# Effects of Anthropogenic Activities on Catchment Forest in Njombe District: A Case of Nundu Catchment Forest

*Ahmad A. Maguo, Innocent, J. E. Zilihona* and Boniphace Kauki*

Institute of Rural Development Planning, P.O.Box 138, Dodoma, Tanzania
*Corresponding author: Email: izilihona@irdp.ac.tz

## ABSTRACT

*This study assessed effects of anthropogenic activities on Nundu catchment forest located in Nundu catchment forest in Njombe District. Specific objectives of the study were to identify anthropogenic activities conducted in the catchment forest, to examine the effect of anthropogenic activities on catchment forest and to determine efforts and constrains for management of catchment forest in the area. Data for the study were collected through interviews with a random sample of 98 household heads and seven key informants, as well as through two Focus Group Discussions (FGDs) with community members. Data were analysed through descriptive and thematic analyses. The study revealed that different economic and social activities were performed to varying degree in and around catchment forest. Social activities included water collection, firewood collection, brewing of local beer, local tourism, rituals, research, and collection of medicinal plants; while economic activities included farming, soil digging, charcoal making, lumbering and hunting. Most of these activities were noted to pose a significant threat to environment such as forest loss, water pollution, and soil erosion. Initiatives that were in place for conservation of the catchment forest included provision of education on conservation to community, involvement of stakeholders, enforcement of bylaws and allocation of buffer zone. However, some challenges existed in conservation efforts in the area. These included poor coordination among stakeholders, limited resources and lack of land use plan to the surrounding villages. Based on these findings, it was recommended that routine monitoring should be conducted to prevent new encroachment, charcoal making, and felling, which are a threat to forests in the area. Demarcation and fencing of hydrological such as water sources in the area is also important.*

**Keywords:** Forest, catchment, conservation

## 1.0 INTRODUCTION

Forest is a biological unit having a vast social organization of living communities at work. These forest communities have a vital role in maintaining a balanced eco-system of the world. Tanzania has been endowed with an immense variety of forest resources (Munishi *et al.*, 2007). However, with continuing pressures of an exploding population and the subsequent growing needs of industries, food, fuel wood, fodder, small timber, etc., depletion and degradation of forests and subsequent adverse changes in the ecosystem are taking place. Forests are essential for life on earth (Chomitz *et al.,* 2007). Three hundred million people worldwide live in forests and 1.6 billion depend on them for their livelihoods (WWF, 2016). Forests also provide habitat for a vast array of plants and animals, many of which are still undiscovered. They protect watersheds, furthermore, it is well known that forests are so much more than a collection of trees in the essence that forests are home to 80% of the world's terrestrial biodiversity, these ecosystems are complex webs of organisms that include plants, animals, fungi and bacteria (Madoffe *et al*., 2008).

Globally forests are being destroyed and degraded at alarming rates. Deforestation comes in many forms, including fires, clear-cutting for agriculture, ranching and development, unsustainable logging for timber, and degradation due to climate change. This impacts people's livelihoods and threatens a wide range of plant and animal species. Some 46-58 million square miles of forest are lost each year-equivalent to 48 football fields every minute. The Amazon, the planet's largest rainforest, lost at least 17% of its forest cover in the last half-century due to human activity (WWF, 2016). The net loss in a global forest area during the 1990s was about 94 million hectares, which is equivalent to 2.4% of the world activity, also it is estimated that almost 70% of deforested areas were converted to agricultural land in the 1990s especially to the catchment forest areas (FAO, 2010).

Many world development institutions and politicians regard population pressure as the major factor causing catchment forest destruction. Nobody can deny the serious global problem of population growth. However, the belief that this is the main cause of catchment forest loss is used by many governments and businesses to imply that there is little or nothing they can do about the problem of rainforest destruction (Revington, 2012).

In Africa, about 22 percent of land is forest and woodland. The Congo Basin is Africa's largest contiguous forest and the second-largest tropical rainforest in the world covering about 695,000 square mile. Only a small percentage of this acreage of forest is protected in Africa, most of the catchment forest undergoes degradation due to secondary activities performed by poor African under the influence of different socio-economic reasons. According to Fleshman (2008), forests in Africa are being cut down at a rate of more than 4 million hectares per year — twice the world's deforestation average.

Tanzania's Mainland has a total land area of 94.5 million hectares out of which 88.6 million hectares (ha) is landmass and 5.9 million ha is inland water (URT, 2013). About 13 million ha of forested land has been set aside as permanent forest reserves under the central government and 1.6 million ha is protective forests for catchment and biodiversity functions (URT, 2013). Tanzania's forests face enormous challenges including deforestation. Tanzania is reported to be among the countries with the largest forest loss per year in Africa (Tremblay and Lowry, 2016). According to URT (2013), high rates of deforestation led to a loss of 403,000 ha of forest per year which is equivalent to 1.16% of forest area.

Sound management of these forests can generate several environmental services such as water catchment, scenic beauty, biodiversity, and carbon sequestration, which in principle could be valued and paid for by various consumers (Munishi and Shear, 2004). Catchment forests are threatened by the prevailing high rate of deforestation and general degradation (Mwabumba, 2015). Degradation of catchment forests is influenced by anthropogenic activities and natural factors such as climate change. According to Nkonoki and Msuya (2014) and Kidegesho (2015), anthropogenic activities around the catchment forest become the main factor of catchment forest degradation when compared with natural factors. Due to the degradation of catchment forests, the government of Tanzania and the international community joined hands in addressing the problem of deforestation through forest resources management focusing on conservation (Kidegesho, 2015). Despite the effort of the government in addressing the problem of catchment forest, still, there is a problem of catchment forest degradation which influenced by anthropogenic activities (NAFORMA, 2015). Furthermore, existing information about the effect of anthropogenic activities on catchment forests is too limited. The limitation arises due to factors such as changes in time, population change, and changes in the culture of the people. Therefore, this study focused on assessing the effects of

anthropogenic activities on the Nundu catchment forest. This catchment forest comprises of Mapala, Itoni, and Nguruka forests. Specifically, the study intended at identifying anthropogenic activities affecting catchment forest, as well as associated effects; and examining conservation efforts and constraints for forest management in the catchment area.

## 2.0 METHODOLOGY

### 2.1 Description of the Study Area

The study was conducted in the Njombe district. This district is one of the districts which is found in the Njombe region. The district is located between latitudes 8°40' and 9°35' and longitudes 34°30' and 35°30'. The district cold climatic conditions in high altitude areas with temperatures ranging from 14ºC-20ºC and rainfall ranging from 1200 -1400mm per year, while lowlands temperatures ranging from 20ºC- 26ºC with long periods of a dry spell with annual rainfall ranging from 400 to 650 mm per year (URT, 2013). Regarding vegetations, the uplands are characterized by extensive grasslands and miombo woodlands; midland areas are covered by miombo woodlands, apple-ring acacia, winter thorn, *Pinus Patula* species, Snot apple*, Uapaca kirkiana,* and extensive grasslands; while lowlands are dominated by bush trees, shrubs and grasslands (URT, 2013). The main economic activity in the area is agriculture.

### 2.2. Study Design, Data Collection, and Analysis

Data for the study were collected through a cross-sectional survey in the study area carried out in June, 2017. A variety of techniques were used in data collection. This involved face-to-face interviews with households' heads using a questionnaire, In-depth Interviews with Key Informants (Tanzania Forest Services (TFS) managers; District Natural Resources Officers, District Natural Resource Officer, District Water Engineer, Ward Executive officer, Village Executive Officer, and NGOs dealing with the environment) and Focus Group Discussions. A questionnaire survey with heads of the household involved a random sample of 98 households selected using a multi-stage sampling technique and systematic random sampling. The sample size was estimated according to Kothari (2004). Quantitative data were analysed through descriptive statistics while qualitative data were analysed through thematic analysis.

## 3.0 RESULTS AND DISCUSSION

### 3.1 Anthropogenic Activities carried out in the Catchment and their Effects on Environment

The findings of this study revealed a different kind of activities performed in and around catchment forest, some of the activities were economic activities and some were social activities.

#### 3.1.1 Social activities

The present survey indicates different social activities were conducted in and around the catchment forest in the study area. The result in Table 1 indicates that the majority (83.7%) of respondents indicated water and firewood collection were the main social activity conducted within the catchment forest, mentioned by 100% and 83.7% of respondents, respectively. Other activities perfumed in the area by a notable proportion of survey respondents (mentioned in order of importance) included brewing of local beer (45.9%), local tourism (43.9%), rituals (42.9%), and research activities (35.7%), and to some extent collection of medicinal plants (23.5%).

**Table 1: Social activities conducted in and around catchment forest (n=98)**

| Social activity | Frequency | Percent |
|---|---|---|
| Rituals | 42 | 42.9 |
| Worship | 7 | 7.1 |
| Collection of medicinal plants | 23 | 23.5 |
| Water harvesting | 98 | 100.0 |
| Brewing of local bear | 45 | 45.9 |
| Local tourism | 43 | 43.9 |
| Research Activities | 35 | 35.7 |
| Firewood collection | 82 | 83.7 |
| Grave yard | 17 | 17.3 |

*Data were based on multiple responses

*Rituals*

The study area is occupied by the Bena tribe, people of this tribe practice ritual as a way of traditional life that is done since during the days of their ancestors. The catchment forests had been used for generations as sacred places, where offerings such as animals, local beer such as *Ulazi* are used for that activity. Traditional believers in this tribe (Bena) believe that there is a relationship between spiritual issues and nature, and they believe, it easy for their prayer to be answered because nature is the way of delivering their prayers to their ancestors. When asked how frequently ritual activities are done in catchment areas, more than half (56.1%) indicated it to be done very frequently. Kyalo (2013) reported that in Africa society rituals are symbolic, routine, and repetitive activities and actions through which make connections with what is considered being the most valuable dimension of life. No serious environmental impacts were reported in the area that is associated with rituals.

*Worships*

Worship is among the social activities performed within the catchment forest, however, nearly all respondents indicated to perform this activity within the catchment either rarely or occasionally. Therefore, not a very prevalent activity performed in the catchment. According to URT (2009) although, the catchment forest is strictly protected in the community, worshiping in these areas is allowed. Wood from the sacred tree is believed to keep its magical powers when fashioned into other objects and was used for making a variety of objects like statues of gods, staff, sceptres, etc. As with rituals, no serious negative environmental impact was noted in this study that is associated with worship.

*Medicinal*

Searching for traditional medicine is another social activity practiced by community members within the Nundu catchment forest. The medicine is for various purposes such as treatment of sick people within and outside the village, treatment of livestock, and pesticides for crops. About four in every ten study participants (43%) of the participants that use the forests for traditional medicine, indicated to perform this activity in the catchment very frequently. The most common tree species used for this purpose include Mdunula (*Osyris lanceolata*). Chaimumaom *et al.,* (2017) argued that plants have formed the basis of sophisticated traditional medicine systems that have been in existence for thousands of years and continue

to provide mankind with new remedies. Furthermore, plants have been utilized as medicines for thousands of years. These medicines initially took the form of crude drugs such as tinctures, teas, powders, and other herbal formulations. The specific plants to be used and the methods of application for particular ailments were passed down through oral tradition (Ganga *et al*., 2011). Since only part of the tree such as leaves, roots, barks are used for medicinal purposes (no cutting down of trees), this activity seemed to be not a serious environmental issue in the area.

*Water collection*

Water collection is another activity which is practiced within Nundu catchment forest. Community members agreed that the catchment forest provides water to the nearby villages surrounding the forest. Local technologies are the main means of water harvesting in the area, for example, wells (Plate 1). Based on technologies used for water harvesting/collection. This activity was noted to have no potential negative impact on the environment in the area.

**Plate 1: Water well in the catchment forest**

*Brewing of local beer*

The brewing of local beer (*Ulanzi*) from Bamboo trees in the catchment forests is a common practice by local people in the area. The activity involves cutting the tree for its juice, and sometimes the activity involves the use of fire consequently wildfires and forest destruction.

*Local tourism*

Local tourism is practiced by local dwellers and other people outside the villages within the catchment forest. Nearby the Nundu forest there is a place for social refreshment where people from Njombe town and people leaving near the forest used to get food, drinks, and other kinds of refreshment. This refreshment area is not within the forest but people can move from that area to the forest for local tourism. While in forests these tourists used to dump litter (i.e. plastic bags, bottles) and others defecate in catchment forest and the faeces are sometimes washed down to waters sources.

*Research Activities*

It was also noted during in-depth interviews with TFS officials in the present study that the Nundu catchment forest is used by various people for research purposes (basic and applied research). Some of the researchers may spend a couple of days researching the forest and some of them are coming in groups. Furthermore, different materials and products are carried by researchers including foods like biscuits, soda, and water. Sometimes all these materials are carried in plastic bags. Containers for the food are usually dumped in the forest after the food has been used and hence threaten the environment. Similar findings were also reported during in-depth interviews with one of the village executive officers as well as during Focus Group Discussions (FGDs).

*Firewood collection*

The findings of the study revealed that fetching of firewood to be another common activity conducted within the catchment forest by local people throughout the year. Firewood collectors in Nundu catchment forest generally firstly collect all available dry wood on the forest floor and then proceed to break dead branches off live trees, although this is done illegally. Firewood collection usually starts within the boundary of the forest then goes to the inner part of the forest. When all available deadwood has been collected, they will then turn to cut down live trees and/or branches. When live wood is cut, neat piles are usually stacked on the edge of the forest where it is left to dry, before they collect them. Women and children are the ones who are mostly involved in firewood collection. According to Ngubane (2010) and Ogato *et al.* (2009), in rural Africa cultures including Tanzania, firewood collection is the responsibility of women and girls as they are responsible for cooking and ensuring there is

enough firewood. When cutting trees is involved in the preparations of firewood, this could be a threat to forest cover and loss of biodiversity. Cutting down of trees for firewood was revealed by some respondents of the study to be done in the catchment.

### 3.1.2 Economic activities

Findings from the present study reveal that different economic activities have been conducted by community members in and around the catchment forest. The leading activities were farming, followed by soil digging, charcoal making, lumbering, and hunting, mentioned by 82.7%, 76.5%, 58.2%, 50.0%, and 32.7% of respondents, respectively (Table 2). Uncontrolled economic activities in catchment forests have been blamed by several scholars as the major challenge in environmental conservation in developing countries (Dagba *et al*., 2017).

**Table 2: Economic activities conducted in and around catchment forest (n = 98)**

| Economic activity* | Frequency | Percent |
|---|---|---|
| Farming | 81 | 82.7 |
| Lumbering | 49 | 50.0 |
| Hunting | 32 | 32.7 |
| Charcoal burning | 57 | 58.2 |
| Soil digging | 75 | 76.5 |

*Data were based on multiple responses

*Farming*

Farming activity is the major encroachment activity practiced by the local community in the catchment forest. The activity involves traditional farming systems (i.e. Vinyungu farming system) and to some extent modern farming system. Main crops produced in these encroached areas include maize, beans, and vegetables. While farming in some areas in the encroachment is seasonal, however, in the valley area is conducted throughout the year. Field activities during farming involve land clearing, fertilizer application, planting, crop watering, weeding, pesticide application, harvesting, and transporting. Interviews with study participants reveal farming within the catchment to be associated with loss of forest cover and biodiversity, water pollution due to chemicals used, as well as soil erosion.

*Illegal lumbering*

Illegal lumbering activity conducted within the forest involves three main stages including pre-field lumbering activity, field lumbering activity, and post-field lumbering activity. The pre-field lumbering activity includes preparation of the site for lumbering such as clearing the site for camping and positioning of machines for lumbering. Field activity involves cutting down a tree for sewing. Post field activities involve transportation of timber from the camping site to the station point for transportation. Illegal lumbering activities have been associated with big open pits in the catchment forests, loss of forest cover and biodiversity, disturbances to the ecosystem as indicated by study participants. Other activities indirectly related to lumbering are also conducted in camping sites such as cooking and smoking. Since these activities are associated with the use of fire, they sometimes lead to wildfires that disturb forests, soils, and biodiversity in the catchment. Environmental pollution resulting from open defecation and dumping of wastes (i.e. plastic bags) by people involved in lumbering activities in the catchment was also noted to be a concern by the interviewee.

*Hunting*

Hunting in forest can trigger numerous, effects that can alter the overall function, structure, and composition of the ecosystem within the forest. Often these effects are straightforward and easy to predict, especially for those species directly targeted by hunting activities. Plant regeneration, food webs, and plant diversity are amongst the various processes that depend upon the presence of fauna (Igben *et al*, 2012). Furthermore, hunters may start the wildfire in which they may fail to control, consequently destruction to forests (FAO, 2009). Hunting is a seasonal activity conducted by villagers in Nundu and Limage villages within the Nundu forest, mostly done during the dry season. The targeted animal includes rat, rabbits, and birds. Sometimes hunting for these animals/birds is done to control crop pests. Effect of this activity on the environment in the area is not very pronounced, however, overexploitation of this resource may lead to biodiversity loss as reported elsewhere (Corlett, 2007).

*Charcoal making*

Charcoal making is the dominant activity performed by local people in the catchment as a means of earning their lives, the activity that involves cutting down of trees. The situation is further worsened by the expanding population. Individuals involved in this activity used to

camp within the forest for several days to ensure security for their charcoal. Charcoal making is practiced illegally as it is not allowed within the catchment for environmental conservation. Plate 2 show a traditional charcoal kiln used by local people in the area for charcoal making. Endangered tree species due to charcoal making and lumbering in the area include *Hegenic absinica, Syzigum cuminii, Ocotea usambrasis, Brachystegia spiciformis.* As with lumbering, water from the catchment is also at risk of pollution from open defecation by people involved in charcoal making in the area. Furthermore, the activity has been associated with frequent outbreak of wildfires that destroys forests in the catchment. Plate 3 shows part of forest burnt by wildfires linked to charcoal making activities.

**Plate 1: Traditional charcoal kiln**

**Plate 3: A picture showing burnt forest in Nundu Catchment Forest due to the anthropogenic activities**

*Soil digging*

Soil digging is one of the encroachment activities practiced in catchment forest; it involves transportation of soil from the forest to other areas including farms which are located near the catchment forest. Soil digging within the catchment forest is also performed by people outside the surrounding villages. The soil is used as fertilizer for their farms, tree plantation, and it is also used for construction purposes. Soil digging has been associated with soil erosion in the catchment, specifically, rill soil erosion, indicated by 90.0% of the interviewed study participants.

### 3.2 Conservation Efforts and Constraints for Forest Management in the Catchment

The existence of the effects of anthropogenic activities in and around the forest had called stakeholders and relevant authorities to initiate efforts to control it. This subsection, therefore, presents the efforts that have been implemented, constraints encountered, and emerging opportunities.

#### 3.2.1 Efforts to control effects of anthropogenic activities

There are several efforts undertaken to make sure that Nundu catchment forest is conserved to

enable it to continue providing its services. The following were the efforts undertaken;

*Capacity building/provision of education on conservation*

Management of catchment forest needs capacity building in both technical and financial support for better conservation. TFS is used to provide technical assistance to the local community on how to utilize forest resources sustainably. However, shortage of resources has been a major challenge to conduct capacity building activities such as seminars, workshops as there are four catchment forests in Njombe district that need to be served with limited resources (In-depth interviews with key informants).

*Stakeholders' participation in catchment forest management*

TFS in collaboration with NGOs related to forest issues such as Njombe Forest Conservation (NJOFOCO), local leaders developed a mechanism to ensure community participation in forest management. Community participates in different ways, among others include information sharing about the prohibited activities. Table 3 show difference stakeholders and their role in management of catchment forest.

**Table 2: Stakeholders and their role in management of Nundu catchment forest**

| | **Stakeholders** | **Category** | **Roles and responsibility** |
|---|---|---|---|
| 1 | Community member | User | Conserve forest, abide rules and regulations on forest |
| 2 | Ward executive officer | Conservator | Law Enforcement |
| 3 | Village executive officer | Neighbour, User | Law Enforcement |
| 4 | Tanzania forest services | User, Conservator, Manager | Law Enforcement |
| 5 | Njombe forest conservation | Conservator | Education provision |
| 6 | Local Government Authority | Conservator | Law Enforcement |

*Rules and regulation*

The catchment forest is protected by Tanzania Forest Act of 2002; however, TFS in collaboration with local leaders and community members has developed several bylaws to ensure protection of catchment forest species. Bylaws developed focused on sustainable utilization of forest species by community members. Among the bylaws includes; no vehicle

is allowed to enter the forest and no farming activity is allowed on water catchment area. There are fines and punishment including imprisonment for violators of the bylaws.

*Establishment of buffer zone*

TFS in collaboration with local government and local community has developed a buffer zone that distinguishes the area where community members are allowed to perform their activities and the area where they are not allowed. According to Kashamakula (2017) (Personal communication), Nundu catchment forest has demarcated its boundary by putting permanent beacons. The aim of putting the boundary is to make community leaving nearby the forest to be aware of the boundary of the forest. People are told to observe the beacons before doing their activities nearby the forest.

### 3.2.2 Constraints to conservation efforts for the catchment

Management of Nundu catchment forest faces different constraints which affect effort developed by different stakeholders at the same time threatening the sustainability of catchment forest. The constraints include;

*Poor coordination*

Management of the catchment in the area requires good coordination among stakeholders such as TFS, department of water management; department of natural resources and environmental management; as well as among local government and central government. However, findings from this study revealed poor coordination among these stakeholders in managing Nundu catchment forest, consequently wastage of resources by each stakeholder to perform their role resulted from duplication of efforts (In-depth interviews with key informants) as reported elsewhere (URT, 2015).

*Limited resources*

Management of Nundu catchment forest requires several resources such as manpower, physical and financial resources. TFS as a responsible institution for management of Nundu catchment forest faces the challenge of shortage of resources for management of the forest. This study revealed that there was only four staff that were responsible for managements of forest resources for the whole Town Council compared to the required 8 staff. In the case of

financial resources, the present study revealed that allocated budget for the forest resources for the whole district was very low compared to demand. Similar apply to physical resources particularly vehicles. All staff depends on one vehicle where the demand is at least three vehicles. Shortage of vehicles reduce the efforts such as number of patrols required and outreach program such as seminars, workshops and education programs for management of catchment forest. According to Kashamakula (2017) (Personal communication), shortage of resources reduces the efforts of institutions responsible for handling bushfire which is a common incident in the study area. The study revealed that in 2016 about 20ha of land was destroyed by bushfire.

*Land ownership and land use plan*

Forests of Nundu catchment are classified as forest reserves; they are owned by the government through Ministry of Natural Resources and Tourism under TFS. The lands are owned by the government and the Catchment forests are fully owned by the government. However, despite the fact that the land and the forest are owned by the Government, it was observed that there were settlements that have been established in some areas of the forest as part of Nundu village which is located near the forest. The study revealed that for the past two and half decades, community started to clear part of catchment forest and establishes their settlement. Furthermore, villages surrounding Nundu catchment do not have village land use plan, a situation that brings difficulties in protecting the catchment from anthropogenic activities.

## 4.0 CONCLUSION AND RECOMMENDATIONS

### 4.1 Conclusion

The findings of this study revealed different kinds of activities were performed in and around catchment forest, some of the activities were economic activities and some were social activities, each performed to a varying degree. Social activities (mentioned according to the order of importance, from highest to lowest) included water collection, firewood collection, brewing of local beer, local tourism, rituals, research, and collection of medicinal plants. On the other hand, economic activities (also mentioned in order of importance) included farming, soil digging, charcoal making, lumbering, and hunting. Most of these activities posed a

significant threat to the environment such as forest loss, water pollution, and soil erosion. However, some efforts/initiatives were in place as well as challenges for conservation of the catchment forest in the area. The efforts included capacity building/provision of education on conservation to the community, involvement of stakeholders, enforcement of bylaws and establishment of buffer zone; while challenges included poor coordination among stakeholders, limited resources and lack of land use plan to the surrounding villages.

### 4.2 Recommendations

i) There is a need for routine monitoring to prevent new encroachment, charcoal making, and felling of trees and hence threat to forests in the area. Demarcation and fencing of hydrological such as water sources in the area is also important.

ii) The government should introduce Payment for Ecosystem services as people leaving nearby forests are the ones who protect the forest. Furthermore, the initiation of small projects such as beekeeping, mushroom farming could be good options for livelihood support to the surrounding community in the area.

iii) The government should make an early warning system for wildfires while they take the precaution of fire control.

iv) The government through TFS should make sure the community is involved in the management of forests through the Joint Forest Management (JFM). This will ensure community benefit and sharing the resources from Nundu catchment forest, consequently better protection of the forest.

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