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Research Article

Factors Affecting Rainwater Harvesting Practices: In Case of Assosa Town, Upper Blue Nile Basin, Northwestern Ethiopia

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Abstract

In many parts of the world, conventional water supplies do not exist, are unreliable or prohibitively expensive. Many actual or potential water shortages can be alleviated if the practice of rainwater harvesting becomes widespread. A study was conducted to evaluate the factors affecting rainwater harvesting practices in Assosa city. The reason for starting the research is that the municipality of Assosa suffers from a severe water shortage, especially at the end of the dry season. The study involved 99 randomly selected respondents and purposively selected respondents using a semi-structured questionnaire. Data were collected using a combination of data collection methods including survey interviews, key informant interviews, and direct observation. The data was analyzed using descriptive statistics such as frequency tables to draw conclusions and recommendations. The results showed that lack of funding played a key role in the adoption of rainwater harvesting and, furthermore, lack of information and poor technology contributed to the failure to adopt rainwater harvesting for domestic use. It was determined that roofing materials were not a problem in the area, but storage areas and gutters hindered rainwater collection. We therefore concluded that the implementation of rainwater harvesting systems in Assosa town was hampered by the lack of resources required for the installation of rainwater harvesting systems. In addition, inadequate accesses to information, particularly for women, and lack of knowledge about the maintenance of rainwater harvesting technologies have contributed to the lack of widespread adoption of rainwater harvesting. We recommend making a conscious effort to subsidize rainwater harvesting in this area. The study also recommends strengthening municipal capacities in the area of rainwater harvesting technology, which is expected to be important for improving rainwater harvesting technology.

Keywords

Domestic Use, Rain Water Harvesting, Socio-Economic, Technology

1. Introduction

Millions of people around the world lack access to sufficient water for their agricultural and domestic needs [1]. In many parts of the world, conventional water supplies do not exist, are unreliable or prohibitively expensive [2]. One of the greatest challenges of the 21st century is overcoming increasing water scarcity [3]. Rainwater harvesting has therefore regained importance as a valuable alternative or additional water source alongside more conventional water supply

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technologies [4]. Many actual or potential water shortages can be alleviated if the practice of rainwater harvesting becomes widespread [5].

Rainwater is a form of atmospheric precipitation in which liquid water falls to the Earth's surface [6]. This is an important part of the water cycle, where seawater evaporates, condenses into clouds, precipitates on land, and finally returns to the ocean via streams and rivers to repeat the cycle [7]. Rainwater harvesting is defined as any human activity aimed at collecting and storing rainwater in a natural or artificial container for use immediately or before the next season for domestic, agricultural, industrial and environmental purposes [8]. The concept of rainwater harvesting is simple and ancient, and the systems can range from small and simple, such as attaching a barrel to a downspout, to large and complex, such as those that harvest water from several acres and serve large numbers of people, are sufficient [9].

In rural areas, the most common technique is small-scale rainwater collection on roofs [10]. The quality of rainwater depends directly on the cleanliness of gutters and retention basins [11]. In some regions, rooftop rainwater is generally of good quality and does not require treatment before consumption [12]. A rooftop rainwater tank can provide good quality water that is clean enough to drink, provided the roof is clean, waterproof and made of non-toxic materials [13].

In other areas, rooftop pools accumulate dust, leaves, organic matter, and bird droppings, which can contaminate the stored water and lead to sediment buildup in the pool [14]. Sometimes storage tank materials or linings can cause an unpleasant taste or odor, and some metals can dissolve, creating high concentrations in the water. Studies have shown that the initial inflow of runoff is more polluted than subsequent inflows and that pollutant concentrations associated with rainfall tend to decrease exponentially over time [15]. Therefore, diversion of the first part of the storm water runoff from the storage facility will improve the quality of water flowing into the storage facility and reduce or even eliminate the need for additional treatment [16].

The reason for starting the research is the fact that the city of Assosa suffers from a serious water shortage, especially at the end of the dry season [17]. Rainwater harvesting is very important there to alleviate the problem. However, the collected rainwater can be used to flush toilets and wash clothes. It can also be used for bathrooms or bathrooms. Treatment may be required before drinking. Because rainwater can be contaminated, it is often considered unsafe to drink without treatment [18]. Therefore, this study evaluated the factors affecting rainwater harvesting in Assosa city.

2. Methods and Materials

2.1. Area Description

2.1.1. Location

Assosa is the capital of the Benishangul-Gumuz region of Ethiopia. The town is located in the Assosa area, at 1,570 meters above sea level. Geographically and jammed local administration units' location in the North and far away 672 Km from Addis Ababa [19].

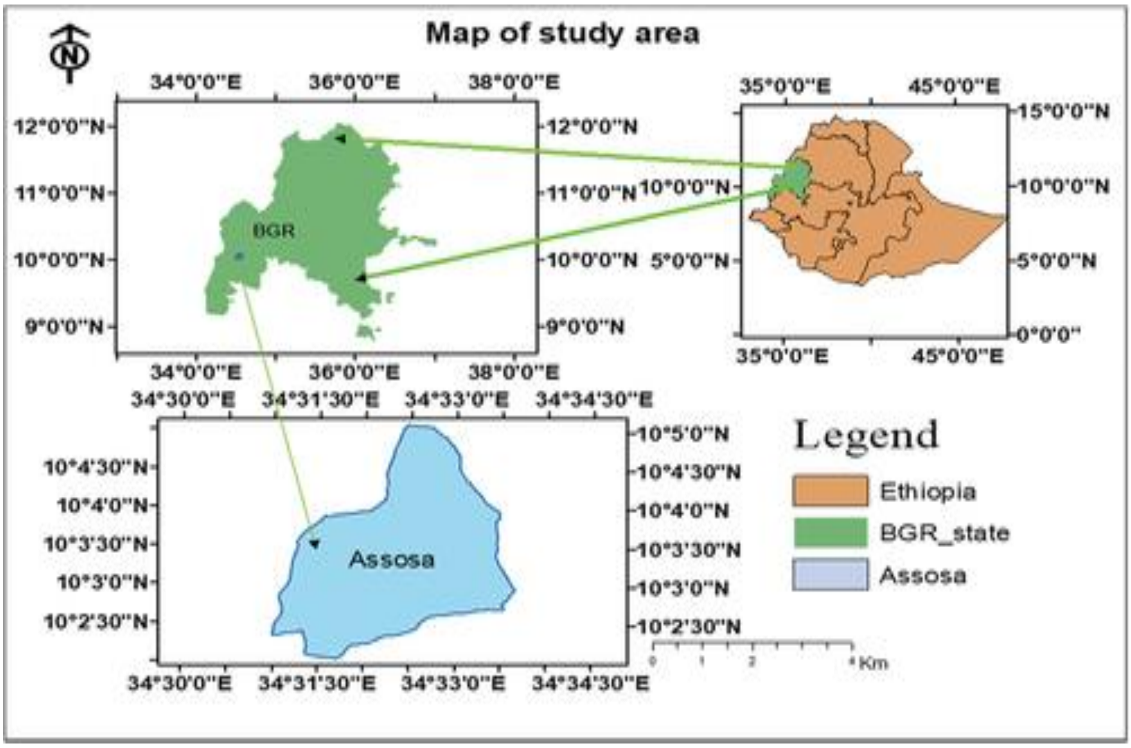

Figure 1. Study area map (Assosa town). Source: [20].

2.1.2. Climate of Assosa Town

In the hottest month (January) it reaches 20-32℃. The climate of the study area is described as the Kola climatic zone. The average annual temperature is 20℃–34℃. The average maximum and minimum temperature is 32.7℃ and 11.6℃, whose minimum temperature is between 23℃ and 11.6℃. In February there is a maximum temperature of 8℃ to 32.7℃. The minimum and maximum annual precipitation is 800–1500 mm. The average annual rainfall is about 99.5 mm. The rainy season lasts from April to November, but most rainfall occurs in the summer season [21].

2.1.3. Topography

Topography refers to the features of land surface. The common feature of the study area is plain and hill surface. The study area wide covered plain from the relief features following the plain and hill. The average altitude of study area is below 1500 mean above sea level [19].

2.1.4. Vegetation

In the study area dominated type of vegetation are, tide, eucalyptus and other dominated trees species, it consists other small trees and shrubs and most of vegetables is low land vegetation. The fruits of area are papaya, banana, mango, orange and etc. The vegetables types of plants are onions, carrots, and other are produced in the areas [19].

2.2. Demographic and Socio Economic Aspect

2.2.1. Population Size and Growth

The total population of the study area is 33671, of which 16720 are men and 16951 are women. 7033 is the total number of households in the study area. The majority of the population, which accounts for 75% of the total population, is Orthodox and the remaining 25% are Muslims and other religions [22].

2.2.2. Economic Activities

The population of Assosa town is mostly engaged by office work, agricultures and trade. All these economic activities are served as means of income and means of livelihood. Very few segment of the population are in area engaged in both office work and agricultural activities. These peoples got to their farm land during the summer season to cultivate and weeding option crops and harvest their crops in the autumn, whereas, during the winter season they are engaged in trade activities in the Assosa city. The crop cultivation in the Assosa town comprises teff, sorghum and pulses. Generally, in the Assosa town also economic activity depends on land both for agriculture and rearing livestock [19].

2.3. Research Design

One of the main objectives of this research was to study the factors affecting rainwater collection in the town of Assosa; for this purpose, obtain a representative population and adequate information; this study used a combination of random and purposive sampling techniques to select the households and key informants surveyed. Random sampling was used to select a sample of households to obtain representative informants, while purposive sampling was used to select a sample of Kebeles (small administrative units). Two of the five kebeles residents in the research area were selected to conduct the research based on the current administrative division system.

For sampling Kebele 01 and kebele 04 include. These kebeles were selected for participation in this study based on various methods including family size, population, standard of living, socioeconomic status, type of water use, and water sources. Kebele 04 is one of the kebele with poor families and former settlements and kebele 01 also one of the most densely populated kebele. For this reason, kebele are deliberately selected.

In general, the study covered a sample of 99 households from a total of 7033 households of the selected kebeles and in each kebele; every household was selected for the study.

2.4. Type of Data and Source

Both primary and secondary data types were used to achieve the specific objectives of this study. Primary data was obtained from key informant interviews, household surveys (questionnaires), focus group discussions, field observations, water officials, the city administration and other interested and concerned organizations. Secondary data were obtained from the district office, magazines, books, periodicals, official reports, and water and sanitation departments of Assosa city.

2.5. Sample Size Determination

The total numbers of household population in the study area is 7033 household heads. So; to collect data from all house hold respondents is difficult due time and money constraints due to that the researcher was used Yamane formula (1967), Sample size determination formula and decided proportional to the total population size. There are 7033 household heads in the two sampled Kebeles. Having the 90% confidence level, the researchers employed the following formula developed by Yemane, 1967 in order to determine the sample size.

$$n = \frac{N}{1+N}(e)^2, n= \frac{7033}{1+7033}(0.1)^2=99$$

Where; n= Sample Size

N= Total population

e= Sample error (0.1)

2.6. Sample Technique

Out of 7033 households, the researcher was selected 99 households randomly using lottery methods. This is due to homogenous nature of the society in addition to the cost and time.

2.7. Data Analysis

The completed answers to the questionnaire were first checked for any discrepancies and corrected if necessary. The responses to the open-ended questions were reviewed to develop a template from which appropriate responses were developed to fit the structured questions. However, the qualitative data obtained from group discussions and observations were structured, organized, described, summarized and interpreted based on research objectives and questions to complement the statistical information. Generalizations and conclusions were then drawn for the entire population of the study area.

3. Result and Discussion

3.1. Characteristics of the Respondents' Demographics

Table 1. Characteristics of the respondents.

Variable	Category	Frequency	Percent
Sex	Male	39	39.40
	Female	60	60.60
	Total	99	100
Age	20 -40	52	52.53
	41-60	34	34.34
	Above 61	13	13.13
	Total		100
Marital status	Single	22	22.20
	married	63	63.60
	widow	3	3.10
	divorced	11	11.10
	Total	99	100
Level of education	Illiterate	4	4.04
	Read and write	64	64.65
	Primary school	9	9.09
	Secondary school	22	22.22
	Total	99	100

According to table 1 illustrated are 60.60% of the respondents replied female and 39.40% of the respondents replied male. Therefore the most respondents replied are male. Further indicate the above table 1 the respondents replied that found in the age between (20-40) are 52.53% of the respondents, in the age between (41-60) are 34.34% of the respondents and found above 61 are 13.13%. From this table 1 we understands that most of the respondents are young age between (20- 40). In marital status indicators 22.20 % of respondents are single, 63.60 % of respondents are marriage, 3.10 % of respondents are widow and 11.10% of respondents were divorced. From this information the researcher conclude that most of the respondents are married. Regarding to educational level are 4.04% of the respondents replied are illiterate, 64.65% of the respondents replied are read and write, 9.09% of the respondents are primary school and 22.22 % of the respondents are secondary school. From this table 1 regarding to educational level the most of respondents are can Read and write.

3.2. The Influence of Water Harvesting Technologies on Encouraging Rainwater Harvesting Among Households

3.2.1. The Participants Were Asked to Specify If They Engage in Roof Water Harvesting

The result showed that 62.6% of respondents collect water from roof while 37.4% of respondents do not collect water from roof. By collecting water from rooftops, respondents can save water for domestic needs.

Table 2. Implements roof water harvesting in Assosa town.

They engage in roof water harvesting.	Frequency	Percentage
Yes	62	62.6
No	37	37.4
Total	99	100

3.2.2. Type of House Roof and the Implementation of Rainwater Harvesting

Table 3. Respondents were asked to indicate the type of roof on their house.

Type of roofing for a house.	Frequency	Percentage
Iron sheet	96	97
Tiles	3	3.0
Total	99	100

The results confirm that 97% of the respondents had houses clad with iron sheets, while 3.0% of the respondents had houses clad with bricks. Roofs helped collect water for domestic and other uses.

3.2.3. Installing a Rainwater Harvesting Gutter System

The participants were requested to specify whether they utilized a gutter system.

Table 4. The gutter network and the execution of rainwater harvesting.

Do you have a gutter system?	Frequency	Percentage
Yes	67	67.68
No	32	32.32

The result confirms that 67.68% of the respondents had a gutter system and 32.32% of the respondents did not have a gutter system. The gutter system plays an important role in rainwater drainage.

3.3. Impact of Socioeconomic Factors on the Adoption of Rainwater Harvesting by Households

The participants were asked to specify their methods of fundraising.

Table 5. How you get funds.

What is your method for acquiring funds?	Frequency	Percentage
Personal funds	99	100
Loan from a financial institution	-	-
Support from the government	-	-
Total	99	100

The result confirmed that 99 (100%) of the respondents use their own money (savings), for activities related to water production. none of the respondents receive funds from state support.

Who is Responsible for Rainwater Harvesting in Your Household?

The respondents were asked to indicate the one who does rainwater harvesting activity in the household.

Table 6. Who implements RWH?

Rainwater harvesting activity	Frequency	Percentage
Myself	32	32.3
My family assist me	42	42.4
Employee	25	25.3
Total	99	100

Table 6 showed that 32.3% of respondents indicated that they practice irrigation on their farm themselves, 42.4% of respondents indicated that they are assisted by their family to practice irrigation in their farm themselves while 25.3% of respondents indicated that they are assisted by employees.

3.4. Factors Affecting Rainwater Harvesting Systems

3.4.1. Social Factors

These include factors such as site choice which have serious consequences on the performance of RWHT and this in turn on the judgment of farmers. For example, a pond whose surface is not covered with plastic, cement, or compacted clay was found to be effective because they lose water within short months.

3.4.2. Economic Factors

Sampled households explained that the problem of finance prevent (60%) from the implementation of RWHT, technical (20%), awareness (13%), and labor (7%) respectively. As compared to rain-fed agriculture and livestock of farmers households believed that RWHT was better in generating income which eradicates the risk and uncertainties in erratic rainfall areas, regardless of its high requirements of labor. Farmers forwarded that problems associated with RWHT are lack of capital, lack of skill, lack of labor, technology, and market problem.

3.4.3. Physical Factors

According to the respondents outlook the different use of the harvested water using RWHT include home garden (5%), domestic use (50%), and sanitation (45%). Women's access to rainwater has social advantage such as upgrade health, saved time undertake the social role productivities and income.

3.4.4. Institutional Factors

Hierarchy of decision making which extends from the Ketena level to Woreda, region and some extent zonal levels also contributes technical support and organizational cultures are among the institutional factors. In this regard, the availability of manpower and work experience of individual farmers is very important for the implementation of RWHT.

3.4.5. Psychological Factors

To attract the attention and understand the farmers' perception of RWHT understanding their attitudes towards the practice plays a great role. Psychological supports which are given to the farmers to encourage them are forwarded by experts of agriculture and extension agents.

4. Conclusion and Recommendation

4.1. Conclusion

Four factors influencing the implementation of rainwater harvesting technology have a huge impact on families in Assosa town. It has Impact on socio-economic aspects of families, environmental aspects and significant reduction in poverty levels of families. The use of water harvesting technologies reduces the time wasted in searching for water and creates houses with more economical requirements. Rainwater collected from the roofs of houses and tents makes an important contribution to the availability of drinking water and for productive purposes such as growing crops or trees, animal husbandry and other domestic water supplies. Labor availability influences the adoption of water treatment technologies. The use of water treatment technologies helps reduce poverty, improve household food security, increase household food security and generate more income. Training should also include education about alternative methods of optimizing domestic water as well as the social, economic and environmental aspects of rainwater harvesting practices.

4.2. Recommendation

Rainwater harvesting can be an important technology for increasing domestic water supplies in arid areas where families are scattered. However, the study concludes that implementation needs to take into account several social and economic factors and therefore measures to promote RWH need to be carefully designed with socio-economic aspects in mind.

1. Rainwater collected from rooftops and tents plays a significant role in providing drinking water. Therefore, it is essential for society to collect it in a safe and efficient manner.
2. The rainfall received should be preserved for domestic or other purposes. The frequency and pattern of rainfall influence the necessity and design of rainwater harvesting systems. Regions experiencing longer dry periods or fewer annual rainy days require more emphasis on rainwater collection.
3. It is imperative to offer training and extension services to communities to foster the development and dissemination of cost-effective rainwater harvesting and storage technologies. Additionally, alternative policy frameworks and social institutions should be designed to encourage the adoption of rainwater harvesting and storage practices.

Abbreviations

ADADO	Assosa District Agriculture Development Office
ENMA	Ethiopian National Meteorology Agency
ATAO	Assosa Town Administrative Office
RWHT	Rainwater Harvesting Technology
RWH	Rainwater Harvesting

Conflicts of Interest

The authors declare no conflicts of interest.

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