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Rainwater Harvesting in the Coastal Savanna Region of Ghana

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Contents

1. Introduction

The problem of inadequate and unreliable supply of good quality water has for many years been an issue of concern to countries in Africa. Ghana is not an exception to this situation. While it is generally agreed that easily available, potable and affordable supply of water is a prerequisite to good hygiene and sanitation, most residents in rural, urban and peri-urban communities in Ghana lack access to adequate clean and reliable domestic water supply and water for agriculture and industrial development.

The water situation in most peri-urban and rural communities within the coastal savanna belt of the country is quite critical. Residents in these communities often suffer from problems related to unavailability, inadequate and poor-quality of water. Where potable water supply is irregular, poor households have often had to resort to alternative sources of water including, rivers, streams, ponds and rainwater to meet domestic and other needs. However, due to the poor management regime applied to most of these water bodies, most of these alternative sources have become polluted with the result that consumers are often predisposed to adverse health conditions. In a bid to address the problem, Government, NGOs and private sector agencies have, over the past years, embarked on several projects to augment good potable water supply to most vulnerable communities. However, resources available for such activities are often grossly inadequate, leading to the persistence of gaps in water supply to these communities.

The harvesting of rainwater has recently received much attention in policy formulation in Ghana (MWRWH, 2007). Government and relevant public and private institutions are emphasizing the fact that harvesting of rainwater, especially in the climatic zones with prolonged dry seasons, is one way to address the gap in domestic and agricultural water supply in the country. The aim of this project is therefore to demonstrate the need for and benefits to be derived from rainwater harvesting and therefore the importance of that practice

to solving part of the water supply problem in the country, particularly the dry areas. The outcome of the project would reinforce the need for the government to take practical action in implementing the Rainwater Harvesting Strategy designed by the Ministry of Water Resources, Works and Housing (MWRWH, 2011).

The area identified for the project is the Coastal Savanna Zone of Ghana which stretches from east of Winneba to the Volta River and lying south of the Akwapim-Togo Ranges. Although the area has many large settlements, it is unfortunately the driest part, with this part of southern Ghana receiving less than 900 mm of rains annually, compared to the other ecological zones of the country which record up to 2000mm a year.

The implications of this situation, especially inadequate water availability and supply go beyond the challenge of accessing adequate drinking water for domestic purposes, but also include limitations imposed on the ability of residents to access water for agricultural and industrial purposes in the area. It is generally accepted that the Coastal Savanna Zone with many large settlements, such as Accra (the national capital), Winneba, Kasoa, Tema, Ada, Sogakope, among others, has a lot of potentials for socio-economic development such as market gardening, livestock production, food processing, and other industrial activities. However, the problem of water scarcity makes the realization of these potentials difficult to achieve.

The project investigates the perception of the residents about the water situation and ways of strengthening and encouraging the use of rainwater in the area to alleviate the situation and consequently promote sustainable development in the area.

Figure 1: Ecological Zones of Ghana

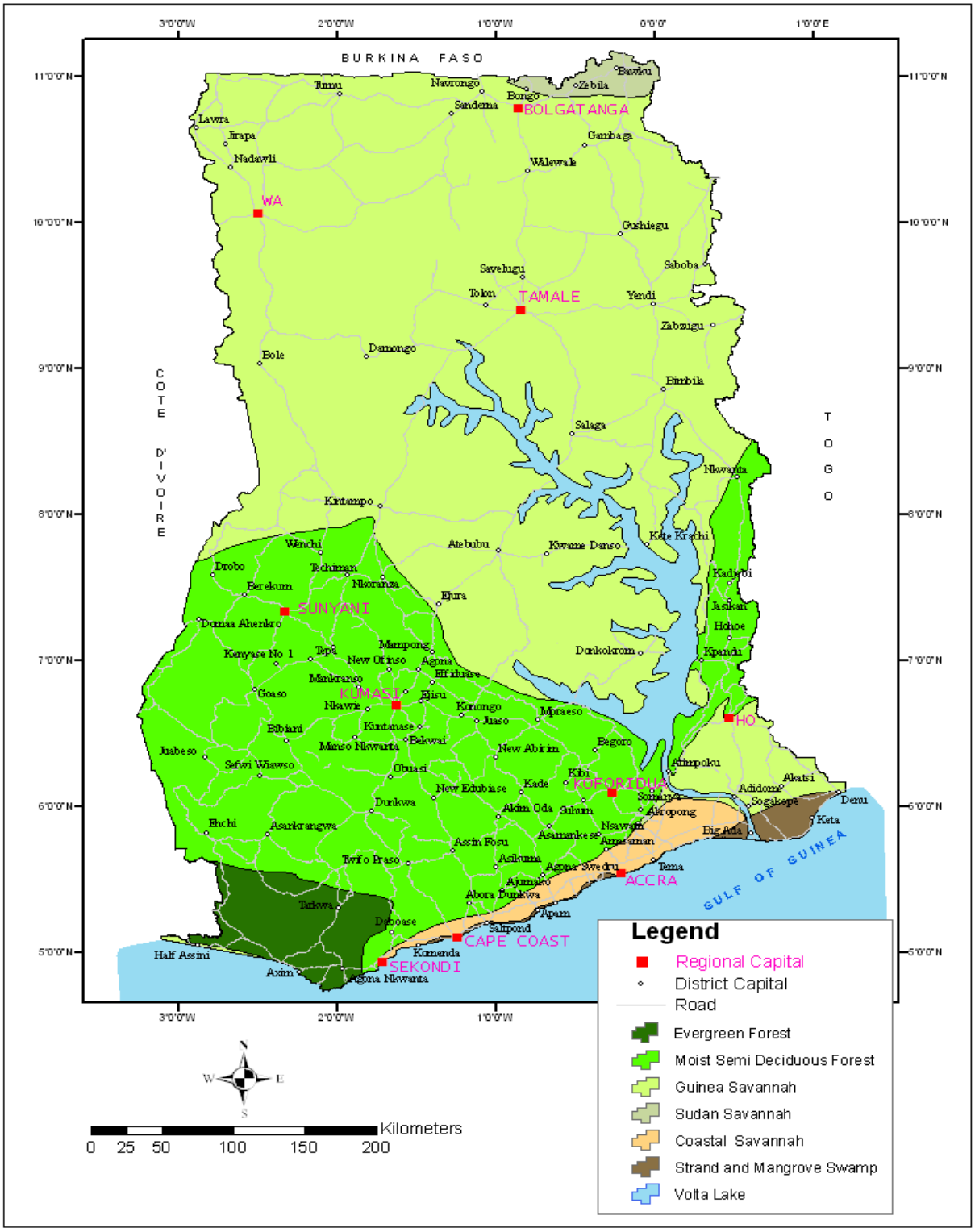
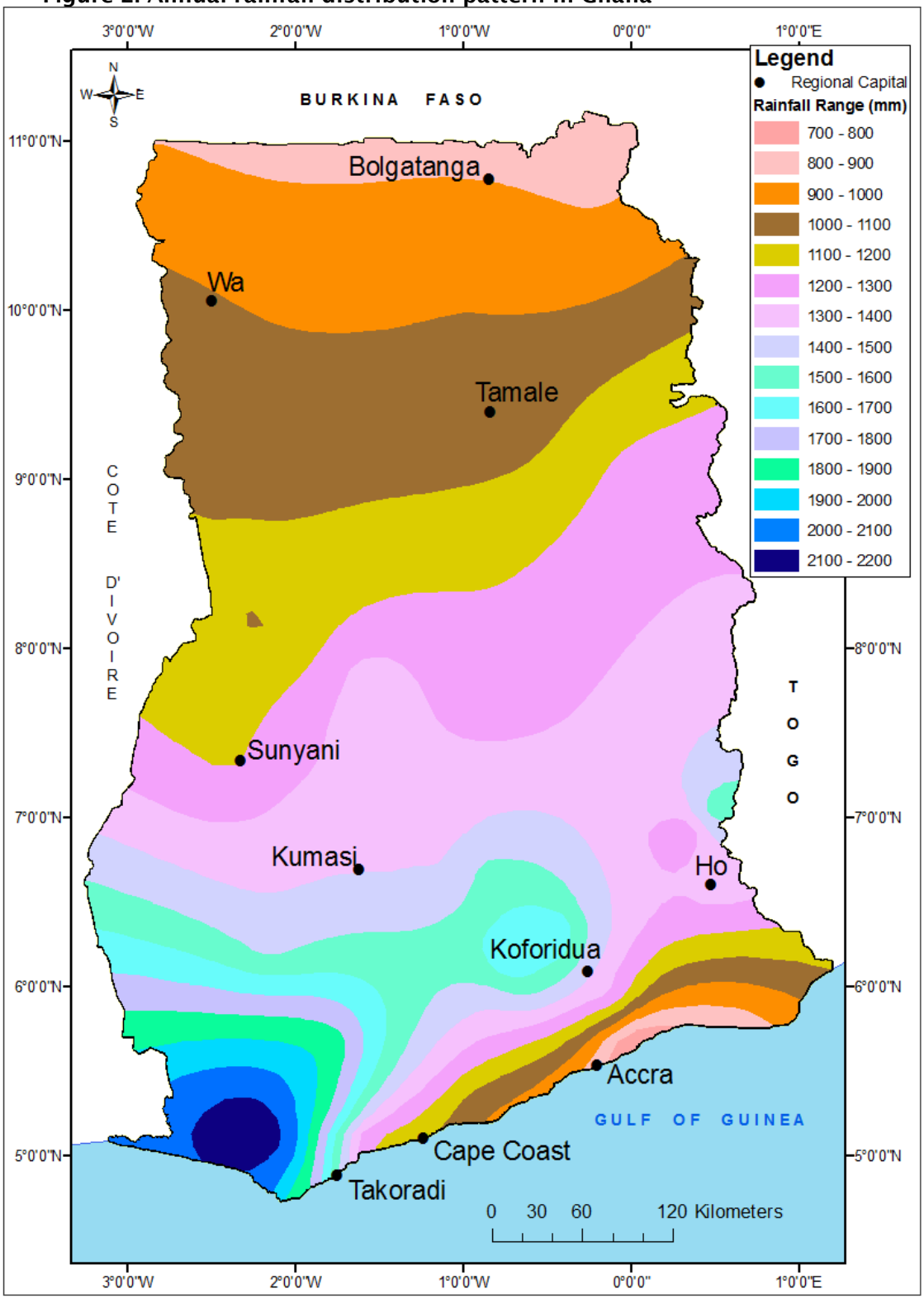


Figure 2: Annual rainfall distribution pattern in Ghana



2. The Central Issue: Research Problem

The location selected for the project is a water-scarce area. The total annual rainfall in the zone is the lowest in the country—i.e ranging between 800 and 900 mm. In addition, its spatial and temporal pattern of distribution is highly variable and this is reflected in the vegetation formation in the zone, which is characteristically savanna grassland and scrubs and thickets with short scattered trees. The vegetation formation in the other ecological zones, vary from wooded savanna to high tropical evergreen forest.

Under the prevailing condition as experience and studies conducted in similar areas have shown (Mbilinyi, 2005), crop and livestock production remains vulnerable and is controlled by the inadequacy, unreliability and erratic nature of rainfall. This situation has been aggravated by the inability of the government to extend potable water networks to most communities in the zone because of the scattered nature of settlements in the area. In addition, the level of partnership between government and NGOs in responding to the needs to provide household drinking water coverage is also low. The supply deficit in household drinking water supply, which is worsened by inefficiency of the public water delivery system, and coupled with the poor quality in many areas, has given rise to increasing dependence on commercial bottled and sachet water for domestic consumption. While the introduction of the bottled and sachet water industries in the water sector could be a way of supplementing existing arrangements for piped water delivery, the quality of these products has often not been monitored to ensure public health safety and good practice within the sector.

Indeed, results from a few studies conducted into the quality of the sachet water suggest that the operations of the industry merit critical attention as most of the so-called “pure water” (i.e. sachet water) sold in communities such as Cape Coast and the national capital, Accra are of doubtful quality (Obiri-Danso et al, 2003; Dodoo et al, 2006). Another, recent investigation of sachet water in Accra (Kwakye-Nuako, et al, 2007) particularly revealed the presence of contaminants

of faecal and zoonotic origin in some of the sachet water examined. This has grave public health implications as the organisms identified can have serious implications in children and adults—particularly immunocompromised individuals as Kwakye-Nuako, et al. have indicated in their study.

2.1 Justification for the Rainwater Harvesting Project

In the face of the water scarcity in the project area, coupled with the general difficulties imposed by the existing geographical and economic situation, such as salinity of water drawn from sources close to the coast and cost involved in accessing water from potable sources, residents have often resorted to rivers, streams, ponds and rainwater as reliable and affordable viable alternatives. The streams in the area are largely seasonal since for most of the year when there are no rains, they are dry. In fact, most of the streams can be considered to be channels for the drainage runoff than permanent water bodies. The large rivers, however, tend to be perennial to some extent, though during the peak of the dry season, the water contained in them are discontinuous. These attributes of the drainage systems in the coastal savanna zone makes local water availability for domestic and agricultural use, especially during the dry season, a major problem. This therefore renders rainwater harvesting an important venture to undertake.

In many parts of rural Ghana, rainwater harvesting stands out as an ancient practice carried out in communities and individual homes, where access to potable water is limited. This practice, though common, is limited because the amount collected per rain or raining period lasts the household only a couple of days mainly because of the small containers used in the storage of the water. A few relatively endowed members of the communities are, however, able to store more water to last for several weeks or months. Some of them are able to harvest more than the needs of their households and therefore sell the surplus to other members of the communities who are less endowed. Such large scale harvests frequently damage the storage facilities or reservoirs since most of them are poorly constructed.

The Government of Ghana has published a National Water Policy (2007) which is intended to provide a framework for the sustainable management of the

country's water resources. The policy recognizes the various cross-sectoral issues related to water availability and use and the links to other relevant sectoral policies such as those on sanitation, agriculture, energy etc. The policy therefore identifies rainwater harvesting as an activity with great potential to increase water availability for household and agricultural use. In order to harness the potential of rainwater, government undertakes to enact appropriate legislation and provide incentives towards making rainwater harvesting a viable option to supplement household and agricultural water requirements.

The overall goal of the draft National Rainwater Harvesting Strategy produced by the government in 2011, covering the medium to long-term horizon is "to promote and strengthen rainwater harvesting for water conservation and as an augmentation measure for water conventional potable networks in peri-urban and rural communities"(MWRWH, 2011).

This was to be achieved through:

- effective regulatory and institutional frameworks
- sustained awareness-raising campaigns to stimulate interest and promote support.
- human and institutional capacity strengthening
- identification of technology options and water quality of rainwater harvesting systems

This study is therefore designed to provide background information to facilitate such government action especially at the district level.

3. Literature Review

Experts and practitioners classify Rain Water Harvesting (RWH) systems variously. However, three categories based on the size of the run-off producing-area have been identified as follows—*(i) On-farm/in-situ systems*[1] *(ii) Micro-catchment systems*[2]*, and (iii) Macro-catchment system*[3] (Mbilinyi et al., 2005; Gowing et al., 1999*).* Although all these categories are not applicable in the proposed study area, the use of RWH techniques (notably tanks and cisterns) for the storage of domestic water is relatively common in most communities in the area.

It is argued that when a sufficient amount of rainwater is harvested, it can fulfill the domestic and/or agricultural and other industrial needs of households during the subsequent dry season. Studies have shown, for example, that a storage tank with the capacity to hold 16,000 litres can provide a good complementary supply to other available water sources for the consumption of a family with five individuals during a period of 10 to 12 months. It would contribute 8 to 10 litres per person per day (Mensah, 1998), which is nearly half of the recommended ideal per capita consumption per day (20 to 25 litres/day/person). The availability of domestic water supply through a cistern also liberates women and children from walking long distances to fetch water. Furthermore, access to harvested rainwater protects the family members against waterborne diseases contracted through the consumption of contaminated surface water.

Despite the benefits associated with the use of rain water its patronage in the proposed project area is low. The system is fraught with challenges that need to be addressed. For example, most of the traditional technologies are largely rudimentary and need improvement by way of the use of permanent materials

[1] This refers to the capturing of rainfall where it falls. The system is accompanied by cultural practices that ensure that crops make most effective use of the scarce water. It is sometimes called water conservation and is basically the prevention of net runoff from a given cropped area by retaining rainwater and prolonging the time for infiltration.

[2] This involves a distinct division of a run off-generating catchment area (CA) and a cultivated basin (CB) where the run-off is concentrated, stored and productively used by plants.

[3] This is characterized by large CAs. The CA area for these systems is located outside the cropped area, where individual farmers have little or no control over them. The systems include intermediate components for collecting, transferring and storing runoff.

and the building of improved reservoirs. In addition, in cases where modern improved versions are developed, community members have very little knowledge about the existence of such facilities and how they are managed, thus presenting a challenge that finds expression in issues linked to innovation adoption addressed by the theory of diffusion (Rogers, 2003). Furthermore, many of the factors that influence the adoption and use of RWH technologies (University of Warwick/DTU, 2003) have not been well-researched and factored into planning of potential RWH schemes. Such critical factors may include, for example community and household characteristics. The former relate to issues such as socio-economic composition of communities, roofing and housing characteristics, satisfaction with present water sources, exposure to permanent RWH systems, availability or otherwise of skilled masons to construct water retaining structures, responsibility for self-help etc; while the latter may incorporate issues such as socio-economic status of households which influence ability to participate in RWH initiatives.

Furthermore, gender issues as far as water management is concerned, is important in the study. The significance and relative roles or influences of males, females and children in water management are important in Ghana and are well discussed (Bour, 2003; Singh, et al., 2005). In particular, the perception, preference and choice of different water resources are considered as critical factors that influence the success or failure of any management system, and as such have been considered in the project.

Rainwater harvesting techniques have indeed been recognized as viable alternative sources of water that would best serve agricultural and domestic purposes. It would need sound policy, planning, and socially-acceptable and cost-effective designs to enhance its promotion in Ghana. In line with this, some experts have for example suggested that to design a rainwater harvesting system, the economic, social and cultural aspects of the location must be taken into account with emphasis on the utilization of locally available unskilled labourers and indigenous building materials (Appan,1999). The problems confronting the widespread adoption and utilization of RWH techniques therefore lie within the realms of policy, science, technology socio-cultural values and careful planning. All it takes is to address the above problems to

enhance widespread utilization and acceptability among residents of the Coastal Savanna Zone of Ghana. In this regard, the project holds the view that an exploration of the interface of such factors will pave the way for the promotion and utilization of rainwater harvesting as a viable alternative solution to the problem of water scarcity in the proposed project area and elsewhere.

4. Aims and Objectives of the Project

This project therefore seeks to identify the obstacles which hinder widespread promotion and utilization of RWH techniques in the study area, and for that matter the rest of the country. In this regard, it reviews various RWH techniques that are currently in use in the area to determine consumers' preference or otherwise of their usefulness. On the basis of this, suitable socio-culturally, economically and technologically acceptable RWH techniques have been identified, developed and promoted in the project area to complement the existing potable formal water supply systems.

The project also aims at shedding an integrated perspective on the problems and prospects for the enhanced utilization of RWH techniques in the Coastal Savanna Zone by linking technical dimensions of the problem with socio-economic and gender issues, examined against the National Water Policy and the National Rainwater Harvesting Strategy frameworks.

5. Methodology

The methodology for the project was structured around several activities to represent a multi-method approach (Marans & Edelstein, 2010). Under this approach activities ranging from literature review, stakeholder workshops, field visits, questionnaire surveys, focus group discussions were undertaken.

A critical component also involves the application of engineering techniques in the design of RWH technology which will be piloted in two communities in the study area. Outlined below is a breakdown of stages/activities which constitute the methodology for the project.

Stage 1: *This was done at TU Braunschweig and entails a comprehensive review of available policies relating to RWH technology development and promotion in Ghana (Objective i).* In this regard, published materials, official reports, research papers from peer reviewed journals and archival materials which relate to the theme of the project were collected and reviewed. The review also identified technological, institutional and policy implementation barriers. This generated relevant information on the status of RWH-related policy in the country and helped project participants and researchers to situate project plans and activities in a national context. Compilation of information on appropriate RWH technologies in the country was also part of the review.

Stage 2: *Organization of Stakeholder Workshops*

This took place in Ghana over two days. One day stakeholders' workshop was organized in each of two districts of the project area. Stakeholders, including representatives from academia, policy circles, NGOs, and District Assemblies—were given the opportunity to deliberate on issues pertaining to RWH technology needs, implementation and management in the project area.

Stage 3: Research Primary Data Collection

This phase of the project involved *fieldwork* in twenty selected communities over a two week period. The work was undertaken by members of the Exceed Guest Team from TU. Braunschweig assisted by research assistants in the Department of Environment & Development Studies, Central University College (Accra-Ghana).It involved the administration of questionnaires in 309 households and focus group discussions.

Structured Questionnaires were used to collect data on pertinent issues such as problems encountered and/or effectiveness in the use of RWH technologies, local peoples' societal beliefs, values and perceptions concerning the technologies in use as appropriate alternatives and their willingness to pay for new and appropriate RWH technologies.

The questionnaires have generated useful policy input data regarding the expectation of current and potential users of improved RWH technology; and their opinions regarding what they consider socio-culturally acceptable and affordable.

Stage 4. Data Analysis & Write up of Research Reports.

The data generated has been checked, assessed and put in the context of the overall project. Data analysis was facilitated by the use of SPSS, and Microsoft Excel statistical programs. Descriptive statistics was also applied, where necessary, to aid the data analysis. These activities were undertaken both in Ghana and TU Braunschweig (Germany) by the project team.

6. Research Output

6.1 Household Characteristics of Respondents

The study focused on household heads as respondents who could better represent the views of the household. The head of household is the person who has economic and social responsibility for members of the household. The gender distribution of the household heads interviewed, indicated that 65% were males and 35% were females. This conforms to the national situation where male household heads make up 65.3% of the population (Ghana Statistical Service, 2012).

Table1: Distribution of the Socio-economic Characteristics of Respondents

SOCIO-ECONOMIC FACTOR	CATEGORY	PERCENTAGE (%)	TOTAL (%)
Gender	MALE	65	100
	FEMALE	35	
Education	EDUCATED	74	100
	UNEDUCATED	26	
Occupation	AGRICULTURE	27	100
	INDUCTRIAL	11	
	SERVICES	46	
	UNEMPLOYED	16	
Marital Status	MARRIED	67	100
	UNMARRIED	33	
Income(Y)	Y=> GH¢200	30	100
	Y=< GH¢200	65	
	UNDISCLOSED	5	

Source: Field Survey, 2012

A total of 67% of the respondents were married and 33% indicated that they were not married. This was significant because those household-heads who were married and with children and other dependants were more responsible for the welfare of the household and this had implications for other issues with respect to the topic of rainwater harvesting. Female heads of households also carried the same responsibility since women are traditionally providers of water in the home. The household sizes in the study area almost reflected the average

household size (about 4.4) in Ghana as published by the Ghana Statistical Service (GSS) in the 2010 Population and Housing Census. The average size of households in the area was 4.2, with the lowest in the range of five and below and the highest in the range of eleven to fifteen.

Seventy-four percent of the respondents in the survey could understand and express themselves in English which is the official language of the country. This was significant and useful because it facilitated interaction with the research team and eased the collection of information through the administration of the questionnaires. According to the World Bank report published in 2009, the rate of literacy in Ghana, among people 15years and above, was estimated at 66.62 percent.

The occupations of the respondents were categorized into three sectors namely primary or agricultural sector, secondary or Industrial and the tertiary or services sectors. Twenty-seven percent of respondents were recorded in the agricultural sector i.e, those into the cultivation of crops or tree planting, rearing of livestock or breeding of fish for sale or for family consumption. Eleven percent (11%) was in the industrial sector which included dressmakers, salt and water factory workers, wood carvers etc. In addition, 46% were in the Services sector and these were mainly petty traders, drivers, mechanics, teachers, religious workers among others. Finally, 16% were recorded as unemployed and were not gainfully employed at the time of the study. Most of them explained that they were farmers however, because of the failure of the rains during the season they did not engage in any economic activity at the time.

The major types of economic activities in the study area make most of them fall within the lower income bracket in Ghana. This was confirmed by the survey as about 65% of the respondents are within the income bracket of GH¢200 (US$105.51) and below per month with about 48% of the 65% earning just the minimum wage (GH¢4.48 or US$2.66 per day) and below. Given an average household size of 4.4 and an average daily income of GH¢4.48 and below suggests that a great proportion of the respondents are poor. This also influences the ability of the population to pay for the installation of the new

rainwater harvesting facility. About 30% had incomes above the GH¢235 (US$123.97) per month while about 5% did not disclose their incomes.

In relation to the amount of water used per day in the households, the study found out that about 59% of the respondent use at most 200 litres of water per day while about 41% use more than 200litres of water per day. However, the amount of water used does not reflect the quality of the water. Most of them depend on sources that are not potable according to World Health Organization (WHO) standards. They depend largely on untreated water for domestic purposes and would therefore be very happy with any technology that would provide them with improved sources of water.

6.2 Water Scarcity and Sources of water in the Study Area

Information gathered under this heading was to confirm the scarcity of water for domestic use in the area and alternative sources of water available in the communities. About 74% of the total respondents indicated that water is scarce in the study area. About 11% of the respondents were indifferent as they indicated that sometimes water is a problem but not all the time. The 15% who were of different opinion said that, because their location is close to the sea, they do not see water as scarce commodity in the area however availability of potable water was a major problem. This implies that coastal areas can have access to water but not all coastal water are potable hence the problem of potable water is the major issue in the coastal savanna that needs urgent attention by the government.

The residents of the area resort to streams, ponds, rainwater and, pipe-borne water as their main sources of water for domestic use. Others who can afford the cost buy bottled water for drinking as a supplement to the other primary sources. The study sought to find out the opinion of the respondents regarding the quality of their sources of water. Only 18% of the respondents said the quality of the streams, and ponds was good while 82% said the quality was bad for domestic use but they use it because of the seriousness of water scarcity in the area. Furthermore, about 19% of the respondents do not use rainwater because their employers regularly supply them with water for domestic use.

6.3 Roofing Types, Rainwater Harvesting and Storage

Water harvesting in general terms can be defined as the collection of run-off rainwater for domestic use, agriculture and general environmental management (Worm and Hattum, 2006). Rainwater harvesting specifically refers to harvesting run-off from roofs or ground surfaces for which three basic components are required namely: roof surface or catchment to collect the rainwater, gutters and drainpipes to transport the water from the roof to the storage reservoir or tank which stores the water until it is used. Since the catchment of a water harvesting system is the surface that receives the rainfall directly from the sky, the type of roofing material in the communities was given special attention. Fifty percent of all the respondents used "slates" or asbestos sheets, 40% used aluminium sheets and 9% used thatch or other organic materials as their roofing material. In general terms, any roofing material is acceptable for collecting rainwater but for drinking purposes, water should not be collected from thatched roofs and roofs made of asbestos roofing materials which have questionable health implications.

Figure 1: Thatched Roofs

Source: Field Survey, 2012

A thatched roof has the tendency of collecting only about 25% of the rains it receives and yields coloured, unclean run-off especially in the first days of the rainy season. Asbestos sheets are also suspected to be carcinogenic. According to Cunha (2011) there are three types of asbestos related lung diseases: asbestosis, a non-cancerous disease of the tissue lining the surface of the lung, pleural disease and lung cancer (of the lungs or their outer living tissue).

However, the general consensus is that the danger in developing cancer from ingested asbestos is very slight (Campbell, 1993). The nature of thatched roofing and the scarce of asbestos as a roofing material are worth serious investigations since the majority of households in the coastal area use these two materials because they are resistant to corrosion from the sea breeze.

Figure 2: Water Storage Facilities

Water Storage Containers

Surface Tank

Source: Field Survey, 2012

The storage facilities used in the study area include surface tanks of different kinds of old containers and a few households have sub-surface tanks made by cement blocks and reinforced concrete.

The facilities are generally small and are only able to hold small quantities of water for a few days. Sixty-six percent of the respondents indicated that they are able to store water for more than three days.

Water storage tank usually represents the biggest capital investment element of a domestic rainwater harvesting system and it is not surprising that households in the project area cannot afford large and more durable ones. For purposes of storing larger quantities of water for longer periods, therefore, house owners should be encouraged to invest more in the construction of storage reservoirs. The rainwater collected is used mainly for domestic purposes (60%) such as drinking, cooking, washing and bathing.

Almost half of those interviewed (48%) responded that they are comfortable with the use of rainwater when available. Their view was based on the fact that they have used it for a very long time and have no evidence of its adverse effects on their health hence it was good. It was established that those who rated rainwater

as bad were those who harvest the first runoff and who have no storage lid for their storage facilities after harvesting and therefore allow contamination. In the case of pipe-borne water, about 93% confirmed that it is good however, 7% rated pipe-borne water as being average in quality. The study realized that the reason why pipe-borne water was rated as average was due to the irregular flow of water through the pipes resulting in accumulation of dirt. In confirming this view, about 95% of the respondents indicated that the pipe-borne water does not flow as required (i.e it is not reliable), with 5% saying it does not flow at all.

6.4 Responsibility for Water in the Household

Generally, responsibility for household chores is shared among all members of the house. Allocation of responsibility is also based on certain cultural beliefs and practices in the country or the community. In the case of the coastal savanna areas of Ghana, the study found out that the responsibility for fetching water lies on the wife and children. From the field work, about 35% of the respondents indicated that it is the responsibility of the wife and children to ensure that there is adequate supply of water for the entire household. About 39% revealed that the responsibility lies solely on the children and not on the parents. It was observed that this is normally the case when most of the children are above twelve years old and their parents are ageing. About 11% of the household wives only were reported to be responsible for their water needs, while wife and husband together were said to be responsible in 12% of the household surveyed.

The case of the "wives only" and "wife and husband only" was observed to prevail in instances where the children are too young to be entrusted with such responsibility. There was no reported case of the husband only being responsible for household water needs in the area.

In the specific case of rainwater the pattern of responses followed that of water supply in general. Wife and children only constituted about 30% while children only represented 43% of those responsible for ensuring that rainwater is harvested for the household during rains. Husband and wife only constituted

about 13% while 11% and 3% were made up of wife only and husband only respectively. In sum, therefore over 84% of the households in the study area have entrusted the responsibility of ensuring that rainwater is harvested for the entire household into the hands of wives and children together.

6.5 Time Spent for Water Collection

The entire area under study does not have a good network of water supply infrastructure. This is partly due to the scattered nature of the settlements which makes it difficult and expensive to extend water supply to each collection of houses. In most of the houses where the pipe lines have been laid the water does not flow regularly. Due to the irregularity of the pipe-borne water supply wives and children have to travel long distances to fetch water for the household. Children who are in school are expected to cover this journey a number of times in order to provide enough water for the household before they go to school. They are also expected to do same when they return from school and this does not give them enough time for academic work.

According to the survey, 42% of the respondents who use streams and ponds as alternative source of water supply indicated that women and children walk for thirty minutes to have access to any of these sources of water. Some of the residents hardly depend on these sources because the streams are mostly polluted; the ponds are salty and are also used by animals hence these are not good enough for human use in the homes. There have been isolated reports of guinea worm outbreaks in the area.

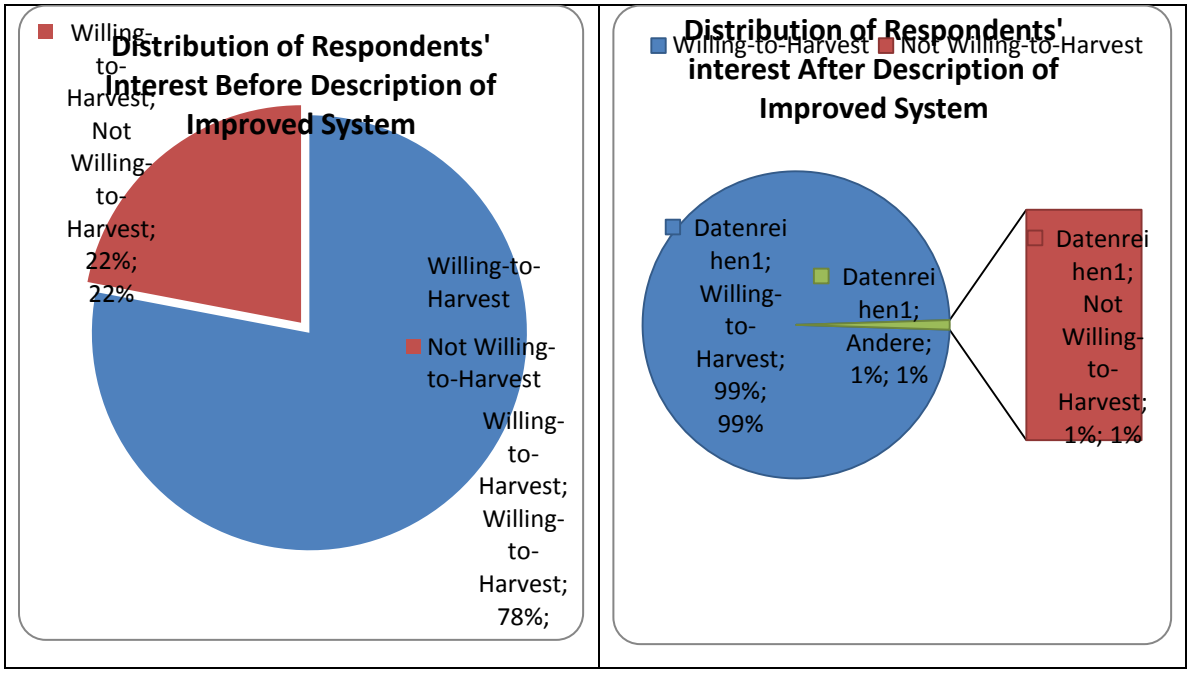
In the case of pipe-borne water, about 89% of the respondents who use pipe-borne water indicated that women and children on the average would have to walk for between at least two to thirty minutes to have access to pipe borne water. About 11% reported that they hardly use the pipe-borne water either because of the distance or because they cannot afford to pay regularly for the water. In addition, they have used the other sources for a long time and these provide for their needs.

Domestic pipe-borne water connections are not common in the communities and the water company provides public stand pipes at selected locations and those whose houses are far away from the pipes have to walk the distance to get the water.

6.6 Interest in and willingness to pay for RWH facility

The idea and usage of rainwater is not new to most of the respondents however, the modern rainwater harvesting system introduced to them is new to most of the people.

Figure 1: Respondents' Interest Before and After Description of New System



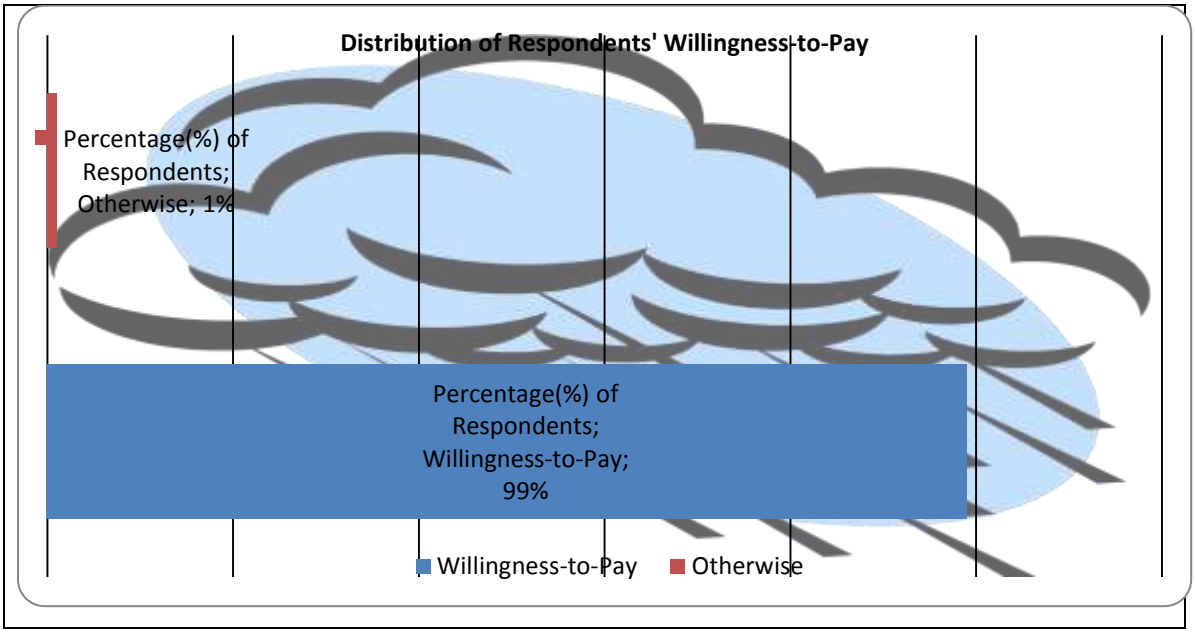
Source: Field Survey, 2012

Indeed, many of the respondents see the new system as an improved water supply system relative to what they are used to. At the beginning of the interviews, about 78% were willing to harvest rainwater during the rains. However, after the oral and pictorial description of the new system the expression of interest increased to about 99%. It was however significant to note that, about 1% was still interested in the old method. Their explanation was that, they were used to the old method and could not predict the challenges and cost associated with the new system. Some added that even if they would adopt the

new system they have to observe its use for some time before they took a decision.

The study established that, the introduction of the new rainwater harvesting system in the coastal savanna areas of Ghana would require an intensive proper education and awareness campaign to enable the entire communities to totally buy into the idea.

Figure 2: Respondents' Willingness to Pay for New RWHS



Source: Field Survey, 2012

A total of 80% of respondents indicated that they were willing to pay for the new rainwater harvesting system. Their mode of payment however, was not in respect of the cost of the total project investment but rather on the basis of 'pay as you fetch' principle. This was due to the fact that their current economic situation would not permit them to commit the total cost in cash to the project irrespective of the potential benefit to their wellbeing and survival.

Although as many as 80% of the respondents indicated their willingness to pay for the new rainwater harvesting technology in their homes, only 29% of the 80% expressed their readiness to pay the value of 50% of the actual cost of the facility. This meant that their ability to pay did not match their willingness to pay for the system to be installed in their homes. The attraction of the new

facility was not supported by prevailing economic situation in the area to enable the individual households pay for the service which they so much desired.

The provision of water supply in Ghana has been considered as a social service although communities are used to paying for the water when provided by the government. The general implication of the popular expression of willingness to pay for the new improved rainwater harvesting facility, therefore, is that households would pay for the water when the system is provided by the "government". This explanation, based on past experience in the provision of social infrastructure, commits central and local administrations to their responsibility to the citizens, especially in deprived areas such as the one under consideration. Government's intention and commitment expressed in the National Water Policy and the draft National Rainwater Harvesting Strategy (MWRWH, 2011) must be effectively implemented to benefit citizens of the coastal savanna region and other such areas with water problems in the country.

At present, rainwater harvesting systems are not an integral part of the building code and there are no clear guidelines for developers to follow. In addition, the systems remain restricted in use because of the high initial cost of the storage facility. These are two main areas which deserve government intervention through policy and program initiatives.

7. Observations and Recommendations

- ***Observation:*** The Government of Ghana has undertaken extensive legal and institutional reforms in the water sector since the 1990s. The creation of a Ministry for Water Resources, the establishment of the Water Resources Commission, the publication of the National Water Policy and the draft National Rainwater Harvesting Strategy are all examples of government commitment to improving the management of the country's water resources. It is noted with regret, however, that effective action on the ground leaves much to be desired. Implementation of some policy directives at the grassroots levels is limited to specific selected areas of the country and other equally deprived regions are ignored. This may be due to gaps in financial and human resource allocations to the water resources sector in general.

- ***Recommendation:*** With respect to rainwater harvesting, it is recommended that government intensifies its programmes and activities, including awareness campaigns and training of artisans at the local level to create renewed interest in the activity. Relevant research institutions should be encouraged to design simple affordable RWH facilities which the average house-owner can adopt.

- ***Observation:*** The climatic conditions in the coastal savanna region have been aggravated in recent years by the impacts of climate change. The local people are unable to adapt to these impacts and their livelihood systems are severely affected mainly as a result of large-scale crop failures

- ***Recommendation:*** Government institutions responsible for climate change adaptation programmes through integrated water resources management are encouraged to replicate the project in the northern savanna region in the area under study. The coastal savanna region can benefit from the activities which have been piloted in the north including water conservation and the involvement of local communities.

– ***Observation:*** The socio-economic conditions of the majority of inhabitants of the area are below the national average. Incomes are low, infrastructural facilities are poor and houses are constructed with inferior materials, especially roofing materials. This situation in particular makes rainwater harvesting a difficult activity to promote although the need for the facility is universally appreciated.

The major source of income in the area is farming which has been under serious threat in recent years as a result of the effects of climate change. The major factor in the agricultural production in area is water.

- ***Recommendation:*** It is therefore recommended that the available water resources, especially the major rivers be harnessed for irrigation. This will improve income levels and improve social and economic lives of the people.

– ***Observation:*** The three basic components of a rainwater harvesting system are catchment or roof surface, the delivery system or the gutters and the storage reservoirs. As indicated earlier, most roofs in the area are either made of aluminium or asbestos materials. With respect to rooftop catchment and storage reservoirs, however most house owners in the area presently use improvised materials such as metals and PVC for gutters and plastic bowls, clay or ceramic jars, old oil drums or empty food containers for water storage. In many developed economies, these essential RWH components are factory-made to standard specifications. These materials are therefore readily available and affordable.

- ***Recommendation:*** It is recommended that manufacturing industry in Ghana takes up the challenge to produce RWH components for sale to the public. Existing metal and plastic factories which have expressed interest in the project should be encouraged through government policy of for example, incorporating RWH into the building code. This will require

every house owner to install a RWH facility and thereby create the market for the manufacturing sector.

8. Conclusion

The Government of Ghana has created an elaborate policy, institutional and legal framework for the management of the country's water resources. The National Water Policy provides a general framework and the draft National Rainwater Harvesting Strategy is intended to provide a road-map for enhanced planning, development and management of rainwater harvesting and serve as a guide for elaboration of a series of action programmes towards the enhancement of rainwater harvesting in Ghana. Recent changes in climatic conditions throughout the country have resulted in the emphasis or rainwater as a viable complementary source of water for domestic and agricultural use.

In the deprived water-stressed savanna regions of the country, there is an urgent need for the government to translate its intentions into action. This should take the form of awareness creation, capacity building, especially among artisans the design of socio-economically acceptable RWH systems based on traditional knowledge and practices. It has been the practice of local communities to look up to government to take the initiative in the provision of social services and that expectation is very high among the water-stressed communities in the coastal savanna region of Ghana. This expectation must be met by the government

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