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Rainwater harvesting and management in the semi-arid areas of Tigray region, Ethiopia

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Located in the eastern part of Tigray Region, Ethiopia, Saesie-Tsaeda district has a total population of 30,829 people, most of whom are dependent on rain-fed subsistence agriculture. Access to adequate quantities of safe water in this semi-arid region is a consistent challenge. To provide an alternative source of water, local NGO ECC-SADCO constructed rain water harvesting structures and set up a sustainable operation and management system in the district. This paper highlights the key lessons from this project activity, specifically regarding rain water harvesting cisterns in semi-dry areas.

Introduction

Tigray Region is the northernmost of the nine regions of Ethiopia. Tigray is the homeland of the Tigray, Irob and Kunama people. It is officially known as Region 1 according to the federal constitution. Its capital is Mek'ele (also spelt Mekelle).

Tigray is bordered by Eritrea to the north, Sudan to the west, the Afar Region to the east, and the Amhara Region to the south and southwest. Based on the 2007 Census conducted by the Central Statistical Agency of Ethiopia (CSA), the Region has a population of 4,316,988, of whom 2,126,465 are men and 2,190,523 women; urban inhabitants number 844,040 or 19.55% of the population. With an estimated area of 41,409.95 square kilometres, this region has an estimated density of 100 people per square kilometre (CSA,2007).

Saesie-Tsaeda is in the eastern part of Tigray. The district has a total population of 30,829 people, of which 14,298 are male and 16,531 are female. Most people in the area are dependent on a rain-fed subsistence agriculture. Access to adequate quantities of safe water in this semi-arid region is a consistent challenge.

To improve the coverage of potable water supply in these areas, the Ethiopian Catholic Church — Social and Development Coordination Office of Adigrat (ECC-SDCOA) and CST (CAFOD, SCIAF and Trocaire) joint office conducted a geological assessment on the potential of the area for availability of water. From these assessments, it was found out that the area has a potential for construction of rainwater collection cisterns (ECC SDCOA, 2010). Therefore this briefing paper provides insights into the process of construction, management and community involvement on this project and tries to draw lessons for other actors who wish to implement similar projects in other areas.

Rainwater harvesting and utilization

Rainwater harvesting (RWH)

People living in rural communities suffer the greatest strains caused by the uneven supply of safe water. Usually they live in areas that rely on natural water sources, such as rivers, streams, shallow wells or stagnant ponds, which are often contaminated with human and animal wastes. As a result, water- and filth-borne diseases account for an estimated 80 percent of all illnesses in developing countries (UNICEF,2002). This fact leads to the need for proper harvesting and utilization of rainwater.

Rainwater harvesting is a technology used for collecting and storing rainwater from rooftops, the land surface or rock catchments using simple techniques such as jars and pots as well as more complex techniques such as underground check dams. The techniques usually found in Asia and Africa arise from practices employed by ancient civilizations within these regions and still serve as a major source of drinking water supply in rural areas. Commonly used systems are constructed of three principal components; namely, the catchment area, the collection device, and the conveyance system moreover, Rainwater Harvesting offers a good arsenic free alternative drinking water source (WaterAid, 2006).

Most rainwater harvesting technologies are simple to install and operate. Local people can be easily trained to implement such technologies, and construction materials are also readily available. Rainwater harvesting is convenient in the sense that it provides water at the point of consumption, and family members have full control of their own systems, greatly reducing operation and maintenance problems. Running costs, are also almost negligible. Water collected from catchments is usually of acceptable quality for domestic purposes. As it is collected using existing structures not specially constructed for this purpose, rainwater harvesting has few negative environmental impacts compared to other water supply project technologies. Depending upon household capacity and needs, both the water collection and storage capacity may be increased as needed within the available catchment area (ICARDA, 2009). Moreover, rainwater harvesting helps to reduce problems such as soil erosion and flood hazards; and the reduced reliance on groundwater allows replenishment of groundwater tables (UNICEF, 2002).

Why is RWH critical in dry areas?

Dry areas suffer not only from limited rainfall but also ‘natural leakage’—90% of rainwater is lost directly or indirectly, and is unavailable for agriculture or domestic use (CRC, 2012). Since Water is a basic requirement for life, livelihoods, and economic development. In many areas, rain is the only source of freshwater for drinking and domestic use, making rainwater harvesting more critical. Rainwater harvesting can help improve local water supplies in any area. It is particularly important in dry areas, for several reasons.

Population growth and economic development have created imbalances in water availability and demand. Rainwater harvesting can alleviate water shortages at the local level, improve equity and reduce social injustice within communities, and between different communities that share a water source (ICARDA, 2009).

Dry lands are fragile environments. Overexploitation and mismanagement of water resources and erosion caused by uncontrolled runoff can cause irreversible damage. Rainwater harvesting can help alleviate both problems.

Rangelands in dry areas often do not have sufficient water for animals to drink, limiting grazing opportunities.

Cisterns

A cistern (Figure 1) is a sub-surface water collection and storage structure, generally dug at the lowest level of a small catchment. To be effective, a cistern should have an adequate catchment (see figure 2) to generate runoff under whatever rainfall conditions are expected, a suitable underlying geological formation, and should make efficient use of stored water. Although cisterns may not be able to meet the total water demand of a rural community, they can play a significant role. These low-cost structures are affordable for poorer households, and a safe, convenient way to store water for later use. Two types of cisterns are common: single-cell and multi-cell. The choice of single or multiple cells depends on the rock and soil characteristics and the storage requirement. Cisterns of a larger capacity (greater than 300 m^3) generally have more than one cell, while single-cell cisterns are smaller, usually built where soil and rock conditions do not allow for large capacity (WaterAid, 2006).

A cistern has three main components: an inlet including a settling basin, a shaft (mouth and neck), and a storage chamber. The inlet allows runoff to enter the storage chamber, while the outlet allows excess water to flow out. The mouth opening facilitates withdrawal of water from the cistern and is 50-75 cm in diameter. A wooden or steel grate covers the opening to prevent the entry of contaminants. The chamber is excavated in soft to medium soils underneath a layer of hard sedimentary rock, 50 cm to 2 metres thick, which forms a natural ceiling to the chamber. The inner sides of the chamber are plastered to minimize leakage. The chamber requires cleaning every four to five years if proper sediment traps are not provided (ICRDA, 2009).

What has been done by ECC-SDCOA and CST?

ECC-SDCOA conducted a needs survey which indicated the scarcity of safe water as very critical problem in Saesie-Tsaeda District. Different water schemes were considered to improve the coverage of potable water supply in these areas based upon the assessed needs and potential sources. After careful consideration, it was decided that cisterns were a viable alternative to alleviate a portion of the water demand. An integral component of this project has been the involvement of the affected communities. The project participants have been actively participating in the planning, construction, and long-term operation of these systems to include:

- Site selection.
- Sand, gravel and stone contribution.
- Contributing funds for maintenance and rehabilitation.
- Providing arable/grazing land for construction of water points without compensation.
- Providing volunteer labour for loading, unloading and transportation of construction materials from the road side to the project site.

To coordinate this significant contribution by the community, ECC-SDCOA made use of the existing community structures (faith leaders, local government, etc.) to build community awareness of the benefits of these water systems. Moreover, ECC-SDCOA established a water quality testing laboratory in order to verify the physico-chemical and bacteriological quality of the water after construction. This testing and analysis has been conducted by the staff hydro geologist after specialist training in water quality testing.

To ensure sustainability of the schemes, the community took the responsibility for the day-to-day operation, maintenance and sanitary measures of the constructed cisterns. Implementation was via village members forming water and sanitation committees for each cistern. Each committee comprises seven members (three men and four women) with responsibility for controlling the water usage. The elected committee members were trained on water management, sanitation, cistern and water point maintenance and in general governance to include formulation of bylaws. In accordance with the endorsed bylaws, the committees took the responsibility for fee collection, mobilizing the community to undertake maintenance of the water points, and ensure the water points are kept free from damage and pollution.

Photograph 1. Cistern for the collected water, also serves as water treatment location (if necessary)

Photograph 2. Constructed structure for catchment area

Methodology of the study

The principal objective of this case study was to assess the impact and sustainability of constructed rainwater harvesting structures in Saesie-Tsaeda district of Tigray regional state, Ethiopia. To realize this objective, primary data was collected through key informant interviews and a critical review of documents. The source of the data for this case study where the staff of ECC SADCO and project participants within the affected communities. The respondents were selected purposively based on their involvement on the project. The information collected from the key informant interviews were further triangulated by the review of documents. Moreover the information collected from the document review and key informant interviews have been analysed by using qualitative data analysis techniques like case study.

Key findings and areas for learning

From the experiences of ECC-SADCOA and CST, it is observed that the constructed cisterns are serving the community sustainably. Observations for this study can be categorized into three main components: before construction, during construction and after construction:

Before construction

Before construction of the cisterns, organizations need to consider the following major factors:

1. **Socioeconomic considerations:** During the planning phase, there should be an emphasis on land ownership, site suitability for cistern construction (topography, soil types, etc.), informing the community about the purpose of the cistern, and resolving any upstream–downstream conflicts.
2. **Estimating community needs:** In collaboration with the user community, demands must be estimated accurately to insure proper system sizing.
3. **Location and storage capacity:** In most cases, rainfall and catchment characteristics dictate the size of catchment needed. The most suitable geological formation for the construction of a rainwater cistern is a good quality, fault-free, 1-2 m thick rock, over 4-5 m deep soft soils.
4. **The catchment area:** The catchment area collects runoff and directs it, to the cistern. The cistern capacity will depend on, the quantity of runoff, which in turn depends on catchment size, rainfall, land slope and soil types.
5. **Environmental aspects:** Water quality is a major concern when cisterns are used. Cistern water can be contaminated during runoff over the catchment, or during and after storage. The main pollutants can include eroded soil, organic matter, human and animal waste, dissolved salts and fuel oil. Stored water can also become contaminated by exposure to the atmosphere and during water lifting and/or pumping,

therefore regular water quality testing system should be conducted. ECC-SADCOA instituted testing every six months.

During construction

The following factors have been identified as key in the construction of cisterns:

1. **Ground preparation:** While preparing the ground, technical issues such as soil type, catchment area and capacity must be considered.
2. **Development of the storage chamber:** As the storage chamber is a major structure, due emphasis should be placed on the quality of the construction, particularly on the casing.
3. **Workforce and time requirements:** Appropriate planning and management of the workforce regarding skills, schedule, and compensation expectations should be well understood for effective construction.
4. **Safety measures during excavation:** Under-designed or carelessly constructed cisterns can be damaged or parts of the structure may collapse, therefore and emphasis should made on health and safety measures.

After construction

The major factor that needs attention after the construction of cisterns is operation and maintenance. This should be done with the same management commitment as other water schemes (such as piped systems). The community should take responsibility for the day-to-day operation, maintenance and sanitary measures of the constructed cisterns. For this to happen, the village members who are the direct beneficiaries of each cistern need to establish a water and sanitation committee and should receive appropriate training.

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