guinea worm were still high in the beneficiary communities due to poor sanitation and hygiene practices and these were: malaria (81.6%), diarrhoea (68.3%), typhoid fever (66.7%), skin diseases (23.3%), intestinal worms (6.7%), and bilharziasis (5.1%). Education on guinea worm eradication has been successful in eradicating the disease in the District. Socio-economically, potable water supply has attracted teachers to the beneficiary communities and encouraged many women to engage in different economic activities including small scale irrigation. The water systems have a high potential for small scale irrigation as a means of income generation. Training of community management committees has also enabled some of them to be self employed.

Although there is not a simple formula to solve the problems enumerated above, in this study some alternatives are envisaged.

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ACRONYMS

AMs	Area Mechanics
AWDR	African Water Development Report
BHs	Boreholes
CFD	French Development Bank
CIDA	Canadian International Development Agency
COM	Community Ownership and Management
CWR	Crop Water Requirement
CWSA	Community Water and Sanitation Agency
CWSD	Community Water and Sanitation Division
CWSP	Community Water and Sanitation Programme
DANIDA	Danish International Development Agency
DAs	Disrtict Assemblies
DHMT	District Health Monitoring Team
DRA	Demand Responsive Approach
DWSTs	District Water and Sanitation Teams
EHAs	Environmental Health Assistants
ETc	Crop Evapotranspiration
ETo	Reference Evapotranspiration
EU	European Union
FAO	Food and Agriculture Organisation
GIWR	Gross Irrigation Water Requirement
GOG	Government of Ghana
GPRS	Ghana Poverty Reduction Strategy
GPS	Global Position System
GSAE	Ghana Society of Agricultural Engineering
GSD	Geological Survey Department
GSS	Ghana Statistical Service
GWCL	Ghana Water Company Limited
GWRC	Ghanaian Water Resources Commission
GWRESP	Ghanaian Water Resources and Environmental Sanitation Project
GWSC	Ghana Water and Sewerage Corporation
HDWs	Hand Dug Wells
HHs	Households

IDA	International Development Association
IDWSSD	International Drinking Water Supply and Sanitation Decade
IWR	Irrigation Water Requirement
JHS	Junior High Schools
Kc	Crop Coefficient
KVIP	Kumasi Ventilated and Improved Pit Latrine
MDGs	Millennium Development Goals
MOM	Monitoring of Operation and Maintenance
MTDP	Medium Term Development Plan
MWH	Ministry of Works and Housing
MWRWH	Ministry of Water Resources, Works and Housing
NCWSP	National Community Water and Sanitation Programme
NGOs	Non-Governmental Organisations
NHIS	National Health Insurance Scheme
NORPREP	Northern Region Poverty Reduction Programme
NORWASP	Northern Region Water and Sanitation Programme
NWP	National Water Policy
O & M	Operation and Maintenance
OECD	Organisation for Economic Co-operation and Development
PHC	Population and Housing Census
POs	Partner Organizations
PURC	Public Utilities Regulatory Commission
PWD	Public Works Department
RWSSI	Rural Water Supply and Sanitation Initiative
RWST	Regional Water and Sanitation Team
SARI	Savana Agricultural Research Institute
SBDUs	Small Business Development Units
SCDA	Saboba-Chereponi District Assembly
SHS	Senior High Schools
TREND	Training Research and Networking for Development
UN	United Nations
UNICEF	United Nations International Children's Emergency Fund
VIP	Village Infrastructure Project
WATSAN	Water and Sanitation

WCs	Water Closets
WHO	World Health Organisation
WMI	Water Missions International
WRC	Water Resources Commission
WSD	Water Supply Division
WV/GRWP	World Vision Ghana Rural Water Projects
WWDR	World Water Development Report
ZCC	Zonal Co-coordinating Council

DEDICATION

I dedicate this work to

My mother, Yamob Limantol

and

My sister, Tayilpu Limantol

All of blessed memories.

CHAPTER ONE
INTRODUCTION

1.1 Background

The recognition that provision of water is in reality one of the most basic necessities for development and improving a people's quality of life led to the launch of the International Drinking Water Supply and Sanitation Decade (IDWSSD) by the General Assembly of the United Nations in November 1980 with the goal to provide all people with water of safe quality and adequate quantity and basic sanitary facilities by 1990. There are still at least 1.1 billion people around the world who do not have access to safe drinking water. Majority of these people live in rural areas and are among the poorest and most vulnerable to be found anywhere in the world (IAH Burdon Groundwater Network, 2007). World Health Organisation (WHO) has set a target of halving the proportion of people without safe access to improved water and sanitation by 2015 **(**Edmore and Sherman, 2008). Water, sanitation and health are very vital not only as a human right, but also as a step to national development and poverty reduction (ibid).

In response to the problems of water supply, water resources development and management in Africa, UN- Water/Africa took a decision in April 2001 in Niamey to develop an African Water Development Report (AWDR) as an integral part of the World Water Development Report (WWDR). The AWDR would provide African countries and other stakeholders the necessary information for obtaining tools and skills to monitor the goals and targets of the Africa Water Vision, which was summed up as 'Water can make an immense difference to Africa's development if it is managed well and used wisely. Given clear policies and strategies and real commitments to implementation, water can be used to help eradicate poverty, reduce water-related diseases and achieve sustainable development.' The AWDR is articulated along eleven key challenges. Among these are meeting basic needs, i.e. to recognise that access to safe and sufficient water and sanitation are basic human needs and are essential to people's health and well-being, and to empower people, especially women, through a participatory process of water management; Securing food supply, i.e. to enhance food security, particularly of the poor and vulnerable, through more efficient mobilisation and use, and more equitable allocation of water for food production (AWDR, 2006).

Indeed, the human right to water is very crucial for leading a life in human dignity. It is a prerequisite for the realisation of other human rights according to the United Nations (2003).

These ideas seem very obvious and a matter of course to many people of the world, especially those born and bred in developed countries, but not to a large portion of the African populace who struggle daily to have a minimum amount of water for their daily basic needs. Even though Africa is generally considered as a continent endowed with abundant water, most urban and rural people on the continent lack adequate and safe drinking water with exposure to preventable water-related diseases. In sub-Saharan Africa alone, 300 million people have no access to safe water supplies – approximately 80% live in rural areas (IAH Burdon Groundwater Network, 2007). Therefore, significantly increasing the coverage of rural water supply in Africa is fundamental to achieving many of the internationally agreed Millennium Development Goals (MDGs). Without adequate and safe water near to dwellings, the health and livelihoods of families can be seriously affected and children's education suffers as the daily tasks of survival take precedence over all other concerns.

A large part of the world's water supply systems in rural and peri-urban areas are used for both domestic and productive uses. However, this practice is often not officially recognised nor is it considered in the planning, design and management of these systems (Arlex *et al*, 2003). At the same time, small-scale productive use of water supply systems can contribute significantly to households' economies and to the fight against poverty. In developing countries like Ghana, traditionally, investments in water supply have been oriented towards solving public health problems. This means that the orientation is on potable water and that the amounts supplied try to meet demands for improved hygiene, such as for sanitation, washing and cleaning. Through this health focus, attempts are made to reduce peoples' spending on the treatment of illnesses and to improve quality of life and peoples' dignity. In this way, it is believed there will be a contribution to the fight against poverty.

On the other hand, in the rural areas it is common to find people needing water for other small-scale productive uses such as irrigation, livestock watering or post-harvest processing. Drinking water supply systems can often meet part of the demands for productive uses at small-scale. These then become multiple use systems. These systems have the potential of fighting poverty in all its dimensions, including health improvement, income generation and food security (Arlex *et al*, 2003). This then conforms to WHO's 1981 call on IDWSSD'S new approach of rural water supply to look at investing in water supply and sanitation in relation to overall development. WHO (1981) affirms that returns are higher if the schemes are linked in a development chain. Hence the ways in which water supply and sanitation have

to be further linked with agriculture to increase food production and improve nutrition must be jointly planned with family health, nutrition and health education programmes by all service providers.

In Ghana, rural water service providers do not take into account the productive uses of water that can help the communities economically to be able to sustain the water supply systems. However, despite their relevance, multiple uses of rural water supply and their impacts have not been studied nor documented widely, especially in Ghana.

1.2 Statement of the Problem

According to WWDR (2009) about 340 million Africans lack access to safe drinking water. The First African Water Week convened in Tunis in March 2008, opened with a call for greater efforts to ensure water security nationally and regionally.

Minnigh and Moeliono (2000) observed that over the past two decades many countries and donors invested heavily in the provision of water supply systems as a basic need and right, and more recently an economic good. The introduction of decentralised water supply to rural communities is based on the view that collecting water from unprotected sources such as rivers or natural water holes is unacceptable either for health reasons or for efficiency. Therefore their goals were clear: improved access to water, acceptable water quality, improving health conditions leading to healthier and more productive communities.

While adequate progress is being made towards the provision of safe drinking water, the scale of the challenge remains massive. Although the water supply target is being attained at a global level, many countries are far from the target, and some risk backsliding. This is particularly the case in sub-Saharan Africa and low-income Arab states (WWDR, 2009).

The sustainability of water facilities provided to rural communities remains a great challenge besides the problem of reliability of the existing systems in terms of geological limitations. These problems sometimes compel the beneficiary communities to return to unprotected sources of water supply much in the same way as those which have not benefited at all (Gyau-Boakye and Dapaah-Siakwan, 1999).

The intended goals of these water supply systems are therefore at a great threat in the face of these challenges. Hence despite the global strive at ensuring safe water for all, it is estimated that on a global scale 25,000 people die each day as a result of water related diseases, and

within every 15 seconds a child under the age of five dies for the very same reason (WHO, 2002, cited in WMI, 2008).

According to Mjoli (2008), the main problem of rural water supply systems is lack of sustainability as efforts made to extend the coverage of this service are not always successful when they are applied to small communities. This is of special concern because in developing countries, health and poverty problems are concentrated in these populations.

Sergio and Carlos (1998) observed that in many countries, rural water supply receives a different treatment in the planning which generally includes subsidies for the installation of the facilities, the use of low cost technologies, health education and community organisation to enable them to participate in the planning, construction, operation and maintenance of the water supply system as a way of ensuring sustainability. Institutional arrangements are also made to support and supervise the operation of such systems. However, despite the efforts made, the fulfilment of goals has not been significant as a result of lack of sustainability mainly due to financial and institutional constraints. Hence, the contribution to reduce the deficit in coverage has not been significant and, in many cases, the water supply system installed has been abandoned or is undergoing deterioration.

In Indonesia, a decline in functioning of the rural water supply systems is observed despite all support and training offered to the community level management committees. Only about 10-20% of villages are able to manage their system in a more or less sustainable way (Minnigh and Moeliono, 2000). Thematic Group (2005) also observed that despite the widespread uptake of community management in many developing countries it is by no means problem-free. Communities often struggle with maintaining their water supply facilities. According to Schouten (2006), water supply to rural communities in developing countries is more than only installing a pump as so many things go wrong afterwards. Some common problems are identified as:

- The pump works well during the first years and then breaks down; there are no spare parts in the area; there is no one in the community who knows how to repair the pump.
- The women in the community complain about the location of the pump; the women were not involved in the site selection.

- The poor people cannot pay the water maintenance contributions and are not allowed to fetch.
- The members of one of the families refuse to pay the maintenance contributions because the family leader was not elected as the chairman of the Water Committee.
- Few months after the official inauguration of the pump the water stops flowing due to geological limitations of the aquifer.

Sergio and Carlos (1998) further report that the main problem of rural water supply systems is that the people do not patronise the system any more or that its sanitary condition may be endangered. The root cause may be that the system has been installed by the government without the involvement of the community in the decision-making process. Thus, people do not feel responsible for the system and usually the adopted solution does not match their life style and there is not willingness or capacity to pay. In addition, institutional mechanisms to support the communities and to supervise the management of their water system do not work.

Obviously, the abandonment or premature deterioration of water supply systems in rural communities would invalidate the efforts made to increase the coverage of water services and the health-based objectives of these facilities.

In Ghana, the Community Water and Sanitation Programme (CWSP) operates under the Demand Responsive and Community Management Approach (DRA). One component of this programme is that the communities are in charge of the operation and maintenance to sustain the project (WaterAid Ghana, 2004a). Health, which has always been the main objective of these programmes could suffer from these new policies. For instance, the 1990 UNICEF study (UNICEF, 1990) found a resurgence of guinea worm epidemics in Northern Ghana after the then Ghana Water and Sewerage Corporation (GWSC) instituted cost-recovery measures for pumps maintenance and tarrifs. Out-break of the disease occurred in villages that benefited from potable water supply and where this water-borne disease had been eradicated. The repairs of the facilities had ceased because communities had defaulted in paying tarrifs and the people resorted to drinking water from ponds, dams and streams (Karikari, 2000). Most rural communities in Ghana live in extreme poverty and find it difficult maintaining these water facilities without assistance, the worst affected being in the Northern Savannah Regions (GSS, 2000, cited in Tay, 2005a). As a result, most hand pumps in these communities have broken down and are crying for rehabilitation.

1.3 Research questions

The questions that this study seeks to find answers to are:

- Are the water systems really achieving the set goals of improving the situation of the inhabitants through eradication of water-related diseases and enhancing their general socio-economic development?
- Are the rural water supply systems adequate to support the multiple uses by the beneficiary communities, including the use for minor dry season vegetable irrigation?
- What are the factors affecting the sustainability of the systems?
- What are the engineering and socio-cultural factors affecting the systems?

1.4 Objectives of the research

As a general objective, this research focuses on assessing the impacts and prospects of rural water supply systems in the communities. The specific objectives were to:

- Identify factors that influence preferential use of unprotected sources
- Identify the general socio-economic impact of the water systems on the people
- Identify the engineering and socio-cultural factors affecting the water systems
- Determine the sustainability of the water systems in the community and
- Determine the potential of the water systems for dry season small scale irrigation.

1.5 Significance of the Study

The Rural Water Supply and Sanitation Initiative (RWSSI) is a response towards the attainment of the goals of the Africa Water Vision declared at the Second World Water Forum in The Hague in 2000 by the African Development Bank (ADB). The objectives of the MDGs became a catalyst for this initiative. The rationale for the rural focus, according to the initiative, is to contribute towards rural poverty reduction. This follows the realisation that as a result of low access to water supply and sanitation facilities in rural areas, rural populations are burdened to a greater extent by preventable water and sanitation related diseases. Also, women and children suffer great deprivation from embarking on productive economic activities due to time and efforts used to fetch water. The deprivation also results in low enrolment rate in education. These problems contribute to increased poverty in the rural areas. Providing access to water supply and sanitation services, the ADB identifies, would contribute to spur economic development in rural areas. There is therefore the need at regular

times to assess the impacts of such initiatives and efforts by other stakeholders at the international, national and at the community levels to find out if there is any progress towards these objectives.

Various concerned individuals and institutions had anticipated the above outlined problems and constraints of sustainable rural water supply systems and made proposals regarding sustainability and efficient use of these systems for the achievement of the set goals. For instance, the report of the International Conference on Water and the Environment dubbed 'Development issues for the 21st Century', held in January, 1992 in Dublin, Ireland had indicated that improvement of rainfed agriculture by small-scale water programmes including collective well-irrigation systems, small reservoir or tank irrigation schemes, multipurpose water harvesting projects, village drinking water supply and community garden programmes can fulfil many rural community needs and are sustainable (ICWE, 1992). The primary strategy, the report indicated, consisted of providing incentives, technical and institutional support to local communities to develop and manage water resources to meet their multiple needs. The major strategy, the report noted, consisted of strengthening the rural water supply and sanitation sector with emphasis on institutional development, efficient management and an appropriate framework for financing of the services especially the operation and maintenance.

The WHO (1981) observed that poor communities have to increase their incomes if they have to pay for improved water services, and the service providers should provide the means for them to do so. Investment in water supply and sanitation must be identified in relation to overall community development. Thus economic and other productive activities like minor irrigation should not be sidelined.

According to Arlex *et al* (2003), people in rural communities use water for multiple purposes and this has two major impacts: on people's livelihoods and on systems' sustainability. Thus a clear understanding of the user's needs in planning and design of the facilities is very important. Not taking cognisance of this reality endangers the sustainability of many water supply systems, as well as the effectiveness of many investments in the sector, and has negative impacts on users' livelihoods. Productive use of rural water supply systems in rural communities is possible but will require a more efficient use of water, so that communities can manage their own multiple use systems (ibid).

An evaluation study in Senegal by Kiyohumi *et al* (2000) found that in order for people in rural communities to afford water facility maintenance fees, most villagers started to grow vegetables using surplus water, and even though they lacked the knowledge and skills of vegetable cultivation, they have always been able to earn enough cash income for the purpose of operation and maintenance of the facilities. As a result, no problems were found in terms of facility operation and maintenance by the community. It was therefore considered that there would be no problem of sustainability.

It may be true that some communities in Ghana and for that matter Saboba/Chereponi District may have inadequate water supply, but in spite of this imbalance in water supply as indicated by the 1st Medium Term Plan (1997-2000) of the Vision 2020 document, some communities might also have more than enough and the excess is not put to use or may be wasted. It is therefore imperative to explore for these scenarios and convert them to opportunities such as minor dry season vegetable irrigation as a way of generating income for maintenance of these facilities.

The study may also be relevant following the government's pronouncement of its intention to support groundwater abstraction for irrigation in the country (MOFA, 2008).

Ayamsegna and Amoateng-Mensah (2002) observed that most rural water supply agencies in Ghana do not effect periodic monitoring to ascertain the performance of the water facilities as well as the water quality except for the initial water quality investigations they conduct. One reason identified is that some of the agencies are only contracted to drill for the communities. To ensure user-satisfaction, acceptance and sustainability of these facilities provided, a partnership monitoring programme has been initiated between the beneficiary communities and World Vision Area Development Programme offices (ibid). However, this is only limited to communities reached by World Vision. Besides the fact that information that would be gathered from this study will be of significant importance in respect of policies and strategies of the government, NGOs and other stakeholders to solve problems facing these poor communities and the rural water supply systems, this study will also investigate the general socio-economic impacts of these systems on the people. In other words, based on this study, a call could be made to responsible institutions to recognise and accept multiple use of water as a challenge which means concrete and integrated solutions to peoples' water needs. More so, it will bring to light, factors that have long been taken for granted but which nonetheless militate against efforts to turn the tide.

Finally, like any academic venture, the upshot of this study will provide a platform for further debate and research into the problems facing the rural water supply systems especially in the study area.

CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction

This chapter examines the definition of water, water sources and supply, national water policy and programmes, sustainability and socio-economic impacts of rural water supply systems as well as engineering and socio-cultural factors affecting these facilities as provided in literature.

2.2 The definition, nature and importance of water

Water, according to Drinking Water Dictionary by Symons *et al* (2000) is 'a transparent, odourless, tasteless compound of hydrogen and oxygen, H_2O. At a pressure of 1 atmosphere (101.3 kilopascals), water freezes at 0^o C and boils at 100^o C. Water, in a more or less impure state, constitutes rain, oceans, lakes, rivers, and other such surface water bodies as well as groundwater.'

Water, an abundant natural resource, is critical for the sustenance of human life. Water occupies a central position in the basic needs of man to the extent that it is next to oxygen in order of importance. Laterally then, water means life and prosperity. Water is a key determinant of sustainable development that should be carefully managed to make for suitable and sustainable human health cum well-being (Ogunnowo, 2004).

The basic purposes for which water is domestically required include drinking, bathing, cooking, and general sanitation such as laundry, flushing of closets and other household chores. Other important uses of water are for livestock and irrigation. Thus, an assured supply of water both qualitatively and quantitatively for these purposes greatly improves the social and economic activities of people (Fanira, 1977; Oyebande, 1986, cited in Ogunnowo, 2004).

The fact that water is a major constituent of all living matter, explains that water therefore is a basic necessity for life. It is very much needed in all aspects of life. This implies that water gives life. Both plants and animals need it for survival and growth. Any shortage or pollution of such a vital resource hinders growth and development. There is therefore the need to harness resources to explore and develop existing water resources and manage them to ensure adequate quantity and quality supply at all times for survival and growth.

Even though Africa is generally considered as a continent endowed with abundant water, both urban and rural people in the continent lack adequate and safe drinking water and face

food security risks, coupled with exposure to preventable water-related diseases. This situation is attributable not only to lack of water but also to the very low level of access to safe drinking water and adequate sanitation facilities. The inadequate access to water and water scarcity affect women and girls disproportionately, especially in rural areas, due to great disparities in rights, decision-making power, tasks and responsibilities over water for productive and domestic activities (AWDR, 2006).

2.3 Water resources of Ghana

Africa is considered globally as a continent endowed with abundant water and Ghana is one of the sub-Saharan African countries that are well-endowed with water resources. For instance, according to (FAO, 2008) the Volta river system basin that consists of the Oti, Daka, Pru, Sene and Afram rivers as well as the White and Black Volta rivers, takes 70% of the country's surface area. The southwestern river system watershed consisting of the Tano, Ankobra, Bia and Pra rivers also covers 22% of Ghana's total surface area. The remaining 8% of the country is covered by the coastal river system watershed, consisting of the Ayensu, Densu, Tordzie, Ochi-Nakwa and Ochi-Amissah rivers. Groundwater is also available in commercial yields in mesozoic and cenozoic sedimentary rocks and in sedimentary formations underlying the Volta basin. Indeed, the Volta Lake - the largest in Ghana, is one of the world's largest artificial lakes with a surface area of 8,500 km^2 and a catchment area of 165 700 km^2 within the country (Karikari, 2000; FAO, 2008). Ghana's total actual renewable water resources are therefore, estimated to be 53.2 billion m^2 per year. (FAO, 2008)

With regard to climate, Karikari (2000) reported that the climate of Ghana is generally tropical with a wide variation of rainfall, influenced by the southwest monsoon. The country's mean annual rainfall varies from 2 000 mm in the southwest coastal area to about 850 mm in the eastern coastal area and 1 000 mm in the north.

With all the endowed water resources, water demand far outstrips supply in Ghana just as is the case in most parts of sub-Saharan Africa. Even though varying from place to place depending on the hydro-geological conditions and financial resources, Karikari (2000) noted that the main sources of water for households are piped supply from treated water sources; untreated piped water from groundwater sources; shallow boreholes; wells; and ponds, springs, lakes, rivers, and streams.

2.4 Sources of water supply

2.4.1 Urban Sources

Generally urban communities in Ghana take the larger share of their water supply from rivers at dams and diversion structures which need to be treated to meet health standards. Surface-water resources can probably serve all urban needs for the near future through corresponding programmes of development and conservation (Karikari, 2000). For convenience sake, however, private individuals who can afford rely much on groundwater supplies through either hand-dug wells with or without pumps or boreholes fitted with pumps.

2.4.2 Rural sources

In developing countries, especially in the rural areas, the people are self-responsible for collecting water. Factually, it is not honest to expect central water facilities in rural Ghana in the near future. So, for water supply in rural areas, it is necessary to look at the different available decentralised water collecting possibilities.

Most rural communities in Ghana have traditionally relied on surface and groundwater sources for their water supply needs. In other words, these communities have a mix of protected and unprotected water sources. Gyau-Boakye (2001) indicates that the surface water sources used by these communities include dug-wells, ponds, dugouts, impoundments from dams, ephemeral streams and rainwater harvesting from roofs whilst the groundwater supplies are obtained from hand-dug wells with or without hand pumps, boreholes fitted with hand pumps, and springs. Gyau-Boakye and Dapaah-Siakwan, (1999) further noted that as part of the official policy to provide potable and safe drinking water for all rural communities in Ghana, the various stakeholders have adopted the rural water supply schemes which are exploited mainly from groundwater resources particularly through hand-dug wells and boreholes fitted with hand pumps. According to them, the rural communities in Ghana can be categorised into two basic groups: that is those that have benefited from the official rural water supply schemes and those that have not. Even for those rural communities which have benefited, there is sometimes the problem of reliability of the existing systems. These problems sometimes compel the beneficiary communities to return to their traditional sources of water supply much in the same way as those which have not benefited at all. These traditional systems, according to Gyau-Boakye and Dapaah-Siakwan, (1999) are often insufficient both in quantity and quality.

According to Karikari (2000), the quality of groundwater in Ghana is generally good and accounts for a large share of the potable-water supply in rural communities, except in some few areas where the water contains iron, manganese and fluoride deposits.

Indeed, groundwater resources appear to be the key to the development of rural water supply and this reflects in its exploitation by the various stakeholders in the rural water sector and should therefore be managed and utilised on sustainable basis to meet future challenges. However, it has to be emphasised that due to geological limitations it is not everywhere that groundwater is available especially in the required quantities. Some rural communities therefore have to rely solely on surface water resources whilst others have to resort to conjunctive use of both surface and groundwater resources.

2.5 Ghana water history and recent developments

2.5.1 History

Gyau-Boakye and Dapaah-Siakwan, (1999) noted that in 1844, during the pre-colonial era, individuals, trading, mining and timber companies and small communities were responsible for their own water supplies. Dug-wells, ponds, dug-outs, streams and rainwater harvesting from roofs were the main sources of these supplies at the time.

The colonial government however, assumed some responsibility for public water supply in the urban and rural areas as a result of periodic droughts, population growth and the emerging of larger communities later in about 1900. Consequently, a Public Works Department (PWD) was formed to explore urban water supplies. As a result of frequent drought in the northern sector, the Geological Survey Department (GSD) came to being in 1920 to assist in offering advice with regards to siting of wells. Water Supply Division (WSD) was also formed within the Geological Survey Department in 1937 as a means of dealing with the severe water supply problems in northern and the south-eastern parts of the country. The provision of water to both rural and urban areas of Ghana was then put under the responsibility of the WSD. The WSD was later separated from the PWD and put under the Ministry of Works and Housing (MWH) following Ghana's independence in 1957.

Later, a number of changes occurred in the institutional set up for water supplies in the country as a way to revamp the sector which necessitated the change of WSD to Ghana Water and Sewerage Corporation (GWSC) in 1965. By the legal Act (Act 310), GWSC was setup as a mandated public utility in charge of the provision of urban and rural water supply for

public, domestic, and industrial purposes as well as the provision, operation, and control of sewerage systems. The policy of GWSC was to supply potable water to rural communities based mainly on groundwater sources (Gyau-Boakye and Dapaah-Siakwan, 1999).

To address the problems that confronted the Ghana water sector, the government took a decision to restructure the sector; hence various reforms have been adopted since 1993. The main aims of the reforms were to separate rural and urban water supply services, to introduce independent regulatory agencies, as well as to include private sector participation (CWSA, 2004).

In line with the reforms, the Community Water and Sanitation Division (CWSD) was introduced in 1994 as a semi-autonomous division of GWSC to be responsible for the water supply and sanitation in rural areas. In 1998, it was transformed into Community Water and Sanitation Agency (CWSA) by Act 564, and became fully independent (GWRESP, 2008; TREND, 2007). In the same vein, the GWSC was also replaced by the publicly owned Ghana Water Company Limited (GWCL) in 1999. The responsibility for rural water supply and sanitation was then decentralized to the District Assemblies (WaterAid, 2005).

These later innovations mandated GWCL to remain responsible only for urban water supply, whilst the water systems in over 110 small towns were decentralized to District Assemblies, which receive support from the CWSA. As a way of instilling responsibility in the people, a demand-driven and community-managed approach was introduced in the latter case (UN, 2004).

The other development has been the shift of the regulation of water supply from the government to independent agencies. The Public Utilities Regulatory Commission (PURC) and the Water Resources Commission (WRC) were two commissions created in 1997 to regulate the sector (CWSA, 2004). The PURC was therefore mandated to be responsible for formulating as well as approving appropriate pricing mechanisms aimed at full cost recovery, as the subsidization of water services was being phased out by the government in 2003 (OECD, 2007). The PURC regulates only the services of GWCL and for that matter has no hand in the services of community-managed water systems. The Water Resources Commission (WRC) on the other hand only regulates water resources. In other words, it takes the responsibility of licensing water abstraction and wastewater discharges (WaterAid, 2005) The other institution created under the sector restructuring process is a Water Directorate at

the Ministry of Water Resources, Works and Housing to coordinate water sector activities (ibid).

2.5.2 The progress of the sector in recent times

2.5.2.1 National water policy and programs

General water sector policies for both rural and urban areas are set by the Water Directorate within the Ministry of Water Resources, Works and Housing (MWRWH). Furthermore, the ministry solicits funding from external support agencies, monitors the sector, and advises the Cabinet (WaterAid, 2005). The Water Sector Restructuring Secretariat, created in 1997 in the MWRWH, oversees the process of private sector participation in the sector (Doe, 2007). Although the sector has made substantial progress, a lack of coherence in policy formulation resulted in a multitude of implementation strategies which led to new problems. The existence of a multitude of institutions with overlapping responsibilities is one main new problem which partly arose from the recent reforms. To overcome the lack of coordination between the numerous institutions which were created since 1993, a National Water Policy (NWP) was launched in February 2008, to introduce a comprehensive sector policy and focuses on the three strategic areas: (i) water resources management; (ii) urban water supply; and (iii) community water and sanitation (GWRC, 2008).

In other words, the aim of the NWP is to formulate a comprehensive sector policy which includes all relevant actors in the sector. According to the MWRWH, the NWP could make it easier for development partners to provide the necessary support to the sector (Appiah, 2008). The NWP has been prepared by the Ghanaian Water Resources Commission (WRC) since 2002 and is based on the Ghanaian Constitution of 1992, the Ghana Poverty Reduction Strategy (GPRS), international agreements and conventions, and other national programs (GWRC, 2008).

2.5.2.2 Rural water policy

For rural water sector, the National Policy is operated on the Demand Responsive Approach (DRA) where acquisition of potable water supply starts with the application for assistance filed by communities through the District Assemblies (DAs). This mostly applies to point sources. One of the key principles of the National Community and Sanitation Policy is the requirement that beneficiary communities pay 5-10% cash contribution toward the capital cost of the least-cost, technically feasible water facility option with intent of involving the

beneficiary communities to demonstrate their commitments, sense of ownership and responsibility (WaterAid Ghana, 2003a).

2.6 Rural Water Sector Service Provision

2.6.1 Community Water and Sanitation Agency (CWSA)

The CWSA is by an Act of Parliament, Act 564, in charge of coordinating and facilitating the implementation of the National Community Water and Sanitation Programme (NCWSP) in rural areas using the decentralized structures at the district and community levels as prescribed in the Act (CWSA, 2008). The CWSA does not directly construct, operate, and maintain utilities for water supply and sanitation. Instead, its role is to coordinate the work of a number of actors which carry out the services in rural areas, including public sector organizations, local beneficiary communities, private sector organizations, and NGOs. The CWSA is also expected to ensure that financial support from development partners is effectively used and to provide rural areas and small towns with hygiene education. To carry out its tasks, the agency operates ten regional offices besides its head office in Accra (CWSA, 2004).

2.6.2 National Community Water and Sanitation Programme (NCWSP)

The NCWSP which was launched by the government in 1994 is managed by CWSA through its national and regional offices. It is a national programme tasked to deliver rural water supply and sanitation facilities and funded by a number of donors and the Government of Ghana. The main donors are the International Development Association (IDA), Danish International Development Agency (DANIDA), Canadian International Development Agency (CIDA), and the French Development Bank (CFD) (CWSA, 1997). The real implementation of the NCWSP is carried out by the Disrtict Assemblies (DAs) through the District Water and Sanitation Teams (DWSTs). The NCWSP focuses on three main objectives in order to achieve health improvements: safe water supply, hygiene education, and improved sanitation (CWSA, 2004). These objectives are outlined by CWSA (2008) as:

- To provide access to water and sanitation services for rural communities and small towns in Ghana
- Ensure the sustainability of water and sanitation facilities provided
- Maximize health benefits by integrating water, sanitation and hygiene promotion

2.6.3 Policy of the NCWSP

As outlined by CWSA (2008), the underlined policy of NCWSP is the Community Ownership and Management (COM) of the water and sanitation facilities installed in the beneficiary communities and the use of the private sector to support the process. A standard implementation strategy, focusing on community management and the demand responsive approach, is adopted by NCWSP.

The key elements and principles of NCWSP are also outlined by CWSA (2008) as follows:

- Demand Responsive Approach
- Decentralized planning, implementation and management
- Community ownership and management
- Community contribution to capital cost
- Private sector provision of goods and services
- Public sector facilitation
- Integration of hygiene promotion with provision of water and sanitation facilities
- Gender mainstreaming at all levels
- Collaboration and coordination with relevant stakeholders

2.7 Sustainability of community projects

2.7.1 What is sustainability?

Sustainability as a term has received many definitions from different scholars with different interpretations. However, the generally accepted definition of sustainability was given by the Bruntland World Commission on Environment and Development 1997. "Sustainable development is the development that meets the needs of the present without compromising the ability of future generations to meet their needs." This definition has received many interpretations and thus difficult to put into practice. The concept of sustainability may continue to be viewed imperfect until better procedures for assessment and evaluation are drawn and universally established. Nevertheless, the concept can be usefully employed in development projects even with the present imperfections in the definition.

In the case of projects initiated by funding agencies such as in the case of rural water supply facilities, sustainability refers to the capability of local institutions to continue both the processes and outputs of the facilities once external support is withdrawn (Fecade, 1994; 217). Even though sustainability may be ideally assessed from project pre-implementation

through post-implementation, the scope of this research is limited to the post- implementation stage due to limited time and resources.

2.7.2 Sustainability of rural water facilities

Studies have shown that some communities manage to keep their water systems going. However, for most communities, sustainability of their water facilities is still a distant dream. Thematic Group (2005) observes that the main factors that lead to problems of management of rural water facilities in these communities are:

- Limitations within the community which include community dynamics, political or social conflict, inability to generate sufficient income for maintenance, failure to account transparently for funds generated, lack of preventive maintenance, lack of community cohesion and lack of capacity.
- Constraints external to the community which include poor design of water systems, poor construction, political interference in planning and resource allocation, lack of spare parts, lack of supportive policies and legislation and, most importantly, failure to support communities in terms of major repairs, conflicts etc.

Biswas and Tortajada (2002) indicate that the sustainability of the community water project depends on the sustainability and the efficiency of the institution that will be responsible for managing them. This means that in order to evaluate the sustainability of the projects, it is necessary to evaluate the institutional efficiency and sustainability of the board and for that matter the various committees at the community level.

In the same vein, CWSP (1993) indicates that sustainability of rural water projects can be achieved by building problem-solving capacity in communities and partnership agencies to resolve problems as they arise. CWSP (1993) envisage sustainability of rural water supply systems to encompass both organizational and financial sustainability. As a recommendation therefore, CWSP points out that the ability to maintain and derive benefits from the rural water supply systems would be achieved if:

- Beneficiaries perceive the need for clean drinking water to be high compared to other needs.
- Water is available in sufficient quantity and is easily accessible.
- Appropriate priority is granted to social or ethnic groups, and beneficiaries feel responsible for their system.

Following its mapping work in the Afram Plains, WaterAid (2005) indicated that sustainability of rural water facilities is a real problem in Ghana. It, however, observed that the new partnership strategy adopted by NCWSP as a measure to improve the sustainability of facilities may avert the situation if reinforced. The new NCWSP partnership involves the Community, government through CWSA and DA/DWST as well as the private sector. CWSA (1997) outlined the structure and roles adopted by NCWSP to improve the sustainability of community water facilities as follows:

2.7.2.1 The Community

NCWSP has adopted a Community Ownership and Management (COM) strategy under which the community owns the facility by playing a major role in planning, siting, financing and building it. They will be responsible for maintaining it by forming a community water and sanitation committee (WATSAN) to manage it and handle a day-to-day preventive maintenance and repair needs by trained two pump caretakers. Women are to play a key role in planning and decision-making and to be leaders of the WATSAN committees as NCWSP believes water is "women's business". Generally the membership of WATSAN is seven (7) which includes the chairperson and vice, secretary, treasurer, hygiene educator, and two pump caretakers. According to the NCWSP, the facility does not receive any cross-subsidies and 5% of the cost of providing it is paid by the beneficiary community (Nyarko, 2004). To NCWSP, underpinning community management is the demand-responsive approach where communities contribute 5% of capital costs.

2.7.2.2 Decentralised and programmatic strategy

The government's role is played through two institutions:

2.7.2.2.1 The Community Water and Sanitation Agency (CWSA)

The overall coordination is nationally carried out by CWSA through its teams at the national and regional level. The Regional Water and Sanitation Team (RWST) selects, organises training for, and monitors the work of Partner Organizations (POs) and other contractors by working closely with DA and DWST in each district.

2.7.2.2.2 The District Assembly (DA)

The DA is the key actor at the district level. It works through DWST, which develops plans for water and sanitation in the district; promotes community demand for the facilities; supervises the work of POs and other contractors; and provides advice and necessary

assistant to the community in respect of operation and maintenance. Although the communities are expected to independently operate and maintain their water supply systems, they are to receive technical assistance from DWST at the district level, consisting of an engineer, a hygiene expert, and a community mobilizer (Komives *et al*, 2008).

2.7.2.3 The private sector

Communities and the CWSA are enabled to contract individuals, private sector consultants or NGOs, to provide technical assistance, goods and services. Local companies are also contracted in the provision of boreholes and hand-dug wells (WaterAid Ghana, 2005b). They include:

2.7.2.3.1 Partner Organisations (POs)

PO is an NGO or a small company with skills in community development, hygiene education and technical issues contracted to work for NCWSP in respect of helping communities to plan and manage the water facilities as well as hygiene promotion. The specific roles of POs are:

- help to build a participatory process of community discussion and decision-making with particular attention to women playing a major role
- help the community form an effective WATSAN committee and train the committee on its management responsibilities
- help the community/WATSAN identify how best to raise funds, organise safekeeping and record-keeping, buying of spare parts
- educate the community on hygiene practices in order to derive health benefits from the facility
- help the community plan the new water facility, select and train caretakers and organise pump maintenance

2.7.2.3.2 Small Business Development Units (SBDUs)

SBDUs are experienced water sector professionals who help RWST in selecting and training of POs.

2.7.2.3.3 Area Mechanics (AMs)

Major maintenance and repair needs are undertaken by district area mechanics (AMs) at the request of and paid by the community. They also help to install pumps and train community caretakers.

2.7.2.3.4 Spare parts suppliers

They are retail shops that stock spare parts and sell directly to communities. A National Supply Network System supplies parts nationwide. The supply points have been zoned into three, with Tamale supplying the northern sector, Kumasi for the middle sector and Accra for the southern sector.

Tay (2005a) has indicated that the cost of operation and maintenance of rural water facilities can become an added burden on the rural poor if the appropriate technologies are not selected or the financial capacity of the communities being built to really take on this task. However, the new sustainability measures being adopted as outlined above seem to have overlooked this fact.

2.8 Impacts of rural water supply

Generally water supply and for that matter rural water supply borders or impacts on wider socio-economic development issues that include the discussions in the following sub-sections.

2.8.1 Water and Health

According to Nicol (2000), health-based view has driven most sector development in the last 30 years, mainly from public health approaches to water supply and sanitation provision. In health terms, the overriding benefits of this approach have been perceived to be the reduced transmission of water-borne diseases such as diarrhoea, typhoid and guinea worm. However, it is noted that at the global policy level, safe water supply and sanitation have been closely linked to better health, whilst at the household level, establishing these links has proven far harder (ibid).

WWDR (2009) observed that provision of sustainable safe drinking water and sanitation services would drastically cut the loss of life from water-related illness and free up scarce health resources in developing countries. The report noted that in developing countries an estimated 3 million people die prematurely from water-related diseases yearly. Majority of these deaths are infants and young children, followed by women from poor rural families who lack adequate access to safe water and sanitation services. Unfortunately, rural communities in Africa are the least served with water supply interventions. In Ghana only 41 % of the rural people have access to safe water (World Bank, 2004 cited in Tay, 2005b). The

lack of potable water and sanitation systems has become a severe public health concern in Ghana, contributing to 70% of diseases in the country (OECD,2007).

Gyau-Boakye and Dapaah-Siakwan (2000) observed that most rural settlements in Ghana have traditionally relied on surface water sources such as streams, rivers, lakes, ponds and dug –outs which are heavily polluted and are the source of water borne and water –related diseases such as diarrhoea, guinea worm, typhoid fever, bilharzia and malaria. According to Tay (2005b), Ghana should be worried as statistics show that the rate of child mortality increased by 2.8 % between 1998 and 2003 while each year, many children die from diarrhoeal diseases which are water and sanitation related and are preventable. In Ghana, infant and child mortality rates are still unacceptably high: one in every nine children will die before reaching the age of five (GSS, 2003, cited in Tay, 2005b). Tay (2005b) further observed that the low level of coverage for both water and sanitation especially in the rural communities has had the following negative impacts on child health and quality of life.

- The incidence of diarrhoea remains very high in Sub-Saharan Africa despite a better understanding of the disease. In Ghana, all health institutions record diarrhoea among the top five reported cases at their outpatient departments.

- In Ghana, fetching water for domestic use is one main household chore in rural areas undertaken by children especially, the girl child. This exposes them to diseases like guinea worm and bilharzias and other water-related diseases as they will usually end up swimming or playing in the water when there is no potable source near.

- Children born to poor families who have no access to basic water and sanitation services are usually found with Yaws, diarrhoea and other water and sanitation related diseases common among them. Availability of a safe water supply, sanitation and hygiene interventions reduces the occurrence of diarrhoea and other water related diseases and for that matter, infant and child mortality.

- When a community has a reliable water supply system, women, especially mothers, are able to devote more time to care for their children thus preventing them from contracting other diseases as quite significant time is saved.

- The quality of water used for domestic and drinking purposes in a house is greatly influenced by accessibility to the source. Since most rural dwellers have to walk over

a kilometre to get water, they are economical in their use of water for domestic purposes, especially for bath, thus skin and other related diseases are common.

Studies show that the highest exposure to diarrhoea and typhoid causing agents as well as intestinal worms is through the use of contaminated water, poor excreta disposal and unhygienic practices. Since excreta disposal and hygiene are all dependent on safe water supply, implications are that communities with inadequate safe water supply are therefore vulnerable to these effects. Good water and sanitation reduce deaths from diarrhoea diseases by an average of 65 % (WaterAid Ghana, 2004a). However, according to Tay (2005b) diarrhoea remains the largest preventable killer of children under five. WWDR (2009) reveals that five thousand children die each day from diarrhoea alone – one every 17 seconds.

In most low-income countries, worm infestation is one of the greatest causes of diseases among children aged between 5 to14. Ghana is no exception with one of the major causes of anaemia in children being intestinal worms. There is an 80 % prevalence rate of anaemia among rural children (Tay, 2005c).

Guinea worm, bilharzias and skin diseases related to unsafe and inadequate use of water are still very prevalent in rural Ghana, especially in the northern sector. This places Ghana in an unenviable second position on the list of Guinea Worm endemic countries in the world, behind war torn Sudan with 3,622 cases including children (Nyarko , 2008; WaterAid Ghana, 2003b). Water Aid (2003b) indicated that nine of the 110 districts (eight in the northern region and one in the Volta region) accounted for 88% of all Ghana's cases. This makes the northern region and northern Sudan the two highest endemic areas of guinea worm in the world. Research has also shown the social and economic impacts of guinea worm on the developing world.

The social impact of guinea worm disease is mainly attributable to the impermanent disability suffered by the patient. Two studies in Nigeria (Adeyeba and Kale, 1991; Smith et al, 1989) found that 58 to 76% of patients were unable to leave their beds for roughly a month during and after emergence of the worm. The more severe and prolonged disability is associated with secondary infection of the wound; this occurs in nearly half the cases (Nwosu et al, 1982; Wurapa et al, 1975).

The impact of this disease is reinforced by the seasonal pattern of its emergence, often peaking at stages of the agricultural year when labour is in maximum demand (Ahearn and de

Rooy 1996; Smith et al, 1989). This seasonality means that a whole community can be laid prostrate concurrently and household members can be prevented from substituting for one another in agricultural and other tasks. A study by Belcher et al (1975) in Southern Ghana indicated that the adult male farmers were at greatest risk of becoming infected with guinea worm resulting in the average work loss of more than 5 weeks. Belcher et al (1975) further also noted that because guinea worm disease is seasonal, coinciding with peak agricultural activities, and few alternative labour sources are available for the incapacitated farmer, a marked reduction in agricultural output occurs. The Dogon people of Mali refer to the infection as "the disease of the empty granary" (WHO, 1998, cited in Cairncross *et a,*2002).

The impact of guinea worm disease does not end when the worm is out and the sufferer returns to work. A study in Ghana by Hours and Cairncross (1994) found that, between 12 and 18 months after emergence of a worm, 34% of patients still had some difficulty performing everyday activities, usually due to pain at the location of infection. While this disability is not necessarily permanent, it extends beyond the incapacity occurring during worm emergence.

The immense impact of guinea worm and other water related diseases in the developing world has generated debates among stakeholders as to the causes of these diseases. Whiles some researchers indicate that the prevalence of water related diseases in Ghana is due to the people's life styles of resisting change; community groups hold their firm belief that inadequate safe water is the prime cause. For instance, WaterAid Ghana (2004b) observed that the prevalence of guinea worm and other water related diseases in most Ghanaian communities was due to people going back to their old habit of preferring drinking from unsafe water sources even though protected sources are provided. WaterAid Ghana (2003a) indicates that Ghana's second position globally in terms of guinea worm infestation was an indictment on the efforts that had been made on the provision of potable water. Hence for rural water supply to make any positive health impact, stakeholders in the provision of safe water to rural communities must intensify work on behavioural change and hygiene education since there were some communities especially in the northern region with potable water sources and yet record high prevalence of guinea worm cases. The use of contaminated water is the cause of many diseases like diarrhoea, cholera, typhoid and intestinal infection among the communities with children being the most vulnerable (WaterAid Ghana, 2004b).

WaterAid Ghana (2003b) observes that despite the high prevalence of water-borne diseases in Ghana especially guinea worm and diarrhoea, basic education on simple purification technologies can yield good impact. This is because people will forever use the many forms of water sources that include rainwater, rivers, lakes, streams and other unsafe sources even upon provision of borehole sources. It is not only the provision of new water facilities that can help eradicate guinea worm; purification can do the trick (ibid).

According to WaterAid Ghana (2005a), provision of water supply systems without integration of sanitation and hygiene promotion or education will not make a health impact on the beneficiary communities. This calls for all service providers of community water facilities to operate an integrated water, sanitation and hygiene promotion approach.

Some studies in literature reveal that rural water supply is yet to make any impact on some communities upon several years of installation. For instance WaterAid Ghana (2005a) reports a finding of a study at Pishigu in the northern region that majority of the people choose to go to the dam contaminated not only with guinea worm, but also breeds disease due to the numerous cattle, sheep, goats, which enter and defecate as well as people step into it daily to fetch water although boreholes are provided for them. The reasons by the people were that dam water is a lot closer, they have been drinking it for centuries and it just tastes sweeter. Besides, they contend that the borehole water makes your stomach hurt, doesn't quench your thirst, and you will become sterile. These are misconceptions and call for intensive education. WaterAid Ghana (2005a) observes that the only way to achieve a positive health impact on a community such as Pishigu, is to make the water the people already prefer safe for use through filtration systems whilst we know boreholes are better. Accordingly, reconstruction with a filtration system attached to the dam and then ran closer to the town will be extremely beneficial especially health wise to the community in a case like Pishigu.

2.8.2 Poverty and Economic/Community Development

The benefits of safe water supply and sanitation are found to be numerous when evaluated as well as put into financial terms. WHO estimated that safe drinking water and basic sanitation projects produce returns of US $3-$34 for each $1 invested (WWDR, 2009). Likewise WaterAid did provisionally calculate returns ranging from $2 to $52 for its related projects (WaterAid Ghana, 2004a). Mathematically, these represent hundreds of percentage profits that are worth a serious business undertaking that can raise the world's poorest people from poverty. Unfortunately, many African nations are yet to awaken from sleep to appreciate this

truth. WWDR (2009) noted that the overall economic loss in Africa alone due to lack of access to safe water and basic sanitation is $28.4 billion a year, or around 5% of GDP.

Attempts have been made by other scholars to estimate the economic impacts of guinea worm on agricultural productivity. A simple method has been to multiply the number of days of labour lost by the mean value of production per day or by the wage rate. From such a simplification, it becomes easy to multiply the loss per household to derive an estimated cost for a whole community. One such study by de Rooy and Edungbola (1988), based on a survey of 87 households, estimated that the rice-growing areas in three states of southern Nigeria sustained an annual loss of $20 million due to guinea worm disease. In spite of its simplistic argument, this study was extremely effective in mobilizing the support of senior politicians in Nigeria for the eradication of the disease (Edungbola et al, 1992).

According to Brieger and Guyer (1990), a more sophisticated approach is to examine the impact on actual production or even to include the incidence and duration of guinea worm-induced disability as predictive variables in an agricultural production function. Audibert (1993) used this approach, in a setting in north-eastern Mali to show that temporary disability accounted for a reduction of 5% in the overall production of two important subsistence crops: sorghum, mainly grown by men, and peanuts, cultivated by women.

WaterAid Ghana (2004a) indicated that in Madagascar, the government has been persuaded by the finding that five million working days and 3.5 million school days are lost annually due to ill-health caused from unsafe water and poor sanitation to prioritise the sector for greater investments. Indeed, clean water and sanitation are so essential and vital if any nation is to fight against poverty, improve health and much more. It was in view of this that water Aid Ghana organised a forum in September 2005 to ask government of Ghana to increase investment in the water and sanitation sector in the 2006 annual budget. Governments around the world have signed up to halve the world's poverty by 2015 through the millennium development goals (MDGs). Within these goals are identified areas or targets to halve the proportions of people living without safe water and sanitation by 2015. To ensure the biggest impact on poverty reduction and economic development, aid must be targeted to ensure it reaches those without access to water in the form of safe water supply provision (ibid). This reaffirms the fact that it is not just the method of water supply, but supply of safe and acceptable water guided by tested policies, monitoring and evaluations, ensuring sustainability and unbiased or equity in supply.

2.8.3 Water and education

WWDR (2009) observed that upgrading water supply and sanitation services can improve education, allowing more girls to attend school instead of spending hours each day collecting water. Tay (2005c) outlined the following as facts and evidence of the impacts of rural water supply on education in Ghana:

- *Children and Health* - most childhood diseases that prevent children from attending school are linked to the use of unsafe water, inadequate sanitation and poor hygiene.
- *School Attendance* - children's attendance and retention rates at school are higher where communities have water and sanitation facilities with proper operation and maintenance. Where reliable water and sanitation facilities are sited close to the home, less time is spent fetching water and that is not necessarily done in the morning freeing children to attend school early. Besides, children are not fatigued collecting water in such a case thus reducing truancy and also enhancing their ability to learn after school. Sub-Saharan Africa has the lowest primary school completion rates in the world with an enrolment rate of 60% in Ghana. Water related diseases still account for a high percentage of childhood illnesses, causing children to lose many school days. Domestic chores related to water are often the main cause of pupils' lateness or truancy at school. In Ghana, children spend averagely two hours daily on domestic chores such as fetching water.
- *Performance at school* - children's performance in school is greatly improved when the incidence of diarrhea disease and worm infestation is reduced. Frequent worm infestation among school going children resulting in anemia and stunted mental growth is one of the major causes of poor performance in school. Many children in rural Ghana suffer from worm infestation leading to malnutrition and anemia. Other water related diseases such as guinea worm, typhoid and bilharzias are also responsible for the frequent many school days lost by children especially in the rural communities. This indeed has a negative impact on their performance in school.
- *Girls' Education* - more girls attend school when adequate water supplies are available. As at the year 2000 about 44 million children in Sub-Saharan Africa were not enrolled in school with more than half of this figure being girls. This worrying situation was traced to Child labour and domestic chores. In most of our

rural communities in Ghana, fetching water early in the morning before school is common chore. Culturally, this is usually done by girls and in some cases; they have to walk more than 2km to get water.

- *Teachers* - are more willing to teach in rural schools where an adequate water supply and sanitation facilities are available.The absence of basic water and sanitation facilities in rural areas is a serious disincentive for teachers to accept rural postings. He noted, for example that in 1999, of 262 teachers posted to the 4 districts in the Upper West Region, only 115 reported at post with reasons traced to lack of potable water. Available literature indicates that in those areas with limited or no access to safe water and sanitation, teachers are exposed to water and sanitation related diseases. For example, inadequate washing as a result of water shortages leads to skin diseases and body odour. Most teachers in the Eastern region of Ghana for instant, were frank to mention that they reduce their interaction in classes where there is a general problem of body odour which studies have attributed to lack of water. Adequate access to safe water means adequate water for domestic use to not only teachers but all people. This indeed, will also make rural postings more attractive and reduce the potential exposure of teachers to water-induced diseases thus enhancing teaching and learning.

2.8.4 Water and agriculture

For many developing countries like Ghana and for that matter the northern sector of the nation, agriculture is a key determining factor of the livelihoods of the people. In other words, agriculture is fundamental for local livelihoods and economic development at all scales. Indeed, agriculture is, and will continue to be for a long time, a key sector for economic development in low-income countries.

However, limited and unreliable access to water for both domestic use and irrigation is a determining factor in agricultural productivity in many of these countries. Water supply in farming communities can have so much impact both directly and indirectly on agriculture. Directly in the form of time spent in accessing water and indirectly in terms of health issues. Probably the most important health implication or health impact of water supply to these farming communities is the issue of guinea worm eradication.

Guinea Worm which is also known as dracunculiasis scientifically, has been known in Ghana for decades. Most endemic communities have a myth surrounding it; many call it the

'preventer,' keeping farmers from their farms for whole planting seasons. The effect normally causes a significant loss to agricultural production during periods of extensive out break (Nyarko, 2008). In simple terms, it therefore means that the provision of potable water supply to these communities is expected to bring not only the health benefits but also a significant improvement in agricultural productivity. Eradicating guinea worm has many positive repercussions beyond health. The infection affects livelihoods and food production and its debilitating nature prevents children from attending school. With a little more work, Ghana can free all its communities from these burdens (WaterAid, 2006).

CHAPTER THREE
MATERIALS AND METHODS

3.1 Introduction

This chapter presents a brief description of the general characteristics and socio-economic infrastructure situation in Saboba/Chereponi District to provide a basis for assessing the socio-economic impacts and sustainability of the rural water projects. The chapter further describes the materials and methods used including appropriate means for data analysis and presentation. Also highlighted in this chapter is the assessment of existing water and sanitation delivery in the district.

3.2 Profile of the Study Area

3.2.1 Physical Characteristics

3.2.1.1 Location and Size

The Saboba/Chereponi District is one of the twenty one (21) districts in the Northern Region of Ghana. It is located between latitudes 10° 10' and 10° 20' N eastwards and longitude 10° 10' N and 10° 20' northwards. It shares boundaries with: - Gushiegu District to the West; Zabzugu/Tatale District to the South; Bunkpurugu/Yunyoo District to the North; Yendi District to the South-West; and Republic of Togo to the East. The District has a total land area of 2,810 sq. Km (MTDP, 2006).

3.2.1.2 Climate and Vegetation

The district is located in the savannah ecological zone. The climate is characterised by alternative wet and dry seasons of equal lengths of six months. Annual rainfall is about 1000mm or less, falling between May and October. A long dry period follows the end of the rains from November to April. Temperature, which is generally high throughout the year, ranges between 21° C and 41° C (MTDP, 2006).

The District's Medium Term Development Plan (MTDP) also reveals that the Guinea Savannah vegetation is degraded in several locations. These areas include areas where agricultural activity is presently high and severely degraded lands that have become uncultivable. Trees sparsely populate such areas and these areas are also with vegetation made up of grass interspersed with drought resistant trees. The common tree species are the "*dawadawa*" and shea trees. The vegetation is greenish only in the rainy season and very dry in the harmattan period.

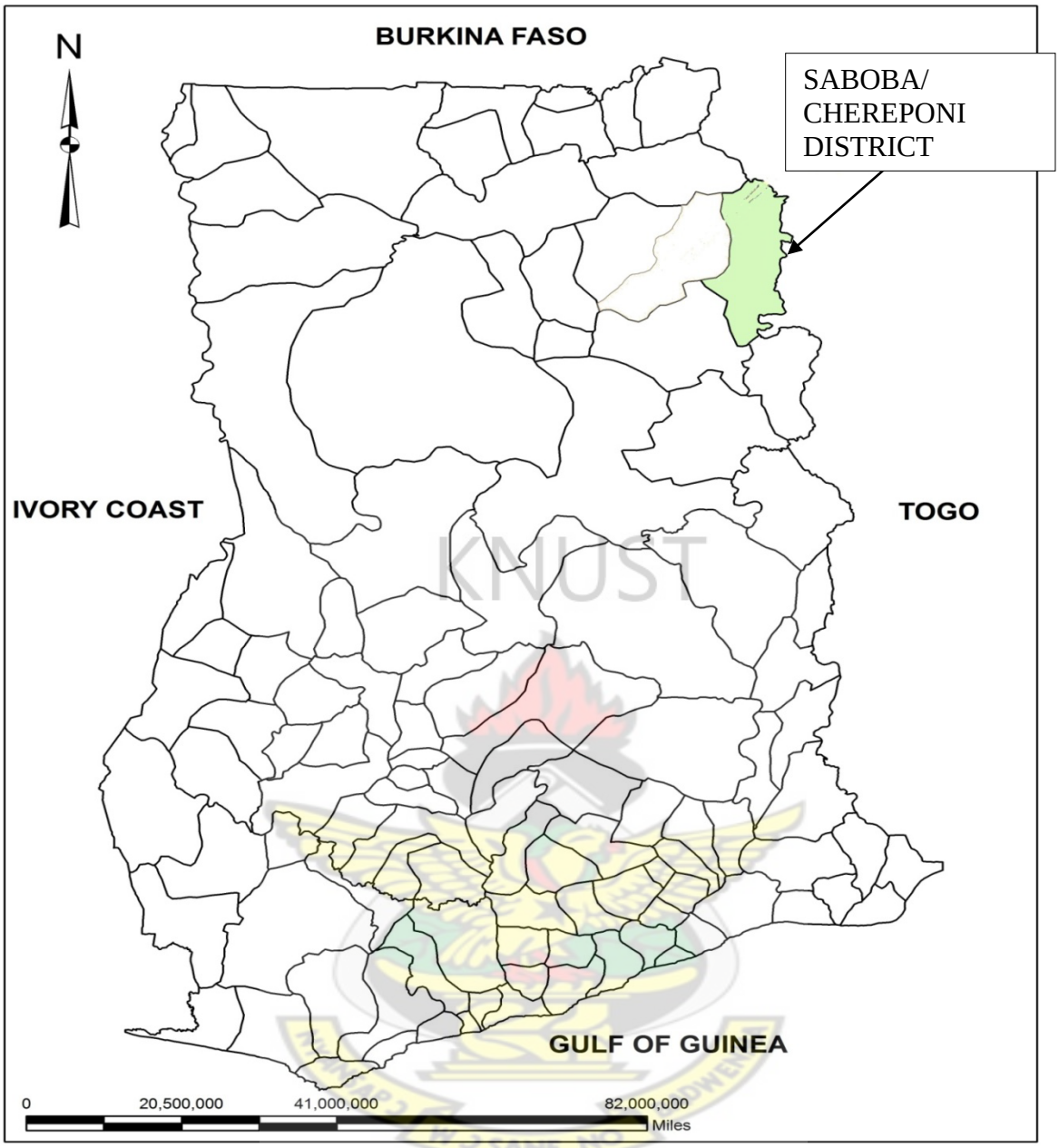


Figure 3.1: Map showing the Location of the Study Area within the National and Regional Context

Source: Saboba/Chereponi District's Dev't Plan, 2006

3.2.1.3 Geology and Soils

The Voltain shale underlies the whole district. Most of the soils in the interior savannah and the transitional zones developed over shale, which contains abundant iron concretions and iron pan (a hard layer in sand or gravel) in their sub-soils (Adu, 1996, cited in MTDP, 2006; Issaka *et al*, 2004). These soils constitute the groundwater laterite (red topical soil) and occupy about 50% of the interior savannah (ibid). The groundwater laterite, due to

impervious iron pan or clay pan in the sub-soil, is characterized by water logging at the peak of the rains. The soils are quite good along the valleys. Alluvial valleys are quite extensive around Kpalba and suitable for rice production. There is considerable soil erosion in the district, becoming severe around Chereponi area. This is due to bad farming practices such as the slash and burn method, and rampant burning of bush in the dry season.

3.2.2 Demographic Characteristics

The population of Saboba-Chereponi District was recorded as 93,847 according to the 2000 Population and Housing Census (PHC). At present the population is projected to be 119,277 using a growth rate of 2.7%, which is typical of Northern Region. This gives the District a population density of about 39 persons/square km as compared to a figure of 33 persons/km sq. in 2000.

The low population density of the district is the result of interplay between a harsh climate and ecology, migration and poverty. It may suggest a relatively low population pressure on the land, but in reality, it constitutes a significant and important constraint on the location of feasible and sustainable community facilities such as potable water supply, schools, health infrastructure, etc.

On the whole, the dependency ratio for the district is 112.0 %, that is, more than one dependent per worker. The district therefore shows distinctly high dependency. This is observed to be of particular concern, given the very low level of economic opportunities that exist in the district. In general, urban localities offer greater economic opportunities and, therefore, attract rural migrants. However, Saboba/Chereponi District (7.0%) is the least urbanized district in the Northern Region. Apart from Chereponi which has a population of 6,241, the rest of the district is predominantly rural in terms of population. The district can be described as a typically rural and scattered. By Ghana Statistical Service and 2000 Population and Housing Census geographical delinealition, there are 408 settlements in the district. With the 2000 Population and Housing Census, only Chereponi which has 6,241 people can be described as urban. With population aside, Chereponi and other five settlements perform typically agricultural functions with very limited urban functions and formal employment avenues.

Chereponi, Saboba, Sambuli, Wapuli, Wonjoga and Sangbana have populations above 1,000 people. The settlement pattern of the district is scattered and many settlements have less than

500 people, and most of the villages are located in the interior sector of the district. One reason could be attributed to their farming method, as farms are located very close to homes. This settlement population distribution pattern does not augur well for development in the case of the distribution of socio-economic and technical infrastructure, which requires certain population threshold to make them viable.

3.2.3 Socio-Economic Infrastructural Facilities

As observed by MTDP (2006), the district has inadequate infrastructural facilities in the areas of water and sanitation, health, housing and education. The commonest sources of drinking water in the district are the rain, spring, river and stream (50.2%). About 17.2% of households use borehole, followed by use of dug-outs for the collection of rainwater (12.7%), (12.4%) use well and pipe-borne water in the form of a standpipe, either inside or outside the house (7.4%). Other sources, constituting mainly tanker supply, represent only about 0.1 per cent of household water sources.

This means that only 24.6 per cent of households have access to potable water (pipe-borne plus borehole); this has implications for water borne diseases for the district. The dependence on these sources of water has major implications for the health of the population. Contaminations during the process of water collection may aggravate the incidence of diarrhoea and other water-borne diseases. Table 3.1 presents the distribution of the type of toilet facility available to households in the district. For the district as a whole, 91.1 per cent of households have no toilet facilities of any sort (MTDP, 2006).

Table 3.1: Type of Toilet Facilities in Saboba/Chereponi District

District	WC	Pit latrine	KVIP	Bucket/ Pan	Facility in another house	Public toilet	No facility	Other
All districts	2.5	2.0	2.3	1.6	1.0	14.5	75.9	0.2
Saboba-Chereponi	1.3	0.6	1.5	0.4	0.7	4.4	91.1	0.0

Source: 2000 Population and Housing Census. Ghana Statistical Service

The use of water closets (WCs) and the KVIP is very limited. About 1.3 % of households in the district have water closets, while 1.5 per cent use the KVIP.

The pit latrine and other types of latrines are relatively uncommon in the district. Members of households with inadequate toilet facilities or with no toilet facility at all, are compelled to

rely on alternatives such as the bush, farms etc. This has significant implications for transmission of infections, and consequently, for the health and well-being of communities, which in turn, may impact productivity negatively.

With regard to health, the district has two major facilities namely: the Saboba Medical Centre located at Saboba, being run by Assemblies of God Church and the Chereponi Health Centre under Ministry of Health at Chereponi. There are smaller clinics at Wapuli, Sambuli and Wenchiki being run by the E.P Church, the Catholic Church and the Ministry of Health respectively. Currently there is no medical doctor in the whole district. The nurse: patient ratio is 1: 3,227. The main reported cases in the district are malaria, diarrhoea, pneumonia, typhoid fever, guinea worm, anaemia, intestinal worms, eye infection, snake bites among others.

On education, the district has 25 nurseries, 92 Primary Schools, 20 Junior High Schools (JHS) and 2 Senior High Schools (SHS) located in Saboba and Chereponi. Saboba has a Technical/Vocational Institute where Junior Secondary School graduates are admitted for courses in Carpentry & Joinery, Building and Construction and Mechanical and Electrical Engineering. With regard to the literacy rate, Table 3.2 depicts the literacy rate in the district.

Table 3.2: Literacy rate in Saboba/Chereponi District

LITERACY RATE	MALE	FEMALE
Not Literate	19,095	21,059
English	3,021	1,958
Ghanaian Language	603	350
English & Ghanaian Language	1,018	507
Other	145	130
Total	23,882	24,004

Source: 2000 PHC, Ghana Statistical Service

It can be inferred from Table 3.2 that the literacy rate among the male segment of the population is greater than the female group. This situation could be attributed to certain cultural practices, which do not allow some people to send their children to school, especially the girl-child. The teacher-pupil ratios of nursery, primary, junior secondary, senior secondary and technical /vocational school for the district were found to be 1:83; 1:55; 1:36; 1:19 and 1:27, respectively (MTDP, 2006). These figures point to the fact that quite a number of children in the school-going age are not attending school. Out of the 412 teachers in the

district, nearly 56 per cent are untrained. The situation even looks more alarming at the pre-school level where as large as 88 percent of the teachers are untrained. Major reasons cited for this state of affairs are lack of accommodation for the teachers and the absence of electricity in certain parts of the district that could serve as pull factors. The literacy rate, defined as the ability to read and write, was estimated at 16% according to 2000 PHC. This figure is comparatively lower than the national average of 45 %. To reverse the trend, the District Assembly has stated quite clearly that education is one of its major priorities.

The district can boast of four (4) dams located at Lower Nansoni, Tombu, Chereponi and Saboba (Toma) and, a few dugouts. These dams basically serve as sources of water for livestock and occasionally, human beings, too. Except Nansoni dam, which is used for dry season gardening where the water stock lasts into the dry season, most of the dugouts are silted and require immediate de-silting.

3.2.4 Assessment of Existing Water and Sanitation Service Delivery

3.2.4.1 Water Supply Facilities

The present water supply system in the district is inadequate and also the existing water bodies such as rivers, dams or dug-outs are being polluted by the society. The district has pipe-borne water systems only at Saboba and Chereponi. However, the supply is inadequate due to population expansion and the constant breakdown of the pumping machines, attributed to structural design defect (DWSP, 2005). Research findings indicate that the provision of boreholes for water is very difficult due to the rocky nature of the land in the district (ibid). A depth of more than 60 metres has to be drilled before hitting the water table. There are 140 boreholes (BHs) and 100 hand-dug wells (HDWs) distributed throughout the district. Indicated below is the summary of water facilities in the district.

Table 3.3: Summary of Statistics on Potable Water Facilities

TYPE	NO. OF COMMUNITIES	TOTAL NO.	NO. FUNCTIONAL	NO. FOR REHAB
Pipe System	2	2	2	2
BH	140	140	79	0
HDW	100	100	60	0

Source: 2005 SIP Database and Update by Validation Committee, Saboba-Chereponi District Assembly.

It must, however, be noted that some of these water facilities (boreholes and hand-dug wells) are unable to provide adequate potable water all year round due to climatic conditions; budgetary constraints to rehabilitate broken ones, re-develop boreholes, rehabilitate small water town systems and upgrading of wells (including deepening) in order to provide adequate water supply all year round. Spare parts for hand pump repairs/replacement, installation of pumps are not readily available in the district. Public use of some of the water facilities are not regulated and therefore may account for frequent breakdown. Also to be noted is the fact that there are no privately owned water facilities and water facilities in the district are communally owned or by organisations like Churches.

Table 3.4: Coverage of Potable Water Facilities, Saboba-Chereponi District

Type	Total Number	No. of Communities	COVERAGE a	
			Population Served	% Population Served
Pipe System	2	2	14,359	13.5%
BH with Pump	140	63	9,600	9.0%
HDW with Pump	18	17	2,250	2.1%
Total			26,209	24.7%

Source: 2005 SIP Database and Update by Validation Committee: Saboba-Chereponi District Assembly.

Coverage of potable water facilities is based on standard number of people to be served by a community-based facility. According to CWSA standard, a pipe system is provided if the population is more than 2,000. A borehole is supposed to serve 300 people, while a hand dug well is to serve 150 people. Therefore the provision of a particular type of water facility depends upon certain population threshold.

The stakeholders in the delivery of water facilities in the district, both past and present, include ActionAid, Community Water and Sanitation Agency (CWSA) under NORWASP CIDA-sponsored project, 5th EU/GOG Micro-project Programme, Church of Christ, World Vision Ghana, the Catholic Church, and Village Infrastructure Project (VIP).

3.2.4.2 Institutions

3.2.4.2.1 District Water and Sanitation Team (DWST)

The District Water and Sanitation Team (DWST) is a sub-body of the District Assembly charged to advise the District Assembly on matters relating to water and sanitation. Its responsibilities include:

i. Collect and maintain baseline and monitoring data and report to DA;

ii. Assist the sub-committee in the selection of communities for facilities;

iii. Assist the CWSA/SBDU to select and train POs and latrine artisans;

iv. Supervise the work of POs, latrine artisans, hand dug well contractors and WATSAN;

v. Provide follow-up support to the WATSANs.

3.2.4.2.2 WATSAN

Under the new decentralisation policy, every beneficiary community of water facility is enjoined to have WATSAN Committee (i.e. Water and Sanitation Committee) in place. Its functions include:

i. Organise meetings and involve community in decision making and action;

ii. Mobilise communities to contribute towards facilities for O & M;

iii. Organise for communal labour;

iv. Organise the maintenance of and repair of water and sanitation facilities;

v. Organise hygiene education and action;

vi. Liaise with Area Mechanics and DWST.

3.2.4.2.3 Community Water and Sanitation Agency (CSWA)

It is responsible for the promotion of sector planning, liaising with other agencies to:

i. Disseminate information;

ii. Train sector actors;

iii. Co-ordinate sector activities;

iv. Monitor and evaluate sector activities

v. Provide technical advice

vi. Mange contracts.

3.2.5 Gender Issues in the Water and Sanitation Sector

Both men and women play important roles on issues regarding water and sanitation. Acquisition of water and sanitation facilities, especially application for the facilities, opening of bank accounts is spearheaded by men. However, issues relating to maintenance of water and sanitation facilities are mostly the preserve of women. Women are the managers of water and sanitation facilities at household level, and are therefore, encouraged to participate actively in any water and sanitation project. Their traditional roles are recognised and every effort should be made to encourage their involvement in the best interest of the communities especially, the sustainability of the water supply facilities. Both men and women serve members on WATSAN Committees in the district.

Potable water is still not seen as essential by most people in the villages. Therefore communities' contributions towards maintenance of existing water facilities or installation of new ones are not encouraging. This is so because men think of water as the sole responsibility of women and therefore are slow and not interested in contributing money towards the maintenance of water systems.

Sanitation is not recognised as a need in almost all the communities. Compounds are normally not swept except on days that the members do not go to farm. In the district, except few households, which have pit latrines (VIP) and few public KVIPs, free-range toileting is a culture or norm. Rainwater harvested during the rainy season is contaminated with dirt and this affects the health of the people and productivity (DWSP, 2005).

3.3 Materials and Data collection

Data for this study were from both primary and secondary sources. Data collection methods, both qualitative and quantitative, were used including literature survey, research tools such as discussions with local communities and various resource persons in the district, departments, particularly the various stakeholders of the rural water supply schemes. In

addition, physical field surveys and experiments were undertaken together with interviews and questionnaires. Other secondary data were obtained from relevant departments.

Focus group discussions were also used to gather information on the perceptions and beliefs on borehole water and its sustainability, water related diseases, causes, and pathways for help seeking and treatment. A vernacular language (*Konkomba, Dagdani and Chakosi*) that is well understood by everyone in the focus group discussions was used. A detailed household survey was conducted together with the use of household questionnaires. Among other crucial issues, the questionnaire addressed socio-economic as well as demographic factors associated with water use.

3.3.1 Sampling Design

In this study, the simple random sampling technique was used to select respondents for the questionnaires. The cluster sampling method was, however, employed in choosing 12 localities within the district. The case-control method was used such that communities with the intervention could be compared with those without in order to identify any impacts. The 12 communities were randomly selected so that information acquired would be representative of the District. Six of these villages were those with intervention and the other six were those of non-intervention (the control group). To ensure that the information obtained was a true representation of the situation, 10 households were sampled in each community.

3.3.2 Equipment used

Equipment used for the study included a pump, Global Position System (GPS), surveyor's staff, double ring infiltrometer, 15 litre bucket, Stop watch, Steel tape measure, swimming life jacket, 100m rope and personal computer with appropriate software (Statistical Package for Social Scientist (SPSS) version 16 and Microsoft Excel) for data entry, organisation and analysis.

3.3.3 Questionnaire Information

Information from the community's perspective on the health and socioeconomic impacts as well as the sustainability of the water facilities in the area were collected using a household questionnaire. A sample size of 120 households from twelve communities in the area was used for the study. Data obtained from the questionnaire provided information on the sources of water used, common water related diseases in the area, water usage for

socioeconomic activities, factors affecting water supply and supply systems as well as their sustainability. Appendix A contains a sample household questionnaire for the study.

3.3.4 Focus group discussions

Focus group discussions were also used to gather information specifically on the sustainability of the water facilities from the community water and sanitation committees (WATSANs) and some community members. Appendix B.1 has a sample of the leading questions used during the discussions.

3.3.5 Interviews

Both formal and informal interviews were used to gather information on common water related diseases, influence of water supply on education, measures for sustainability of the facilities, water sources usage preference, etc. These were granted to health services, schools, district assembly, various water supply providers (NGOs) as well as women at water fetching points. Appendix B.2 shows a sample of leading questions of formal interview with the providers.

3.3.6 Infiltration Rate Test

Soil infiltration rates using the double ring infiltrometer were conducted at three locations each in four communities with functional water facilities namely, Wapuli, Demong, Toma and Ugando. This was carried out at a place of the community's choice for possible dry season vegetable irrigation. These were mainly valley lands. Specific locations of infiltration tests in each community were determined using a GPS.

At Wapuli

1) First infiltration rate at latitude 09° 44.059' N and longitude 000° 06.454'E at an elevation of 148m above mean sea level.

2) Second infiltration rate at latitude 09° 44.071' N and longitude 000° 06.480'E at an elevation of 147m above mean sea level.

3) Third infiltration rate at latitude 09° 44.089' N and longitude 000° 06.453'E at an elevation of 147m above mean sea level

At Demong

1) Infiltration rate at the first point was at latitude 09° 29.733' N and longitude 000° 12.765'E at an elevation of 135m above mean sea level.

2) Infiltration rate at the second point was at latitude 09° 29.717' N and longitude 000° 12.783'E at an elevation of 134m above mean sea level.

3) Infiltration rate at the third point was at latitude 09° 29.702' N and longitude 000° 12.764'E at an elevation of 135m above mean sea level.

At Toma

1) Infiltration rate at the first point was at latitude 09° 42.671' N and longitude 000° 18.759'E at an elevation of 121m above mean sea level.

2) Infiltration rate at the second point was at latitude 09° 42.629' N and longitude 000° 18.750'E at an elevation of 120m above mean sea level.

3) Infiltration rate at the third point was at latitude 09° 42.650' N and longitude 000° 18.692'E at an elevation of 121m above mean sea level.

At Ugando

1) Infiltration rate at the first point was at latitude 09° 58.267' N and longitude 000° 11.147'E at an elevation of 157m above mean sea level.

2) Infiltration rate at the second point was at latitude 09° 58.284' N and longitude 000° 11.128'E at an elevation of 157m above mean sea level.

3) Infiltration rate at the third point was at latitude 09° 58.278' N and longitude 000° 11.113'E at an elevation of 157m above mean sea level.

The infiltration data were used together with climatic, soil and crop data to estimate the amount of water required for irrigation.

3.3.7 Climatic Data

Representative climatic data for the study area that included rainfall, temperature, wind speed, relative humidity, sunshine duration and evaporation were obtained from Yendi

Meteorological station and Savana Agricultural Research Institute (SARI), Tamale (Nyankpala). These were used in the estimation of the irrigation water requirement.

3.3.8 Crop Data

Crop data which include crop coefficient (Kc) and reference evapotranspiration (ETo) were derived from 30 years mean monthly climatic data to compute crop evapotranspiration (ETc). These were also used in the estimation of the irrigation water requirement.

3.3.9 Available yields of the water systems

Available water yield test were conducted on all water facilities in the study communities. These included boreholes, hand dug wells and dugouts. This data was required to establish whether the supply yields were capable of meeting domestic needs and for small scale dry season vegetable irrigation.

3.3.10 Methods

3.3.10.1 Questionnaire Data Analysis

Data from the administered questionnaire (120) were screened, coded and entered into SPSS (version 16) and analysed. Analysed results were presented in the form of descriptive statistics. These provided the communities' perspective on the general socioeconomic and health impacts, sources of water used and mitigating factors as well as sustainability of the water supply systems.

3.3.10.2 Infiltration Rate Analysis

Infiltrometer (double ring) was driven into the soil for the determination of the soil infiltration rate at the predetermined locations in the four communities. Measurements were taken in the inner ring whilst the water level in both rings was maintained at the same level. The outer ring served as buffer to prevent the effects of lateral water flow. Data obtained was analysed and plots of cumulative time against depth were drawn using Microsoft Excel.

3.3.10.3 Available yield of hand dug wells

According to Sahasrabudhe (2000), the actual pumping test for determining available well yield is most reliable. However, it is difficult to conduct this test accurately and can lead to overestimation of the yield of a well. On the other hand, recuperation test is very simple to perform but it does not give the maximum safe yield hence should be carried out generally in a driest period to take worst condition into account. In this study, recuperation test was therefore considered appropriate and was used in the determination of the well yield.

In this method water level in the well is depressed by pumping to any level below the normal level. Then the pumping is stopped and time taken by the percolating water to fill the well to any particular level is noted. The total quantity of water flowing into the well was calculated by knowing a cross-sectional area and rise in the water-level after stoppage of pumping. The rate of percolation or the yield of the well was arrived at by dividing the quantity of water by the time. All yield tests were carried out in the driest period (January, February and March) in order that worst conditions were taken into account.

3.3.10.4 Available yield of a borehole

Since the boreholes provided these rural communities are fitted with hand-pumps, the yields would be dependent on human power, hence the available yield was measured based on human power. The following steps were used:

- Ten different people fill a 15 litre bucket each by pumping and the time for each was noted
- The average time taken to fill the 15 litre bucket by pumping was found
- The average available yield of the borehole was then determined

3.3.10.5 Estimating volume of water in a dugout

An empirical equation developed for use in determining the storage capacity of a dug out by Gulik *et al* (2003) was used for estimating the volume of water in a dug out. This is given as:

Estimated volume (m^3) = Average Length [m] x Average Width [m] x Average Depth [m] x 0.00081

To measure the average length and breadth of the dugout, a rope and a tape measure was used. For an average depth, the depth of the dugout was measured at regular intervals of about 2 metres across the length and breadth and the average computed.

3.3.10.6 Irrigation water requirement (IWR)

Food and Agriculture Organisation (FAO) Modified Penman Monteith method was used to determine ETc and hence IWR. The relation is given as:

ETc = Kc x ETo

CHAPTER FOUR
RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents the analysis of responses from the study data both quantitatively and qualitatively. It presents the demographic characteristics of respondents, sources of water supply, factors limiting effective water supply in the area, general socio-economic impacts, health impacts, sustainability of rural water supply systems and small scale irrigation potential of these systems. The chapter further explores the sustainability of the type of engineering works used in providing the water systems.

4.2 Demographic Characteristics of Respondents

The background information of the respondents took into account variables such as age distribution, sex, level of education, occupation, ethnicity, religion and length of time lived in the community. It should be clearly indicated, however, that the respondents here refer to the household representatives who were mostly adults who led the responses of the household supported by other available household members in the house including children during the interview. The responses in this study are therefore those of the entire household, but for convenience sake, the respondent in this write up shall always refer to the person who led the responses during the interview.

4.2.1 Age Distribution

Table 4.1 Age distribution of respondents

Age Group (years)	Frequency	Percentage of Total (%)
21 – 30	31	25.8
31 – 40	36	30.0
41 – 50	27	22.5
51 and above	26	21.7
Total	120	100

Out of a total of 120 respondents interviewed, the largest age group fell within 31–40 years representing 30.0%. This is followed by 21–30 years, with a percentage of 25.8%. The lowest and oldest group interviewed was 51 years and above with 26 respondents representing 21.7% as shown in Table 4.1. Indeed, each of the respondents interviewed was at least 21 years old. This outcome is in line with the survey objective, which employed purposive

sampling technique. This technique was employed in order that the target segment of people was adults who had lived in the community for at least 10 years. This way, one was at least sure that people being interviewed had some reasonable information.

4.2.2 Gender Distribution

Another significant part of the survey worth mentioning is the sex distribution. The distribution of the sample according to gender shows that out of the 120 respondents interviewed, 100 of them representing 83.3% were females whilst 20, representing 16.7% were males. The results of the distribution does not necessarily depict the gender distribution of the entire population of the district but in conformity with the objective of the survey that targeted the people who had fair knowledge and information about the water situation in the community. It was noticed that in all the communities, women were directly responsible for water fetching and for that matter most of the questions were directed to them by their spouses.

4.2.4 Years Lived in the Community

Responses revealed that 71.7% of the respondents had lived in the study communities for 10 to 20 years. As shown in Table 4.2, a number of these respondents had lived in these communities for over 30 years, with some born there.

Table 4.2 Years Lived in community by Respondents

Year period	Frequency	Percent of Total (%)
10 - 20 years	86	71.7
21 - 30 years	10	8.3
31 - 40 years	7	5.8
41 - 50 years	10	8.3
51 - 60 years	2	1.7
61 and above	5	4.2
Total	120	100.0

4.3 Factors that Influence Preference use of Water Sources

4.3.1 Communities without Intervention

In order to identify the types of water sources for communities without water supply system, respondents were required to indicate from a list of water sources which they used. Responses showed that in these communities, surface sources were relied on, depending on

the season and for that matter the accessibility. Rain harvest and streams are the major sources of water for these communities in the rainy season. They, however, had no choice in the dry season but to travel for about 4-5 km to the River Oti depending on the location of the community to fetch water for their daily use. For the six (6) communities without water supply interventions that were among the twelve (12) studied, Figure 4.1 shows the results of the choices of water sources in the rainy season with the given corresponding reasons. The survey reveals that the patronage for rain harvest and stream is higher due to easy access, represented by 41.67%. Some 31.67% of the respondents also indicated that streams serve as their only alternative choice of water source in the rainy season since they do not have roof that can help harvest rain water. The rest of the respondents from these six communities representing 26.66% indicated that other small water systems (ponds, natural water holes or small dug holes, etc) were their sources of water in the rainy season.

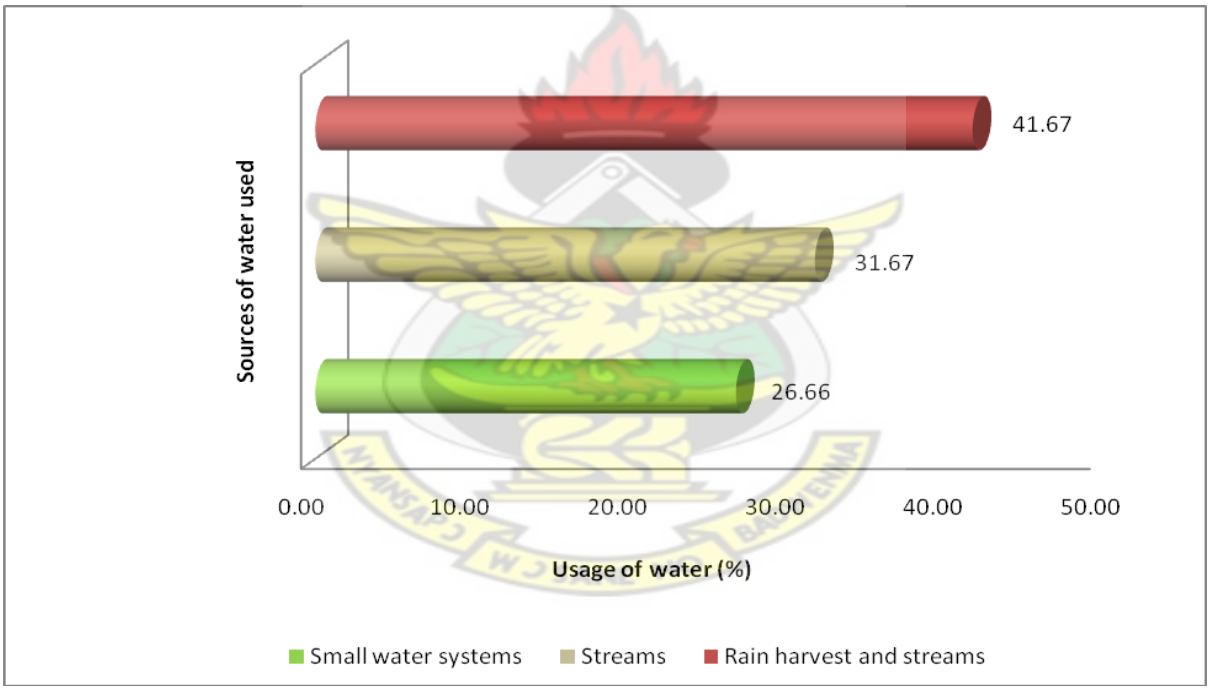


Figure 4.1: Choice of Water Source in Communities without Water Supply in Rainy Season

4.3.2 Communities with Intervention

In the selected beneficiary communities, households had a mix of both protected and unprotected water sources. Protected water sources here meant only the boreholes (BHs) and hand dug wells (HDWs) fitted with hand pumps. Unprotected sources included River Oti, streams, small water systems; open hand dug wells and dugouts.

Respondents were also asked to indicate their choice of water sources. Figure 4.2 presents the relative responses for choice of water source in the rainy season for all the communities sampled. Out of a total of 60 respondents of the communities with water facility, 33 of them representing 55% access dam/dug out, rain harvest and streams because they are easy to access and tasted good. Another 11 respondents representing 18.33% showed that they used small water system and rain harvest because it is not time consuming and also because they do not spend money in using it. The remaining 16 respondents used BHs and HDW because they believed it is free from germs.

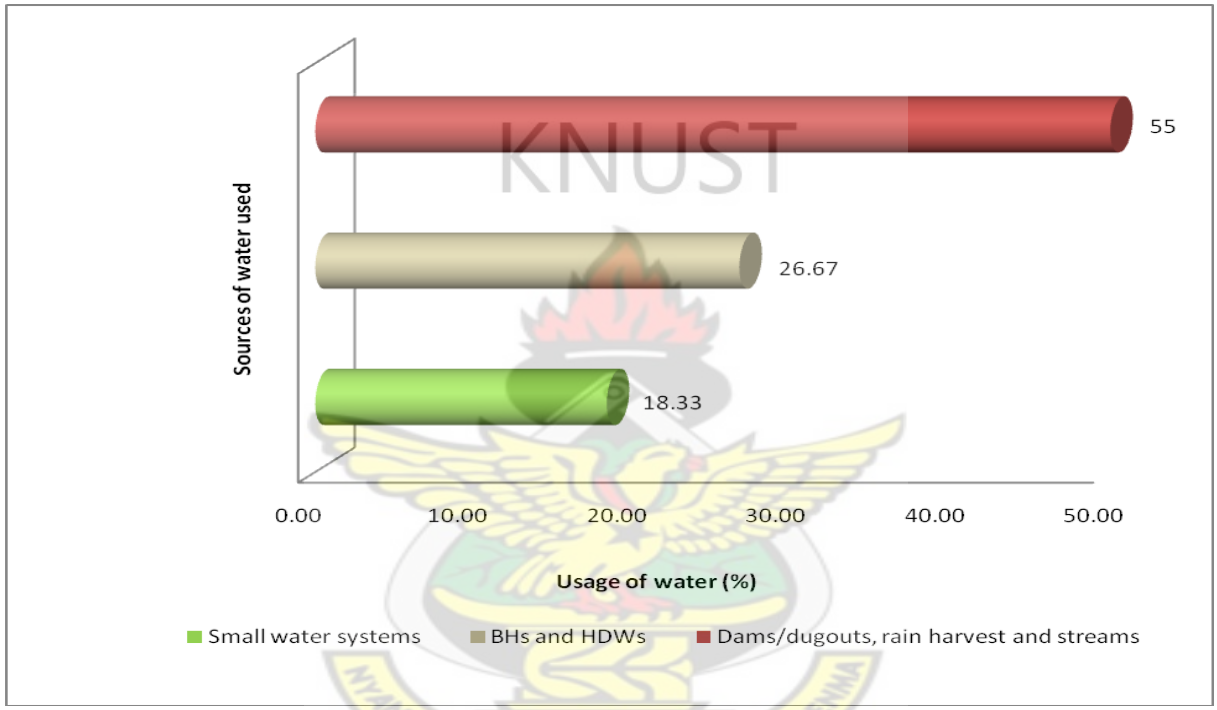


Figure 4.2: Choice of Water Source in Communities with Water Supply in Rain Season

4.4 Engineering and Socio-cultural Factors Limiting Effective Water Supply

This study found that there are a number of factors, which have led to the ineffective provision of water in the district. These factors ranged from engineering, environmental/geological limitations, technological, and socio-economic to cultural reasons.

4.4.1 Engineering shortcomings

Some engineering flaws were identified to have contributed to the ineffective supply of water in the beneficiary communities. These flaws were identified mainly on dugout facilities. All the five dugouts provided in five of the studied communities had failed and did not store water except that of Toma. There were two types of failures identified on all of them: overtopping failures and structural failures. These were all due to poor engineering designs

and shoddy works. Large cracks, settlements and slides resulting from poor compactions were some signs of structural failures of embankments. Overtopping had caused all the dugouts to lose parts of the embankments leading to failure and subsequently the inability of all the dugouts to store water except that of Toma. Even though, the Toma dugout (Moadani) is still perennial despite failure of part of its embankment due to overtopping, it was still suffering from many engineering design defects. For instance, its upstream was opened towards human settlements even though could have been avoided. Not only does it collect dirt from the nearby houses, it is suffering from serious siltation as a result of sand transported by runoff through the open end and walk ways into it. Its original maximum depth was estimated as 6.5 metres during the dry season, but it was found to be 4.17 metres during this study (February-April). The bed was very muddy; a sign of siltation. Indeed if no urgent measures are taken to save it from its current state, it is more likely that it will not survive dry out for the next 10 years. It needs dredging and closing of embankment towards human settlements as well as prevention of encroachment by settlement structures. The pictures in Appendix E (Figs. XIII-XXII) depict the state of the dugouts in the study area.

4.4.2 Settlement patterns

The settlement pattern in the study area is much dispersed and therefore not suitable for development purpose especially the provision of water facilities. In most of the studied villages the houses were scattered and this scattered settlement pattern in the communities was revealed to have affected the provision of potable water. For instance, most respondents from Wapuli, Demong and Toma have expressed concern that they were disadvantaged in terms of distance to the siting of the facilities and hence were not using the provided sources but rather use unprotected surface sources that were relatively near. They noted that they were therefore not contributing to the repairs of these facilities since they were not using them. In Wapuli for instance, some houses were about 2-3km away from the facilities which were all sited at the same place.

4.4.3 Site Selection

Indeed, while attributing the foregoing problem to settlement patterns; it is important to also note that the social and technical criteria used by most providers were inappropriate even taking into consideration the geological limitations and the fact that water cannot be found everywhere. For instance, in all the beneficiary communities studied, the facilities were all sited at the same place, in fact, within a $100m^2$ of land. This is a disadvantage to houses

which are dispersed far away and compels most inhabitants in such houses to resort to nearby open sources. A woman who fetches water several times a day, wants to have the new facility as close to the house as possible. If it is located further away than an old source (stream, river, or pond), she is most likely to use the old source, especially if she is not convinced it is unsafe. At Toma, for example, all the three BHs and a HDW were all sited at the base of a dugout; at Demong all the three BHs were also sited at the base of a dugout and the same to all communities with multiple facilities. It was a source of concern to most of the respondents in those communities who raised questions as to whether it was possible to find water only at one site. They claimed that subsequent providers did not carry out any site exploration and never consulted them but went near the existing facility and sited theirs. At N-nalog, the people contended that if the providers had heeded their appeal, then the two facilities provided at the same place with very low yield to the extent that they had to be closed down could have been avoided. They noted that the subsequent BH provided at their suggested site had a very good yield but was only closed down due to high fluoride content.

Views of household respondents on the influence of water facility location on its usage are illustrated in Figure 4.3. It was clear from the illustration that majority were of the view that the locations of the facilities had negative influence on their patronage. It was revealed that those who noted that the locations bear negative influence were households very far (averagely 2.5km) away from the facility whilst those who thought the location had no influence were those in the middle of the community (averagely 1km) away. That, in this researchers view still goes to support the highest score, negative influence. These are the group of people who find it better fetching from nearby traditional sources.

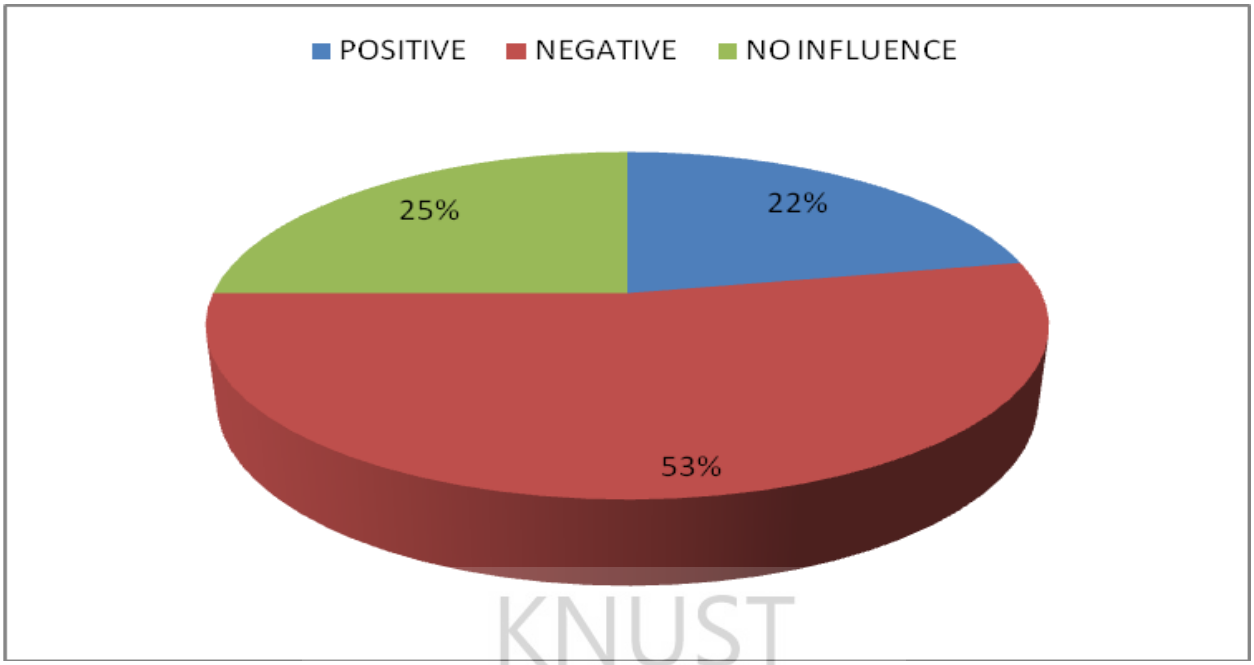


Figure 4.3: Influence of location of facility on usage

4.4.4 Socio-cultural

The involvement of the community in all aspects of the provision of water facility is very critical not only to ensure sustainability of the facility but also to ensure that the community actually patronised and used it. Especially in siting the facility, the community will best know places that should be avoided since they know their own environment. As already mentioned in the preceding subsection, it was revealed that most water facilities were sited without consultation or in some cases disregarding the community's suggestions. This has led to the abandonment of some facilities. For example, at Borigbang, the respondents expressed concern that they had advised the providers not to site the borehole at the current place for not only it is their sacred shrine but also that the place was waterlogged but their suggestion was dismissed and the facility sited there. This facility has since been abandoned and the people have resorted to their traditional water sources. They claimed that as a result of the shrine, the borehole always broke down and was poor in yield hence they abandoned it. It explains why a guinea worm case was recorded there.

4.4.5 Environmental/geological limitations

The study area falls within the Voltaian formation system and this reflected in the poor yields of most of the facilities especially the hand dug wells (HDWs). Indeed the HDWs have proved to be not suitable in the area due to the very low groundwater table especially in the dry season. A lot of HDWs as well as some few BHs were revealed to dry up during the dry

season. Indeed all the HDWs in the area except one at Toma were all found dried up during the survey. Physical constraints e.g. poor aquifer with limited storage seems to have a contributory factor in limiting water supplies in the area.

4.4.6 Skilled personnel

As discussed in detail in the section on sustainability, many boreholes that were installed well over ten years ago were no longer functioning. In Wapuli for instance, with 4 BHs and over 1000 population only one borehole was now functioning as others were broken down leaving most community members without access to potable water. Experience during this research in most of these communities showed that the people were really willing to determine their own destiny but they lacked the 'technological knowhow'. The WATSAN members were not well trained to take up minor repairs to avoid expenses in calling on outside mechanics. This is coupled with the fact that many young and knowledgeable men who could take up the task of WATSAN have left the communities for obvious reasons.

4.4.7 Ignorance and lack of awareness

One major factor contributing to the problems of ineffective water provision is ignorance and lack of full awareness by the communities. Many are still not awake to the fact that they own the facility and need to contribute for its sustainability. Assessment of the progress made in the area has shown that donors have done a tremendous job but this dangerously created a donor-dependency syndrome within receiving communities. In all the beneficiary communities, some inhabitants expressed ignorance at the state of the broken down BHs. Since the BHs were no longer working, they were viewed to belong to the providers or the District Assembly. Most of the household respondents also expressed ignorance on the dangers of drinking unprotected water.

4.5 General Socio-economic Impact

As outlined in the literature, the immediate objective for the provision of every rural water supply facility is not only to provide safe drinking water aimed at preventing water related diseases, but also to reduce the burden of chores for women and children in order to reduce poverty as well as promote education in the rural areas. Indeed, aside this primary objective, there are other enormous benefits that could be derived from rural water supply programmes especially for women. There is always an underlying hope that women would use some of the time they saved on income generating activities in order to increase their economic

independence. In other words, enormous socio-economic impacts are always predicated on provision of any rural water facility but the story may be different after its introduction.

It is imperative to indicate that the benefits of rural water supply are gender sensitive; based on the traditionally defined responsibilities of men and women in society and at home as was found in the study area.

4.5.1 Gender benefits

From all the women and men who were interviewed to analyse the impact, there were some differences between communities, but common themes emerged. In all the communities without interventions, both women and men were positive that the provision of water facility would make it easier for women to fetch water and save much time for other socio-economic activities. To them, women would no longer be restricted to fetching water from very far river or streams in safety during the best part of the day: a facility, they indicated would mean that they could collect water whenever they liked and whenever they needed it - even at night. They were very positive about the time it would save.

The survey results from four of the communities with water facilities on the other hand, have admittedly confirmed some of the above predicted benefits but with many limitations. These communities include Demong, Wapuli, Ugando and Toma. Respondents from the other two beneficiary communities, N-nalog and Borigbang have, however, all refuted any benefits derived from the provided facilities. From these two communities, the respondents claimed that since from onset the facilities have not benefited them in any way but rather have brought petty quarrels and enmity among the once friendly community due to its very poor yield as well as frequent breakdowns in the case of that at Borigbang. The facilities in these communities were thus abandoned and not in operation. This indeed, is in contrast with statements commonly made by people including some service providers that water facilities in all beneficiary communities have made enormous benefits to the inhabitants. It explains that such statements, though widely asserted, are often just general statements or assumptions which have not first sought the direct impact of these facilities on the said inhabitants and subsequently linking that to the socio-economic benefits.

The survey results showed that out of the 60 respondents from the beneficiary communities, 46.7% have indicated that despite the inadequacies and other shortcomings of the water facilities, they have been helpful to them in several ways as against the 53.3% that believe

that the facilities have not been helpful to them. Giving reasons for their claims, those who gave credit to these facilities pointed out that at least they give them water all year round as well as help them save much time. They also explained that before the provision of the facilities, they were compelled to travel a number of kilometres depending on the location of the community to fetch water from River Oti or other small water systems, sometimes in the night.

At a domestic level, this 46.7% respondents further supported their claims noting that the water facilities provided them have improved access to safe drinking water - and to water in general. This has also resulted in higher crop production and thus improved food security or higher household income, they admitted. On the other hand, many female respondents have noted with concern that improved water supply has merely entailed substituting one tedious task (fetching water) for another (agricultural labour) - which meant that the men are gaining at the expense of the women. As a validation of this claim by women, all the men respondents from four of the beneficiary communities interviewed also commented on the women's extra time; but expressed that they have more time to help men work their land. This shows how true it is to say that the provision of water facility in a rural community has a downside for women as well as benefits. It turned out from results of both the household survey and focus group discussion with WATSAN committee that women did indeed spend more time saved on their husbands' fields, while quite a number of men had increased the size of their fields. Although some women had increased the size of their own plots, their number was relatively small. Indeed, the results of the interview have demonstrated the need for research well in advance of any rural water facility provision so that awareness-raising activities during the provision period could try to ensure that women got a fair share of expected benefits. One thing was clear, if the burden of women's domestic workload is to be eased, there is a lot to be done. Asked how they use the time saved, most women indicated that apart from being engaged by their husbands, they go into income-generating activities that include vegetable cropping, *Pito* brewing, agro processing as well as petty trading.

Most female respondents including a few concerned men admittedly noted that people in the communities who are mainly farmers were very poor due to low farm yields in recent times with women worst affected. To them, any further burdening of women as was the case was unfortunate and unacceptable. They suggested that there was the need for sensitisation of

community members, in particular women, to be more aware of possible setbacks in the provision of water facility in order to see how negative impacts can be reduced.

Indeed, despite the fact that one grave task (searching for water) had been partially replaced by another (farm work), all the women in four of the beneficiary communities admitted that life had become easier. "*When you wake up in the morning or return from farm in the evening there is no worry of where and how to get water, you just go to the borehole*," said one. This fact seemed to outweigh the heavy field work.

4.5.2 Specific Impacts

4.5.2.1 Findings on social impacts

The study revealed that a lot of social benefits have been realised in the beneficiary communities since the inception of the programme compared with non-beneficiary communities. Some of these benefits are highlighted in the following subsections.

4.5.2.1.1 Education

The research found out that teachers were more willing to teach and stay in the water facility beneficiary communities than non-beneficiary communities provided that they could get their drinking water from these sources. Indeed, teachers were found staying in all the beneficiary communities except at N-nalog and Borigbang where the facilities were not functional. Although, teachers' quarters were found provided in all the non-beneficiary communities, they were all empty as no teacher accepted to stay there. An interview with some of the teachers who were found teaching revealed that even though they wished to stay in those communities considering the low cost of living there as communities were willing to feed them, they could not get potable water to drink hence were compelled to ride bicycles from town to teach. They admitted that on most occasions, they fail to come to teach due to tiredness from riding. On the other hand, most teachers found staying in the beneficiary communities noted that they were comfortable since they could get potable water to drink coupled with the fact that the communities were assisting them with regards to feeding despite the lack of electricity.

An interview with the district director of education revealed that over the years most teachers have always refused postings to communities without potable water supply and even few who accept do not want to stay there but ride bicycles for long distances to teach which makes teaching and learning ineffective. It was noted that this has always led to poor performance of

schools in these communities. As to why teachers could not be forced to stay in these communities with quarters, it was recounted that an incident in the year 2000 where two teachers who were forced by the district education director to stay in Wadiig, all got infested with guinea worm due to lack of water facility has softened the stand of the education office.

The study, however, revealed that most school children, especially girls were often late to school every morning in the beneficiary communities than those in non-beneficiary communities. For instance, 85% of the household respondents from the beneficiary communities indicated that their children were often late to school due to water collection as against 15% from non-beneficiary communities who admitted the same fact. This was further confirmed during an interview with the teachers from both types of communities. Even though teachers at non-beneficiary communities also noted that most children do not bath before coming to school, especially in the dry season, they were punctual at school since they were not engaged in fetching water due to the distance. However, it was revealed that most girls were not sent to school because of water fetching in these communities.

During interviews with the WATSANs, it was revealed that school children, especially girls were used by teachers as well as mothers to fetch water every morning and evening. However, due to inadequacies of the facilities, these children most often spend hours in queues resulting in lateness to school. Besides, it was noted that these children are often fatigued in collecting water thus sleep on their desks in school or sometimes play truant.

Some teachers however, blamed children's frequent absence at school on household chores as well as the typhoid and malaria diseases that were a source of worry to people in the study area. For instance, some teachers in Demong noted that at least 3 pupils are taken ill from the primary school daily and diagnostic records from hospital always indicate either typhoid or malaria. To them, personal hygiene and sanitation needed to be improved in the communities.

4.5.2.1.2 Community Capacity Building

It was ascertained that training on community development, especially WATSAN Committees, had brought a lot of benefits to individuals and the community as a whole. Some of these benefits include:

- Local institutions established have increased community participation in the decision making process at every level of the programme implementation in the communities and the zonal levels. This has not only instilled in every community member the

interest of participation in community issues but has really enhanced the involvement of women in community affairs and decision-making. Indeed, women were made the chairpersons of the WATSAN Committees in three of the beneficiary communities studied. It was not seen to have unearthed only their leadership abilities, but has helped in the community's appreciation of women's roles in all spheres of life as well as built the confidence of other women in taking up leadership roles. A lady WATSAN Committee chairperson at Wapuli remarked: 'At first I never knew I could play men's role, but now I found myself doing it better'. 'I urge all women to dare leadership roles without fear and they will always realise the great capabilities hidden in them', she noted. The programme has created employment and leadership opportunities for women as well as local coordination capacity in rural villages. Nevertheless, gender relations were revealed to have changed in favour of women since the programme implementation. From participation in decision making, and community management activities, progress has been significantly greater for women in beneficiary communities than for women in non-beneficiary villages.

On all accounts, participation in community level affairs was higher for women in beneficiary communities than for women in non-beneficiary communities. This applied to attendance of public meetings in their own and other villages, speaking up at such meetings and being a women's leader in their own village or a cluster of villages. These were all associated with their involvement in the management of community water facilities. It was indeed, a revelation of gender benefits in the programme.

- The training in basic accounting and management for local capacity development has helped in providing skills in community mobilisations for Zonal Co-coordinating Council (ZCC) in the case of World Vision Ghana Rural Water Projects (WV/GRWP) and WATSAN Committees. This has fostered local community organisational capacity in the beneficiary communities. Indeed, it was revealed that people in the beneficiary communities were easily organised for communal activities than those in non-beneficiary communities. In other words, through WATSAN Committee, the community mobilisation becomes easier and cooperative. Pump volunteers have also benefited from training in general servicing and maintenance of the hand pumps. This has not only enhanced their ability in mobilising women groups and community

members towards the effective management and sustainability of the facilities, but has put some of them in jobs. For instance, an interview with the WATSANs revealed that a total of 6 caretakers including a woman were now gainfully employed as motor and bicycle repairers as a result of the training given them on pump repairs. In addition, training courses on health and hygiene have benefited WATSAN members a lot, not counting the impact of the education on their families and on the entire community.

- An interview with all the WATSAN Committees also revealed that they act as community elected leaders as well and represent the community in all issues. By virtue of their training, WATSAN Committees are able to manage and resolve conflicts of any kind in the community. Community and family conflicts were said to have reduced drastically in some of the beneficiary communities through WATSANs interventions.

4.5.2.2 Findings on economic impacts

The research findings revealed that despite the 'improved' water situation in the beneficiary communities, water collection is still time-consuming. Women in both communities with intervention and those without any intervention have a working day of 15 to 16 hours throughout the year. On average, women from both types of communities spend 2 hours and 7 hours of this time on fetching water during rainy season and dry season respectively. In other words, there was no difference in average time used in fetching water in both types of communities. The only benefit to those in beneficiary communities making a difference is the reduction in drudgery of going too far for the water. Otherwise time spent in queues at the source point due to inadequacy was virtually found to be the same as that spent by those travelling to River Oti or other open sources in non-beneficiary communities. This still high time in water collection occurs in a situation where, on paper, all households in beneficiary communities have year-round access to potable water supply meant to reduce the time of water collection. It was revealed that in the rainy season, most households in the beneficiary communities resort to unprotected sources just as their counterparts in non-beneficiary communities or sometimes turned to conjunctive use of both.

The study found out that women in the area provide income to the family in four ways: by doing agricultural work on the land of the household, by engaging in expenditure-saving activities such as *pito* brewing, food selling, shear nut processing, vegetable gardening, by hiring themselves out as daily wage farm labourers, as well as some operating micro-

enterprise work like hair salons in bigger communities like Wapuli and Demong. *Pito* brewing in particular is a very common economic activity in all households except Muslims, and provides family income at crucial times: in the dry season when income from other sources is absent. During the dry season when *pito* brewing becomes more lucrative for all households, it was revealed that women from the beneficiary communities are able to fetch enough water overnight to be able to still brew whilst their counterparts in the communities without water facilities found it difficult. Beside *pito* brewing, it was also revealed that most women from the beneficiary communities who are determined were able to fetch water overnight during dry season and spend the rest of the day time at the river side on vegetable gardening where it was noted that one could make between GH¢30 to GH¢40 per week. Although some women in non-beneficiary communities were also engaged in dry season vegetable gardening, they were relatively very few as they spent much of their time fetching water from far sources, 4-5km away. It means that indirectly water facilities are making positive economic impacts despite the inadequacies, provided that women were ready to spend extra time overnight to fetch water during the dry season.

The functionality of the water facility therefore has significant economic consequences. Breakdowns of the water facility or no facility cause *pito* women in the study area a loss at an average of GH¢80 per person per month in earnings during dry season. Actual losses varied with the profitability in each community. This was revealed during households' interviews. Extrapolating this loss to an average of 6 months in the dry season, the inadequate operation and maintenance of the water facility or lack of the facility will therefore constitute a loss of GH¢480 to each *pito* brewer.

In addition to financial losses, each woman lost, on average, 5 hours per day in the dry season, for reproductive and/or personal activities. The provision or improvement of water supply to the extent that women spent one hour per day on collecting water would result in an improvement of their annual income. In other words, each woman might save 5 hours per day for domestic, social, economic and management activities.

4.6 Health Impacts

4.6.1 Water-related diseases

The research delved into the assessment of most common diseases experienced in all selected communities. This was to assess the health-based view that has been the driver of most rural water programmes. In all the studied communities, respondents indicated that they

experienced diseases like typhoid, diarrhoea, malaria, intestinal worm, bilharzias and skin diseases especially during the rainy season. Cases of guineaworm were however, rare and not found in the study area, except one case in Borigbang. It is indeed, a proof of guineaworm eradication in the area; a success and progress that, in the researcher's view could only be attributed to the efforts of the educational programmes on guineaworm eradication centred on water treatment by boiling and filtering. Attesting to this were testimonies by respondents from non-beneficiary communities coupled with the fact that, ironically, a case found was in a beneficiary community. They all noted that guineaworm was a dreaded enemy in all the communities until they received education on water treatment and filtration and from which time no single individual has suffered a case again, even though they still do not have any water facility. WaterAid Ghana (2003b) observed that it is not only the provision of potable water facilities that can help eradicate guineaworm; purification can do the trick. The responses from 11 out of the 12 studied communities indicate that the prevalence of the disease ended between the years 1996-2001 in those communities. It was also revealed in this study that the prevalence of guineaworm stopped earlier in non-beneficiary communities than it did in the beneficiary communities. This, however, may not have necessarily meant that the disease was prevalent even after the introduction of the water facility but could have been that those communities were among the guineaworm endemic communities that were prioritised to benefit from the water facilities. But the recent case meant that the people are ignorant and do not patronise these facilities.

Cases on other water-related diseases mentioned above were not so different between the beneficiary and non-beneficiary communities except that again, cases of bilharzias were recorded in some beneficiary communities. It is therefore not clear if indeed, water supply is making any health impact on the lives of these rural folk. From the 60 households interviewed in the beneficiary communities, the indicated prevalence of malaria was 81.6%, diarrhoea (68.3%), typhoid (66.7%), skin diseases (23.3%), intestinal worms (6.7%), and bilharzias (5.1%) with one guineaworm case. On the other hand, the survey results of the responses from the 60 households interviewed in non-beneficiary communities indicated the prevalence of malaria as 98.3%, diarrhoea (73.4%), typhoid (68.4%), skin diseases (16.8%), intestinal worms (3.3%), with no cases of bilharzias and guinea worm. Comparing the cases of these diseases in non-beneficiary communities to the beneficiary communities, some upward differences exist in malaria, typhoid and diarrhoea cases. However, there were downward differences in the cases of skin diseases and intestinal worms. It is important to

note that even though there are some differences in the prevalence of these diseases in the two types of communities; in reality the impact of water supply cannot be derived from these results. This is because the prevalence of each disease is equally high to the same extent in both types of communities. For instance the cases of malaria, diarrhoea and typhoid have reached an alarming stage in both types of communities.

Information obtained from the district health services has confirmed that cases of these water related diseases in the district have been very high among the top ten diseases in recent years with typhoid and malaria taking an upward trend. Statistics obtained from the district health services department on common water related diseases are as shown in Table 4.3.

Table 4.3: Cases of water-related diseases in the District, (NRC=No Reported Cases)

Disease	Cases recorded during the past ten years									
	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Guinea worm	NRC	NRC	NRC	NRC	NRC	NRC	NRC	30	21	4
Typhoid	NRC	NRC	NRC	161	287	3844	7725	5494	7847	9494
Diarrhoea	3637	5818	4456	4350	5532	4833	6899	5684	1944	2261
Intestinal worms	NRC	NRC	NRC	130	311	1036	2056	1943	1360	442
Malaria	11388	25006	20981	16806	23459	20729	26467	22818	10857	20051
Skin diseases	3138	3134	3819	2055	3853	3872	5233	4001	NRC	NRC

Source: Saboba District Health Services (DHMT)

Some health personnel felt that, despite the high figures and upward trend of some of these diseases over the last few years the health and hygiene education that include guinea worm eradication programme being conducted in most parts of the District had impacted positively on the incidence and prevalence of diseases. However, information gathered in the communities showed disparities, access to education as well as high illiteracy levels, poverty and human development in the communities which seriously impacted on hygiene appreciation and consequently water quality.

In an interview with the District Director of Ghana Health Service at the District Health Directorate, it was pointed out that high cases of water related diseases has remained a great concern to the health service in the District considering the threat to lives and the general socio-economic development of the populace. The major disturbing ones were noted as typhoid, guineaworm, diarrhoea, intestinal worms as well as malaria. According to the health

service, even though guineaworm cases had declined drastically over the past few years, as shown in Table 4.3, a single case recorded was of a very serious emergency case to them considering its socio-economic effects on the victim.

The research also revealed that unlike other diseases that cut across all age groups, diarrhoea was age related. It was noted to be much common among children of ages between 1-5 years and a few instances between 6-10 years. Some Community Health Nurses interviewed at Wapuli and Demog expressed concerns about the frequent occurrence of diarrhoea among children. These are, however, water facilities beneficiary communities. Most mothers in all the communities studied indicated that the under fives were very much affected with diarrheal diseases, while some mothers viewed this as a daily household problem. To some of them, diarrhoeal outbreaks were common when children under five years start growing teeth. However, the Community Health Nurses interviewed, attributed it to the use of unsafe water sources coupled with poor hygiene and sanitation.

4.6.2 Water supply, sanitation and hygiene issues

The study found out that all the households (HHs) in the study area have no sanitation facilities-hygiene solid waste disposal systems and child friendly faecal disposal facilities. All the HHs as well have no appropriate hand washing facilities. About 93% of HHs in the beneficiary communities could not cite critical moments to wash hands as well as demonstrate proper ways of washing hands. They had not also heard of hand washing activities and have not participated in any community hygiene promotion activity. It was found out that all the HHs did not know at least one way of preventing the various water related diseases except for guinea worm and malaria. Only 11% of the HHs clean their water storage containers at least once a week. Nevertheless, the study further revealed that all the hygiene educators as well as all the WATSAN Committees members could not cite critical moments to wash hands, indicate at least one way of preventing most prevalent water related diseases like typhoid, diarrhoea, etc.

4.6.3 Perceptions about the causes of water-related diseases

In seeking the views of the respondents in all the studied communities as to the causes of these diseases, most of them seemed to have clear answers to their predicaments. Out of the 60 respondents from the beneficiary communities, 20.3% attributed it to only water sources, 20.3% attributed it to poor sanitation, 15.3% said it was poor personal hygiene and 11.3%

indicated water and mosquitoes as the cause whilst the rest thought it was mosquitoes only, their diets, nature and infections from others. This is further illustrated in Table 4.4.

Table 4.4: Views on the causes of the disease(s) for communities with water facilities

Causes	Percentage
Eating habits	3.7
Water source and mosquitoes	11.3
Infections from others	3.7
Poor personal hygiene or unhygienic practices	15.3
No idea	7.0
Poor diet	3.7
Unsafe water source	20.3
Mosquito bites	10.3
Poor sanitation condition	20.3
Combination of poor sanitation and personal hygiene	3.7
It is natural	1.7
Total	100.0

On their part, respondents from non-beneficiary communities gave their views on the causes of the prevalent diseases in their communities as illustrated in Table 4.5. Out of the 60 respondents, 41.7% attributed these diseases to their sources of water, 33.3% noted that it is a combination water sources and mosquitoes whilst others mentioned factors such as, poor personal hygiene and diets, poor sanitation and hence mosquitoes, eating habits as well as too much work in the scorching sun. Even though almost all the respondents have attributed their health plight to their sources of water, they indicated that they were their own enemies considering the poor personal hygiene practices and sanitation conditions around them. In both beneficiary and non-beneficiary communities, all male respondents blamed the situation on poor hygiene practices by women who were the main collectors of water and its usage. Their main concerns could be summarised as follows:

- Most women in beneficiary communities lacked hygiene awareness or were work loaded thus tended to patronise unprotected sources they considered relatively accessible especially during the wet season
- Contamination during collection at water source, e.g. using unclean containers
- Contamination during transport, e.g. putting of leaves in water to stop spillage

- Contamination during storage and use in the house, e.g. one cup to fetch water, etc.
- No washing habits before cooking on return from toilets and no perception of risks involved.

Table 4.5: Causes of the disease(s) for communities without water facilities

Cause	Percentage
Eating Habits	1.7
Water Source And Mosquitoes	33.3
Poor Personal Hygiene Or Unhygienic Practices	3.3
Poor Diet	1.7
Unsafe Water Source	41.7
Mosquito Bites	6.7
Working In Scorching Sun	1.7
Poor Sanitation Condition	1.7
Combination Of Poor Sanitation And Personal Hygiene	1.7
Combination Of Eating Habits, Unsafe Water Sources And Poor Personal Hygiene	6.7
Total	100.0

In non-beneficiary communities, concerns were more and more from both male and female respondents. For instance, touching on the issue of health implications of their unprotected water sources and their own prevention measures, few of the respondents contended that water from these sources in the rainy season was generally clean whilst majority have expressed great concern about the safety of such sources. According to them, these sources, especially the small water systems and the streams are always polluted by animals such as the scavenging local pigs. Due to lack of sanitation facilities in these communities, everyone goes for 'free range' (open defecation) and not only do the runoff during rains convey the faecal matter into these sources, they pointed out that pigs feed on this human excreta and share these same sources with human beings. Even though they filter based on the education given them by the guineaworm eradication programme, they believed water from these sources is the main source of their frequent illnesses especially typhoid fever. Interestingly, the interview in most of the houses where both sexes were present generated heated debates between men and women as each side shifted blames on the other regarding unsafe water sources and unhygienic water usage practices in the house. The men contended that women were lazy in filtering water from such sources in the rainy season with claims that those were flowing sources and hence clean. They also pointed out that, even though rain water is pure, the manner in which it is harvested by women makes it sometimes even more unsafe than the other sources. They explained that women put the harvesting containers on the bear floor

where the rain-splashed materials including earthworms are always found in the water. They believe that if these attitudes of women are not changed, then not even a potable water source can make impact on their health problems with respect to water use. Women on their part also blamed the men for not arresting such animals like pigs that go to swim and pollute these water sources. They further indicated that it is the responsibility of the man to build a safe platform or water harvesting system and not the woman. This notwithstanding, they indicated that they do their best to filter their drinking water before use.

In consonance with the communities views about the causes of these water related diseases, the District Health Directorate has identified some major causes termed as 'the peoples' attitudes'. Reports from the directorate noted that even though most communities have been provided potable water sources, the inhabitants have refused or have shown less patronage for these facilities especially in the wet season citing various unacceptable reasons such as water taste or saltiness. According to WaterAid Ghana (2003a and 2005a) the prevalence of water related diseases in most Ghanaian communities was due to the people's attitude of preference for drinking from unsafe water sources even though protected sources are provided with the reason that the water tastes sweeter.The district health service attributed the high prevalence of the deadly typhoid fever, diarrhoea and intestinal worms in the district to unsafe water sources, poor personal hygiene and poor sanitation, and further noted that due to lack of sanitation facilities people openly defecate everywhere and this dirt flows into the unprotected surface water sources patronised by most inhabitants. This shows the urgent need for health and hygiene education to be conducted in all parts of the district. In other words, it was noted that to curb the current situation, the people's attitude must change and this requires a more active education campaign on health, personal hygiene and sanitation by collaborative effort of health services, CWSA and other donor agencies in the water sector operating in the area, such as World Vision Ghana, churches, as well as the District Assembly.

According to Nicol (2000), it is a fact that at the global policy level, safe water supply has been closely linked to better health, whilst at the household level, establishing these links proves far harder. The survey results indicated that the cases of water related diseases in both water facilities beneficiary and non-beneficiary communities were equally high, hence water supply can therefore not be said to have made any significant health impacts in the beneficiary communities. To really ensure that potable water supply leads to good health, it is

essential that it is accompanied by provision of sanitation facilities and hygiene education. In other words, water and sanitation facilities should necessarily be planned together coupled with hygiene education in order to yield good results. This is because most of these diseases in these communities, although water-related could be much attributed to poor hygiene and sanitation as viewed by most of the inhabitants.

Nevertheless, inadequacies of the systems especially as a result of breakdowns are the major contributing factor to the non-realisation of their health impacts in the beneficiary communities. In each of the beneficiary communities, it was either all the facilities were broken down or the breakdowns were more than those functioning as shown in Table 4.6 compelling the inhabitants to resort to unprotected traditional sources exposing them to water related diseases. Until reliable measures are taken to ensure sustainability of these facilities, this situation may never change. Even though the hurdle of guineaworm that was causing them to lose an average of three months' farm days was overcome through education on water filtration, to these farmers typhoid is more worrisome than guineaworm. An average loss of farm days estimated from the households' responses of all the 12 communities was six months especially those who go through surgery.

4.7 Sustainability of Rural Water Supply Systems

4.7.1 Managerial Sustainability

The new Community Water and Sanitation Programme (CWSP) strategy adopted involves a new partnership and allocation of roles in planning, financing, developing and managing the new water facilities. As spelt out in the literature (CWSA, 1997), the District Assembly (DA) and the District Water and Sanitation Team (DWST) are the Local Authority responsible for programme implementation at the district level. In other words, the DA works through the DWST. At the community level, it is the Water and Sanitation Committee (WATSAN) that manages community inputs to the project and the long term operation and maintenance of the water facilities in the case of point sources.

It is the responsibility of the DWST to supervise the work of the Partner Organisations (POs) contracted by donor agencies to build up the ability of the community to own and manage the water facility. The PO provides follow-up training for WATSAN Committee and caretakers and assists the WATSAN Committee to carry out user education. DWST is also tasked with providing on-going support, helping WATSAN Committees to solve management problems and to find spare parts and services in the open market. In other words, even after the POs

have done their work and the facility is in place, communities will continue to require some form of support from the DWST. Part of this support could be on hygiene education and providing information. The essence is to prepare and equip the community well enough for a long-term management and sustainability of water facility. Even though the preceding structure was found to be in place during the survey, the states of the facilities in the communities did not reflect the supposed functionality of this structure. The research identified many problems associated with the management of the community water facilities that cut across the above structure. A discussion with members of the DWST revealed that though the problems of community water facility management were mainly attributable to the inactivity and the lack of commitment on the part of the WATSAN Committees as well as the apathy on the part of the community members, the ineffective collaboration among stakeholders was a part. Also admitted by the DWST to have contributed to the ineffectiveness of the WATSAN Committee is the inability of DWST to provide the required follow-up support to the WATSANs in terms of accessing spare parts from the market. It was further acknowledged that the short term training could not equip members of the WATSANs with adequate skills to carry out the task without frequent follow-up and refresher courses. This, however, could not be possible with limited logistics and financial strength as was faced by the DA, DWST pointed out. One fact was clear: the responsibility of DWST is not just to pay regular visit or monitor the WATSANs to ascertain the problems they encounter, but to write proposals to donor agencies or negotiate with the DA for funds to support the committees in terms of refresher courses and repairs of major faults on the facilities. These were all lacking.

The survey on the study area revealed that there were lot of management problems at the community level and were serious treats to the sustainability of the facilities. This was clearly translated in the states of the facilities in the six beneficiary communities. For instance, out of a total of 17 hand pump water facilities in the six beneficiary communities studied – 15 BHs and 2 HDWs fitted with pumps, only six were functional whilst others were broken down or abandoned. The breakdown is shown in Table 4.6. Spare parts for hand pump repairs/replacement, installation of pumps, the survey revealed, are not readily available in the District. This, besides the preceding reason, accounted for the state of the water facilities in the district. As a result of poor management at the community level, the use of some of the water facilities is not regulated and therefore also accounted for frequent breakdowns.

Table 4.6: The state of hand pump facilities in the study area

Name of the community	Number of hand pump facilities	State of the facility	
		Functional	Non-functional
Demong	4 BHs	2	2
Wapuli	4 BHs	1	3
Ugando	3 BHs	1	2
Toma	3 BHs	2	1
Borgbaln	1 BHs	Nil	1
N-nalog	2 HDWs	Nil	2
TOTAL	17	6	11

Table 4.6 depicts the state of the water facilities in the District as was observed during the field survey. A validation of this finding is the 2005 assessment record of the district on the functionality of these water facilities in the district as shown in Table 4.7.

Table 4.7: Summary of Statistics on Potable Water Facility by Type, Total Number, Functionality, Rehabilitation and Privately – Owned

Type	No. of communities	Total No.	No. Functional[1]	No. For Rehab[2]	Privately-Owned[3]
Pipe System	2	2	2	2	0
BH with Pump	140	140	79	0	0
HDW	100	100	60	0	0

Source: 2005 SIP Database and Update by Validation Committee, Saboba-Chereponi District Assembly.

This explains that about an average of 48% of the point sources in the District as at 2005 were not functional, a signal to the fact that the sustainability of these sources was at a great treat if appropriate measures were not taken.

One thing was clear; WATSAN Committees were formed in each of the communities following the provision of water facilities and were still in existence except that of Toma. In Toma, it was revealed that most of the members of the committee were not permanent residents in the community and hence their departure led to the collapse of the committee and has since not been formed. However, all respondents from the other five communities were aware of the existence of the committee. Nevertheless, it was revealed that almost all the committees were inactive in one way or the other. Only 11% of the respondents indicated that

the committees were active as against the 89% who refuted the activeness of the committees blaming it on the lack of sacrifice as members were much engaged in their farm activities and never met to deliberate on issues affecting the facilities.

Also important to note is the Community's perceptions about existing water supply systems and hence their support to management. Some communities felt that they did not own existing water supply systems. For instance, informal discussions with some community members in Toma during the study revealed that the first borehole that once supplied water to them had been unrepaired since it broke down several years back. The Mechanic for the area explained that the community members were not even aware who was responsible for repairing the borehole between them and the DA. One respondent clearly said, "We are not clear as to whether the borehole is in the hands of the community people or the DA". In response to the researcher's suggestion that beneficiary communities should always endeavor to manage their own water supply systems, one elderly male respondent, clearly said, *"Ni ye Assembly yan la"* (It belongs to the Assembly). Most communities'/inhabitants felt that they did not own the facilities and were not interested in taking up Management and maintenance measures and to repair although they were using them. In reality, community people feel entitled to access but are not willing to take management and maintenance responsibilities, hence the need to seriously take them on board during implementation of any developmental project including water facilities.

An interview with household respondents showed that out of a total number of 60 respondents, 15 respondents representing 25% indicated that the communities were the sole owners of the provided water facilities as against the 75% who still thought that the providers were the owners. It was clear that most communities still felt no sense of ownership and responsibility for the water facility despite the so called demand-driven or Community Ownership and Management approach policy adopted by CWSP. The old feelings of 'Government built it, so let them repair it' when the facility was broken down could still be observed among most community members. This explains the source of apathy on the part of the community members that could have possibly affected the morale of the committees.

The membership of each of the existing WATSAN Committees interviewed was seven (7) – five males and two females. These included: the chairperson, the secretary, the treasurer, two hygiene educators and two pump caretakers. The general role and responsibility of the committee is to improve water supply, sanitation, health and hygiene in the community as a

team and ensure that these facilities do not breakdown often and are regularly maintained for the benefit of the community. This includes holding regular meetings to discuss water and sanitation issues as well as managing and finding solutions to possible conflicts within the committee and the community as a whole. The specific roles are also spelt out to the committee members as highlighted in the literature (CWSA, 1997; NORPREP, 2007). It was, however, revealed that almost all the committees interviewed during the focus group discussions in this survey were very much ignorant about their responsibilities. According to all of them, they hold meetings only as and when a problem arises; that is when the BH breaks down or need arises involving money. Even though, all the committees admitted that they received both Technical and Management training which included basic record keeping skills on basic record books like cash book, payment register, minute's book and visitors' book, none could produce any of such records when an attempt was made to inspect them during the focus group discussions. They all admitted not keeping such records. This explains that, besides the committees' failure to hold regular meetings and consult with the community, they do not as well render any accounts about their income and expenditure to the community. The identified results of this inactiveness of the WATSAN Committee in this survey were the apathy on the part of the community members and the abandonment of the broken down water facilities.

Indeed, one identified root cause of ineffectiveness of the committees was illiteracy. Almost all the committee members in all the studied communities, except in Wapuli where the Assembly Member was part, were illiterates. This explains partly why the committees failed to keep the required basic records.

To conclude, the management of community water facilities is a process that seeks to involve all the stakeholders in the Community Water and Sanitation Programme (CWSP) aside the WATSAN Committee, particularly DWST/DA, POs, Service Providers, Area Mechanics (AM), as well as EHAs Town/Area councils in constant collaboration and consultation in order to address problems that might rise beyond the ability of the WATSAN Committee. This way, the WATSAN Committee would be put on its toes and well abreast with issues and problems that might arise through education and thus plan actions to address them. A short fall in the role of any of these other stakeholders affects the effectiveness of the WATSAN Committee thus impacting negatively on the sustainability of the water facility.

4.7.2 Site Maintenance and Hygiene Sustainability

Water related health status is generally used to determine the impact of a water facility in a community. The main aim for the provision of any water facility therefore is to improve health by reducing general mortality and socio-economic losses caused by preventable waterborne diseases through access to safe and reliable water points. This will be a mirage if the environment of the facility is not hygienically kept. Hygiene education and sanitation are therefore promoted along with any water supply. According to NORPREP (2007) guidelines for WATSANs, adequate sanitation and hygiene is expected to be maintained at all types of water sources be it protected groundwater sources or unprotected surface sources through:

- Maintaining pump site cleanliness
- Proper water collection
- Proper water transportation and
- Proper storage of water.

Some water contamination sources were identified during the interviews with some service providers as:

- Bathing/wading/washing in or near water sources
- Farming and application of chemicals near water sources
- Siting of water points close to cemeteries
- Pit latrines situated near water sources
- Closeness of community refuse dumps to water points
- Indiscriminate defecation around water bodies and
- Stagnant waters or dirty pools near water points.

It is the responsibility of the volunteer health and hygiene educators in the WATSAN Committee to act as motivators in ensuring proper sanitation and hygiene practices by stimulating the participation of other community members in hygiene and sanitation activities as well as encourage and promote hygiene and sanitation best practices to prevent disease

transmissions. In other words they have the following specific roles to play as was identified during interviews with providers:

- Maintain water site cleanliness
- Make sure hygiene promotion works
- Stimulate the participation of other community members in hygiene and sanitation activities and
- Encourage the proper storage and use of water.

Even though each of the committees interviewed had two hygiene educators (all females) who demonstrated a little knowledge about their role, the realities on the ground proved their inactiveness. Critical observations at all the borehole sites in all the six beneficiary communities studied suggested that the sanitary conditions there were nothing to boast of. Sites were weedy, and in most instances eroded gutters and troughs filled with stagnant waters poured from washed clothing, muddy and possible breeding places for mosquitoes. So astonishing and disturbing were cases where women found it comfortable washing on the aprons or platforms of the borehole even though the laundry pads for washing were provided. They pour dirty water after washing right at the base of the borehole, forming stagnant waters and found nothing wrong with that when interviewed during the field survey. They were confident that nobody was going to talk about it since that was the norm. This explains the extent of inactiveness of the hygiene educators as well as the entire WATSAN Committees. Hand pumps have not been cleaned yet people line up at the sites day and night to fetch water. People farmed so close, in fact, to the base of the water facility even though all the respondents indicated that could affect the facility. It goes to suggest that though the people are well abreast with the dos and the don'ts, they did what pleased them regardless of its effect on the entire society. They do these with impunity since the management is weak and inactive. Figure 4.4 depicts the attitude of the users of the facility and the sanitary conditions at BHs sites in the studied communities: The situation was the same or even worse off at the other communities (see Appendix E).

(a) (b)

Figure 4.4: Boreholes with sanitation threats: scene at (a) Toma, (b) Demong

The research revealed that even though all the respondents including the WATSAN Committee members showed awareness of environmental sanitation and hygiene issues, it had little or no detectable impact on their sanitation and hygiene practices. In other words, the research found no evidence on good sanitation and hygiene practices among the respondents. For instance, to a question as to what constitutes good sanitation and hygiene at a water facility site during focus group discussions with the WATSANs, easily mentioned by all the committee members were things like weeding/cleaning, sweeping, backfilling, repairing of pad, gutter or trough. However, site observations during this study showed nothing better than the pictures in plates (a) and (b).

4.7.3 Repair and Maintenance Sustainability

All the respondents in the beneficiary communities indicated that, indeed, not only has each borehole in the community at one time or the other broken down or gone through repairs, some have been abandoned due to their inability to repair them. This was further confirmed during focus group discussions with the WATSAN Committees as well as the researcher's personal observation at the sites. The probability that there will be more abandonment in the next two years is envisaged if there is no wade in. There is therefore an urgent need for all stakeholders especially, the DWST, the Area Mechanics (AM), WATSAN Committees as well as the community to put heads together in developing effective fund raising methodologies and ways of accessing spare parts and personnel to take care of any breakdown. Most of the abandoned BHs, observably require major repairs as well as significant sums of money that averagely was estimated during discussions with WATSANs to be about GH¢210/BH.

(a) (b)

Figure 4.5: The state of most BHs in the study area: pictures at (a) Wapuli, (b) Demong

The study delved into the selection criteria, responsibilities and abilities of the trained Volunteer Caretakers/Mechanics to repair and maintain the hand pumps as in line with the research objective. In that regard, the survey interviews with the DWST, the providers as well as the WATSAN Committees identified the following criteria which were often used:

- Both sexes should be involved
- They should be GOOD at working with their hands
- They should be young so that they have the strength and good eyesight to do the job
- They should be hard working, reliable and trusted by the community and
- They should be resident in the community and available on regular bases.

It was widely noted that the Caretaker concept is, in fact, a determinant factor in the sustainable operation and management of water supply facilities. In other words, it plays a practical role in maintaining the water extraction device (hand pump) which is a key component for sustained water supply for community good.

In the study area, the common type of pump found was the Submersible AFRIDEV hand pumps with identified main integral parts as Pump Head, Pump Cylinder, Rising Main and Pump Rod. Two of NIRA AF-85 types were also found at N-nalog. The fast wearing parts designed for only one/two years life span were also identified as in Table 4.8.

Table 4.8: Fast wearing parts

PARTS	FUNCTIONS
U-seal Bearings Valve Bobbins O-Ring Centralizers	Supports for plunger For fulcrum & Hunger Plunger & Foot-valve Support for Foot-valve For Pump Rod

Source: NORPREP Sponsored Watsan TOT Training

Pump repairs and maintenance are often required to be conducted on the pump when there is a problem and need a well-trained personnel who is conversant with the right steps and troubleshooting. The following were the identified steps for repairs and maintenance of hand pumps during interviews with providers:

- Know the cause of the problem and determine the solution needed
- Dismantle and go straight to the problem area of the pump
- Replace defective part/parts and reassemble/mount back pump and
- Then record details of the repairs.

As a repairer or caretaker, the study also revealed that the most important skill required of the personnel is the ability to troubleshoot. Table 4.9 presents some troubleshooting in hand pump repairs.

Table 4.9: Troubleshooting in pump repairs

PROBLEM	CAUSE	REMEDY
Abnormal Noise	-Worn out bearings -Handle fork touches pump head	-Replace bearings
No water	-Defective plunger seal -Rods/pipes disconnected	-Replace seal Replace broken rods & join pipes
Delayed flow	-Leaky valves & pipe joins	-Replace valves and properly join pipes
Reduced discharge	-Worn out valve bobbins, U-seal	-Replace parts

Source: NORPREP Sponsored Watsan TOT Training

There are primary responsibilities that ought to be adhered to by the Caretakers in order to prevent any possible major breakdowns or damages. They are often referred to as Preventive

or Periodic Routine Maintenance Checks. These were identified during this study as in Table 4.10.

Table 4.10: Primary Caretaker's responsibilities

ROUTINE CHECKS	PERIODS & TIMES
-Fulcrum & Hanger nuts -Fulcrum pin & Hanger pin lockers -Flange & Base nuts	WEEKLY
-Bearings -Stroke Test (how many strokes of water to flow in the morning & stokes to fill a bucket)	MONTHLY

Even though, the criteria for the selection of Caretakers specifically spelt out the need for gender balance, this was not observed in the studied communities. Not only were they all men and may not be sensitive to water supply issues, most of them were old and seemed not to be energetic enough. Explaining why that contrast, most of the committees noted that because it was voluntary and had no remuneration attached, young ones did not want to take up the task.

An attempt was made to assess the knowledge of the Caretakers about their responsibilities as well as problem detecting abilities, otherwise known as troubleshooting. All the committees in the studied communities admittedly revealed that apart from replacing defective plunger seal which is relatively easy for them, they could make no other attempt on the borehole. They all further admitted that until a problem was reported to them, they conducted no routine maintenance on the facility. A close examination of all the boreholes revealed that none was lubricated – all parts were dry and noisy when in operation. This suggests that apart from being inactive, the caretakers were not well trained. It also came to light that in certain communities, the old trained Caretakers had migrated and new ones selected but received no training. For instance at Demong, it was revealed that all the Caretakers had migrated and replaced by untrained persons hoped to be trained later. This indeed, was noticed to be impacting so much negatively on the facilities. Whilst trained Caretakers were also to train others in the communities to ensure that more people acquire the skills, this was found to be lacking. Training more women could be a solution considering the probability that men migrate more frequently than women. In the event of major faults they indicated that they called in the Area Mechanics (AM) who comes to repair at a cost borne by the community.

They, however, lamented that the repair charges by the hired mechanics are most at times very high compelling them to abandon the facility.

The research also revealed that besides the AM, all the WATSAN Committees were not in linkage with other stakeholders, particularly DWST, the providers, spare parts shops, and neighbouring WATSANs or agencies in order to access resources. This, the study identified was the main barrier in the acquisition of spare parts which was noted to be the greatest constraint in the repairs and maintenance of water facilities in the area. The scarcity of spare parts was identified by all the WATSAN Committees as their major problem in the repairs and maintenance of boreholes in the district. They were of the view that if the parts were readily available in Saboba, the District Capital, it would have been very helpful to them since the time and transport cost to purchase the parts from Tamale (160km away) would be minimised.

Noteworthy, was the fact revealed during an interview with the providers that, some parts, such as rod (Afridev) and sleeve bearing (Nira), can easily be damaged if children play with the pump. Even though these parts are said to be very expensive, it was noted that if the community use the pump carefully, they will not damage the rod and hence will avoid the expense. Observations on the use of BHs in the study area, however, point to the fact that most BHs will be abandoned in the near future unless serious management structures are put in place. At Toma and Wapuli for instance, children were sighted climbing and playing with the BHs (Fig 4.6) whilst some adults watched on unconcern, an indication that they saw nothing wrong.

(a) (b)

Figure 4.6: Children play with BHs: pictures at (a) Wapuli, (b) Demong

4.7.4 Financial Sustainability

A major factor thought to be contributing to the problems of ineffective water provision and maintenance sustainability is the weak financial resource base of most communities, especially the farming villages where incomes of inhabitants are not regular. Certain times it is not only a problem of money collection but also a breakdown in accountability. The committee may stop meeting with the community and in which case they probably would have lost focus on their responsibilities and find it difficult mobilising funds.

It is the responsibility of the POs to help the communities understand the need for Operation and Maintenance (O&M) contributions and why maintenance is their duty. The O&M contribution should necessarily not be a condition of conversion. Nevertheless, if such contributions are not respected or satisfactorily made, it beholds on the DWST to put pressure on the community to honour or establish it during the follow-up work after the phase out of POs.

4.7.4.1 Fund raising methodologies

During the survey interviews with the providers, the following ways of raising funds for O&M were identified for the beneficiary communities:

- **Cash Contributions:** This has a number of options that includes
    a) Levying individual adults, family or compound
    b) Paying on regular basis, e.g. monthly for regular income earners and on seasonal basis for farming communities like this research area and
    c) Levying same or different amounts for both sexes.
- **Communal Farms or Labour:** This is where a community may decide to establish a community farm or organise communal labour to generate income for maintenance.
- **Levy on each 'Garawa' or Bucket Fetched:** Some communities may decide to levy at the water point each 'Garawa' or Bucket of water fetched
- **In-kind contributions:** Some farming communities may agree to deduct some specified amount of each farmer's produce as an annual contribution for maintenance.

Indeed, it is the entire community that should decide on which method and amount will work best for them and not only the WATSAN. This way, they are more likely to support the fund-raising.

This investigation on the financial sustainability of the water supply facilities in the study area revealed that it was the WATSAN Committees that imposed the method of collection of O&M contributions on the people. For instance, out of the 60 household respondents from the beneficiary communities, 57, representing 95% favoured the communal farming as against the remaining 5% who support cash contributions. However, in all the beneficiary communities studied except in Wapuli where Pay-As-You-Fetch method was used, cash contribution method was imposed on the people by the WATSANs. Beside the fact that, this affects the community's commitment and support to the WATSAN, it also derails their confidence and trust in the Committee. Since the Committee did not meet with the whole community in deciding the mode of money collection, basic rules or bye-laws and sanctions for those who fail to honour payments could not be set. This made it difficult for the Committee to sanction any such failures. It was brought to light in this research that though most inhabitants who did not support the method used could not complain for fear of intimidations, but never contributed as they faked reasons such as 'I sent a child to hospital and no more have a pesewa, etc.'

At Wapuli where a woman was the chairperson of the Committee, it was revealed that the Pay-As-You-Fetch (5GHp/Garawa) was part of her innovation to replace the Cash Contribution that had failed them. Even though, the Committee still endorsed it as a good alternative, some shortcomings and side effects were identified in this research; most women, especially the poor ones, resorted to unprotected sources and went far to their traditional sources to fetch water. They also accused the committee and some leading members in the community, including the Assembly Man for monopolising the community water facilities. This, in fact, has not only eroded their confidence and trust in their leaders, they hate them as some of them openly remarked during this survey. One of its challenges identified by the Committee was that it was difficult to get someone who could stay at the site throughout the day to collect the money since it was not possible to employ someone. The result, the Committee noted was that some people have always timed when no one was there and went to fetch without paying and that appeared to most community members as though the Committee was favouring some individuals. In spite of all its challenges, the Committee

noted that it was fruitful during the dry season due to the drying up of other surface sources. The need for only borehole water for all domestic purposes during this period arises. The Committee takes advantage of the situation to raise funds through the Pay-As-You-Fetch system. It was realised that in bigger communities like Wapuli, the people engage in other economic ventures such as trading in addition to farming and hence a sizeable number could raise funds to pay readily for the water during the dry season. Nevertheless, it was also revealed that people in the smaller communities like N-nalog, Ugando and Borgbaln were easily organised for communal activities than the bigger communities. They responded better to communal issues but had low income levels and do not practice the Pay-As-You-Fetch system. They relied solely on Cash Contribution as a means of raising funds. The bigger communities like Wapuli and Demong with multi-tribes were very difficult to organise hence Committees were compelled to take decisions without community involvement. Worth to acknowledge was the fact that a woman leader could be more active and innovative than a man in WATSAN. This was demonstrated at Wapuli during discussion with the WATSAN members.

Reasons given by those in support of cash contributions indicated that, earnings from communal farming could have been the highest yielding source but the unstable nature of the rains in the District may affect the communities' farm produce. However, majority on the other hand believe it calls for only little time sacrifices during the normal farming season to establish such a farm. Some suggested using 'Taboo' days for that, since that was to the benefit of the entire community. Better still, they think communal labour could do.

4.7.4.2 Frequency of fund raising

Apart from Wapuli where the Pay-As-You-Fetch system was used, the other five beneficiary communities have no regular contributions; they contribute only when the facility develops a fault. Indeed, many have admitted it has been the cause of delays in repairs any time a fault developed. Also revealed was the fact that all the communities had not operated their Bank Accounts again ever since the provision of the facilities averagely five years ago. Inspection of bank savings books during this study confirmed the findings. In other words, they have virtually nothing in their accounts as shown in Table 4.11. This contravenes the CWSP's rules and explains why most BHs are abandoned in the communities. It brings to light that most communities in the research area are weak with regards to fund raising methodologies towards O&M of the provided water facilities. Availability of funds at all times will ensure

quick repairs and maintenance works on the boreholes to be carried out whenever there is a breakdown.

Table 4.11: Some Basic Data from Communities

Community	Population	Cash at Hand (GH¢)	Cash at Bank (GH¢)	Total cash (GH¢)
Wapuli	1,611	53.60	15.46	69.06
Demong	908	15.00	11.23	26.23
Toma	747	Nil	Nil	Nil
N-nalog	488	17.50	20.03	37.53
Ugando	473	30.00	10.45	40.45
Borigbang	318	25.00	12.55	37.55

Source: Field Data (Jan, 2009), 2000 population results available at Saboba-Chereponi D/A.

Table 4.11 shows the amount of monies in the coffers of the six beneficiary communities. This is woefully inadequate to maintain and sustain any type of rural water supply facility. Indeed, considering the importance of water as a basic necessity of life, human, material and financial resources should be necessarily mobilised to ensure its sustainability.

The cost of spare parts for maintenance of hand pumps was also noted to have been frequently increased in recent years. This is due to the fact that the spare parts are not made locally but imported. The ever increasing exchange rate of the cedi to major foreign currencies like the U.S. Dollar ($) is the major contributing factor. The communities therefore need to improve upon their fund raising methodologies and raise enough funds for repairs and maintenance purposes.

4.7.4.3 Funds Accountability

As to whether accounts on monies collected are rendered to the communities, only 10 respondents representing 17% of the 60 household responses from the beneficiary communities answered in the affirmative while 50 responses representing 83% noted that accounts are not rendered. This group pointed out that for people to continue to contribute, good account records on monies collected and how it is used should always be rendered to them. It is the only way by which impressions that the monies are embezzled or misused may be erased. The O&M fund is the community's money; hence the entire community should know what is happening to their money and not only the few WATSAN members. Otherwise they will be less likely to contribute next time around, most of them noted with concern. It

was clearly revealed in this research that though all the households interviewed were much aware of their rights to arrange for accountability any time through a community meeting called by community members, they were all afraid of intimidations from WATSAN members who were respected in one way or the other in each community. This sends a signal that the Committee was probably not duly selected from diverse interest groups as well as people of different social status. The committee was probably a "ONE MAN SELECTION"- the Chief or any other leader selecting the committee.

4.7.5 Management and Maintenance Improvement

Experience in the studied communities shows that villagers are willing to determine their own destiny but they lacked the 'practical know how'. In other words, the communities are ready to improve their lives and hence prepared to take their own development in their hands. Their main challenge is lack of education. Respondents were of the view that since most community members were illiterates and the fact that contributing in support of community development programmes such as provision of water facilities was new to most of them, the entire community training or sensitisation on local fund raising and its management will help them understand issues better. Such sensitisation programmes laid emphasis on the need for local fund raising and how often that should be done. Other fund raising methods such as contribution in-kind, for example, farm produce which could be sold and the money paid into community account could be explored. Making of community farms and voluntary contributions from individuals are sources that could be looked at. Respondents identified certain factors that they considered could be the cause of low level of fund raising at the communities. These are shown in Table 4.12.

Table 4.12: Causes of Low Level of Fund Raising

Cause	Frequency	Percentage
Lack of accountability on the part of WATSAN	20	33.3%
Poverty	35	58.3%
Apathy on the part of community members	5	8.4%
TOTAL	60	100

In almost all the households visited, the respondents highlighted at least two reasons why they think people fail to honour O&M contributions in the community. Each respondent, however, stressed a particular reason. These are categorised and analysed in Table 4.12. Most households were of the view that poverty is the major cause. About 35 respondents representing 58.3% were in favour of this. To them, poverty has made people to shirk their

responsibilities. The least was those who attributed the problem to apathy on the part of community members. These were 5 respondents representing 8.4% of the households interviewed. That, in my view, still goes to support the highest score, which is poverty. It is likely that those who showed this indifferent attitude towards raising funds were among the poorest that could not pay their contributions.

The research revealed that lack of accountability (33.3%) is also a contributing factor. It has been established that some of the WATSAN Committee members are not transparent and trustworthy. They collect money from the people but never report back how it was used. Attempts by community members to seek accountability often lead to petty squabbles.

4.8 Potential of the water supply systems for small scale irrigation for vegetables

The potential of these water supply systems for small scale irrigation for vegetables would depend on a number of factors that include:

- The adequacy of the systems
- The people's willingness to use the facilities for this purpose and
- The availability of market for the produce.

The adequacy of the systems further depends on the yield, type of crop to be grown, soil characteristics, climatic and water management factors.

With regard to the people's willingness to use the facilities for the purpose of small scale minor vegetable irrigation, 65% of respondents from the six beneficiary communities indicated their readiness provided it becomes a unanimous decision by the entire community, as against 35% who expressed concern about the inadequacy of the systems due to poor yield.

An interview with some farmers at Tilangbelni, a suburb of Saboba who engage in small scale dry season vegetable irrigation using a natural water system close to River Oti, revealed that there was a good market for all kinds of vegetables especially okro, *ayoyo*, tomato and other leafy vegetables. For instance, it was revealed that each farmer got on the average an amount of GH¢ 40.00 per week on less than an acre of any of the above mentioned vegetable crops.

Table 4.13 presents all the provided facilities in the study communities and their functionality.

Table 4.13: The facilities in the study Communities

Community	Facilities	State of the facilities	
		Functional	Non-functional
Demong	4 BHs and a dug out	2 BHs	2 BHs and the dug out
Wapuli	4 BHs, 2 HDWs and a dug out	1BH	3 BHs, 2 HDWs and the dug out
Ugando	3 BHs and a dug out	1BH	2 BHs and the dug out
Toma	3 BHs, 1HDW and an earth dam	2 BHs, HDW and the dam	1BH
Borgbaln	1 BHs	Nil	1 BH
N-nalog	2 HDWs	Nil	2 HDWs

4.8.1 Water Supply Availability in the Communities

1. **Toma**
   Two functioning BHs, one HDW and an earth Dam
   a) First BH available yield = $3\times10^{-2}m^3$/min =1.8 m^3/h
   b) Second BH available yield = $3.1\times10^{-2}m^3$/min =1.86 m^3/h
   c) HDW yield = $3\times10^{-2}m^3$/min =1.52 m^3/h
   d) Estimated volume of water in the dam = 9.99 m^3
2. **Demong**
   Two functioning BHs
   a) First BH available yield = $3.02\times10^{-2}m^3$/min =1.81 m^3/h
   b) Second BH available yield = $3.21\times10^{-2}m^3$/min =1.93 m^3/h
3. **Wapuli**
   Only one functioning BH with available yield = $3.2\times10^{-2}m^3$/min =1.92 m^3/h
4. **Ugando**
   Only one functioning BH with available yield = $3.15\times10^{-2}m^3$/min =1.89 m^3/h

According to Dapaah-Siakwan and Gyau-Boakye (2000) for hand pump BHs meant to supply rural communities in Ghana, a successful yield is considered to be at least 13 L/min (0.78 m^3/h) or more. This minimum yield per BH is designed to meet the demand of communities with population ranging between 200-2000 in accordance with the Government policy (Dapaah-Siakwan and Gyau-Boakye, 2000) of providing per capita water consumption of 25L.

All things being equal and supposing an average pumping period of eight hours per day (8h/day) as inferred from household responses, Table 4.14 presents an estimated available ground water supply from the current functioning facilities in the various communities.

Table 4.14: Water demand and available water in the study Communities

Community	Population	Average per capita water demand (litres)	Total domestic water demand per day (m^3)	Total available ground water per day (m^3)	Surplus water available for any activity per day (m^3)	Total Surplus water available over dry period of six months (m^3)
Toma	747	26	19.422	41.44	22.018	3963.24
Demong	908	28	25.424	29.92	4.496	809.28
Ugando	473	25	11.825	15.12	3.295	593.1
Wapuli	1611	30	48.330	15.36	Nil	Nil

From Table 4.14, it implies that the estimated total surplus available water from the current functioning water supply facilities for any activity over the six months dry period in the various communities are:

I. For Toma
   3963.24 + 17.66 = 3980.90 m^3

II. For Demong
   809.28 m^3

III. For Ugando
   593.1 m^3

It might double or triple in Demong and Ugando if the broken down water facilities are repaired. In Wapuli, however, the supply may still not be adequate for domestic purposes upon repairs of the broken down facilities.

4.8.2 Soil Infiltration Rate

Soil basic infiltration rate at three points each in four of the studied communities with operational facilities are shown in Table 4.15.

Table 4.15: Soil infiltration rates in the study area

Community	Basic Infiltration Rate (mm/h)			Average Basic Infiltration Rate
	First point	Second point	Third point	
Toma	7	6	8	7.00 ± 1.00
Demong	7	8	8	7.70 ± 0.58
Ugando	8	10	9	9.00 ± 1.00
Wapuli	10	9	8	9.00 ± 1.00

4.8.3 Irrigation Water Requirements

The estimated total crop water requirement (CWR or ETc) and irrigation water requirement (IWR) of tomato crop grown in the field for 180 days in the study area during the period of

Oct-Mar/April were 1012.61 mm and 847.35 mm respectively. Gross irrigation water requirement (GIWR) was therefore 1210.50 mm taking into consideration the irrigation efficiency of 70% for watering cans likely to be used. According to Agodzo (1998), CWR and IWR of tomato in Tamale are 668 and 604 respectively during the period of Oct-Jan/Feb whilst those of okro are 487 and 450 respectively during the period of Nov-Feb/Mar. Keraita and Drechsel (2007) also observed that for vegetables grown in the field for 90-120 days, the crop water requirements range between 300 and 700 mm depending on the climatic conditions and the season of the crop at the location. The difference between the estimated values in this research and those of literature (Agodzo, 1998) is mainly due to irrigation frequency, number of days, and the irrigation efficiency as well as the number of years of climatic data used in the estimation. A daily irrigation frequency was used in this research. In the savannah areas where ETc is very high, daily application is the appropriate frequency for vegetables if they are to look fresh and give good yield. However, daily frequency means higher CWR and IWR hence the above values. In view of water scarcity in the area, it would be prudent if the farmers use drip irrigation method with higher efficiency of about 75%-80% in order to reduce water wastage and hence low IWR. This will be best done by pumping water to overhead tanks especially where yields are very low. It will also reduce the labour intensiveness and drudgery of the sprinkler method of using watering cans.

4.8.4 Irrigation potential of the available water

Considering the GIWR of tomato being 1210.50 mm (≈ 1.21 m), it implies that to irrigate an acre of tomato, the total amount of water required can be calculated as:

Total GIWR = GIWR × Total area to be irrigated

Total tomato GIWR = 1.21 m × 10000 m^2 = 12100 m^3/ha (121 m^3/acre)

This presupposes that the current functioning facilities at Toma are capable of meeting domestic water demand and to irrigate about 0.33 ha (33 acres) of tomato, those at Demong can irrigate about 0.07 ha (7 acres) of the same crop whiles at Ugando irrigating about 0.05 ha (5 acres) is also possible. The potential would be higher if crops with lower CWR like okro, ayoyo, or other leafy vegetables are grown as well as upon repairs of the broken-down water facilities in the various communities.

According to Dapaah-Siakwan and Gyau-Boakye (2000), the average BH yields of the Voltaian System of which the study area is part range from 6.2-8.5 m^3/h. Particularly significant is also a fact observed by Dapaah-Siakwan and Gyau-Boakye (2000) that although

the BH yields in the Voltaian System are relatively low compared with the Basement Complex and the Coastal Provinces which have yields ranging from 2.7-12.7 and 3.9-15.6 m^3/h respectively, the Voltaian System is less densely populated compared with those two other hydrogeologic units of Ghana. This simply implies that ground water extraction in the Voltaian System is/would be less.

CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS

5. 1 Introduction

This chapter draws from the analysis and discussions made in relation to the results in arriving at conclusions and recommendations for the study.

5.2 Summary of Findings

The study found out that most inhabitants in the beneficiary communities tended to patronise unprotected water sources than the BHs especially in the rainy season for certain reasons including:

- Inconvenient siting or location of the facilities (siting facilities far away and in waterlogged areas)
- Water from open sources was believed to have sweet taste and thirst-satisfying unlike that of BHs which they contended was salty and made one's stomach hurt yet not thirst-satisfying
- It is tiresome and exhausting fetching water from BHs
- It is time wasting getting water from hand pump systems due to poor yields because of pressure from the populace. Much time of averagely an hour is spent in a queue at the source point
- To avoid quarrels and breaking of good relations over water that wells with hand pump sources are always characterised with.

The study also found out that lack of sanitation facilities, poor hygiene and poor sanitation practices have been the cause of the high prevalence of water related diseases in the District.

It was found that potable water supply has attracted teachers to the beneficiary communities but inadequacy has resulted in children's lateness and truancy to school especially the girl child.

Economically, it was found out that the provision of water facility has encouraged many women to engage in different economic activities which involved intensive use of water unlike their colleagues in communities without water facilities.

The study also found that the establishment of water facilities has inculcated in community members especially the WATSAN members community mobilisation skills as well as put most of them in jobs such as bicycle and motor repairs through WATSAN training. It has also been established that the involvement of women in these activities has encouraged them to improve their participation in decision making and leadership skills at the community and zonal level.

The research identified that the sustainability of the rural water systems in the District was a serious problem. Dugouts were found to have been poorly engineered; there were two types of failures identified on all of them: overtopping failures and structural failures. Sparse settlement pattern was also identified to have hindered effective supply of water to the communities. It was also found out that providers did not consult communities in siting and location of the water facilities and this has affected the sustainability of the systems.

It was also identified that lack of community sense of ownership had affected their support for management and the sustainability of the water systems.

The study also found out that the water facilities in some of the communities were capable of meeting the peoples' domestic needs and for small scale vegetable irrigation.

5.3 Conclusions

This study focused mainly on the general socioeconomic impacts, potential for small scale irrigation and operational sustainability of rural water supply systems in farming communities considering Saboba/Chereponi District as a case. In relation to socioeconomic impacts, the research revealed that rural water supply systems had both economic and social impacts in farming communities. With regards to economic impacts the water systems contributed to the establishment of vegetable gardening and small businesses such as *Pito* brewing, food selling and shear nut processing. The contribution of rural water systems to the activities mentioned above was in terms of increasing the geographical access of the beneficiary communities to water. In terms of social impact, the water systems contributed to reducing the drudgery associated with fetching water, attracting teachers and other workers to beneficiary communities. Health wise, results of this research have shown that the provided rural water supply systems in the District have had insignificant health impact on rural communities as a result of poor sanitation and hygiene practices in the District.

The determination of the yields of the water systems revealed a potential for small scale irrigation. However, limited attempts were made in that regard due to lack of awareness of the potential.

Although the new partnership strategy or structure adopted by NCWSP as a measure to improve the sustainability of the water supply facilities was in place, the reality on ground had proved its ineffectiveness and poor management of the facilities. This was as a result of inactiveness of the WATSANs, lack of monitoring role from the service providers, DA/DWST and other stakeholders- lack of support to communities in terms of major repairs as well as apathy on the part of community members. This was further compounded by external constraints such as inconvenient locations of water-points, geological limitations, poor design of water systems, poor construction, lack of spare parts, and lack of support.

These indicate that there is the need to identify strategies to address the challenges so as to improve the impacts of rural water systems in the District.

5.4 Suggestions for improvements

In respect of the findings of this research, the following recommendations are worth considering.

To really ensure that potable water supply leads to good health, it is essential that it is accompanied by provision of sanitation facilities and hygiene education. Water and sanitation facilities should necessarily be planned together; coupled with hygiene education in order to yield good results. All service providers of community water facilities should operate an effective integrated water, sanitation and hygiene promotion approach. There is an urgent need for a more active education campaign on personal hygiene and sanitation to be conducted in all parts of the district in order to curb the current high prevalence of water related diseases. This requires collaborative efforts by the District Assembly (DA), health services, and other donor agencies.

To achieve positive health impact of rural water systems, providers should rather make the water the people already prefer safe for use through filtration systems even as we know boreholes are better. Hence, reconstruction with filtration systems attached to dugouts which the rural inhabitants prefer due to its water taste and if possible ran closer to the village will be extremely helpful especially health wise to the community. Water supply systems should be planned and designed with clear understanding of the needs of the user.

Also important to be considered is the need for more participatory tender boards at the District level to allow communities play a part in the selection of more qualified and competent contractors to avoid irregularities in the construction of dugouts such as poor compaction of embankments and absence of spillways.

The District Assemblies in collaboration with the service providers as well as CWSA should facilitate the sale and provision of spare parts depots in the districts. This will make the parts more affordable and available and increase the likelihood of long term sustainability of the water facilities.

Enhancement of institutional capacity at both the district and community levels is urgently required for the sustainability of rural water supply systems in the district. Hence, there is an urgent need for DA in collaboration with CWSA to reactivate the DWST and provide adequate logistics to enable it undertake its monitoring and supervisory role frequently at the communities. They shall in turn monitor the works of the POs and other contractors as well as strengthen the WATSANs. In the same vein, DA should initiate the Monitoring of Operation and Maintenance (MOM) programme as in DANIDA operating areas that involves quarterly visits to the communities by the District Environmental Health Assistants (EHAs) to carry out both sanitation and technical assessment to ascertain how well the facilities are functioning, review their fund raising methodologies and financial records as well as check on payment practices for accountability. Records of these quarterly visits should be compiled at the District level to give a systematic picture of what is happening in the District in respect of these water facilities for appropriate actions to be taken.

The District Assembly should also, in collaboration with the CWSA and the service providers, organise frequent refresher courses for the WATSAN committees as well as women's group and other local institutions in the communities. Relevant topics which could be considered include basic management skills, book keeping and home management including the need for personal and environmental hygiene. Methodologies for local fund raising and accountability of funds are also important.

The community should be allowed to take an active part in all aspects of the project planning, designing and implementation, most especially in deciding on the type of water facility and in choosing the site. It is well established that community participation in the entire project cycle is a determining factor for having a greater chance of ensuring a sustainable water

supply facility, especially in the rural communities. As observed by Thematic Group (2005), the community should be considered as an important institutional entity for water service delivery and not as some artefact as was in old days of participation for any sustainable rural water provision.

There is the need for communities to know that in deciding on the location of a water facility, it goes beyond socio-cultural factors and mainly depend on the geological factor. This will help them learn to accept and patronise the facilities wherever they are sited. It therefore calls for a sensitisation campaign by the collaborative effort of the DA and CWSA in all communities in the District. Nonetheless, all service providers should be encouraged by CWSA to incorporate both social and technical criteria in siting of water facilities in the communities. In other words, communities should always be consulted and made to understand why the water facility may not be sited at their place of choice.

More women should be encouraged to be part of WATSAN committees in all communities since they are 'water experts' and water issues concern them more. Communities should also be encouraged to present competent volunteers who can read and write on WATSAN committees in order to ensure good record keeping and transparency. The community needs to be strong enough to keep a check on the committee, to ensure that they are kept informed. A financial system should therefore be put in place such as the operation of a bank account, record-keeping as well as regular reports to the community.

Since communities play a very important role in the selection of WATSAN Committee members they should be encouraged to do that with a sense of patriotism devoid of personal interests and prejudices. Education, activeness, innovativeness, transparency as well as patriotism should be key ingredients to look for in selecting WATSAN Committee members. Members must also be permanent residents in that community.

Productive use of water systems in the communities for minor dry season vegetable irrigation is possible and could help these communities raise funds for the operation and maintenance of these systems with ease. This should be legally recognised and receive institutional support as well as possibly upgrading these water systems by pumping water to overhead polytanks.

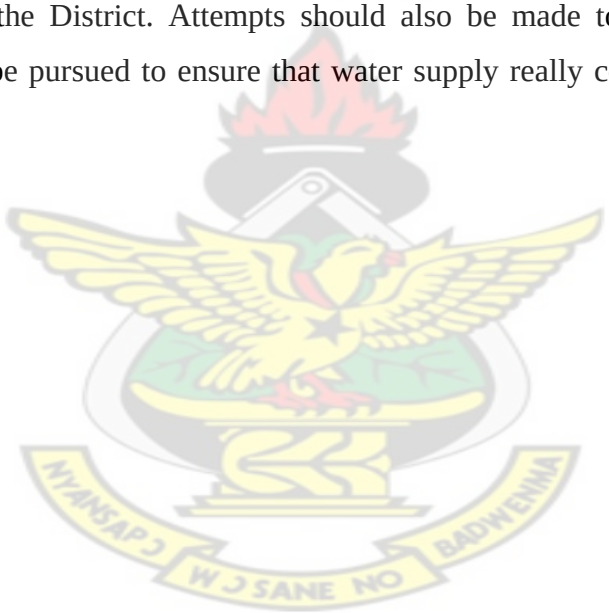
For effective sustainability of the water facilities in the District, there is the need for stakeholders to take into account the high demand for multiple uses of these water systems in the communities during planning, designing and implementation of these facilities. The DA,

in collaboration with CWSA and the service providers should ensure that this is adhered to. Pumps should be mounted on all the facilities and possibly extending to gardens as a means of income generation for O&M cost. The same should be done to dugouts.

Communities should be educated intensively on a better culture of maintenance with regard to the facility usage. The DA should, as a matter of urgency, vote for funds to assist communities with regard to major repairs of the water facilities whilst preventive maintenance should still be the sole responsibility of the communities.

5.5 Recommendations

The study could not elaborately consider the relationship between water supply and the health status of the people in the District due to lack of time, resources and equipment. It is therefore suggested that a detailed study should be conducted to establish the relation between water supply and health in the District. Attempts should also be made to find out the various measures that should be pursued to ensure that water supply really contributes to improved health status.



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APPENDICES

APPENDIX A: SCHEDULED QUESTIONNAIRE FOR HOUSEHOLD RESPONDENTS

(A) BACKGROUND INFORMATION

1a. Age i) 1-10 [ ] ii) 11-20 [ ] iii) 21-30 [ ] iv) 31-40 [ ] v) 41-50 [ ] vi) 51 and above [ ]

2a. Sex: i) Male [ ] ii) Female [ ]

3a. Educational Status: i) None [ ] ii) Primary [ ]
iii) Middle/Secondary/technical [ ] iv) Tertiary [ ]
v) Others (specify) …….....

4a. Occupation/profession …….....

5a. Ethnicity/Tribe …….....

6a. Religion i) Christian [ ] ii) Moslem [ ] iii) Traditional [ ]
v) Others (specify) …….....

7a. Place of residence (name of the community or village, etc) …….....

8a. Number of years lived in the community…….....

(B) NATURE OF WATER SUPPLY AND USAGE

Note the following abbreviations used: BH = Borehole, HDW = Hand-dug well

1b. What is the size of your Household? .....

2b. What is/are your source(s) of water supply in the rainy season? (check all that apply)

i) BH [ ] ii) HDW [ ] iii) Dam/Dug-out [ ] iv) Rain Harvest [ ] v) River [ ] vi) Stream [ ] vii) Small water system [ ] viii) Others (specify) ……..

3b. Why do you use the source(s) chosen in the rainy season?

i) It is easily accessible (not far from my house) [ ] iv)I do not waste time at this source [ ]
ii) I do not spend money on water from this source [ ] v) It is free from germs or safe [ ]
iii) The water tastes and smells good [ ] vi) Spiritual reasons [ ]
vii) Others (specify) …….

4b. What is/are your source(s) of water supply in the dry season? (check all that apply)

i) BH [ ] ii) HDW [ ] iii) Dam/Dug-out [ ] iv) Rain Harvest [ ] v) River [ ] vi) Stream [ ] vii) Small water system [ ] viii) Others (specify) ……

5b.Why do you use the source(s) chosen in the dry season?

i) It is easily accessible (not far from my house) [ ] iv)I do not waste time at this source [ ]
ii) I do not spend money on water from this source [ ] v) It is free from germs or safe [ ]
iii) The water tastes and smells good [ ] vi) Spiritual reasons [ ]

viii) Others (specify) …….....

6b.Would you say the source of water you mainly depend on serves your water needs throughout the year? i) Yes [ ] ii) No [ ]

7b. If no, why does it not serve you throughout the year?.....

.....

8b. Do you face seasonal water shortages? i) Yes [ ] ii) No [ ]

9b. If yes, during what season do you face the shortage?

i) Dry Season [ ] ii) Rainy Season [ ]

Other, (specify) …….....

10b. How do you cope or manage with the water situation during periods of water shortage? .....

11b. How many *'Garawa'* of water do you fetch in a day for the whole household during the dry season? i) 1 – 6 [ ] ii) 6 – 12 [ ] iii) 12 – 18 [ ] iv) 18 and above [ ]

12b. How many *'Garawa'* of water do you fetch in a day for the whole household during the rainy season? i) 1 – 6 [ ] ii) 6 – 12 [ ] iii) 12 – 18 [ ] iv) 18 and above [ ]

13b. If there is a difference between the answers to questions 11b&12b above, what are the causes?

(i) in the dry season

……

……

(ii) in the rainy season

……

……

14b. Supposing there were no current constraints how many *'Garawa'* of water do you think that the household should be using in a day regardless of which season we are in? …….....

14b(i) Why is the household not able to meet all the water requirements on the daily basis in the dry season? .....

……

14b(ii) Why is the household not able to meet all the water requirements on the daily basis in the rainy season? …….....

…….

15b. Do you give animals water? i) Yes [ ] ii) No [ ]

16b. If yes, how many *'Garawa'* of water per day in

i) dry season a) 1 – 6 [ ] b) 6 – 12 [ ] c) 12 – 18 [ ] d) 18 and above [ ]

ii) rainy season a) 1 – 6 [ ] b) 6 – 12 [ ] c) 12 – 18 [ ] d) 18 and above [ ]

17b.Do you pay for using water? i) Yes [ ] ii) No [ ]

18b. If yes, how often?

i) Every time [ ] ii) Sometimes [ ] iii) rarely [ ] iv) I don't [ ]

19b.How much money does the household spend in a day on water for the whole Household's consumption? GH¢ …….....

20b. Which members of the household are directly responsible for fetching of water? (Tick one)

i) Male and female children [ ] ii) Female children only [ ]

iii) Mothers and Adult females [ ] iv) All category of people except adult males

v) Others (specify) …….....

21b.What time of the day do you fetch water? (check all that apply)

i) Morning [ ] ii) Afternoon [ ] iii) Evening [ ]

22b. How many people fetch water in a day?

i) 1 [ ] ii) 2 [ ] iii) 3 [ ] iv) 4 [ ] v) 5 [ ] vi) 6 [ ]

vii) Others (specify) …….....

23b. How many go to school?

i) 1 [ ] ii) 2 [ ] iii) 3 [ ] iv) 4 [ ] v) 5 [ ] vi) 6 [ ]

vii) Others (specify) …….....

24b.Do they often go to school late? i) Yes [ ] ii) No [ ]

25b. Do you consider time wasted at water collecting points as a serious problem?

i) Yes [ ] ii) No [ ]

26b. If yes, in what way? ……..

27b.Do you spend so much time in queues at your main water collection point during the dry season?

i) Yes [ ] ii) No [ ]

28b.Do you spend so much time in queues at your main water collection point during the rainy season? i) Yes [ ] ii) No [ ]

29b. How long (minutes, hours, etc) does it take you in a day to fetch all the water you need for the house during the dry season? …….....

30b.How long (minutes, hours etc) does it take you in a day to fetch all the water you need for the house during the rainy season? .....

31b. How many round trips do you make in a day before you can access all the water you fetch for use in a day during the dry season? …….

32b.How many round trips do you make in a day before you can access all the water you fetch for use in a day during the rainy season? ……..

33b.How far do you travel to obtain water?

i) I don't travel since I have in-house water supply facilities [ ]

ii) Less than 100 metres [ ] iii) 100 – 200 metres [ ]

iv) 200m – 1 Km [ ] v) Beyond 1 Km [ ]

34b. Do you consider distance travelled to obtain water burdensome? i) Yes [ ] ii) No [ ]

35b. If yes, in what way? (explain).. …….....

36b. Would you say that water supply situation has improved? i) Yes [ ] ii) No [ ]

37b. Give reasons for your answer (in Q. 36b above)

……

38b. Give suggestions as to how best the water supply could be improved

.....…….....….....

……

(C) THE SANITATION AND HYGIENE SITUATION

1c. Do you have a toilet (excreta disposal) facility in your house? (Tick)

i) Yes [ ] ii) No [ ]

2c. If yes, which one of the following applies to you? (Tick)

i) Open pit latrine [ ] ii) flush latrine [ ] iii) KVIP [ ]

iv) Other, specify. …….....

3c. If no, how do you dispose of your excreta (faeces)? (Tick one)

i) Communal latrine – open pit [ ] ii) Communal latrine – KVIP [ ]

iii) Free- range [ ] vi) Other, specify. ……...

4c. Do you see free – range as the best means of disposing of human excreta?

i) Yes [ ] ii) No [ ]

5c. Comment on your answer in Question 8c. …….....

…….....

6c. Do you have hand washing facility in your house? (Tick) i) Yes [ ] ii) No [ ]

7c. What do you think are the critical moments for you to wash hands? .....

……

8c. What do you think is the proper way to wash hands? …….

9c. Have you heard of any hand washing activity? i) Yes [ ] ii) No [ ]

10c. Have you participated in any community hygiene promotion activity? i) Yes [ ] ii) No [ ]

11c. How often do you clean your water storage containers?

Daily [ ] Weekly [ ] Monthly [ ] Yearly [ ] Others, (specify)…….....

D) WATER SUPPLY AND HEALTH INTER-RELATIONSHIP

1d. Which of these diseases do members of the household complain about? (Check all that apply)

i) Guinea worm [ ] ii) Diarrhoea [ ] iii) Cholera [ ]

iv) Bilharzias [ ] v) Skin diseases [ ] vi) Intestinal worm [ ]

vii) Typhoid [ ] viii) Malaria [ ] iv) Other, (specify)……...

2d. How often do the household suffer from the disease(s)?

Daily [ ] Weekly [ ] Monthly [ ] Yearly [ ] Others, (specify)……...

3d. What do you think is the cause?

……

4d. Give reasons for your answer……..

5d. How can such disease (s) be prevented?.....

.....

6d. How long does it often take for the patient to recover from the disease(s)? (indicate all that apply)

i) Guinea worm……. ii) Diarrhoea…….. iii) Cholera…….

iv) Bilharzias…… v) Skin diseases……. vi) Intestinal worm…….

vii) Typhoid…….. viii) Malaria……... iv) Other, (specify)……....

7d. What was the last cost of treatment or medication for the disease(s)? (indicate all that apply)

i) Guinea worm……. ii) Diarrhoea…….. iii) Cholera…….....

iv) Bilharzias…….. v) Skin diseases……. vi) Intestinal worm…….....

vii) Typhoid……... viii) Malaria……... iv) Other, (specify)…….....

8d. Has any member of your household died from any of the diseases mentioned in (1d) above? i) Yes [ ] ii) No [ ]

9d. If yes, who died? (check all that apply)

A child [ ] An adult [ ] Others, (specify)……

10d. How many lives in your family have you lost through the disease(s) in (1d)? .....

11d. What type of disease commonly attacks children in your house (check all that apply)?

i) Guinea worm [ ] ii) Diarrhoea [ ] iii) Cholera [ ]

iv) Bilharzias [ ] v) Skin diseases [ ] vi) Intestinal worm [ ]

vii) Typhoid [ ] viii) Malaria [ ] iv) Other, (specify)…….....

12d.How many children were attacked by this disease in the past one month? .....

13d.What is their average age? (Tick one)

i) Under 1 year [ ] ii) 1 – 5 years [ ] iii) 6 – 10 years [ ]

iv) 11-15 years [ ] v) Other (specify) …….....

14d.What in your view was the cause of the disease?

……....

15d. Give reasons for your answer

……....

16d. What type of disease commonly attacks adults in your house (check all that apply)?

i) Guinea worm [ ] ii) Diarrhoea [ ] iii) Cholera [ ]

iv) Bilharzias [ ] v) Skin diseases [ ] vi) Intestinal worm [ ]

vii) Typhoid [ ] viii) Malaria [ ] iv) Other, (specify)……....

17d. How many adults were attacked by this disease in the past one month?

…….....

18d. What is their average age? (Tick one)

i) 18-23 years [ ] ii) 24 – 29 years [ ] iii) 30 – 35 years [ ]

iv) 36-41 years [ ] v) Other, (specify)…….....

19d.What in your view was the cause of the disease?

…….....

20d. Give reasons for your answer

……....

21d. Had there been any incidence of child or infant death in this house? (Check one)

i) Yes [ ] ii) No [ ]

22d. If yes, how many casualties (state the number of deaths) …….....

23d.What was the cause? …….....

24d. Give reasons for your answer

……....

25d. Is guinea worm disease prevalent in this community of late? i) Yes [ ] ii) No [ ]

26d. If yes, what do you think is/are the cause(s)? (check all that apply)

i) From the water we drink [ ] ii) Spiritual [ ] iii) No idea [ ] iv) Other, (specify)….....

27d. Is there any case of Guinea Worm infection in your house? i) Yes [ ] ii) No [ ]

28d. If yes, how many people are currently infested? .....

29d. If no to Q25d, was it prevalent in the past? i) Yes [ ] ii) No [ ]

30d. If yes, since when did it stop? ……..

31d. What in your view, has stopped its prevalence? (check all that apply)

i) our source of drinking water [ ] ii) Spiritual [ ] iii) No idea [ ]

iv) other (specify)…….....

32d. Which group(s) below was/were mostly infested with this disease?(check all that apply)

i) Children and infants [ ] ii) the youth [ ] iii) the aged [ ] iv) all age groups [ ]

32d. Does this disease affect your social and economic activities? i) Yes [ ] ii) No [ ]

33d. If yes, in which way? ……...

E) WATER SUPPLY, ENGINEERING AND SOCIO-CULTURAL ISSUES

1e. Did the water supply providers consult the community with regard to the type of water facility to provide? i) Yes [ ] ii) No [ ]

2e. If no, would you have opted for a different type of water facility if you had influence?

i) Yes [ ] ii) No [ ]

3e. Give reason(s) for your answer in (2e)?

.....

4e. Did the providers consult the community as to the location of the water facility before siting? i) Yes [ ] ii) No [ ]

5e. Does the location of the water facility have influence on its usage? i) Yes [ ] ii) No [ ]

6e. If yes (to 5e), what type of influence? i) Positive [ ] ii)Negative [ ]

7e. Give reason(s) for your answer in (6e)? .....

.....

8e. Do you personally have any problem with the siting or location of the water facility?

i) Yes [ ] ii) No [ ]

9e. If yes, what is your problem with the siting?.....

.....

10e. Will you consider the water facility provided in the community as the best source of water? i) Yes [ ] ii) No [ ]

11e. Give reason(s) for your answer in (10e)?.....

.....

12e. How will you grade the engineering work on the water facility provided you?

i) Good [ ] ii) Very good [ ] iii) Poor [ ] iv) Very poor [ ]

13e. Give reason(s) for your answer in (12e)?.....

.....

F) WATER SUPPLY AND SOCIAL ISSUES

1f. Has there been high emigration rate in your community? i) Yes [ ] ii) No [ ]

2f. If yes, would you say that water supply situation is a contributing factor?

i) Yes [ ] ii) No [ ]

3f. Give reasons for your answer…….....

4f. If no to (1f), would you say that good water supply is motivating people to stay in the community? i) Yes [ ] ii) No [ ]

5f. Do you experience issues of conflict or frequent quarrels among community members over water? i) Yes [ ] ii) No [ ]

6f. If yes, what are the main issues of frequent quarrels over water? .....
.....

7f. Is water supply a problem in your community during social functions like funerals, marriage ceremonies, etc? i) Yes [ ] ii) No [ ]

8f. Give reasons for your answer in (7f)…….....

G) WATER SUPPLY AND SOCIO-ECONOMIC ACTIVITIES

1g. Do you use water for any economic activity? i) Yes [ ] ii) No [ ]

2g. If yes, what kind of economic activity do you operate? (Check all that apply)

i) Pito brewing [ ] ii) Agro-processing like shear nut processing [ ]

iii) Rice milling, etc [ ] iv) Others, (specify)…….....

3g. How many *'Garawa'* of water do you use in a day for these activities? …….....

4g. How would you describe your water supply for the activities in (2g)?

i) Very sufficient [ ] ii) Quite sufficient [ ] iii) Insufficient [ ]

5g. If no (to Q. 1g), what is/are your reason(s) for not engaging in such activities?

i) No adequate water [ ] ii) Lack of time due to other activities [ ] iii) Do not consider it profitable [ ] iv) Others, (specify)…….....

6g. Do you practice any dry season agricultural activities using water in your community?

i) Yes [ ] ii) No [ ]

7g. If yes, what agricultural activity do you practice in the dry season?

i) Aquaculture [ ] ii) Crop irrigation [ ] iii) Others, (specify)…….....

8g. If crop irrigation, what type of crop do you farm? (Check all that apply)

i) Tomatoes [ ] ii) Pepper [ ] iii) Okro [ ] iv) Garden eggs [ ] v) Others, (specify).....

9g. If yes, how many *'Garawa'* of water do you use in a day for this activity? …….....

10g. What is your source of water for this activity? (Check all that apply)

i) Borehole [ ] ii) Hand-dug well [ ] iii) Dug-out [ ]

iv) River [ ] v) Others, (specify) …….....

11g. If no (to Q.1g), and supposing you had enough water and more to spare, will you like to engage in dry season agricultural activities? i) Yes [ ] ii) No [ ]

12g. If yes (to Q.11g), what agricultural activity will you like to practice in the dry season?

i) Aquaculture [ ] ii) Crop irrigation [ ] iii) Others, (specify)…….....

13g. If crop irrigation, what type of crop will you like to farm? (Check all that apply)

i) Tomatoes [ ] ii) Pepper [ ] iii) Okro [ ] iv) Garden eggs [ ] v) Others, (specify)…….....

14g. Do you experience shortage of farm labourers due to migrant labourers not willing to stay in the community with reasons due to water supply? i) Yes [ ] ii) No [ ]

15g. Do you think water supply has any effect on your farm attendance and on productivity?

i) Yes [ ] ii) No [ ]

16g. Give reasons for your answer in (15g)…….....

17g. Has your attendance to farm activities improved due to water supply?

i) Yes [ ] i) No [ ]

18g. Do you think water supply in your community has helped improved your farm size?

i) Yes [ ] ii) No [ ]

H) WATER FACILITY MANAGEMENT AND SUSTAINABILITY (BH & HDW COMMUNITIES)

1h. How many boreholes do you have in the community?

i) 1 [ ] ii) 2 [ ] iii) 3 [ ] iv) 4 [ ] v) 5 and above [ ] vi) None [ ]

2h. How many hand-dug wells do you have in the community?

i) 1 [ ] ii) 2 [ ] iii) 3 [ ] iv) 4 [ ] v) 5 and above [ ] vi) None [ ]

3h. Have these facilities been helpful to your community? i) Yes [ ] ii) No [ ]

4h. Give reason(s) to your answer in (Q.3h) above.....

……...

5h.Who owns the water facilities? (check all that apply)

i) Government [ ] ii) District assembly [ ] iii) The community [ ]

iv) NGOs [ ] v) A religious body vi) Other, (specify)……...

6h. Have the borehole(s) ever broken down? i) Yes [ ] ii) No [ ]

7h. If yes, how often does this water facility breakdown in this community?

i) Daily [ ] ii) Weekly [ ] iii) Monthly [ ] vi) Others, (specify)……

8h. How long does it take for a broken down borehole to be repaired.

i) Within a day to 3 days [ ] Reasons …….....

ii) It takes 4 days to 7 days [ ] Reasons …….....….....

iii) It takes more than one week [ ] Reasons …….....

iv) It takes months [ ] Reasons …….....

9h. Who repairs the water facility when it breaks down?

i) Hired personnel [ ] ii) Those who provided them [ ] iii) Members of the community [ ]

10h. Averagely how much does it cost to repair your broken down pumps? .....

11h. Who bears the cost of repairs?

i) The providers [ ] ii) The community [ ] iii) Others, (specify)……...

12h.What in your view has been the cause of the break down of the borehole(s)? .....

13h. Do people farm around the water facilities in your community? i) Yes [ ] ii) No [ ]

14h. In your view, do you think application of chemicals in farms and flow of dirt to the immediate surroundings of the water facility can affect it? i) Yes [ ] ii) No [ ]

15h. Give reason(s) to your answer in (14h) above.....

……

16h. Who are those that maintain hygiene at the water facility site?

…….....

17h. Have they been trained on hygiene promotion? i) Yes [ ] ii) No [ ]

18h. How often do they weed and clean the borehole site?

i) Daily [ ] ii) Weekly [ ] iii) Monthly [ ] vi) Others, (specify)…….....

19h. To what extent can you say that the water facility site is hygienically kept in this community? i) Good [ ] ii) Very good [ ] iii) Poor [ ] iv) Very poor [ ]

20h. What is/are your source(s) of funds for the maintenance and management of the water facilities in the community?

i) Contributions [ ] ii) Earnings from community farm [ ]

iii) Funds raised from sale of water [ ] iv) Others, (specify)…….....

21h. Do you normally get enough funds for the maintenance of the water facilities?

i) Yes [ ] ii) No [ ]

22h. If no, how do you make for the short fall? .....

23h. How does this affect your ability to maintain the water facilities?

.....

24h. Do you think the use of these facilities for economic activities such as dry season minor irrigation could help raise funds for this purpose? i) Yes [ ] ii) No [ ]

25h. Do you encounter problems in respect of the maintenance of the water facilities?

i) Yes [ ] ii) No [ ]

26h. If yes, enumerate these problems…….....

…….....

…….....

27h. What efforts are being made by the community to combat the problems you have identified?

.....

……

28h. Has the community been successful in its efforts in reference to question 27h?

i) Yes [ ] ii) No [ ]

29h. Is it within the community's capability to continue with these efforts? i) Yes [ ] ii) No [ ]

30h. If no (to Q. 28h), what do you think militate against your efforts to address these problems?

.....

31h. Do you have easy access to spare parts for maintenance of the boreholes?

i) Yes [ ] ii) No [ ] iii) Some how [ ]

32h. Do the community members actively participate in the maintenance of borehole(s)?

i) Yes [ ] ii) No [ ]

33h. If no, what effects has this apathy got on the maintenance of borehole(s)?

.....

34h. How often is routine maintenance carried out?

i) Daily [ ] ii) Weekly [ ] iii) Monthly [ ] iv) Yearly [ ] v) When it breaks [ ]

35h. Who does the routine maintenance? .....

36h. Has the maintenance team received any level of training? i) Yes [ ] ii) No [ ]

37h. If yes, what sort of training? i) Technical training [ ] ii). Management training [ ]

iii) Combination of both i and ii [ ]

38h. Who did the training? .....

39h. Is the maintenance team active? i) Yes [ ] ii) No [ ]

40h. If yes, is the team performing its duty? i) Yes [ ] ii) No [ ]

41h. If no, how is this impacting on the borehole?

.....

42h. Who manages the boreholes? …….....

43h.What are the duties and responsibilities of the management team?

…….....

……

……

44h. Are these being carried out to the latter? i) Yes [ ] ii) No [ ]

45h. If no, what are the effects of their inactiveness on the boreholes?

.....

46h. What roles do women play in the management of the water facility/water point in this community?.....

47h. What roles do men play in the management of the water facility/water point in this community?

.....

48h. What roles do children (boys and girls) play in the management of the water facility/water point in this community?.....

49h. From all what you have said, can you say that water facilities are well maintained in this community? i) Yes [ ] ii) No [ ]

50h. If no, what ways would you suggest to ensure proper management and maintenance of water facilities in the community?

……

……

……..

APPENDIX B: SCHEDULED INTERVIEWS WITH MANAGERS

B.1 WATSAN Committees

NAME OF COMMUNITY: …….....

FACILITY AND OWNERSHIP

1. How many boreholes do you have in the community? .....
2. When were (was) they/it installed? .....
3. How many hand-dug wells do you have in the community? .....…….....
4. When were they dug? .....
5. How helpful have these facilities been to the community…….....

   …….....
6. Who owns these water facilities? .....

REPAIRS AND MAINTENANCE

7. How often does the water facility breakdown in this community? …….....

   …….....
8. What in your view has been the cause of the break down of the water facility?

   …….....
9. How long does it take for a broken down hand pump to be repaired?

   …….....
10. Who repairs the water facility when it breaks down? .....
11. Averagely how much does it cost to repair your broken down facility? .....
12. Who pays for the cost of repairs and general maintenance of the facility?

    …….....
13. Do you think the use of these facilities for economic activities such as dry season minor irrigation could help raise funds for this purpose? Yes [ ] No [ ]
14. Who does the routine maintenance and how often is it carried out? .....

    …….....
15. What sort of training has the maintenance team received and how active are they?

    …….....
16. Do you have any problem(s) in respect of maintenance of the water facilities?

    Yes [ ] No [ ]
17. If yes, enumerate them …….....

    …….....
18. What efforts have you made to combat these problems? .....

…….....

19. Do the community members participate actively in the maintenance of water facilities? Yes [ ] No [ ]

20. If no, what are the effects of this apathy on the maintenance of the facility? .....

…….....

SANITATION

21. Who are responsible for ensuring good sanitation at the water facility site? .....

…….....

22. Have they been trained on sanitation promotion? Yes [ ] No [ ]

23. What do you think constitutes good sanitation or hygiene at the water facility site?

…….....

24. What measures have been taken by the sanitation team to ensure good sanitation at the water facility site? .....

…….....

25. How often do they weed and clean around the water facility site?

…….....

26. Do people wash at the site of the water facility? Yes [ ] No [ ]

27. Do people farm around the site of the water facility? Yes [ ] No [ ]

28. In your view, do you think the application of chemicals, washing and flow of dirt to the immediate surroundings of the water facility can affects it? Yes [ ] No [ ]

29. Give reason(s) to your answer in (Q.17) above …….....

…….....

30. Do you think that the water facility site is hygienically kept all the time in this community?

…….....

MANAGEMENT

31. What are the duties of the management team?

…….....

…….....

32. To what extent can you say the management team is up to their task and performing their duties?

.....

33. Were members of the WATSAN committee duly selected from diverse interest groups in the community (e.g. ethnic, religious, composed of men and women, from different sections of the community, etc)? Yes [ ] No [ ]

34. How often does the committee hold regular meetings and consult with the community as well as render good accounts about their income and expenditures? .....

35. Have the committee members been well trained on their duties and responsibilities as well as some basic records keeping skills? .....

36. How well is the committee able to keep basic record books like cash book, payment register, minute's book and visitors book (**note:** the interviewer to inspect the available records to confirm)?.....

37. How well does the committee relate and consult with the other units like the unit committees, the churches or mosques, the assemblyman, chief and elders?.....

38. Do members of the community respect the work of the committee and give them the necessary support? .....

39. From all what you have said, can you say that the water facilities are well-managed and maintained in this community? .....

40. What other ways would you suggest to ensure proper management and maintenance of water facilities in the community?.....

B.2 Service Providers

Name of the Provider/Organisation ……..

1. Who constitute the management committees of the water facilities at the zonal and community levels? .....

2. Who constitute the maintenance team? .....

3. What are the duties and responsibilities of both the management and maintenance teams?……..…

……..……

4. Are they entirely active and performing their duties fully by your assessments? .....

…….....

5. How often are they trained or taken through refresher courses? …….....

6. What is the expected role of the community members? …….....

…….....

7. How often do you monitor and assess the performance of the management team and the facilities?

…….....

8. How often is the routine maintenance on the water facility supposed to be carried out?

…….....

9. In which way do you assist in the repairs and maintenance of the facilities in the communities?

…….....

10. Financial constraint is noted to be the major problem facing the communities with respect to the repairs and maintenance of the facilities. How do you assess the possibility for conjunctive use of these sources for small scale dry season irrigation of vegetable crops by the community to generate income for this purpose? ……....

……....

11. Do you know the aquifer capacity can support this additional activity? ……

12. What measures are being put in place to ensure good sanitation at the water facility site? …….....

13. What constitutes good sanitation at the water facility site? ……

APPENDIX C: CROP WATER REQUIREMENT FOR TOMATO

C.1 Crop Calendar for tomato (*Lycopersicon esculentum*)

Crop development stage	No. of days	Date	Kc
Initial	35	15th Oct-18th Nov	1.05
Crop development	45	19th Nov-2nd Jan	1.054
Mid season	70	3rd Jan-13th Mar	1.15
Late season	30	14th Mar-12th April	0.9

C.2 Estimation of crop water requirement for tomato (*Lycopersicon esculentum)*

Month	ETo (mm/d)	Kc	ETc (mm/d)	No. of days	ETc /month	Effective rainfall (ρ_e) in mm/month
October	4.44	1.05	4.62	17	78.54	69.74
November	4.55	1.05	4.73	30	141.9	5.19
December	4.84	1.10	5.32	31	164.92	1.98
January	5.14	1.12	5.76	31	178.55	0.97
February	6.01	1.15	6.91	28	193.48	4.73
March	6.16	1.00	6.16	31	190.96	18.71
April	5.95	0.90	5.36	12	64.26	63.94
TOTAL				180	1012.61	165.26

Kc, ETo and ρ_e were derived using 30 years climatic data from meteorological station.
$\rho_e = 0.8\rho$ where the mean monthly rainfall, $\rho > 75$mm/month and
$\rho_e = 0.6\rho$ where the mean monthly rainfall, $\rho < 75$mm/month
IWR = ETo - ρ_e = 1012.61 – 165.26 = 847.35mm

APPENDIX D: INFILTRATION RATES

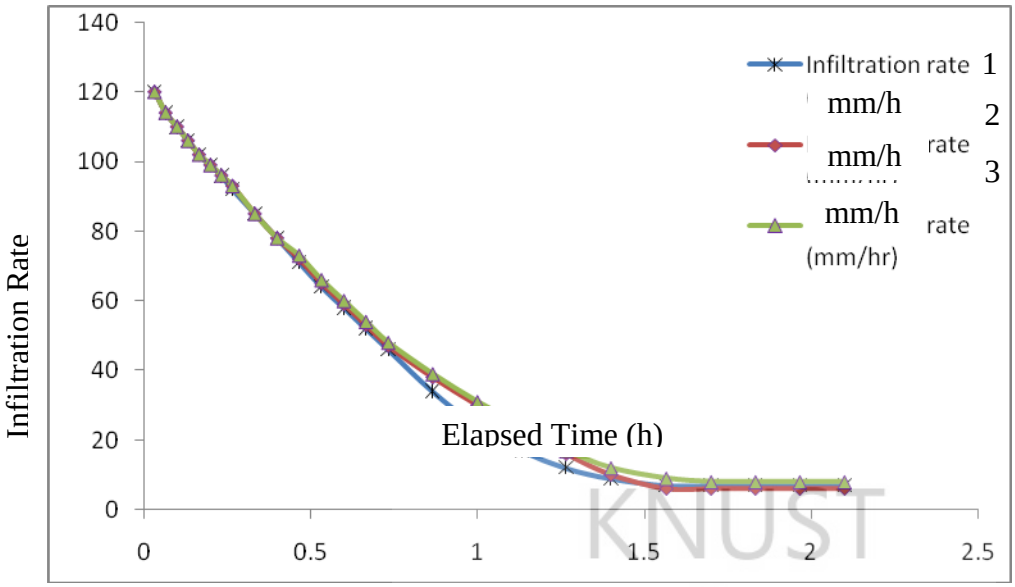

Fig. D1: Soil infiltration rates at three locations in Toma Community

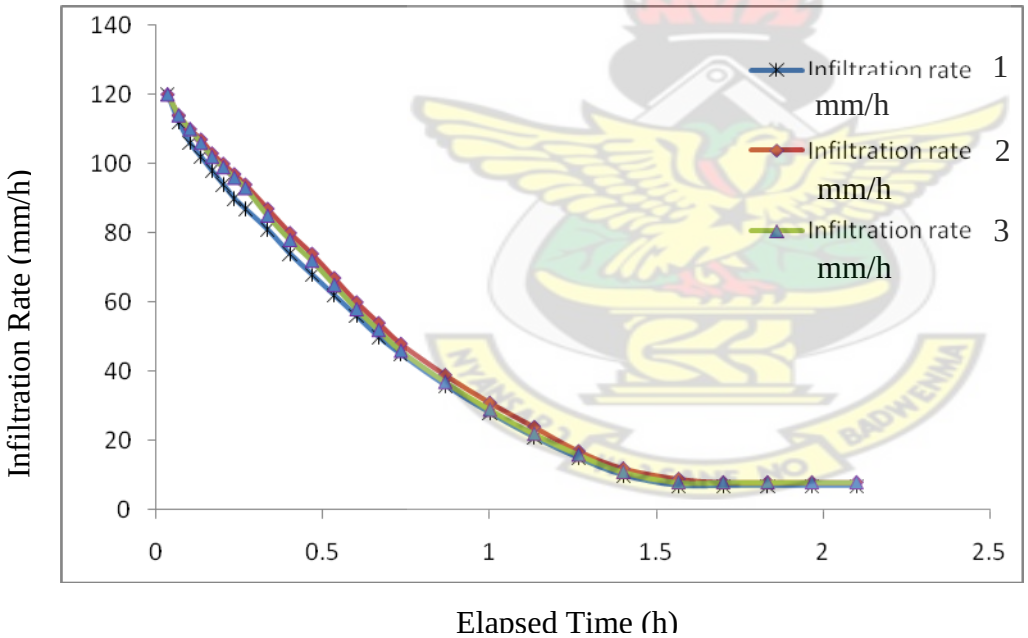

Fig. D2: Soil infiltration rates at three locations in Demong Community

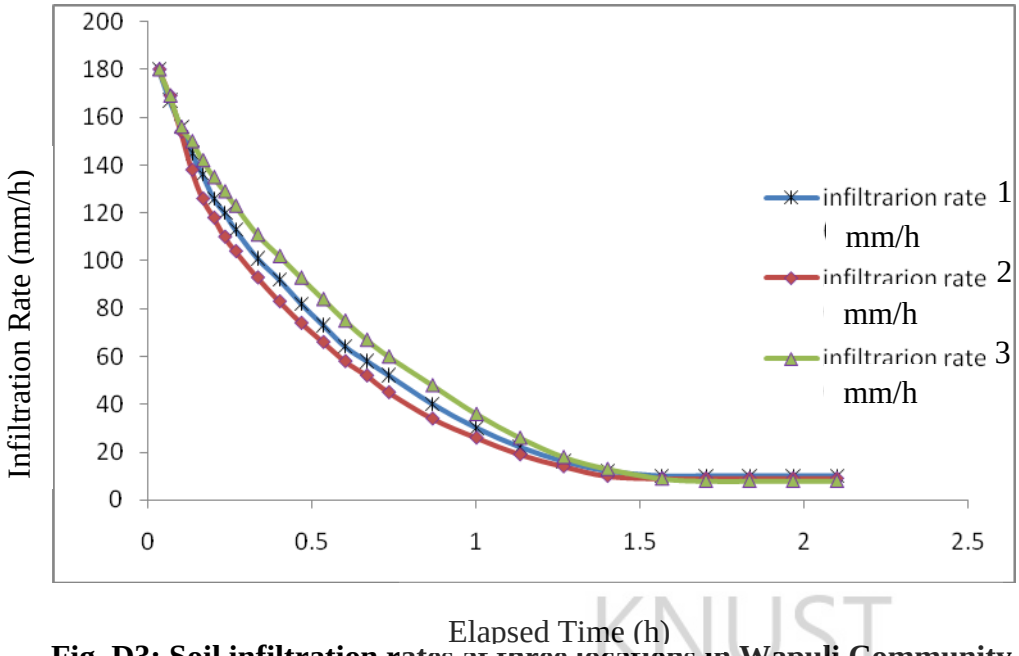

Fig. D3: Soil infiltration rates at three locations in Wapuli Community

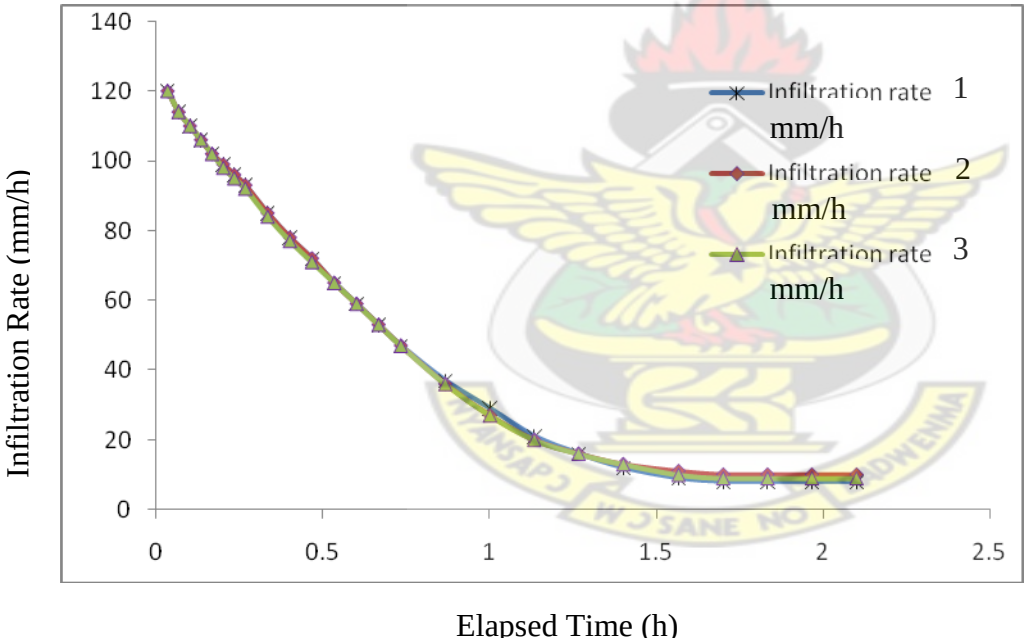

Fig. D4: Soil infiltration rates at three locations in Ugando Community

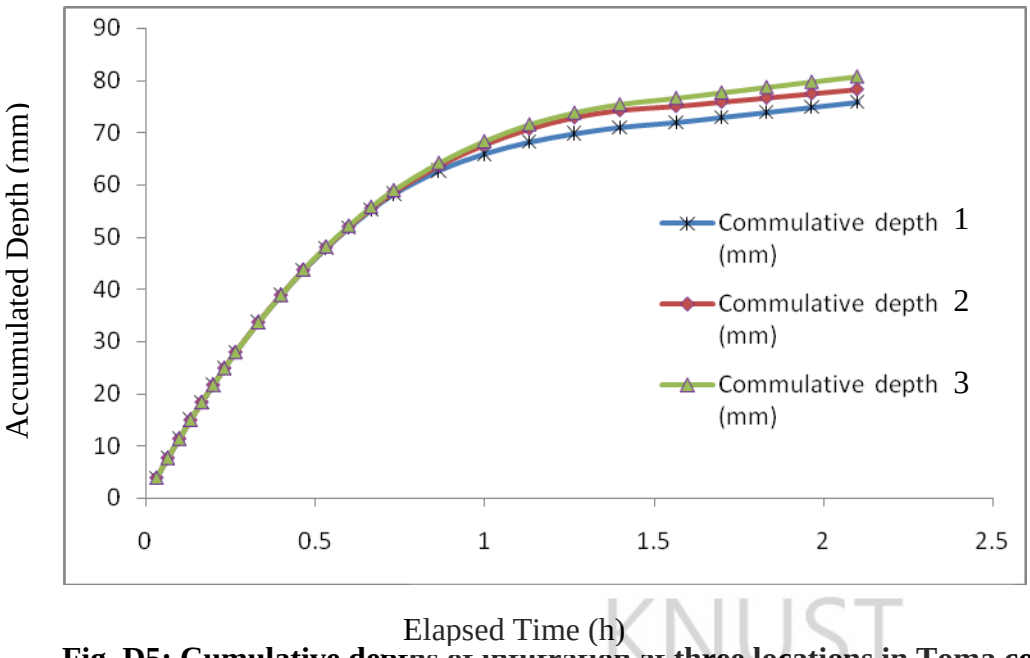

Fig. D5: Cumulative depths of infiltration at three locations in Toma community

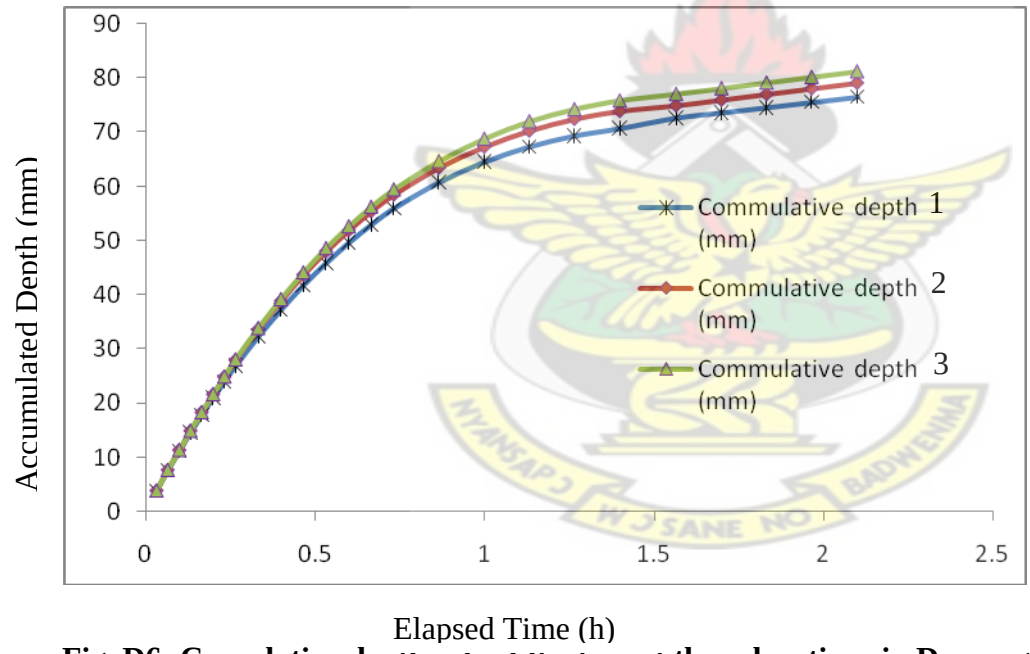

Fig. D6: Cumulative depths of infiltration at three locations in Demong community

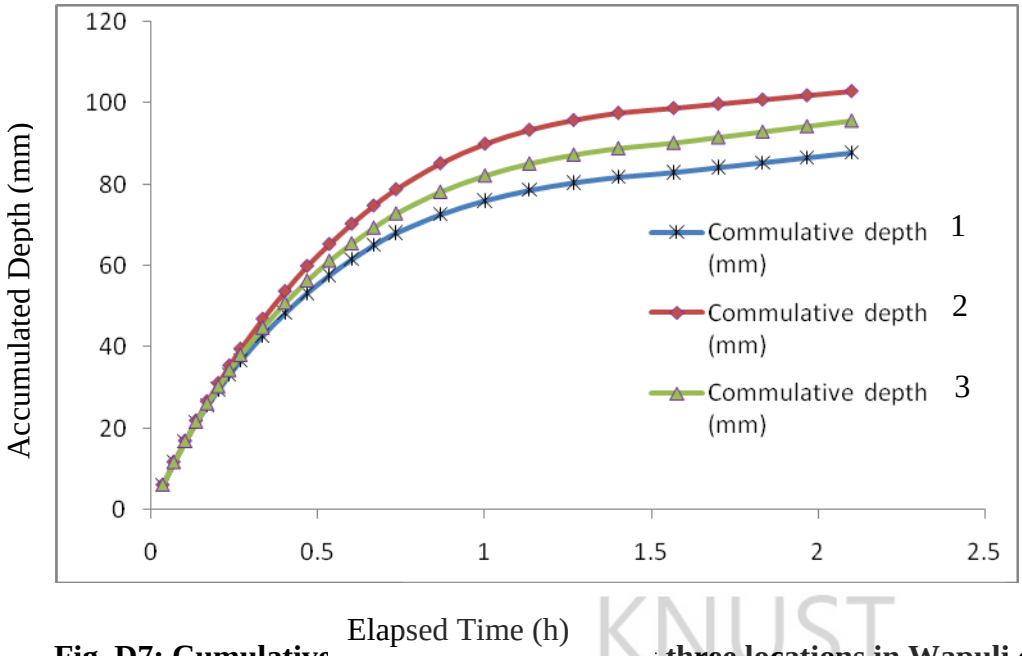

Fig. D7: Cumulative depths of infiltration at three locations in Wapuli community

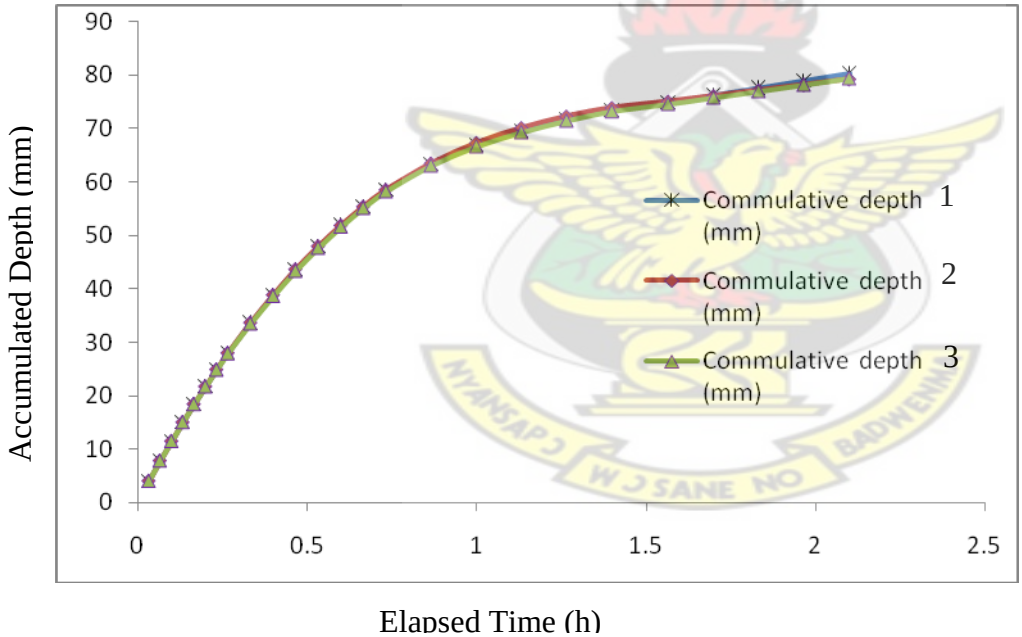

Fig. D8: Cumulative depths of infiltration at three locations in Ugando community

APPENDIX E: PLATES OF SANITATION SCENES, ENGINEERING FLAWS AND METHODOLOGY USED

Fig. I: Women wash in apron

Fig. II: Dirty water being poured in apron

Fig. III: Broken trough and muddy site

Fig. IV: Filth being created at BH site

Fig. V: Mud and stagnant water at BH site

Fig. VI: Broken trough and erosion at BH site

Fig. VII: Farming around water facilities

Fig. VIII: Farming close to water facilities

Fig. IX: Growing algae at BH site

Fig. X: Application of chemicals close to BHs

Fig. XI: Dirty water being poured in apron

Fig. XII: Stagnant water created at BH site

Figs. I-XII: Sanitation scenes of the water facilities

Fig.XIII: Paths leading directly into Dugout

Fig.XIV: Dugout dries up due to failure

Fig. XV: Dugout opened towards settlements

Figs. XIII-XV: Dugout opened towards settlements with paths leading directly into it.

Fig. XVI: Dirt and sediments from homes ran into dugout


Fig. XVII: Runoff from homes gets into dugout through leading paths

Figs. XVI and XVII: Dugout collects dirt and sediments from settlements

Fig. XVIII: Eroded dugout embankment

Fig. XIX: Embankment slides

Fig. XX: Failure due to overtopping

Fig. XXI: Failure due to poor compaction

Fig. XXII: Eroded dugout embankment

Figs.XVII-XXII: Failure of dugouts due to poor compaction and overtopping

Fig. XXIII: Surveyor's staff in use

Fig.XXIV: Determining average depth of dugout

Fig.XXV: Measuring yield of a HDW

Fig.XXVI: Depth of water in the HDW

Fig.XXVII: Infiltrometer being used

Fig.XXVIII: Measuring soil infiltration rate