



Original Article

Investigation of the Effect of Human Disturbances on Mahungu Gree Belt Forest Reserve (MGFR) in Dodoma City, Central Tanzania

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Human disturbances are the human activities, whether legally or illegally conducted in an ecosystem as they may lead to removal or death of plants. The study was piloted at Mahungu Green Belt Forest Reserve (MGFR) in 2015 to examine the effect of human disturbances. Systematic random sampling was applied. A total of 36 plots of 50 m x 50 m were established in the seven transects at an interval of 400 m. Ongoing human activities were identified and recorded. GPS was applied to locate plots, aligning transects and recording coordinates. The compass was used to direct the transect. 100 m tape was used to measure the plots. Inferential statistics was applied whereby human activities frequency and relative frequency were calculated. The identified and recorded most frequently occurred human activities were firewood collection, charcoal making, grazing and trespass routes. MGFR is potential in terms of biological diversity; it is recommended that; introduction ecotourism as and environmentally friendly projects; determination of all plant species of MGFR; education campaigns by Dodoma Universities; encourage woodlot development at household level; awareness creation; provision of environmental conservation education; enhance non-woody income-generating projects; discourage settlement expansion into the remaining forest patch; funds should be made available throughout to ensure regular patrols by field security guides, and enhance alternative sources of energy to the local people.

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INTRODUCTION

Globally, green belts have been known to be areas of vegetation or a mass plantation of pollutant-tolerant trees for mitigating the air pollution by intercepting, filtering and absorbing pollutants in a sustainable manner (UNEP, 2007; Missanjo et al. 2015). The green belt is an area of open land or open space around a city on which building is restricted. The National Forest Policy (URT, 1998) stated that green belt is all land bearing a vegetative association dominated by trees of any size, exploitable or not, and capable of producing wood or other products. Forest reserves are portions of state lands where commercial harvesting of wood products is excluded in order to capture elements of biodiversity that can be missing from sustainably harvested sites. Green belt forest reserves represent potential approach towards the enhanced supply of ecosystem goods and services in many urban and peri-urban areas in the tropics, including Dodoma Municipality. MGFR as a part of the whole green belt of Dodoma municipality. It was established by the United Republic of Tanzania under Capital Development Authority (CDA) in 1973 so as to cater for firewood, recreational, windbreak and climate regulation in the city. The sustainability of many forest reserves and green belt forests is threatened by the ongoing high extent of deforestation due to conversion of forest reserves into farmlands and human settlements, thus calling for protection attention. The disappearance of species has been described as a loss of plants and animals with potential economic value. The loss of genetic diversity is as a threat to global climate and

the environment hence severely impacting human and environmental sustainability (Huston, 1996). Human beings are connected to plants and animals around them (Sinclair and Ryan, 2011). Biological diversity often has immediate significance to traditional societies whose people live close to the land and water sources (Primack, 2006).

Forests are very important in Tanzania due to the ecosystem goods and services they offer to people and the ecosystem as a whole. Forests provide firewood, charcoal, wild edible fruits, poles, timber and tubers (Mugasha et al., 2013). The services offered by forests include water catchments, carbon dioxide sink, and shelter. They also, support wildlife, as well as provide, regulation of temperature and rainfall, prevention of landslides, among other services (Kupnick, 2001). Woody plants, including shrubs, woody climbers and trees play an important role such as generating of income to the people through various exploitation (Malimbwi et al., 2010). Kupnick (2001) stated that the diversity of plant life is an essential underpinning of most of the terrestrial ecosystems. In the tropics alone, it has been estimated that 25,000-30,000 species are in use for various purposes (Howell et al., 1961). According to Environmental condition of Tanzania report (URT, 2008), the daily human needs for vegetation resources are always the most threats to the existing plant species diversity, as most of them involve the removal of plant materials. Most of the vegetated areas were very safe when the human population was low; however today they are increasingly getting depleted to the level that we cannot have a

clear idea of the number of plant species existing in our environment.

The Dodoma Green Belt Forest Reserve was announced in the CDA report (URT, 1976) as an area for recreational purposes, source of dead firewood, windbreak, soil erosion prevention and protection of biological diversity. A number of studies conducted in European countries revealed that elevated overexploitation of forest resources both in the urban and wild started in the 1990s (Parviainen et al., 2000) Urban forests faced a great challenge from the change of land uses such as settlement instead of the former aims of protection for recreational purposes. In the wild, open and protected land destruction was a result of the expansion in technology that demanded forest materials for furniture, construction, and also establishment of new settlement or institutions. Many countries remain not focused thoroughly on plant species diversity and human disturbances to the ecosystem natural resources (Brown et al., 2007) of which Dodoma in Tanzania is among them. Human activities, whether legal such as accesses roads or illegal like logging have a negative impact on the ecosystem.

Influence of Human Population to Plant Species Diversity

Vegetation condition has been reduced considerably over the years by human activity and together with frequent fires leaving very small sections of the original ecosystems leading to a large-scale change on plant species composition, dominance and diversity (Sinclair & Ryan, 2011). The human population increase leads to challenges on natural environment including vegetation depletion due to the overwhelming demand for plant resources in public areas, hence more pressure on the protected areas (Margulis and Schwartz, 2000). In addition, Zimmerman et al. (1996) and Manning et al. (2001) pinpointed that the growth of the human population and increasing urbanization has led to the shrinking or total destruction of the habitats of many plants and the changes can only be observed through organized botanical research. The dramatic and continued reduction in the population of plant species for the reasons other than habitat loss, particularly for high-value timber species

where over-harvesting threatens wild populations (Smith and Wyk, 2008).

Over the last decades, it has been observed that the wealth of living forms inclusive of plants is being lost. The consequences of this loss cannot be foreseen, but it is generally recognized to be one of the greatest problems the human being is expected to face in the future (Smith and Wyk, 2008). Plant species diversity is shaped by their extraction and use by humans. In the natural and human process, plant diversity has developed with continuous gain and loss, though it is clear that in recent decades the balance has become negative (Margulis and Schwartz, 2000). The environmental change revolves around questions of how we measure real change and how much of the observed change results from various factors such as human activities, wildlife congestion and wildfires (Smith and Wyk, 2008).

According to National Beekeeping Programme (URT, 2004), Tanzania has a good environment for producing various products, among them bee products favored by the high diversity of plant species that provides nectar and pollen that attract honey bees. The threats to a number of plants are manifold ranging from unsound agricultural practices, urban expansion and industrial development to injudicious and non-suitable collecting by enthusiasts, an increasing need for plant material resource and supply of traditional medicine and sometimes simply ignorance about the plight of the environment in general (Smith and Wyk, 2008). The successive patterns of human land use, including pastoralists, agro-pastoralists, agrarian communities and hunter-gatherers have contributed to climate change and thus generating a diverse and dynamic ecology (Maunder et al., 2002).

The main threat to vegetation in East Africa is from the felling of trees for small scale agriculture (Maunder et al., 2002). Beentje (1994) pinpointed that most of our beautiful natural vegetation and plant species are facing a number of challenges including damage caused by human activities that alter their composition and diversity. Native vegetation areas are complemented with exotic plants, especially in settlements, of which some have become invasive. However, little has been

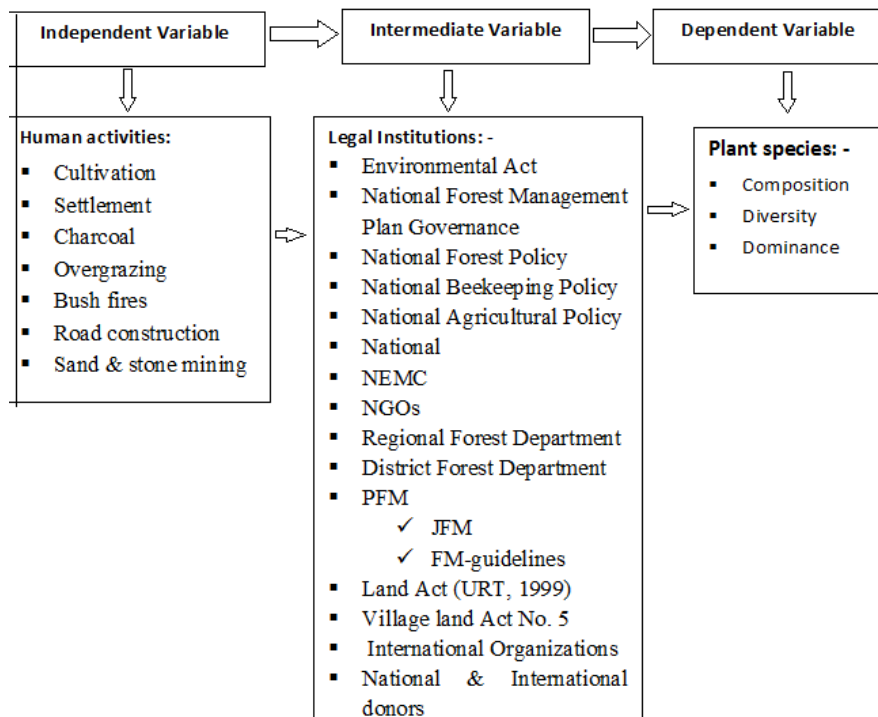
done on the assessment of plant species diversity as well as their associated composition dynamics (Beentje, 1994).

Factors Influencing Disturbances on Mahungu Green Belt Forest Reserves (MGFR)

The need for goods and services offered by the ecosystem calls for overexploitation of biological diversity (Malmer and Nyberg, 2008). While the conservation organizations strive for resources protection, communities struggle harvesting such resources to improve their livelihood. The Ujamaa Community Resource Team (2010) highlighted that natural resources are strained when there is a direct benefit to the community through the generation of income and other associated tangible resources. Naughton (2007) conducted an investigation on green belt diversity and revealed that poverty, improved technology and increase in population intensifies the rate of demand for the ecosystem protected natural resources including land for settlement, even though the land-use zoning set aside some areas for protection purposes. Further exploration is vital to found out the challenges facing the species diversity.

The world accommodates enormous plant species diversity with a variety of values to both human beings and wildlife (Sapieha, 2008). Recently, Tanzania's average annual deforestation rate has been revealed to be at a global high of per cent, more than twice the global average of 0.5 per cent. The country is losing between 300,000 to 400,000 hectares of forest each year, and experts warn over the possibility of increasingly rapid climate change effects (Kessy, 2013). Little has been documented on the human disturbances to forest reserves. Mligo (2011) noted that the forest species are threatened because of cultivation, firewood collection, charcoal making and expansion of settlements. Most of the wetlands of south sub-Saharan, including Botswana and Tanzania are polluted, thus affecting aquatic life; however, much has not been studied thoroughly (Goldberg, 2015). The human activities, whether legal or illegal have a potential influence to plant species diversity of which the world of science may not be aware. This study aimed to investigate the effect of human disturbances (activities) on MGFR, as shown in *Figure 1* below.

Figure 1: Conceptual Framework



heaviest concentrations on the hills of the region Capital Development Authority (URT, 2002).

The vegetation of Mahungu Forest Reserve is dry savanna shrub-thicket land with scattered trees and grassland patches interrupted with trees and shrubs. The common plant species include *Commiphora coerulea*, *C. ugogensis*, *C. africana*, *Acacia tortilis*, *A. senegal*, *Maerua decumbens*, *Combretum apiculatum*, *Grewia forbesii*, *Brachystegia spiciformis*, *Sclerocarya birrea*, *Julbernardia globiflora*, *Delonix elata*, *Markhamia acuminata* as indigenous taxa, while the exotics include *Peltophorum pterocarpum*. MGFR, being in Dodoma region has a dry savanna type of climate characterized by a long dry season lasting between late April to early December and a short single wet season during the remaining months. The region lies in a rain shadow behind the mountains area of Dodoma on the eastern side (URT, 2002). The temperature of the region varies according to altitude, but generally the average maximum and minimum for October to December are 31 °C and 18 °C (degrees Centigrade) respectively. The corresponding figures for the cool and dry season of June – August are 27 °C to 28 °C and 10 °C to 11 °C (degree centigrade) (URT, 2002). The average rainfall for Dodoma town is 570 mm, about 85% of this rainfall is four months between December and March. Rainfall is somewhat higher in the more agriculturally productive parts of Mpwapwa and Kondoa districts. Rainfall in Dodoma region is not only low, but it is rather unpredictable in frequency and amount, particularly in the month of January in which most crops are generally sown (URT, 2002).

The identified agriculture crops grown in Dodoma Municipality were Sorghum bicolor (sorghum), *Zea mays* (maize), *Oryza sativa* (paddy), *Phaseolus vulgaris* (beans), *Pennisetum glaucum* (bulrush millet), *Manihot esculenta* (cassava), *Arachis hypogaea* (groundnuts), *Vigna subterranean* (Bambara nuts) (URT, 2002). Other crops were *Helianthus annuus* (sunflower), *Sesamum indicum* (simsim), *Vitis vinifera* and *V. laburnifolia*. Dodoma Region is almost entirely dependent on agriculture and animal husbandry, which are practised in rural areas at the subsistence level. It is also one of the regions with large numbers of livestock including cattle, goats, sheep, poultry and pigs (URT, 2002).

Sampling Procedures

Systematic random sampling was employed during data collection to give equal chances to any element to be selected. The first plot was set randomly at a distance between 50 m to 100 m from the reserve edge to avoid the edge effects, then preceded systematically at an interval of 400 m. Systematic random is a probabilistic sampling which is applied to avoid the edge effect. The observed human activities were recorded. The sampling frame was 600 hectares (6,000,000 square meters). The sampling unit was a rectangular plot of 50 m x 50 m [2,500m²]. Sarma (2006), stated that the basic unit from which the researcher wishes to extract data should be determined. The sample size was 36 plots laid at an interval of 400 m within which human activities were recorded. The parameters of interest were the human activities in the sample plots. Human activities as parameters of interest are the variables to be investigated (Sarma, 2006).

Data Collection and Analysis

Observation method was employed whereby the human activities found in the set plots were recorded. Kawulich (2005) argued that observation is a way of gathering data by watching behaviour, events, or noting physical characteristics in their natural setting. Observations were both direct and indirect. Direct observation is when the researcher watches interactions, processes, signs or behaviours as they occur. Indirect observations are when the researcher watches the results of interactions, processes, or behaviours; such as measuring the events such as disturbances done by a person in a particular study site (Kothari, 2004). Data collection checklist was used to record any revealed plant species, as well as the observed human activities. Global Positioning System (GPS) was applied for recording the coordinates of the plot and boundaries of MGBFR, while a compass was used for orientation of the bearing.

Data were analyzed as $HA\% = \frac{\sum n}{\sum N} \times 100\%$; where HA = a single type of human activity; \sum = summation; n = total occurrence of a single type of human activities; N = total number of occurrences of all human activities categories.

RESULTS AND DISCUSSION

Human Disturbances (activities)

During this study, a number of human activities were recorded (*Table 1*). Various reading such as UNDP (2000) has stated that human activities ruin the environmental resources in many of the African countries. Besides, desertification has irreversibly destroyed a great amount of land previously available for grazing. Deforestation for agriculture, charcoal making and soil erosion are equally proceeding at an alarming rate. Furthermore, food production by local people is declining while fuel wood is increasingly hard to collect in most depleted general lands forcing communities to encroach into protected areas (UNDP, 2000). It has been posited that recognition of the causes and effect of environmental variables can help in drawing the conclusions that can help conserve and protect the environment (NGS, 2001). The majority of Tanzanians use fuelwood and charcoal as the main source of energy however the use of charcoal is more pronounced in big cities like Dar-es-salaam (>83%) while over 87% of fuel wood is used in the rural area (the United Republic of Tanzania, 2008). Tanzania depends on charcoal and firewood as sources of energy and thus contributing to environmental damage. Loss of biodiversity and deforestation are among six major environmental problems facing Tanzania, whereas the others include land degradation, accessibility of water, air and water pollution and aquatic systems degradation, which are massively contributed by human activities such as logging for timber, charcoal production, grazing, and firewood collection (Assey et al., 2007).

In this study, several human disturbances (activities) were identified (*Table 1*). Legal human activities such as access road or patrol road construction and maintenance, and illegal activities like logging for charcoal, and stone collection were identified at MGFR. Legal activities include settlement, cultivation, tree cutting, road construction, stone collection, timber extraction; grazing, firewood production to list a few, while illegal activities may be as the same as the legal ones, except that they are conducted in the site where it is not permitted, based on the environmental act, laws and policies. Leinster and

Gobbold (2010) pinpointed that the environment we live experiences two major categories of human activities, namely the legal and illegal activities, and all these have an impact to biological species richness and distribution evenness. The protected areas, apart from being under total protection or allowing a very minimal rate of resources collection such as dead woods, still many illegal activities prevail. However, both legal and illegal activities do not guarantee the survival of biological species and the abiotic environment. All categories of human activities may alter the vegetation types of species composition through either removal of the introduction of invasive plant taxa. A study conducted in South America, North America, European, Asian and African continents by Sandbrook et al. (2018) applying camera traps (Bycatch method) revealed illegal human activities in the protected forests seeking for various forest resources.

Table 1: Human disturbances per plot for plot 1-36

PLOT NO.	FW	CHC	GR/BR	CU	UPR	RP	TPR	SC	SSCR	BK	TAA	TNS	REMARKS
1	0	0	1	0	0	0	1	0	0	0	2	26	Trample, new dung
2	0	0	1	0	0	0	1	0	0	0	2	30	Trample, new dung
3	0	0		0	0	0	0	0	0	0	0	22	Intact
4	0	1	1	1	0	1	1	0	0	0	5	18	New cow and goat dung Firewood pieces found, old charcoal
5	1	1	0	0	0	0	0	0	0	0	2	30	kiln
6	1	0	0	1	0	0	1	0	0	1	4	32	Firewood bundles found
7	1	0	0	0	0	0	0	0	0	0	1	29	Firewood bundle found
8	1	1	0	0	0	0	0	0	0	0	2	29	<i>Combretum molle</i>
9	0	1	0	0	0	0	0	0	0	0	1	19	<i>T. sericea</i> logged
10	1	1	0	0	0	0	0	0	0	0	2	26	<i>T. sericea</i> logged
11	1	0	0	0	0	0	1	0	0	0	2	25	<i>J. globiflora</i> logged
12	0	0	0	0	0	0	0	0	1	0	1	24	Service route
13	1	1	0	1	0	0	0	0	0	0	3	17	<i>Rods, old kiln</i>
14	1	0	0	0	0	0	0	0	1	0	2	22	<i>J. globiflora</i>
15	1	1	0	1	0	0	0	0	0	0	3	44	<i>J. globiflora</i>
16	1	0	0	1	0	0	1	0	0	0	3	15	<i>J. globiflora</i>
17	1	1	0	0	0	0	0	0	0	0	2	36	<i>T. sericea</i>
18	1	1	1	0	0	0	0	0	0	0	3	23	Old charcoal kiln, cows found <i>Terminalia sericea</i> & <i>Delonix elata</i>
19	1	0	0	1	1	0	0	0	0	0	2	25	logged
20	0	1	1	0	0	0	0	0	0	0	2	20	Old kiln
21	0	0	1	0	0	0	1	0	0	0	2	30	Goats found
22	1	1	1	0	0	0	1	0	0	0	4	28	Severely grazed
23	0	1	1	1	0	0	1	0	0	0	4	28	3-old kilns <i>B. spiciformis</i> , cows, goats & sheep
24	1	1	1	0	0	0	0	0	0	0	3	31	found
25	1	1	1	0	0	0	0	0	0	0	3	13	Cows, goats & sheep
26	1	1	1	0	0	0	0	0	0	0	3	20	Cows, goats & sheep

PLOT NO.	FW	CHC	GR/BR	CU	UPR	RP	TPR	SC	SSCR	BK	TAA	TNS	REMARKS
27	1	0	1	0	0	0	0	0	0	0	2	0	Old settlement, <i>Xeroderris stuhlmannii</i> & <i>Combretum molle</i> cut.
28	1	0	1	0	0	0	1	0	0	0	3	17	Left firewood, trample
29	1	0	1	0	1	0	1	0	0	0	3	25	Up routed plants, new dung of goats and cows
30	1	1	1	0	0	0	0	0	0	0	3	22	10-Stumps of <i>J. globiflora</i>
31	1	1	1	0	0	0	0	0	0	0	3	18	Cow dung, charcoal kiln
32	1	1		1	0	0	0	0	0	0	3	20	Old charcoal kiln
33	1	1	1	0	0	0	0	1	0	0	4	27	Old settlement
34	0	0	0	0	0	0	0	0	0	0	0	16	Intact
35	0	0	0	0	0	0	0	0	0	0	0	13	Intact
36	0	0	0	0	0	0	0	0	0	0	0	21	Intact
TOTAL	24	19	17	8	1	1	11	1	2	1			

Key: -

FW = Firewood; **CH** = Charcoal; **GR/BR** = Grazing/Browsing; **CU** = Cut/Cutting; **UPR** = Uprooted; **RP** = Rope; **TPR** = Trespass Route(s); **SC** = Stone collection; **SSCR** = Security Service Car Route; **TAA**=Total Human activities; **TNS** = Total number of species; **BK** = Beekeeping; 0 = Not recorded in the plot; 1 = Recorded in the plot.

Out of the 10 identified human activities in MGBFR, firewood collection took the lead (67%), preceded by charcoal (53%), grazing (47%), cutting rods size (22%), trespass routes (31%), service road (6%) and the rest activities got 3%. The sum of the percentages sums up more than 100% because the occurrence of activities has been calculated

Table 2: Human activities occurrence percentage in 36 plots

Human activity	Total plots activity occurred	Percentage in plots
Firewood	24	67
Charcoal	19	53
Grazing	17	47
Cutting	8	3
Uprooting	1	3
Ropes	1	3
Trespass routes	11	31
Stone collection	1	3
Service car routes	2	6
Beekeeping	1	3

focusing on the total number of the plots they occurred, such as for firewood, it occurred in 24 plots; then;

$$\text{Firewood (FW)} = \frac{24}{36} \times 100\% = 67\%.$$

The relative frequency revealed 27.0% for firewood, 21.0 for charcoal, 19.1% for grazing, 12.4 % for trespass routes, 9.0% for cutting rod

size, 6.7 for service car routes, and the rest including ropes, uprooting, stone collection and beekeeping got 1.1% each.

Table 3: Activity, occurrence and relative occurrence in the 36 plots

Activity	Occurrence	Relative occurrence [%]
Firewood	24	27.0
Charcoal	19	21.0
Grazing	17	19.1
Cutting	8	9.0
Uprooting	1	1.1
Ropes	1	1.1
Trespass	11	12.4
Stone collection	1	1.1
Service car routes	6	6.7
Beekeeping	1	1.1
Total	89	100

Firewood collection, apart from being legal has implications for planting biological diversity. The collection of dead Woodsy discourages important bacteria and tiny insects carried together with

firewood outside the reserve. The soil improvement from the decaying of woody materials is severely discouraged. Also, plant seedlings and lower growing plants are easily destroyed during

firewood collection. The most damaged woody plant species by human activities were *Julbernardia globiflora*, *Terminalia sericea*, *Brachystegia spiciformis*, *Combretum molle*, while *Lannea schimperi*, as well as *Brachystegia spiciformis*, were debarked for ropes.

Effect of Human Disturbances (Activities)

Human activities conducted in protected land may lead to removal or damage to resources (Plate 1-5). Most of the human activities involve the removal or damage of plant species in various ways, as highlighted in this study. The findings by Mligo (2011) and Kimaro and Lulandala (2013) revealed that human disturbances had an influence on plant species composition and diversity. Sale & Francis (2011) who conducted a study on impacts on forests came up with results that human activities led to deforestation, industrialization, and expansion of many other socio-economic activities that

collectively led to degradation of environmental resources.

This includes the removal of organic plant materials that were meant to remain improving the soil nutrients for ecological benefits. It also encourages the damage of live trees due to demand for ropes, such as *Brachystegia spiciformis* and *Lannea schimperi* bear a suitable bark for ropes (Plate 1). Sassen et al. (2015) study in Uganda found that human activities in protected forests involved wood fuel extraction, illegal commercial fuelwood harvesting. A situation that quantities of dead wood were affected by fuelwood collection up to at least 1000 m inside the boundary of the park. This implies that the illegal collection of dead woods from protected forests may encourage illegal cutting for commercial purposes and thus leading to damage of biological diversity and or environmental damage in general.



(Plate 1: Firewood tied with barks of *Lannea schimperi*; Plate 2. Illegal collection of stones in Mahungu Green Belt Forest Reserve (MGFR); Plate 3: Goats browsing in the southern part of Mahungu Forest Reserve; Plate 4: Old kiln near *Brachystegia spiciformis* stump; Plate 5: Eroded service road in the south-west of Mahungu Green Belt Forest Reserve (MGBFR).

Goats are the famous browsers, usually damaging leaves and twigs of shrubs, saplings, small trees as well as the lianas. Most of the Legumes and Convolvulaceae family including *Turbina stenosphon*. Old women and young boys are regularly found herding livestock in the forest reserve, especially very early in the morning and late in the evening (Plate 3). The study conducted in Ethiopia by Giday et al. (2018) revealed that livestock direct browsing and grazing or indirectly by cutting livestock fodder plants, especially during the dry season leading to reduction of plant species inside the forest, an indication that the higher the livestock number in the area the more of the plants were depleted.

Stones are preferred for household's construction as well as a source of income, sold in tones. The accumulation of these stones (Plate 2) is associated with destroying the lower growing plants, seedlings, poles and even larger plants. It also loosens the soil and thus stimulating soil erosion. Charcoal making was noted to be the most damaging activity that involved cutting trees with the highest diameter for higher production of charcoal for sale. The trees ready to produce fruits were revealed to be cut. The situation results in suitable habitat for wildlife was removed, reduced plant diversity and abundance, reduced carbon dioxide sinks and climate regulators reduced the windbreakers and also, spoiled the natural scenery (Plate 4).

Other studies like by Sassen et al. (2015) have supported that charcoal making involves cutting trees, hence leading to damage of forest biodiversity. There were roads that facilitate the passage through the forest reserve regularly by the forest staff. The access routes, apart from being among legal activities, they always involve removing the vegetation, disturbing soil, a process that encourages soil erosion by either wind or water runoff (Plate 5). The study findings by Calskasn (2013) The percent of damage in terms of wounding, bending and crushing of trees were 64%, 31% and 5% respectively (for Bulldozer -I), 66%, 24% and 10% respectively (for Bulldozer -II), 60%, 34% and 6% respectively (for Excavator-I) and 56%, 29% and 15% respectively (for Excavator - II). It was also determined that on steep terrain when excavators were used, 12.23% less forest area

was destroyed compared with when bulldozers were used and 16.13% less area was destroyed by excavators on very steep terrain.

CONCLUSION AND RECOMMENDATIONS

There is a linear relationship between the increase in the independent variable (human activities) and the dependent variable (plant diversity, composition and dominance). The legal and illegal human activities had an impact on plant diversity, whereas the illegal ones dominated due to continuous occurrence haphazardly such as charcoal making and overgrazing. The controlled human activities focused only on the well-planned sites, and not otherwise. Protected land faces high pressure from the bordering community as a result of the high demand for natural resources to sustain their life.

From the presently conducted research, recommendations are made in order to sustain the unique forest reserve and ensure sustainable development and environmental management in Dodoma Municipality. Introduction ecotourism as among environmentally friendly project that leads to income generation with minimal damage to abiotic and biotic components; it involves viewing attractive features or natural scenery such as attractive vegetation, big holes, caves, extra-large trees and fauna. Others include determination of all plant species of MGFR, education campaigns by Dodoma Universities, encourage woodlot development at the household level, awareness creation, provision of environmental conservation education, enhance non-woody income-generating projects, discourage settlement expansion into the remaining forest patch, funds should be made available throughout to ensure regular patrols by field security guides, and enhance alternative sources of energy to the local people.

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