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Assessments of Environmental Impacts of Uluguru North Water Catchment Forest Reserve in Morogoro, Tanzania

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ABSTRACT

A study was conducted with the aim of assessing the environmental impacts of water catchment area in Uluguru North Catchment Forest Reserve (UNCFR), Morogoro Tanzania. It focused on identifying human activities contributing to water sources drying and distortion of water quality, the measures taken by local people towards conserving water sources and knowing how people understand the impacts of water catchment degradation. The purposive research design was used to guide this study. The collected data were analyzed by using Microsoft Excel Programme and Statistical Package for Social Sciences. The results showed that 53.3% of people living in North Uluguru have basic primary education which may be the reason to the continuing degradation of the water catchment in North Uluguru Forest. About 56.7% of the respondents were peasants implying that are very poor and their lives depend on activities that were not friendly to the environment. Moreover, 57% of the respondents practice agricultural activities along river banks depending much on water which is available in rivers for irrigation and hence contributing to drying of water sources. About 58.3% of farmers tend to apply both pesticides and fertilizer in their farming practices and this significantly contribute to water catchment pollution. About 53.3% of respondents are aware of the impacts of agriculture in water catchment areas. This study suggests that agricultural activities are the main cause of water sources degradation and conservation can be done through planting trees, avoiding cultivation near water sources, in steep slopes and awareness creation to avoid environmental degradation.

Key words: Environment, pollution, water quality, degradation, human activities, resources management

INTRODUCTION

Environmental impacts assessments showed that most of the environmental impacts associated with water catchment degradation are linked to different human activities taking place along the catchment areas[1]. Anthropogenic forces that alter the physical landscape cause substantial soil erosion which have adverse impact on surface water bodies and therefore necessitating sediment control as important aspects of catchment management planning. Land use type also has an effect on the soil erosion process which contributes to land degradation[2]. Based on Bai *et al.*[3], land degradation may be defined as long-term loss of ecosystem function and productivity caused by disturbances from which land cannot recover unaided.

The human activities leading to the environmental impacts includes agricultural activities which are associated with deforestation through cutting trees mostly done by charcoal markers as the source of fuel and firewood[4]. Improper applications of fertilizer, pesticide and herbicide on crops which contribute to chemical deposits in soil, which later are carried out by runoff and leaching into rivers, lakes and groundwater[5-6]. These environmental impacts bring about adverse effects to the living organisms and the environment in general[7]. Among the impacts includes water pollution, drying of water sources including rivers, water shortage which lead into poor water supply, lack of access to clean and quality water[8-9].

In Tanzania, Uluguru Mountains receive large amounts of rainfall and are ranked by the central government as the most important water catchment areas in the country[10-11]. Past research reveals that Uluguru Mountains is of high benefit to the people living in Morogoro, Pwani and Dar es Salaam regions[11-13]. Although water is relatively abundant, access to clean water is a serious problem in some areas because clean and safe water is not protected and the springs are subject to sources of pollution and contamination[10]. Despite of the fact that Uluguru mountains is ranked as the most important water catchment area that receive large amounts of rainfall that feeds the down streams rivers still there is a problem of access to clean and quality water to the demanding communities[10-11]. To overcome the above mentioned constraints associated with access to clean and quality water, the environmental impacts of Uluguru North water catchment areas were assessed. The aim of this study was to find out what are the anthropogenic activities carried out at Uluguru Mountains leading to water catchment degradation. This was done by identify human activities that lead to drying up of water sources and distort the quality of water. The outcomes of such an assessment was expected to assist the local people to correctly use appropriate measures towards conserving water sources after knowing the impacts of water catchment degradation.

MATERIALS AND METHODS

Description of research site: The UNFR is part of a chain of 12 mountain blocks in the Eastern Arc Mountains, which stretch 900 km from Makambako (in southern Tanzania) to the Taita Hills in south coastal Kenya[11]. The Uluguru mountain forest lies immediately South of Morogoro town in Tanzania East Africa between latitude 7° and 8° S and longitude 37° and 38° E. The Uluguru Mountain Forest is approximately 180 km from Dar es Salaam and about 46 km long rise abruptly out of the coastal plain at approximately 300 m above sea level to a peak of 2600 m. Uluguru Mountain Forest is covered by six forest reserves, which cover the total area of 404 km^2. The tops of the large mountain peaks are found in two large Catchment Forest Reserves (Uluguru North and South) managed by the Catchment Forestry Project under the Central Government Forestry and Beekeeping Division. The source of water in the country was as they supplied water to Dar es Salaam and also held globally important biodiversity values. There are also Catchment Forest Reserves on the lower slopes of these mountains and a few smaller forest reserves owned by the local authority and managed by the District Forest Officer through the District Council.

Climate: The area is characterized with oceanic rainfall and temperature. Estimated annual rainfall ranges are 1200- 3100 mm, on the western slopes and 2900-4000 mm on the eastern slopes. The estimated maximum and minimum temperatures were 22 and 17°C during December and July respectively. The forest reserve has high catchment values and has one of the highest rainfalls in Tanzania without a marked dry season. On the eastern side the reserve is part of the Ruvu river catchment and supplies Dar es Salaam with water. On the western side it supplies Morogoro town and villages on the mountain slopes[14].

Topography: The reserve covers the steep summit ridge and easterly slopes of the northern half of Uluguru Mountains between Morogoro town and Mgeta to Bunduki depression within an altitudinal range of 1000 and 2340 m. From the north east to south west, the main summits were Lupanga (2138 m), Kinazi (2150 m), Bondwa (2120 m), Nziwane (2270 m), Magari (2340 m), Miwa (1900 m), Mnyanza (2140 m) and Kifuru (2010 m)[14].

Vegetation: The main vegetation type occurring in Uluguru North forest reserve is a high montane forest with a canopy layer dominated by the species of *Albizia gumifera, Allanblackia stuhlmanii, Allanblackia uluguruensis, Aningeria adolfii, Cephalosphaera usambarensis* and *Syzygium guinense*. With the exception of rock outcrops, the vegetation was moist forest. Moreover, sub-montane forests occur on the eastern slopes and montane forests occur between 1500 and 1900 m altitude[15].

Population: The population of the study area is estimated to be 3000 people living around the Uluguru North forest reserve and these are the people that are expected to conduct various anthropogenic activities that cause environmental impacts to the forest reserve.

Research design: Purposive research design was used to guide the study in assessing the environmental impacts of water catchment area in Uluguru North Catchment Forest Reserve (UNCFR).

Sample size and sampling technique: Purposive sampling techniques was used to select farmers, government forest officers, livestock keepers and other key stakeholders for this study including charcoal makers and Nongovernmental organizations (NGOs) working in Uluguru North Catchment Forest Reserve (UNCFR). The sample size was calculated based on the following statistical formula:

$$SS = N / (1+ N) * (e)^2 \quad (1)$$

Where:
SS = Sample size
N = Population
e = Precise level

So, from the formula above respondents from the group of local peoples (farmers, livestock keepers and charcoal makers), respondents from government forest officers and respondents from Non-governmental organizations from the UNCFR were obtained. The respondents were drawn from Tangeni, Mongwe, Maguruwe and Bunduki villages.

Data collection method

Primary data collection: Structured questionnaires with open and close ended questions were used as a primary source of data collection.

Secondary data collection: The key source of secondary information for this study was from various publications and reports that were relating to the research objective. Also reviews from different literatures in books, published journals and online journals, magazines, internet and other electronic sources were used as a source of secondary data for this study.

Data analysis: The analysis of data for this study were both descriptive and statistical analysis based on data and information collected from primary and secondary sources about the study. Quantitative data were analyzed using the Statistical Package for Social Science (SPSS) software to compute percentages, tabulation and cross-tabulation of responses.

RESULTS AND DISCUSSION

The results explained by presenting sex, marital status, ages and education level and respondents' occupation. It further showed the results of respondents' practices to agricultural activities, fertilizer and pesticides usage in agricultural activities, respondents' awareness to the impacts of agriculture in water catchment areas, source of energy for cooking and water sources conservation.

Sex and marital status distribution of the respondents: Most of the respondents from this research were female as compared to male, 51.7% which means 31 of them were female and 48.3% equal to 29 were male (Table 1). This implies that female is the one mostly engaging themselves in agricultural activities and other household's activities which include collection of firewood as source of energy in their homes. It has been acknowledged widely that the responsibility for agricultural productivity, collecting firewood and drinking water for many African communities usually falls to girls and women[16].

Out of the 60 respondents 31 were single (51.7%) and 29 were married (48.3%) (Table 2). A study by Spring[17] explained the differences between single and married and how they respond to changes in land and water resources management. Environmental conservation and management of catchment areas requires collective efforts of the community to keep it to the sustainability.

Percentage age of the respondents: Results in Table 3 showed that the percentage age of respondents was 61.7% from the ranges 18-35 years and 38.3% above 35 years. That was to say the age group of respondents involved from this research and which practice agricultural activities is from 18 years to 35 years (Table 3). A study by Massawe *et al.*[18] reported that environmental degradation due to deforestation and massive tree cutting for firewood, charcoal and house

Table 1: Sex distribution of the respondents at North Uluguru Forest reserve

Sex	Frequency	Percent
Male	29	48.3
Female	31	51.7
Total	60	100

Table 2: A distribution of marital status of the respondents

Marital status	Frequency	Percent
Single	31	51.7
Married	29	48.3
Total	60	100

Table 3: Age distribution from 60 respondents

Age	Frequency	Percent
18-35	37	61.7
Above 35	23	38.3
Total	60	100

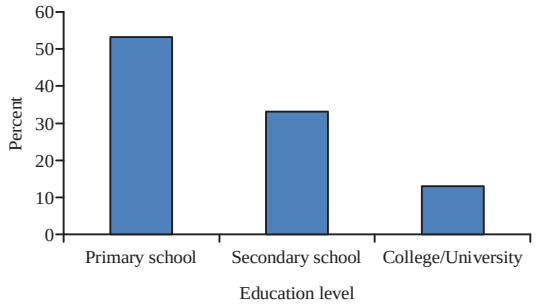

Fig. 1: Respondents' education level distribution

construction were done by farmers below the age of 40 years. Therefore, since youth were mainly involved in agricultural activities; they were likely to be responsible for water catchment degradation of Uluguru North Forest Reserve.

Education level: Education level of the respondents, mostly were at primary level compared to other levels, about 32 people were at primary level (53.3%), 20 people at secondary level (33.3%) and only 8 respondents were at college level (13.3%) (Fig. 1). These results showed that a good number of people living in North Uluguru Forest Reserve they have basic primary education which help them to be able to access some of the very important information concerning water catchment conservation that are brought to them through different media including radio. But also this level of education to most of the majority may be the reason to the continuing degradation of the water catchment in North Uluguru Forest Reserve. This argument may hold since the level of education tends to influence some of the conservation practices to be easily adapted if the community is well educated to the extent that it become very simple to practice environmentally friendly activities[18].

Respondents' occupation: The results from this research showed that 34 of the respondents were peasants and this is about 56.7% of all respondents and 17 respondents were employed which is about 28.3% and only 9 respondents (15%) were students (Table 4). These results may imply that majority of people in the community are poor, so their livelihood depends much on activities that are not friendly to the surrounding environment. A study by Doggart[15] reported that, there was relationship between levels of education and environmental degradation. For that reason the Uluguru Forest Reserve will continue being degraded unless some efforts are placed to try conserve water catchment.

Table 4: Distribution of respondents' occupation

Respondent's occupation	Frequency	Percent
Employed	17	28.3
Peasant	34	56.7
Student	9	15
Total	60	100

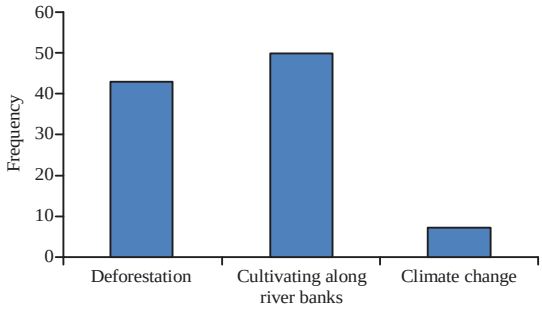

Fig. 2: Factors contributing to drying up of water sources

Factors that contribute to drying up of water sources at Uluguru north forest reserve: Result showed that 43% of the respondent said deforestation and 50% of respondents mentioned cultivating along river banks as the human activities which contribute to drying up of water sources while 7% of the respondents mentioned climate change as one of the factor that cause drying up of water sources (Fig. 2). These findings tell that a good number of people in the study area tend to practice agricultural activities along river banks depending much on water which is available in rivers for irrigation and hence contributing to drying of water sources. Several land related problems have been reported in mountainous environments. They include among others, massive deforestation happening in Uluguru Mountains where local communities cut down trees for different purposes including charcoal making, fuelwood, building materials for their houses and also clearing of farms which is associated with cutting down trees[18]. Cultivating along river banks is another crucial human activity that contributes to drying up of water sources in Uluguru Mountains where by local communities practice crop production just near the rivers leading to siltation of river banks and finally drying up of water sources[19-20]. The other thing contributing to drying up of water sources is the issue of climate change as the result of human activities[18].

Human activities that distort the quality of water in the study area: Results from this study showed that 32% of the respondents mentioned fertilizer application, 8% mentioned pesticides usage and 2% mentioned herbicides usage in their agricultural activities as the causes of water quality distortion

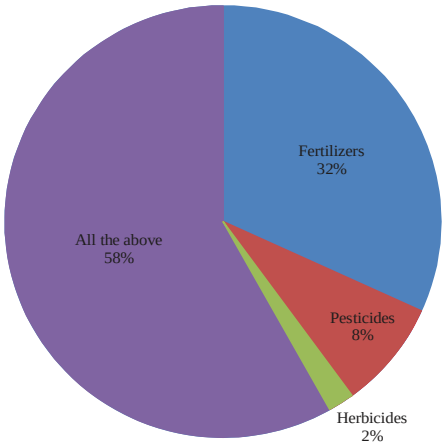

Fig. 3: Activities that distort the quality of water

and 58% of the respondents mentioned both the use of fertilizers, pesticides and herbicides as the causes of water quality distortion (Fig. 3). The results imply that most of farmers in Uluguru mountain tend to apply both pesticides and fertilizer in their farming practices and this signify the contribution to water catchment pollution especially river that receive run-off water from different areas and direct it towards rivers including washed pesticides and fertilizers[21]. Decline in water quality may be the result of using agro chemicals such as sulphate of ammonia (SA), Diammonium phosphate (DAP), Urea, Phosphorus and Potassium (NPK) and Calcium Ammonium Nitrate (CAN). However the physical science study should be undertaken to develop the baseline data for biophysical parameters for further environmental monitoring.

Measures taken by local people towards conserving water sources: Conservation of water sources by local people in Uluguru Mountain is done through planting trees, cultivating away from water sources and by avoiding cultivating in areas with steep slopes. The results showed that 62% of the respondents in this study conserve water sources through planting trees, while only 21 and 17% of the respondents conserve water sources by cultivating away from water sources and avoiding cultivating in areas with steep slopes respectively (Fig. 4). However by laws as an instrumental role in managing natural resources, they should be applied in order to enforce farmers to plant more trees, not cultivate along water sources and also cultivating away from steep slopes so as the activity of water sources conservation to be sustainable. Some studies done along the catchment areas have defined the integration of traditional norms and customs as the appropriate tools for managing particular resources[11,18]. In addition to above, village authorities together with

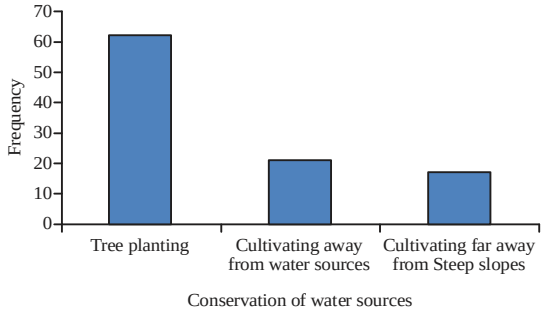

Fig. 4: Conservation of water sources by local people in the study area

Table 5: Awareness to the impacts of agriculture in water catchment areas

Awareness to the impacts of agriculture to water catchment	Frequency	Percent
Yes	32	53.3
No	28	46.7
Total	60	100

development partners have to develop bylaws intending to enhance the management of various resources. Generally the study has found that there is little concern from the local people living in Uluguru Mountains specifically the North Uluguru Forest Reserve on conserving water sources since they practice farming methods that are somehow not friendly to the water sources like fertilizer and pesticides application. On top of agricultural activities, they depend much on forest resources as their main source of energy for cooking and hence creating problems to the health of the catchments and finally failure in conservation of water sources.

Awareness to the impacts of water catchment degradation: Results showed that 53.3% of respondents responded positively while 46.7% of respondents responded negatively meaning that they are not aware or they know little about the impacts of agriculture in water catchment areas (Table 5).

Public awareness on conservation has been enhanced but it is still not adequate and efforts have to be stretched. The awareness of local people to the impacts that comes as the results of water catchment degradation in North Uluguru Forest Reserve is not enough to the extent that they can relate what they observe on the environment as the adverse effects of what they are practicing on their daily life. This can be the reason for some of them being illiterate in the sense that they don't know how different anthropogenic activities may result into adverse environmental effects[11,18]. Extensive and inefficient land use practices, limited local environmental awareness, weak law enforcement, weak management

capacity are one of the factors contributing to catchment degradation in this community.

CONCLUSION

The quality of both surface water and groundwater is affected by natural and anthropogenic factors. Largely, Uluguru Mountain farmers have a tendency to practice anthropogenic activities and apply both pesticides and fertilizer in their farms which contribute to water catchment pollution. Embedding gender equity into policy at all levels will be crucial to achieving resources managements. The study explored that the public awareness on conservation is not enough for the people based on their education status and therefore more effort have to be placed to enhance awareness regarding the environmental degradation around water catchment areas.

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