PULMONOLOGY

Agricultural Implications of Land Use Changes in Miiriga Mieru East Sub-County, Kenya

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ABSTRACT

Miiriga Mieru East Sub County is situated in Meru County. This sub county is in the proximity of the Meru Municipality and has been experiencing a high rate of land use / cover changes which has affected agricultural production significantly. The agricultural land has been subdivided due to high population increase and urbanization. This has led to decrease of agricultural land and impacted on agricultural production and biodiversity. The reduction of agricultural land has led to the rural livelihoods to experiencing food shortages. This paper has sought to explore land use changes, agricultural production trends as the main drivers behind deteriorating agricultural land, relationship between population, land use changes and implications on agricultural production. The land use changes classification of Landsat TM image and change analysis done, population data was processed and analysed and correlated to food production. Miiriga Mieru Sub County has experienced significant land use changes over the period of study. The forest cover decreased from 48.18% in 1988 to 23.04% in 2014. This trend shows decrease in the forest cover. The built up area increased from 0.51% in 1988 to 3.34% in 2014. The increase of built up area is attributed to the need for settlement as population increases. The area under agriculture increased from 51.31% in 1988 to 73.62% in 2014. Agricultural lands and urban areas have being increasing while as forest areas experience a decrease as population continues to steadily. The main driver to deteriorating croplands especially after 2000 was due to increasing built up areas that have come as a result of increased land sub-divisions and population pressures. The built up area increased from 1.46% in 2000 to 3.34% in 2014. The cropland areas decreased in from 77.40% in 2000 to 73.62% in 2014. Impact of population growth on land use changes is depicted by the continued increase of human population as shown by the population census of 1989 to 2009, continued decrease in forest areas and increase in urban areas.

KEYWORDS: GIS, Land Use, Livelihods and Agricultural Production.

INTRODUCTION

Land-use change influences the basic resources of land, including the soil. Its impact on soil often occurs slowly such that the land managers hardly contemplate initiating any mitigation measures. Poor land management and urbanization has degraded vast amounts of lands leading to reduced agricultural production, hence a major threat to many rural and urban livelihoods in many developing countries, which depend on agriculture for sustenance. Crop production is the cultivation of crops with special regard to maximization of the total yield gained per acre in one planting season. The problems of food supply and farming are among the most bewildering, diffuse and frustrating of mankind contemporary dilemmas (Gregory & Paul 1976). Urbanization has taken up the use of agricultural lands hence the reduction of food supply as the area under food crops reduced. The world grain stocks was noted to have dwindled to dangerously low levels, highlighting the fragility of food supplies in a world where the population is expected to rise (FAO, World Food Summit in Rome Italy 2009). The Kenyan economy is dominated by agriculture regardless of the fact that only 15 to 17 percent of its total land area has sufficient fertility and rainfall to be farmed and only 7 to 8 percent can be classified potentially productive land. The high production areas keep livestock and grow crops while low production areas mostly livestock farming is practised. (FAO, 2009).

Land use, in Miiriga Mieru East, Meru County and its environs, is changing fast due to proximity to the Meru county headquarters situated in Meru municipality. The devolution has encouraged the investors to invest in the area thus the new development of both commercial and residential areas within the sub county. The influx of satellite university campuses in the town has also led to the student and workers seeking to invest and reside in the area. While some areas are undergoing cultivation, others are being converted into residential and commercial areas. The impact of the changes in land use has affected the sustainability of agricultural production in the area. The fast changing land uses and the geomorphologic processes in the area make land parcels dwindle and land use change highly sensitive to erosion and degradation. There is need for a framework and guidelines for sustainable land use like agriculture and urbanization. (Meru county government, 2014)

Satellite remote sensing plays a crucial role in providing information on land use on local, regional and global scales especially where aerial photographs are missing or out-dated. The remote sensing has the ability to detect

and monitor land use. Its capability depends on its capacity to adequately deal with the reference database while simultaneously accounting for both short term and long term changes. Satellite remote sensing techniques have proven useful for monitoring and assessing land cover and land use changes. There is large number of methods used to detect land use changes that can be broadly grouped into change enhancement methods and 'from to' change information extraction methods. Change enhancement methods do not identify explicitly what kind of land uses have changed but they only provide change or no change information and perhaps a relative magnitude of change. 'From to' change information extraction methods, the post classification approach is the most commonly used and effective technique for land use change detection. It requires the comparison of independently produced classified images. This 'from to' change information about land use is obtained from a cross tabulated change matrix (Lu et al, 2004).

This Paper has the main objective of this research was to analyse the changes in land use of the Miiriga Mieru East sub county and its impacts on agricultural production. The main objective comprised of the other specific objectives as follows:

- To determine the changes in land use in Miiriga Mieru east sub county from 1988 to 2014
- To determine the implications of land use on agricultural production
- To determine the impact of population growth on land use changes

The land use changes in the Miiriga Mieru east sub county was studied over a period of over ten years using the land sat TM(thematic mapper)/ETM+(enhanced thematic mapper plus) imagery path 168 row 60.

MATERIALS AND METHODS

Study Area

Miiriga Mieru East is one of the divisions created in the North Imenti district that is part of the larger Mieru district. Miiriga Mieru covers an area of 973 square kilometres with a population census of 56,958 according to the 2009 census. This translates to a population density of 58 persons per square kilometre. (Meru County Office, Imenti North Sub County, 2014).

The Meru county and specifically the Miiriga Mieru sub county is primarily an agricultural area concentrating crop farming and livestock keeping. The way of life of the settled community is mainly consist of small scale farmers. A large number of people live in villages and market centres. Population growth over the years has meant that the rural areas meant for farming has been shrinking allowing for urban area development. Major cash crops include coffee, maize (corn), beans, sorghum and millet, and wheat. Tobacco, potatoes, maize, beans, sorghum and millet are staple food crops. Bananas are also taking root as a major cash crop in the area.

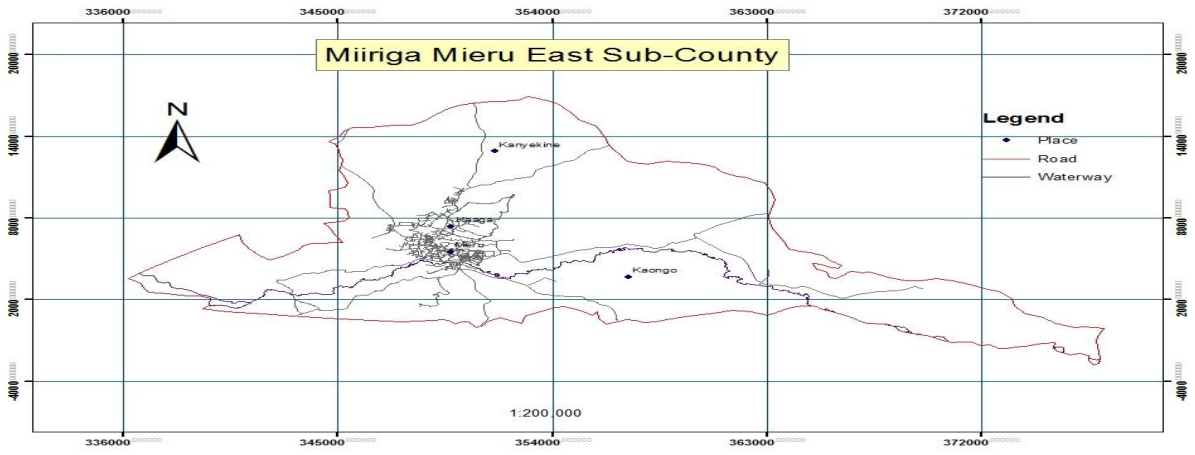

Figure:2.1: Administrative boundary

The cartographic data used in this study was to establish the boundary of the area of study. An Administrative map of Kenya at scale of 1:1 000 000, year 1997 was obtained from survey of Kenya. Other data sets that were obtained shape files defining the location and sub locations for the sub county. The topographic maps were used to establish the boundary of the study area

The remote sensing data that were used for this study were Landsat satellite images, downloaded from the USGS website. The Landsat images are medium resolution multispectral imagery that was preferred for this study. The Landsat images were ideal for the study as the have the longest consistent recording of the earth`s surface since 1972. The data sets that were used for this study are images for 1988, 1995,2000,2005,2009 and 2014.The images used have a spatial resolution of 30x30 metres. They were processed- calibrated, corrected for various distortion and orthorectified. The images were acquired for the dry season so as to minimise the phonological differences (Munyati,2000).

The population census is an enumeration of all persons in a country at a specified time. It is the primary source of benchmark statistics of the size, distribution, composition and other socio-economic characteristics of the population. In this study the census of the country were downloaded from the Kenya National Bureau of Statistics website for the years 1989, 1999 and 2009. (KNBS, Kenya population and housing census, 2009). The data was filtered to acquire only the census of the area of the study based on the sub locations that make up the Miiriga Mieru East sub county.

Agriculture is the cultivation of crops and rearing of livestock to sustain and enhance human life. The agricultural production in this study is the total crop production and livestock production per year estimated in tonnes from the ministry of Agriculture Meru county government. The production statistics were obtained from the field officers operating in the sub county.

Table 1: Agricultural production data for Miiriga Mieru East sub county (Meru county Government).

Year	Area(KM^2)	Agricultural production(Tonnes)
1988	973	130409
1990	973	123199
1995	973	124000
2000	973	232113
2005	973	235999
2009	973	236757
2014	973	237936

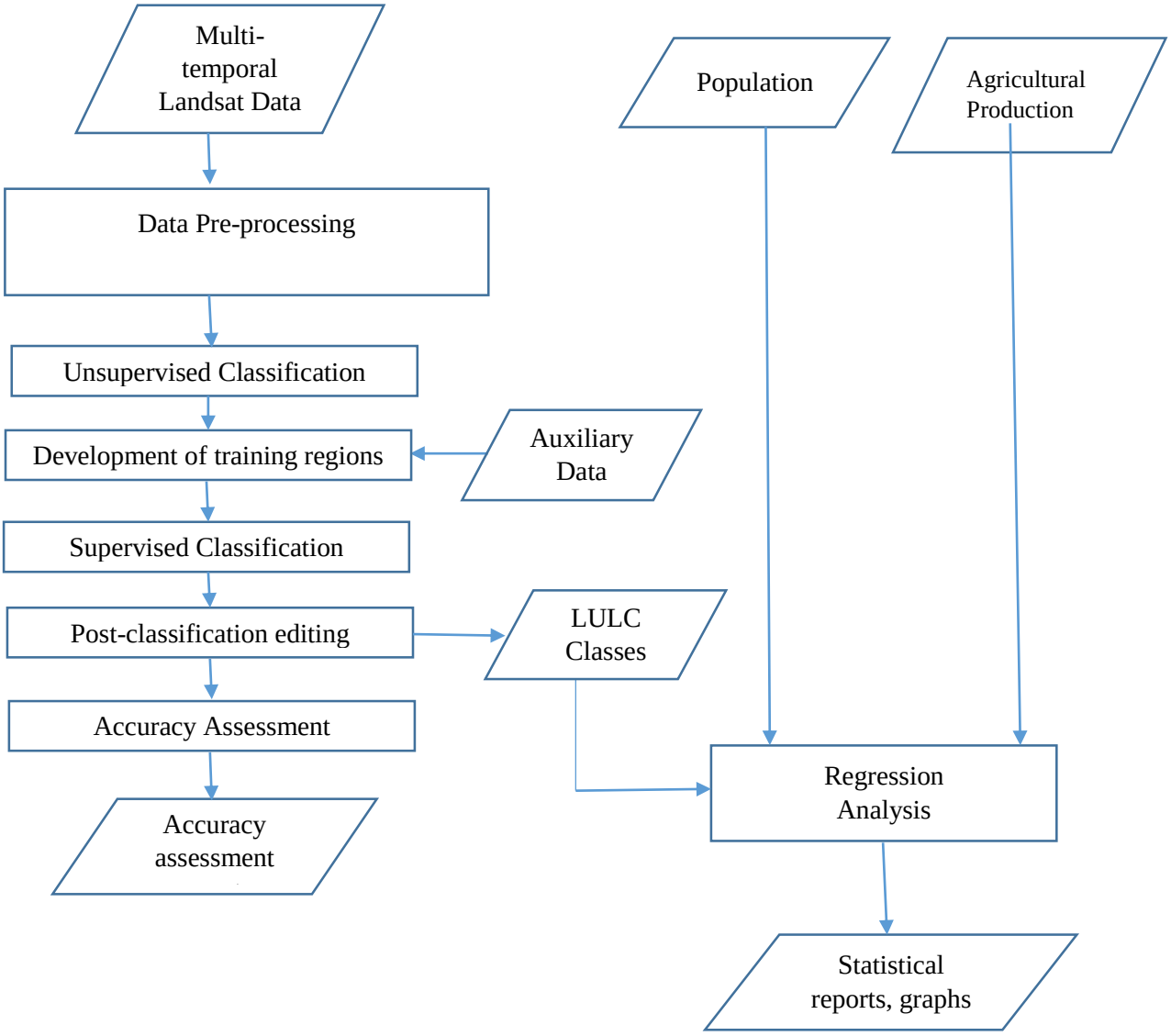

Figure 3.1: Methodology

RESULTS AND DISCUSSION

LULC-Classification Results

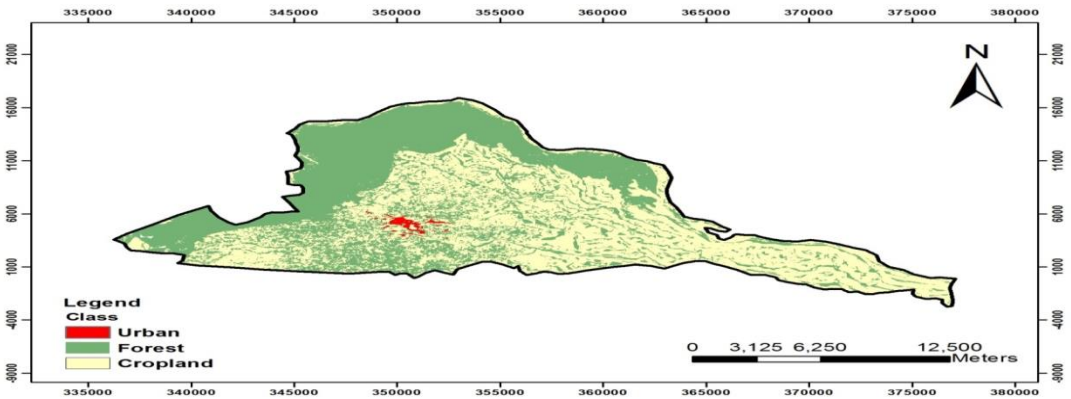

Figure 4.1 Classified image 1988.

The classified image of the 1988 shows the area under forest, urban and agricultural are covering 167.88 Hectares, 15772.32 and 16795.54 Hectares respectively

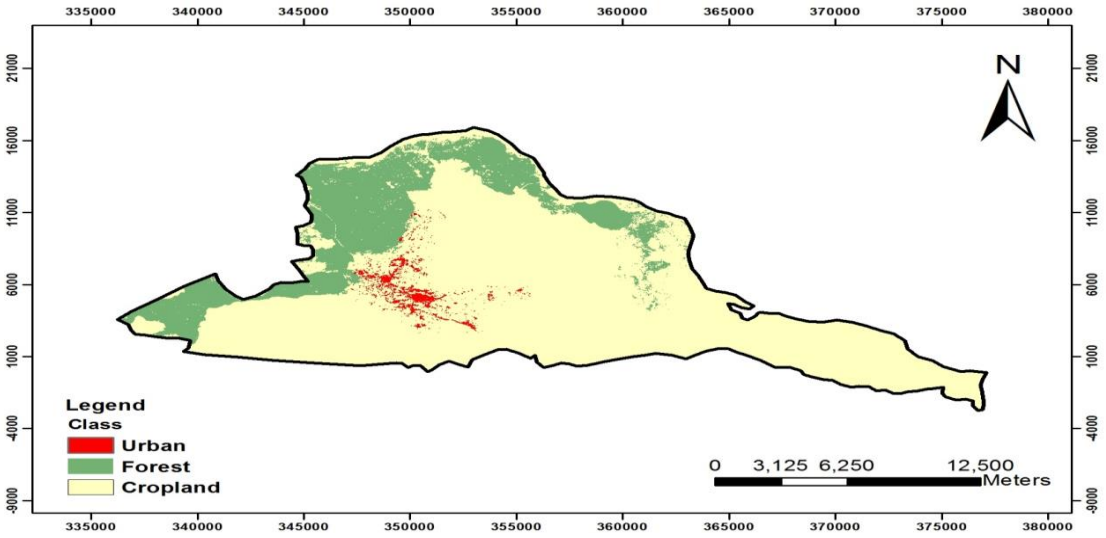

Figure 4.2 Classified image, 2000.

The classified image of the 2000 shows the area under forest, urban and agricultural are covering 477.42 Hectares, 6920.60 and 25337.71 Hectares respectively

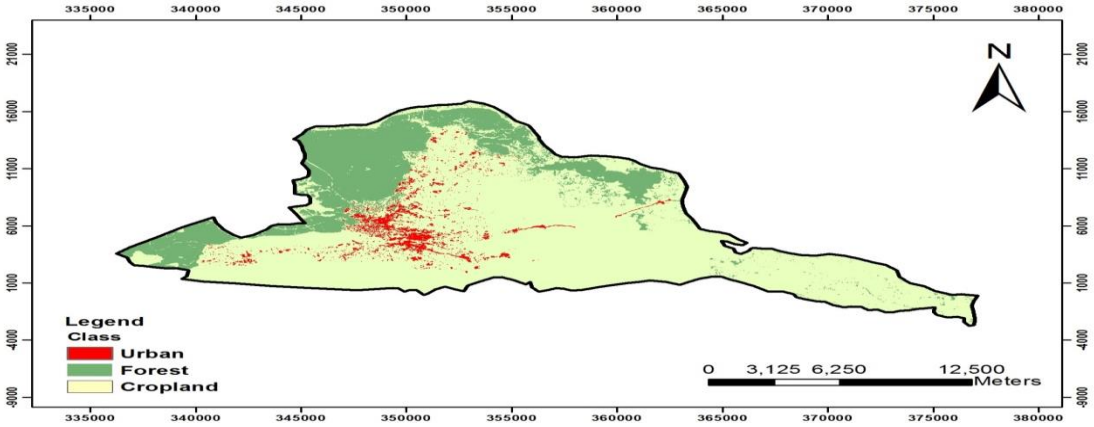

Figure 4.3 Classified image, 2014.

The classified image of the 2014 shows the area under forest, urban and agricultural are covering 1092.96 Hectares, 7543.73 and 24099.09 Hectares respectively.

Table 4.2 Change detection results

	Forest(Ha)	Urban(Ha)	Agricultural land(Ha)
1988-1995	-7,840.44	106.38	7,734.06
1995-2000	-993.15	203.58	789.57
2000-2005	1,089.18	24.84	-1,114.02
2005-2009	-1,119.69	100.80	1,018.89
2009-2014	654.57	489.96	-1144.53

The table 4.2 provides the epoch changes with forest area experiencing decline for the epochs 1988-1995, 1995-2000, and 2005-2009. 2009-2014. It is important to note that the cropland areas depict a reversal trend to that of forest areas, where there is an increase in the epochs 1988-1995, 1995-2000 and 2005-2009, and a decrease in

the epochs 2000-2005 and 2009-2014. The urban areas constantly maintain an increasing trend from 1988 through 2014 epochs.

Relationship between Population census and urban growth

The study has shown that there is steady increase in population from 1989 to 2015. Since the population data does not overlap with land use and land cover data, a regression analysis to interpolate the population data for the whole study period was done. The population grew by a factor of 1.8 and the urban area by 6.5. The relationship between urban area and population has a strong positive correlation, with$R^2 = 0.8833$. The figure 4.10 depicts that there is an increase in both population and the urban areas, but with a higher increase trend for population.

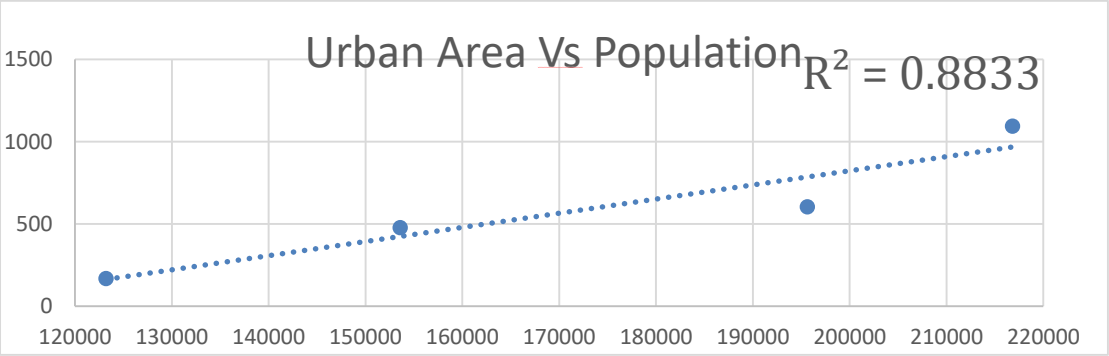

Figure 4.4 Regression analyses for urban area versus population.

Relationship between Agricultural Production and agricultural land

The agricultural production depicts an upward trend for the period of study in consideration. However, the Agricultural land area does not maintain an upwards trend especially after 2000 up to the end of the study period, 2014. These changes in the trend can be attributed to the external influences such as technological improvements in the agricultural methods of farming.

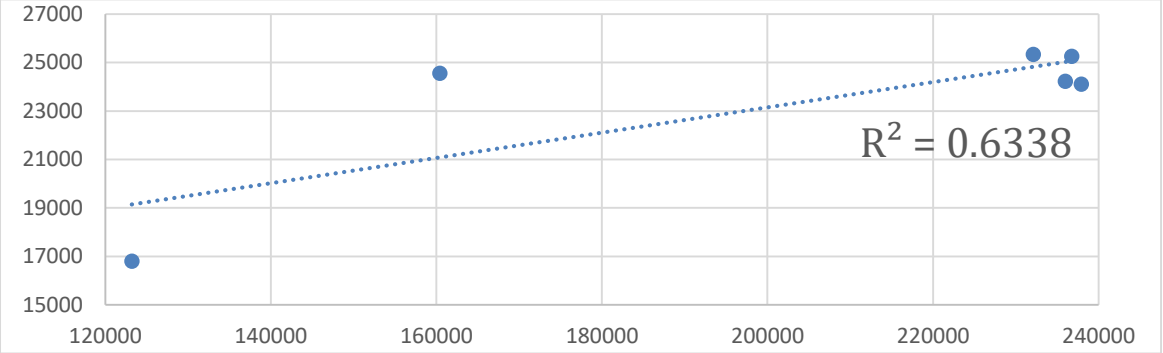

Figure 4.5 Agricultural land Area versus Agricultural production

Using the linear regression analysis both Agricultural land and agricultural production have an increase trend, with production experiencing a higher rate than cropland. The relationship between the agricultural production and the cropland have a weak correlation $R^2 = 0.6338$ indicating that the other factors such as improved farming methods, introduction of new crop species may be affecting production. Large amounts of prime land are converted into urban land use. This is demonstrated in that in 1988 to 2014, forest reduced by 56.24%, agricultural land increased by 50.60%, and urban increased by 260.08%. The effect of unavailability of land for agriculture has led to low agricultural production.

The land tenure in Miiriga Mieru is predominantly freehold which makes it easier for ownership of land and land use is not restricted to any zoning by the planners. Lots of land subdivision has led to the decrease of the agricultural land. Most individuals use the land for agricultural purposes.

Owing to the proximity of the area to the Meru county headquarters the land use has been changing with time (Meru county government, 2013).The urban development has been competing for space with agriculture and

forest. The allocation of the agricultural land for urban development has led to the decrease of agricultural lands and the quality of the land for farming purposes.

The population growth and the demand for land for settlement and food have led to regular and intensive ploughing of lands. This kind of ploughing has led to loss of soil nutrients and the diminishing of the agricultural production of the lands as seen in **Figure 4.5**.

Forest plays a key role in the ecosystem of both the flora and fauna (Serneels, S. & Lambin E F (2001)). The allocation of forest land for agricultural and urban development by the government has led to decreased forest cover. The clearance of forest has contributed to change in weather conditions that are key factor affecting the agricultural production. The unfavourable weather condition also affects the agricultural production negatively (Yuan,D.and Elvidge, C. (1998).

The cleared forest areas provide agricultural lands have provided fertile virgin lands that are good for agriculture leading to higher agricultural production. On the other hand, the clearance of the forest makes the soils in the cleared areas and the neighboring farms vulnerable to erosion. This contributes to degradation of the soils due to erosion by runoff water, loss of soil nutrients hence the once productive agricultural lands are stripped bare resulting to low agricultural production. This is demonstrated in the **figure 4.5** showing the agricultural production trend.

The land use change is significant to the agricultural production being that the agricultural land has decreased and the population increase has put pressure on the agricultural land for settlement purposes (**figure 4.4**). Land use in a particular area impacts the forest cover and the diversity of the forest species of both flora and fauna. They reduce the forest cover area and the species both flora and fauna change their adaptation to the changes. The reduction of the forest cover also affects the weather conditions that make the flora and fauna to change and more so affects the agricultural production of the surrounding area.

CONCLUSION

In conclusion, Miiriga Mieru Sub County has experienced significant land use changes over the period of study. The forest cover decreased from 48.18% in 1988 to 23.04% in 2014. This trend shows decrease in the forest cover. The built up area increased from 0.51% in 1988 to 3.34% in 2014. The increase of built up area is attributed to the need for settlement as population increases. The area under agriculture increased from 51.31% in 1988 to 73.62% in 2014. Agricultural lands and urban areas have being increasing while as forest areas experience a decrease as population continues to steadily. However, the increase in agriculture production is not principally due to the increase in arable land, as shown by an $R^2 = 0.63$, which may be attributed to other factors such as improved farming methods.

The main driver to deteriorating agricultural lands especially after 2000 was due to increasing built up areas that have come as a result of increased land sub-divisions and population pressures. The built up area increased from 1.46% in 2000 to 3.34% in 2014. The cropland areas decreased in from 77.40% in 2000 to 73.62% in 2014.

Impact of population growth on land use changes is depicted by the continued increase of human population as shown by the population census of 1989 to 2009, continued decrease in forest areas and increase in urban areas.

ACKNOWLEDGEMENTS

We acknowledge Jomo Kenyatta University for allowing us to work on this research work.

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