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SURVEY ARTICLE

# Implication of Socio-economic Factors on Land Use and Forest Cover Changes in and Around Magamba Nature Reserve in Tanzania; Perception of Local Stakeholders

Solomon Jeremiah Sembosi

Department of Research and Protection, Southern Tanzania Elephant Program, Iringa

* Corresponding author email: solomonjeremiah54@yahoo.com

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## ABSTRACT

Rural settlements in mountainous regions are a typical process that occurs in many places around the world and have a number of implications on the landscape. Among them is a threat it possesses to the conservation and management of Afromontane ecosystems. This study assessed the socio-economic factors that drive the changes in land use and forest cover and the extent of land use and vegetation cover in and around Magamba Nature Reserve. Focus group discussion, direct field observation and household survey were used to acquire socio-economic information that impacts land use and forest cover. Through the use of Remote Sensing and GIS methods Landsat satellite images of 1995, 2008 and 2015 were employed to identify the extent of the changes in land use and forest cover. The perceived factors for the changes include education level, unemployment, landless/limited, landholding, population pressure, expansion of built-up areas and agricultural land at the expense of other land covers. This study revealed the transformation of natural forest and associated vegetation from one form to another. There was a decrease in natural vegetation from 61.06% in 1995 to 26.02% in 2015 and increase in built-up areas by 6.69% and agricultural areas by 4.70%. This study recommends conservation monitoring and strong law enforcement relating to natural resources so as to promote sustainable use of resources to rescue the diminishing ecosystem services.

**Keywords**: Forest cover, land-use, cover changes, Magamba Nature Reserve, Tanzania

## 1 Introduction

Due to increase in anthropogenic activities the natural resources are decreasing in high rate around the globe. This has been accelerated due to increase in the need for areas such as for agricultural activities either in small or large scale, industrial areas and settlement areas given the increase in population in different places (Tiffen, 2003: Olson et al., 2004: Baus, 2017: Lataa et al., 2018: Mondal, and Sanaul, 2019). This has altered the earth surface significantly including the depletion of forest and vegetation covers. Hence, we can recognize the changes in land patterns in different areas at different rates (Geist and Lambin, 2002: Garg, 2017). Human actions have accelerated the dynamics in land use and forest cover while on the other side leading to changes that have an impact on the human's daily life (Agarwal et al., 2002: Ohri and Poonam 2006: Garg, 2017). Among many impacts, there is a decrease in availability of different products and services that are of great importance to human and livestock as well (Crossman et al., 2013: Mondal, 2017).

The appearance of forest cover, land uses and other vegetation in a certain area is an outcome of socio-economic activities done on the area given the natural resources that are present in such locality (Lupo et al., 2007: Mondal, 2017). As the time goes on land is becoming a scarce resource due to pressure from different anthropogenic activities (Vanacker, 2002). Therefore, enough information is required regarding forest cover and land uses for the selection of best planning strategies of land uses to cover the increasing needs and wants for sustainable development. Changes in forest cover and land use has become a hot topic recently around the world as it has a great significance in delivering enough information for monitoring the

changes in the environment and general management of natural resources (Bracchetti, et al.,2012: Melendez et al.,2014). Therefore, changes in land use and the associated land cover has been identified to be the key driver of changes in the environment and has significant consequence upon many international and national policy issues (Lambin et al., 2001: Ali, 2018: Kozak, 2018).

In rapid and unrecorded changing of forest cover and land uses, observing the earth from space is crucial in understanding the impact of human being on natural resources over time. There is a significant increase in awareness concerning land use and forest cover as different nations overcome the problem of uncontrolled development in deteriorating environmental quality (Zeleke and Hurni, (2001): Nagendra et al., 2004). Given the decrease in forest cover in different reserved areas around Tanzania, this study has been undertaken to evaluate the perception of the local stakeholders regarding the changes in forest cover in and around Magamba Nature Reserve (MNR). As one of the endemic Afromontane ecosystems with abundant of flora and fauna which are decreasing at an alarming rate. This is very important as it will help in providing an accurate evaluation of the health of the forest and other vegetation over time. Moreover, these results will be significant in assisting the preparation of appropriate guidelines for forest land management and to provide an assistance in explanation and prediction of new land-use changes as far as local communities are the main stakeholders.

## 2 Research Methodology

### 2.1 Study Area

MNR is found within the Eastern Arc Mountains and lies between 04°38S and 38°10'E and 04°38'S and 38°19'E (figure 1). The topography of this land is rippling, and the forest is covered with a wide range of mountains. The altitude varies between 1650 to 2300 mean annual sea level. The soils are primarily loams with varying amounts of sand and color that vary from red through gray-brown to black with pH value ranging between 3.5 and 8.5. They are ample in minerals like Manganese, Magnesium, and Iron. The yearly rainfall is gauged to be about 800 mm per annum. Temperature ranges between 25°C and 30°C during the months of June to September. Generally, the area is normally dry with temperature ranging between 15°C and 21°C. In most places of the forest, the majority of trees are evergreen throughout the year. The forest is rich in trees for conservation as well as a wide variety of species of birds and small mammals. The forest mostly has a continuous stand of trees, which may attain a height of about 45 m or more.

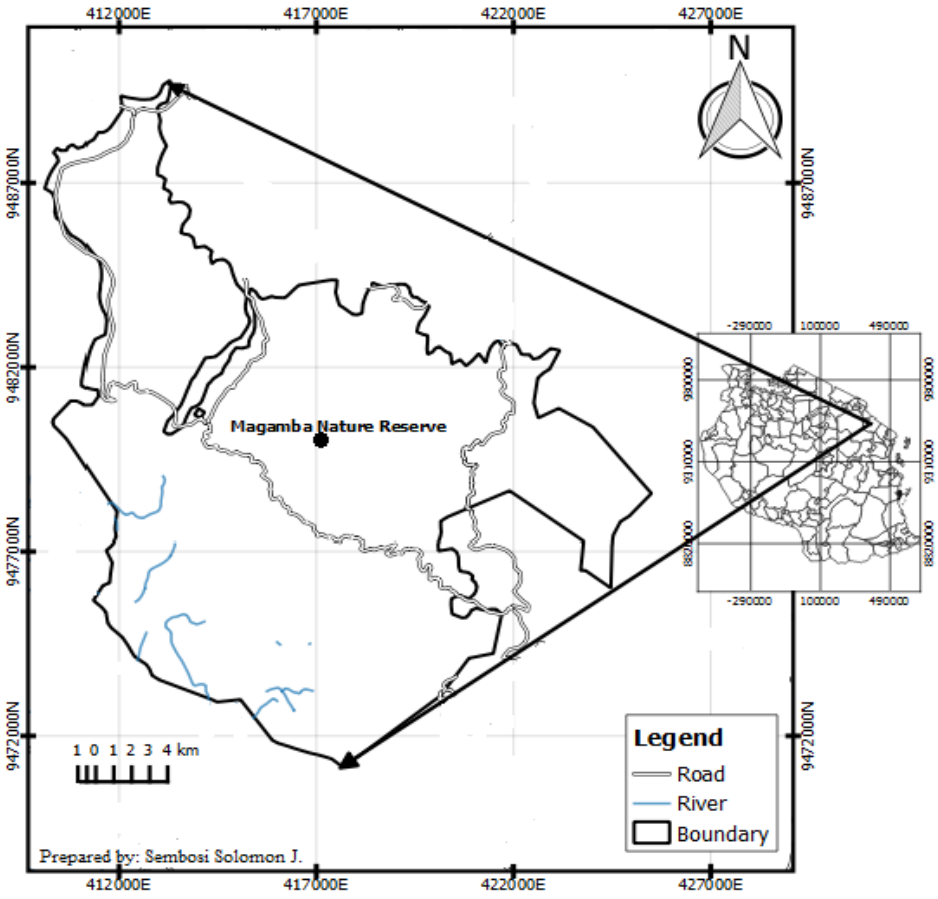


**Figure 1:** *Location of MNR, Tanzania*

### 2.2 Identification of Perception of Local Stake Holders Towards Socio-Economic Factors Influencing Land Use and Forest Cover Changes

For this study data were collected using interviews through questionnaires, direct observation and focus group discussion. Although the Nature Reserve is surrounded by 17 villages only three were selected purposely based on closeness to MNR and accessibility. In the selected villages, only a total of 90 households 30 from each village was picked randomly for an interview. The survey using questionnaires was addressed to obtain information pertaining the expansion of agricultural lands, built-up areas, importance of MNR to the local community, land tenure as well as awareness on land use and forest cover changes in and around MNR.

### 2.3 Focus Group Discussions

In order to obtain enough information regarding the changes in land use and forest cover in and around the MNR, this study involved longtime residents and government officials. During the discussion checklist comprising of questions concerning historical trends of forest cover, land uses, the significance of MNR to local communities, problems encountered by the management officials, economic activities of the local communities in connection to MNR and demographic issues of the local communities surrounding MNR were covered. For the confirmation of the expansion of the agricultural lands and built-up areas to the forest, direct field observation method was done.

### 2.4 Analysis of Land Use and Forest Cover Changes in and around MNR

From United States Geological Survey (USGS) data interface, satellite images were obtained and used to analyze the changes in land use and forest cover in and around MNR. The selection of the images was based on seasonality as all the images were acquired during the dry season to ease the identification of vegetation and they were having a resolution of 30m. The images scenes were from the path 167 and row 63 such that Landsat 5 TM of July 1995, Landsat 5 TM of September 2008 and Landsat 8 OLI of January 2015. Geo-referencing of the image scenes was done using the topographical map of the area having a scale of 1:50,000 of 2008. For the verification of the land use and forest cover depicted from the image scenes ground truthing using GPS was done.

### 2.5 Data Analysis

Qualitative information was analyzed using content and structural-functional analysis. This technique is very significant in describing how social realities relate to each other within the social system and with the physical environment (Nzunda et al., 2013). Descriptive statistic was used for analyzing the quantitative information involving frequency and percentage to describe their influence on the changes of land use and forest cover. The factors considered are education level, unemployment, limited landholding, population pressure, agriculture expansion, landless and easy acquisition of land.

## 3 Results and Discussion

### 3.1 Perception of Local Stake Holders on Socio-Economic Factors Influencing Land Use and Forest Cover Changes

#### 3.1.1 Education level

Table 1 indicates a summary regarding the level of education of the assessed local individuals that inhabit around the MNR. Education generates a positive attitude, awareness, motivation, and values. Furthermore, is detected as one of the aspects that impact an individual's perception and decision making on a certain development (kajembe and Luoga 1996; Nzunda, 2011; Nzunda, 2013: WDR, 2018). As a consequence, education encourages better management of household resources and reduces stress on easily accessible natural resources. In addition, understanding education levels of individuals are among the key important issue in evaluating their knowledge and skills in judging and reasoning different matters. 41.1% of the

interviewed respondents have primary education, and 20% have secondary education, 18.9% did not attend school at all, 16.7% vocational training while only 3.3% have attended college education. Given that, for the wisely use of natural resources education is a very important factor to be considered. Low education and/or lack of education enhance loss of natural resources as its difficult to understand intensely the consequence of clearing natural vegetation. Especially for different activities such as agriculture and settlements establishment. Hence, this entails that level of education among the individuals in the community has a critical influence towards the changes in land use and forest cover (Tekalign et al., 2018). This result links well to Nzunda et al., 2013 who states that an increase in the level of education of the household decreases the likelihood of causing changes in the environment.

**Table 1:** *Education Level*

| Response | Frequency (n) | Percentage (%) |
|---|---|---|
| Did not attend school | 17 | 18.9 |
| Primary education | 37 | 41.1 |
| Secondary education | 18 | 20.0 |
| Vocational training | 15 | 16.7 |
| College | 3 | 3.3 |
| Total | 90 | 100.0 |

### 3.1.2 Unemployment

The results show 27% of the interviewed households respond the changes on land use and forest cover in and around MNR is an outcome of unemployment situation faced by most of the individuals living around the study area. Most of the rural areas are characterized by individuals employ themselves mostly in the agricultural sector. Even though lack of capital for most of the local individuals has caused most of the locals to engage in various illegal activities such as illegal lumbering, charcoal burning and illegal mining which has a great impact on vegetation cover. Apart from that most of the individuals around the study area have relied on harvesting for business the forest products as the only option which is quick and easy to obtain income. From this observation forest, related activities generate more income to the people engaged in such activities and thus likely for most of the people to engage more (Ali, 2018). This observation corresponds well with the documentation by Mdemu et al. (2012) who state that income generated from forest-related activities in Pugu and Kazimzumbwi forest reserves is higher and maybe two times the income generated from agricultural activities. It is not shocking that shifting of people's livings from agricultural activities to forest-related activities are mostly driven by the higher earnings associated with it, as documented by Mdemu et al. (2012).

### 3.1.3 Limited landholding

The results indicated that 5% of the respondents (figure 2) report that changes in land use and forest cover is due to limited landholding. During the group discussion with the local stakeholders and government officials, this was identified to link with the issue of land tenure. Given the areas around MNR have not been measured/surveyed most of the people own unplanned areas or farms. This has tempted individuals to expand their areas towards the neighboring natural vegetation such as woodlands and grasslands. This situation has been identified to be the cause of changes in land use and forest cover due to unplanned land use such as the expansion of farm size and establishment of built-up areas (Tekalign et al., 2018). This insight corresponds with Kikula (1997) who reported a link between land tenure and sustainable agricultural activities which can allow sustainable management of natural vegetation. Therefore, for the protection of the current vegetation cover and associated land use land rights and/or occupancy of the surveyed areas is significant.

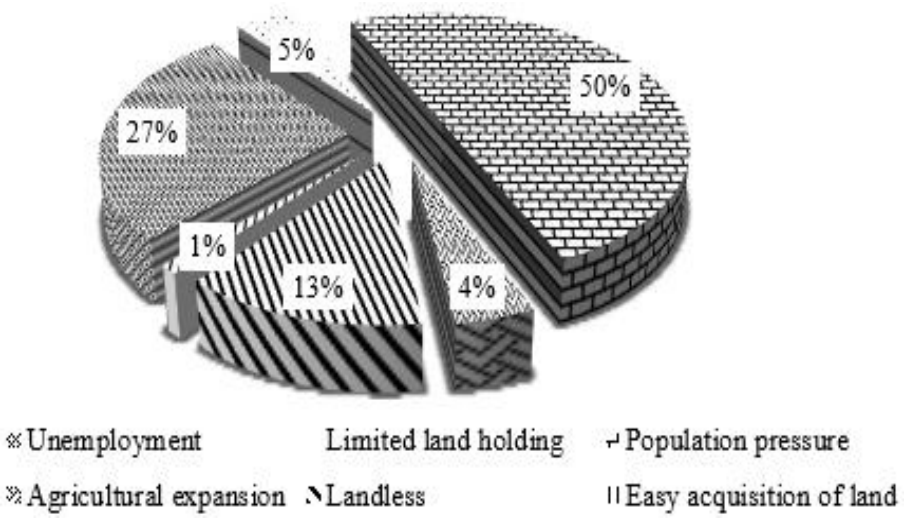


**Figure 2***: Factors perceived by local stakeholders that impact changes on land use and forest cover in and around MNR*

### 3.1.4 Population pressure

Figure 2 indicates 50% of the interviewed individuals reply population pressure triggers changes on land use and forest cover in and around MNR. From the focus group discussion, it was revealed that most of the inhabitants around the area are not natives. The increase in population has been facilitated by factors such as good weather condition which has influenced immigration of the people searching for land to engage in agricultural activities. As a result, this has influenced changes in land use due to the establishment of built-up areas and forest cover dynamics as an outcome of encroachments as the area is a mountainous and thus land shortage. It has been identified that there is an influx of people which lead to increase in demand of resources in and around MNR. These findings correspond well with Mbonile et al. (2017) who documented the major reasons for migration in most places is due to the movement of people from their former residential areas to seek land for agriculture and settlement. Moreover, Noe (2003), Nzunda et al. (2013) and Twongyirwe, (2018) cited the immigration of people into different areas triggers pressure on natural resources leading to changes in land use and vegetation cover. Moreover, according to Malugu (2007) described the increase in population is associated with the growth of settlement and cultivation activities which all of this impact land use and forest cover.

### 3.1.5 Agriculture expansion

Figure 2 indicates 4% of the respondents replied changes in land use and forest cover is due to agricultural expansion. Given the area is a mountainous most of the individuals have expanded their farm size into MNR in order to have enough areas for cultivation. But also, from the observation done in and around the study area some of the locals have decided to establish cultivation areas within the boundaries of MNR due to lack of areas for cultivation. This expansion of agricultural activities has resulted in changes of land use and forest cover in and around MNR. This observation corresponds to the statement that expansion of areas for cultivation is influenced by the increase in demand for agricultural products in different places around the globe and it has resulted into a reduction in the amount of natural cover or vegetation (Lyaruu, 2002; Tiffen, 2003: Twongyirwe, 2018).

### 3.1.6 Landless and easy acquisition of land

Figure 2 indicates 13% of the individuals claim landless accelerate the rate of land use and forest cover changes in and around MNR. Besides that, only 1% said changes in land use and forest cover is due to the easy acquisition of land. Lack of land or landless for some of the individuals resides proximity to the reserve significantly increases the temptation of establishing or expanding unplanned farms towards the natural vegetation (i.e. woodlands and forests). The influence of this situation is due to lack of title deed or

certificate of occupancy over land and thus lack of clearly surveyed or demarcated land leading to shifting cultivation to a different portion of land or poor land uses. Among other factors, this condition has been the cause of changes in land use practices and forest cover due to the expansion of agricultural areas as observed around the study area during the field survey. This observation concurs with Nzunda et al. 2013 results which stated that land use and associated land rights play a crucial role in defining the use and management of land resources sustainably as they stipulate availability and/or accessibility of using resources. On the other side, documents by Place (2009) and Clover and Eriksen (2009) supports this argument as it has stated that the security of land tenure has a direct connection with sustainable farming activities.

### 3.2 Land Use and Vegetation Cover Distribution in and Around the Study Area for Three Consecutive Years

Analysis of changes on land use and land cover from the classified images reveal significant changes in and around the study area as shown in (figure 3) for the three studied periods (1995, 2008 and 2015). For all the studied periods, seven land use and forest cover were identified. In year 1995 natural forest dominated the area by 61.06% (8051.35 ha), followed by woodland 17.70 % (2333.37 ha), then forest plantation 10.72% (1413.97 ha), grassland 6.24% (822.61 ha), shrub-land 2.72% (358.95 ha), agricultural land 1.28 % (169.33 ha) and built-up area was 0.28% (36.50 ha). The percentage cover for agriculture and built-up areas in and around MNR for this period were small signifies the nature reserve was little affected by anthropogenic activities. In 2008 the percentage cover of the natural forest, grassland, shrub-land and woodland declined by 45.63% (6017.27 ha), 10.46% (1379.46 ha), 7.67% (1011.95 ha) and 13.18% (1737.77 ha) correspondingly. On the other side plantation forest increased to 14% (1845.91 ha), while agricultural land and built-up area appeared with the coverage of 2.14% (282.16 ha) and 6.91%. (911.56 ha). This indicates that anthropogenic events in and around the MNR were active during this period.

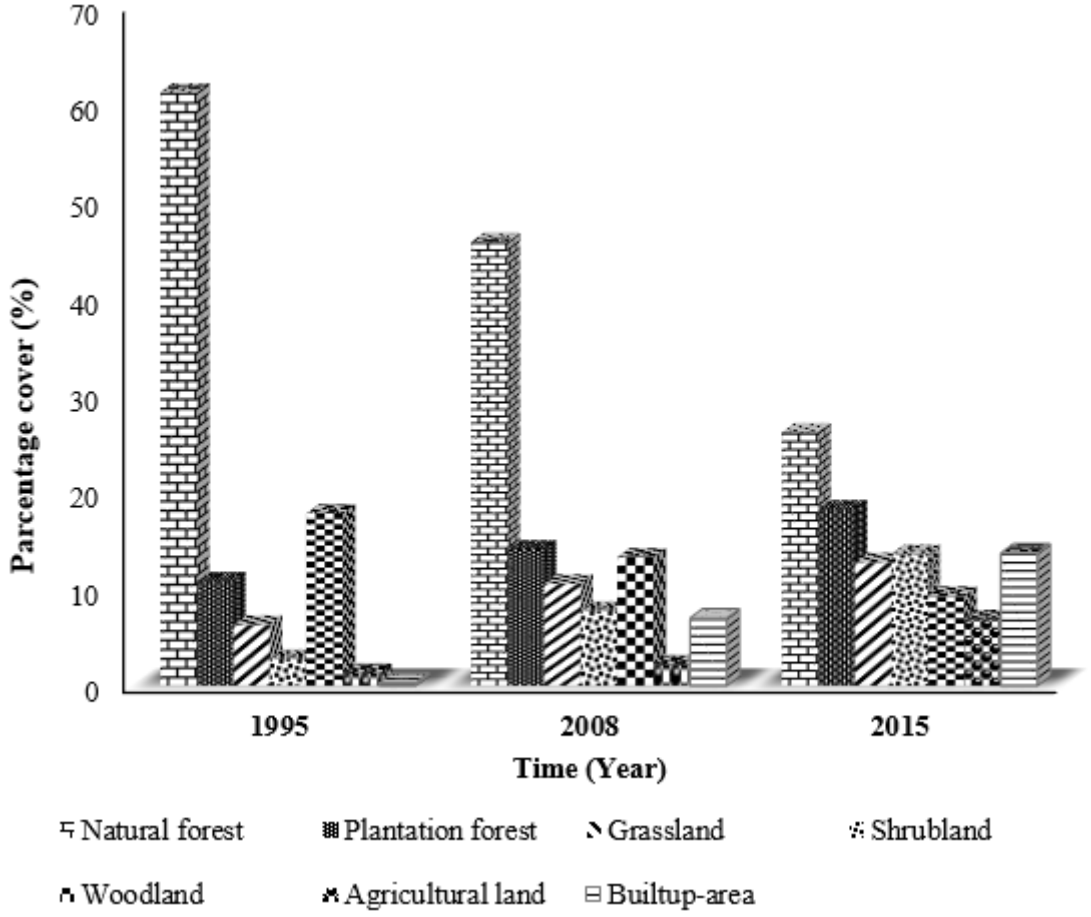


**Figure 3:** *Distribution of land use and forest cover in and around MNR between 1995 – 2015*

For the year 2015 natural forest decreased, such that only 26.02% (3431.3 ha) remained while the forest plantation increased to 18.13% (2390.59 ha) and woodland decreased to 9.22% (1216.34 ha). Other land use and forest cover that remained include 12.67% (1670.63 ha) for grassland, 13.51% (1781.76 ha) for shrub-land, 6.84% (902.54 ha) for agricultural land and built-up area increased to 13.60% (1792.92 ha) compared to previous periods. This indicates that agricultural activities increased from 1995 to 2015 at the expense of other land cover categories such as woodlands and natural forest. Among other anthropogenic activities that affect natural vegetation agriculture is reported to have a higher significant effect (Angelsen and Kaimowitz, 2001; Lambin et al., 2001; Achard et al., 2002; Grau, 2005; Twongyirwe, 2018). On the other side expansion of settlements for the three studied periods has a major consequence on the decrease of forest cover and other natural vegetation (Weber and Puissant, 2003: Hassan et al., 2018: Ke et al., 2018).

**Table 2:** *Cover area, changed area and the rate of change between 1995 and 2008 for the study area*

| **Land cover in 1995** | | | **Land cover in 2008** | | | |
|---|---|---|---|---|---|---|
| **Cover class** | Area (ha) | % cover | Area (ha) | % cover | Area change (ha) | % cover change |
| **Natural forest** | 8051.35 | 61.06 | 6017.27 | 45.63 | -2034.08 | -15.43 |
| **Plantation forest** | 1413.97 | 10.72 | 1845.91 | 14.00 | 431.94 | 3.28 |
| **Grassland** | 822.61 | 6.24 | 1379.46 | 10.46 | 556.85 | 4.22 |
| **Shrub-land** | 358.95 | 2.72 | 1011.95 | 7.67 | 653 | 4.95 |
| **Woodland** | 2333.37 | 17.70 | 1737.77 | 13.18 | -595.60 | -4.52 |
| **Agricultural area** | 169.33 | 1.28 | 282.16 | 2.14 | 112.83 | 0.86 |
| **Built-up area** | 36.50 | 0.28 | 911.56 | 6.91 | 875.06 | 6.63 |
| **Total area** | 13186.08 | 100.00 | 13186.08 | 100.00 | | |

As indicated in Table 2, natural forest and woodland decreased at the rate of -156.46 ha/year (-1.19%/year) and -45.82 ha/year (-0.35%/year) for the period of 13 years consecutively (i.e. 1995 and 2008). Plantation forest, grassland, shrub-land, agricultural land and built-up area increased at a rate of 33.23 ha/year (0.25%/year), 42.83 ha/year (0.32%/year), 50.23 ha/year (0.38%/year), 8.68ha/year (0.07%/year) and 67.31 ha/year (0.51%/year), respectively. The decrease in natural vegetation (i.e. natural forest and woodland) and increase in anthropogenic activities (i.e. built-up and agricultural areas) are accredited by the increased demand for land by the local communities living around MNR. Forest fire is a serious problem around the area but other factors such as settlement, agricultural activities (maize, beans and horticultural crops) (Temgoua et al., 2018), timber, poles and firewood (as a main source of energy for most of the households around the reserve) were claimed by local people during the interviews to be the reasons for decrease in natural vegetation.

**Table 3:** *Cover area, changed area and the rate of change between 2008 and 2015 for the study area*

| Land cover in 2008 | | | Land cover in 2015 | | | |
|---|---|---|---|---|---|---|
| Cover class | Area (ha) | % cover | Area (ha) | % cover | Area change (ha) | % cover change |
| Natural forest | 6017.27 | 45.63 | 3431.3 | 26.02 | -2585.97 | -19.61 |
| Plantation forest | 1845.91 | 14.00 | 2390.59 | 18.13 | 544.68 | 4.13 |
| Grassland | 1379.46 | 10.46 | 1670.63 | 12.67 | 291.17 | 2.21 |
| Shrub-land | 1011.95 | 7.67 | 1781.76 | 13.51 | 769.81 | 5.84 |
| Woodland | 1737.77 | 13.18 | 1216.34 | 9.22 | -521.43 | -3.96 |
| Agricultural area | 282.16 | 2.14 | 902.54 | 6.84 | 620.38 | 4.70 |
| Built-up area | 911.56 | 6.91 | 1792.92 | 13.60 | 881.36 | 6.69 |
| Total area | 13186.08 | 100 | 13186.08 | 100 | | |

From 2008 to 2015 grasslands, shrub-land and built-up areas have increased as indicated in Table 3. The grassland increased at a rate of 2.21% (291.17 ha/years), shrub-land increased at a rate of 5.84% (769.81

ha/year), built-up area increased at a rate of 6.69% (881.36 ha/year) and agricultural land increased at the rate of 64.70% (20.38ha/year) for the average period of 7 years. Moreover, in 2015 natural forest decreased to -2585.97 ha/year (-19.61%) and woodland decreased to -521.43 (-3.96%). This rapid decrease is due to the increased population around the area as reported by the 50% of the respondents during the interview. These results concur with the argument by DeFries et al. (2010) that forests and other natural vegetation will decline as local populations increases around the forest areas. On the other side, Geist and Lambin (2002) identified population pressure to be one of the factors that influence the disappearing of tropical forests and natural vegetation in general.

## 4 Conclusion

The collected information from this study facilitates prioritization of natural vegetation such as forests towards improved management for sustainable development. This study identified socio-economic implications on land use and forest cover changes in and around MNR. From the identified changes in and around the study area, this study claim was mainly due to socio-economic factors while the other factor observed in the study site was fire. Factors that influence observed changes include education level, unemployment, limited landholding, population pressure, agriculture expansion, landless and easy acquisition of land. According to the local stakeholder's perceptions, population pressure ranked the first among of the identified factors that influence changes in and around MNR. Besides that, the study indicated the increase in plantation forest, shrubland, agricultural land, grassland and built-up areas while on the other hand natural forests and woodlands decreased. This study concludes that the situation has to be reversed otherwise natural vegetation especially natural forests will extinct in the future. Conservation education, especially in rural areas where most of the natural resources reside, should be prioritized more in order to build enough capacity concerning the importance of forest existence and other ecosystems.

## 5 Declaration

### 5.1 Acknowledgment

The author would like to express his appreciation to the management of Magamba Nature Reserve and the village authorities for granting permission to conduct this study.

### 5.2 Competing Interest

The Author declares that no conflict of interest exits in this work.

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