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LAND COVER AND LAND USE DYNAMICS ON MEDICINAL PLANT SPECIES IN THE SHAI OSUDOKU DISTRICT OF THE GREATER-ACCRA REGION OF GHANA

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ABSTRACT
In recent times, the use of medicinal plants by individuals and organizations has been intensified because of their proven efficacy and the availability of many of these plants. The study intents to identify and delineate different land cover and land use dynamics of medicinal plant species in the Shai Osudoku District of the Greater-Accra Region of Ghana. Initially, land cover categories at multiple spatial scales and the changes over a period of 26 years (1985-2011) were gathered using satellite remote sensing. Secondly, a household data was collected using a semi-structured questionnaire guide by employing a snowball technique on the 108 respondents from the three communities to examine the impact of land use change on medicinal plants that are perceived to be endangered. The image analysis indicated that area classified as exposed/degraded/built-up has reduced over the years from 63.7% in 1985, 38.4% in 2000 and 36.1% in 2011, whereas savanna vegetation had increased from 23.5%, 15.7% and 26.3% in 1985, 2000 and 2011 accordingly. The results of the multiple linear regression showed that the overall model was statistically significant (F=438.5, p-value=0.000). Thus, expansion in infrastructure, plantation agriculture, financial issues were identified as the major causes of land use changes; and hence, the disappearance of some medicinal plant species in the area. In order to preserve and conserve these valuable medicinal plant species, a community-based medicinal plant farms approach is recommended for the communities.

KEYWORDS: Medicinal plant, multiple spatial scales, satellite remote sensing, exposed, degraded.

INTRODUCTION
All over the world, medicinal plants play an essential role in the maintenance of human health especially among the people in the tropics. More than 50,000 plant species have been identified to be used in various human cultures for medicinal purposes (Schipmann *et al*., 2002; Lange *et al*., 1997; Lewington, 1993). According to Lee (2004), many conventional drugs originate from plant sources and that some of the most effective drugs in use today are plant based. These include aspirin which is derived from the bark of willow; digozin derived from foxglove, quinine derived from the bark of cinchona, and morphine from the opium poppy. Lee (2004) further indicated that scientific interest in medicinal plants has burgeoned due to increased efficiency of new plant-derived drugs, growing interest in natural products and rising concerns about the side effects of conventional medicine. The World Health Organization (WHO) reports that about 80% of the people in developing countries depend on plant-based traditional medicine for their primary health care (Farnsworth *et al*., 1995). Medicinal plants are of critical importance in poor communities where even relatively cheap orthodox medicines remain prohibitively expensive. Globally, the use of traditional medicine using medicinal plants has received a renewed attention during the decade of 1990 (WHO, 2002; Ravi *et al*., 2010). Schippmann *et al*., (2002) and Lange *et al*., (1997), noted that there are about 50,000 known species of plants used in traditional and modern medicine systems. The World Health Organization (WHO, 2002) has estimated that the present demand for medicinal plants is approximately US $14. The demand for medicinal plants is expected to increase by more than US $5 trillion in 2050 (Chandra *et al*., 2006). In many developed countries popular use of traditional medicine is fuelled by the concern about the adverse effects of chemical drugs, questioning of the approaches and assumptions of allopathic medicine, and greater public access to health information (WHO, 2002). Therefore, traditional, complementary and alternative medicines are becoming more popular. It has been observed that the percentage of the population that has used such medicines at least once is 48% in Australia, 31% in Belgium, 70% in Canada, 49% in France and 42% in the United States of America (WHO, 2002). In tropical Africa, more than 4,000 plant species are used for medicinal purposes, and 50,000 tons of medicinal plants are consumed annually in the region (Karki, 2000). Interest in medicinal plants is becoming more and more recognized in health care delivery, particularly in this part of the world because they are affordable, readily acceptable by consumers and locally available (ACDEP, 2003; Falconer, 1994; Abbiw *et al*., 2002; Brown, 1992). In Ghana, approximately 75% of trees on cultivated lands have medicinal uses (FAO, 2005). In recent times however, concerns have been expressed about the disappearance of medicinal plants due to land use changes emanating from population growth and expansion in infrastructure development (Gyasi, *et al.,* 1995). This is because there is a high variability in time

and space in the biophysical environments, socioeconomic activities, and cultural contexts that are associated with land-use change. Despite the long tradition of usage of medicinal plants by individuals and organizations, their proven efficacy, and lack of affordable alternatives, the continued availability of many of these plants is in jeopardy; and, is increasingly under various environmental, socio-economic and institutional threats. It is estimated that 117 species of medicinal plants are threatened by extinction in Ghana (FAO, 2005). Food and Agriculture Organization (FAO, 2005), has also estimated that the rate of deforestation in Ghana has also increased by 50% over the last ten years. This phenomenon is threatening the medicinal plants and traditional health care systems in Ghana. Habitat destruction and over-collection means sources of medicinal plants are becoming increasingly scarce. Identifying the causes of land-use change therefore requires an understanding of how people make land-use decisions and how various factors interact in specific contexts to influence decision making on land use (Lambin, Geist, & Lepers, 2003). Making decisions on how land should be put can be influenced by factors which operate at various levels. These factors are categorized as direct/proximate and indirect/underlying. The direct or proximate causes of land-use change constitute human activities or immediate actions that originate from intended land use and directly affect land cover (Ojima *et al*., 1994). These involve a physical action on land cover. On the other hand, indirect or underlying causes of land-use change are the fundamental forces that underpin the more proximate causes of land-cover change. As noted by Leemans, Lambin, McCalla, Nelson, Pingali, and Watson (2003), these fundamental forces operate more diffusely, that is from a distance, often by altering one or more of the direct causes. The underlying causes are however, formed by a complex of social, political, economic, demographic, technological, cultural, and biophysical variables that constitute initial conditions in the human-environment relations and are structural in nature (Geist & Lambin, 2002; Contreras- Hermosilla, 2000; Ledec, 1985). Observations of the vegetation cover in the study area shows an extensive use of land which has led to a decline in area extent of vegetative cover. This spatial variation in land use of the area has been influenced by many forces: including, history of human settlements and land tenure, agro-ecological settings, means of production and the awareness on the options available which include access to markets (Maitima, 2004). The study area abounds in a diversity of plant species that are of medicinal value used in the manufacturing of herbal drugs for the treatment and management of various diseases. Ayikuma, Agomeda, Kodiabe, and Doryumu are principal localities within the study area noted for the collection of raw plant materials for the production of some herbal drugs by institutions such as the Centre for Scientific Research into Plant Medicine of the Council for Scientific and Industrial Research at Mampong-Akuapem in the Eastern Region of Ghana. These plant species include: *Lippia multiflora, Capparis erythrocarpos, Clausena anisata, Pileostigma thonningii, Gardenia ternuifolia, Pergularia daemia, Maytenus senegalensis, Deinbollia pinnata, Kigelia africana, Euphorbia drupifera, Zanthoxylum xanthozyloides, Securinega virosa, Azadirachta indica, Balanites aegyptiaca, Bridelia ferruginea, etc*. The study investigates the causes that have brought changes in land cover and land use dynamics of medicinal plant species in three communities, namely Dodowa, Ayikuma and Agomeda in the Shai Osudoku District of the Greater-Accra Region of Ghana.

METHODOLOGY

Study Area

The Shai Osudoku District is situated in the Southeastern part of the Greater Accra Region of Ghana. It lies between Latitude 5° 49' and 6° 12' North and Longitude 0° 15' East and 0° 20' West (Fig. 1). The District has a total land area of 1,102 km^2 representing 41.5% of the regional land area, thus making it the largest in the Greater Accra Region. The area is characterized by gentle and undulating land with heights not exceeding 70m with few isolated hills including Yongua inselberg (427m) and the Shai Hills (289m) found toward the western portions of the district (Medium Term Development Plan (Dangme West District Assembly, MTDP) 2013). Prominent among the water bodies that drain the area are the Volta at Natriku and Dawhenya Dam on the Dekyidor stream. As part of the hot and dry southeastern coastal plain of Ghana temperatures in the area are high for most parts of the year, with the highest during the main dry season (November–March) and lowest during the short dry season (July–August). However, occasional moderate and altitudinal influences are observed along some parts. Rainfall is generally very low, and mostly erratic, and occurs between September and November each year. Mean annual rainfall increases from 762.5mm on the coast to 1220mm to the North and Northeast close to the foothills of the Akuapem range and on the summit (MTDP, 2013). The predominant vegetation is savanna, which is interspersed with shrubs and short trees, a characteristic of the Sub-Sahelin type. Most of the vegetation remains dry for most parts of the year, particularly toward the South, except for the short rainy season. However, higher vegetation types, ranging from thickets to light forest, are common along some stream courses. Some light forest with tall trees is also found along the foothills of the Akuapem range, especially around Dodowa, Ayikuma and Agomeda. A Forest, Game and Wildlife Reserve exist around the Shai hills. Large strands of *Borassus* palm are found around the eastern portions of Dodowa and Ayikuma. Isolated stands of baobab trees are common all over the plain. In the Volta flood plain areas, tall swampy grass and tall grass savannah with isolated patches of thicket and trees represent the main vegetation type in the district (MTDP, 2013).

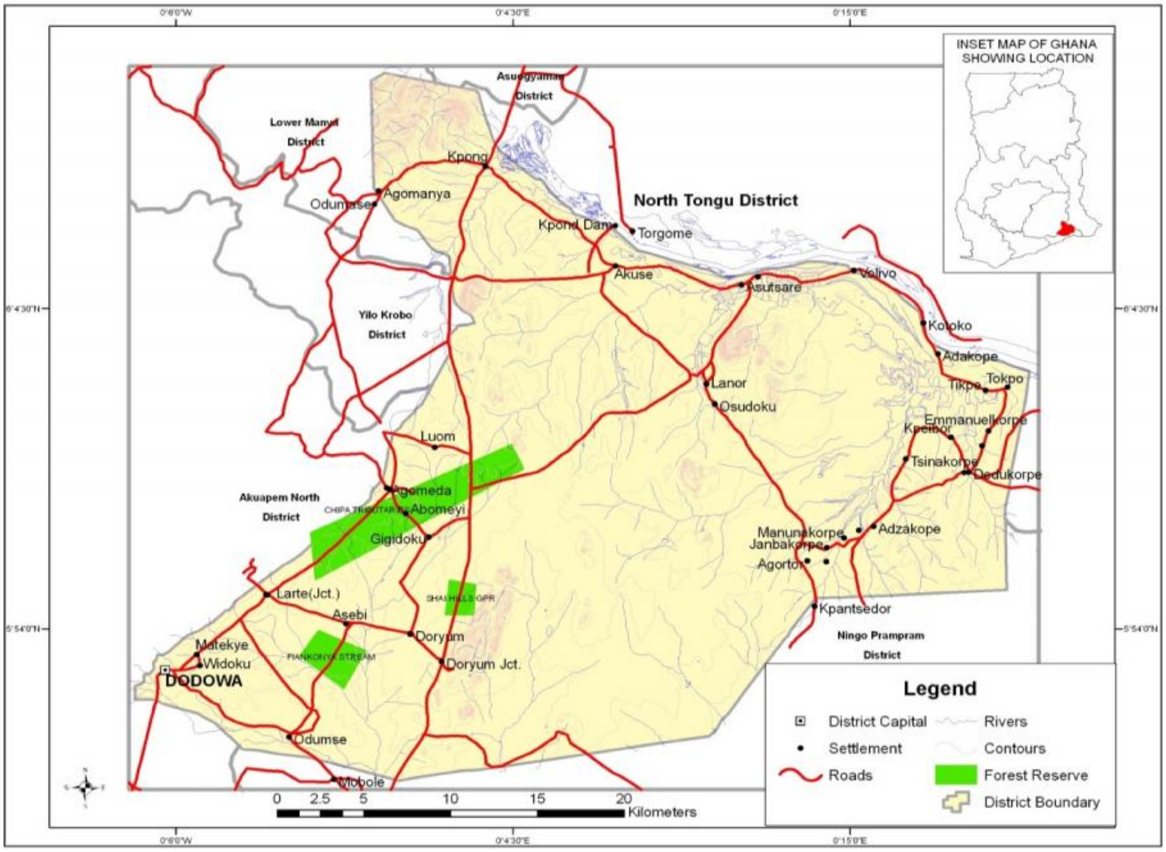

FIGURE 1: Map of Shai Osudoku in the Greater Accra Region

Methods and Source of Data

Satellite imagery made up of LANDSAT TM and ETM+ span 26 years and covered three different periods (1985, 2000 and 2011) was used to generate land use/cover map and to analyze the spatio-temporal changes that had taken place in the area vis a vis medicinal plant species. The images were downloaded from the internet (USGS/Global Land Cover Facility) and subjected to various processes including enhancement, sub setting and classification using first, ISODATA algorithm with 25 classes and later knowledge based supervised classification with the Maximum Likelihood algorithm after training sites were identified on an ArcGIS 10 platform. The five main land use/cover categories identified were: i) *Forest and reverine vegetation,* ii) *Exposed/degraded/built-up,* iii) R*ocky/burnt surfaces.* iv) S*avanna vegetation* v), and *water bodies*

Besides, a field survey was also undertaken in two land used categories namely exposed/degraded/built-up and forest/riverine vegetation. Each of the two categories was demarcated into10 plots with each having a plot size of 10m x 10m. A total of 18 plots were observed for species density. The Global Positioning System (Gamin etrex GPS) with error margin of 8-10m was used to spatially locate the plants/trees in each plot to avoid duplication. Available plant species identified within each plot was classified as trees, shrubs, or herbs (appendix A). For the household data collection, 36 respondents each from the three communities of Dodowa, Ayikuma and Agomeda were interviewed. Leaders were contacted and used as key informants in each community. To ensure some level of representativeness, the key informants were made to lead the team of enumerators to each of the groups identified after which a snowball approach was adopted to locate the other interviewees. In all 108 respondents between the ages of 20-50 years and above were interviewed in the three communities. Informal group discussions were also conducted to enable researchers get more insights into land use changes and availability of the medicinal plant species. The data collected were analyzed with the Predictive Analytic Software (version 20) while the informal discussions were noted down and manually analyzed. Descriptive statistics such as frequency table and a multivariate analysis were employed to analyze the changes occurring in the land uses.

RESULTS

Three Land Use / Land Cover maps were generated from the False Colour Composites of Landsat Imagery of 1985, 2000 and 2007 after analyses had been done. Five distinct classes of characteristics emerged from the analyses of these maps *viz:* Water Bodies; Exposed /Degraded / Built-up Areas; Rocky Surfaces; Riverine / Reserve Forest; and Coastal Grassland Vegetation.

Visual interpretation of the land use and land cover maps (Figs. 2 & 3) shows interesting variations. Spatially, in 1985, greater portion of the study area was under exposed/degraded and built-up followed by savanna vegetation which covered the north and north-west. In 2000 and 2011 forest and riverine vegetation had more or less taken over the savanna vegetation in the north and north-west. Interestingly, while the savanna vegetation shifted to the central part of the areas there was a reduction in exposed degraded/built-up areas. As depicted in the Fig. 4, generally forest and riverine vegetation increased from 6.9 % to 22.4% and reduced slightly to 21.6% during the years under review. In terms of exposed/degraded/built-up areas, a reduction was observed from 63.7% in 1985, 38.4% in 2000 and a further reduction to 36.1% in 2011. On the contrary, land use category described as savanna vegetation reduced from 23.5% in 1985 to 15.7% in 2000 and increased to 26.3% in 2011. In short, visual interpretation of the maps (Figs. 3) showed spatial variation in land use/cover in the present study area. However, the 1985 image was characterized by noise in the form of cloud and shown in white around south-central and north-western part of the district (Fig. 2) which was a major setback of the analysis.

In terms of species composition and richness, the abundance and basal area were compared in both the forest/riverine vegetation and exposed/degraded/built-up areas (appendix A). In the former, the total number of trees enumerated were 47 representing an average of 4.7 trees (SD=1.14, N=10) per plot (100m^2) while the latter, a total of 41 trees were also enumerated and this represented an average of 4.1 trees (SD=0.57, N=10) per plot (100m^2). It was observed during the field survey that the forest/riverine vegetation areas abound with species of *Khaya senegalensis*, *Zanthoxylum zanthoyloides* and *Leucena glauca* whereas none was observed in the exposed/degraded/built-up areas. Nevertheless, the exposed/degraded/built-up areas also had species of *Mangifera indica*, *Cassia siamea, Parkia clappertoniana, Citrus sinensis, Morinda lucida* and *Moringa oleifera* which were absent in the forest/riverine vegetation area whereas *Adansonia digitata* abound in both land uses.

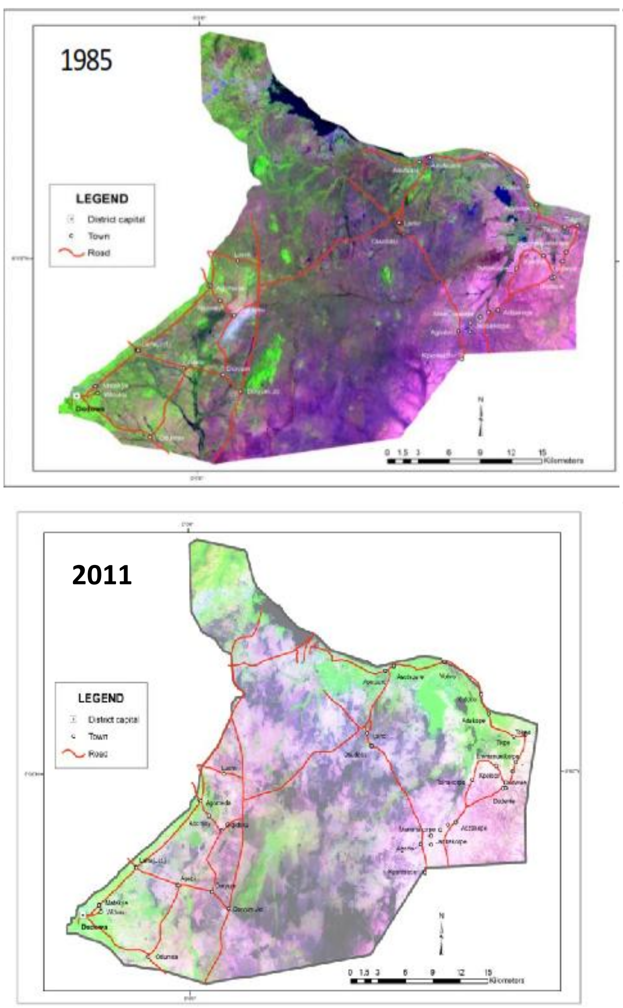

FIGURE 2: False colour composite

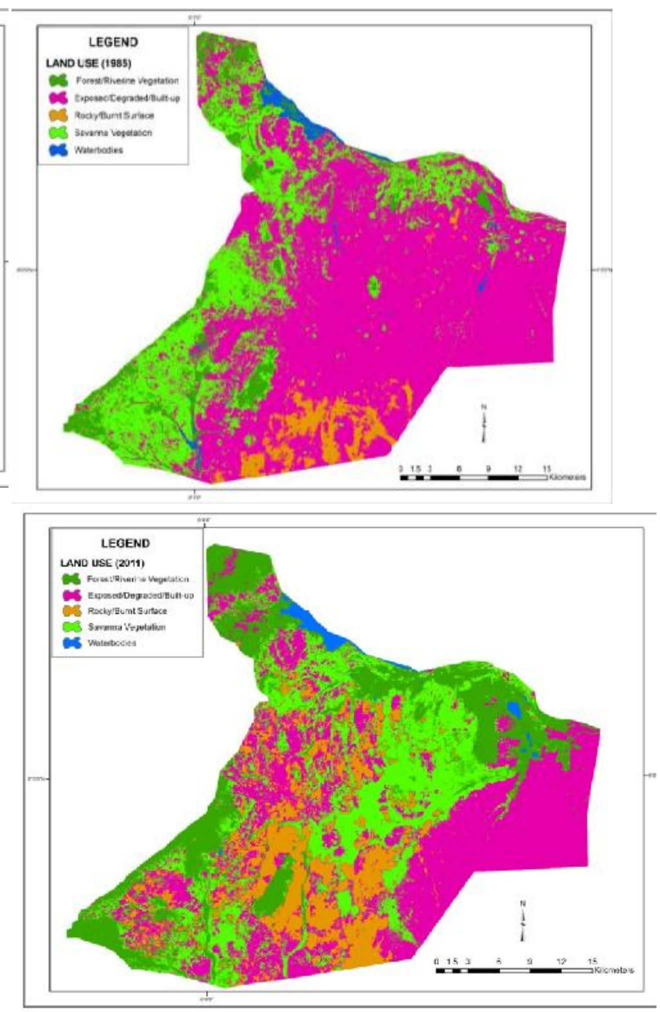

FIGURE 3: Land use/cover map

Land use/ Land cover Change Analysis

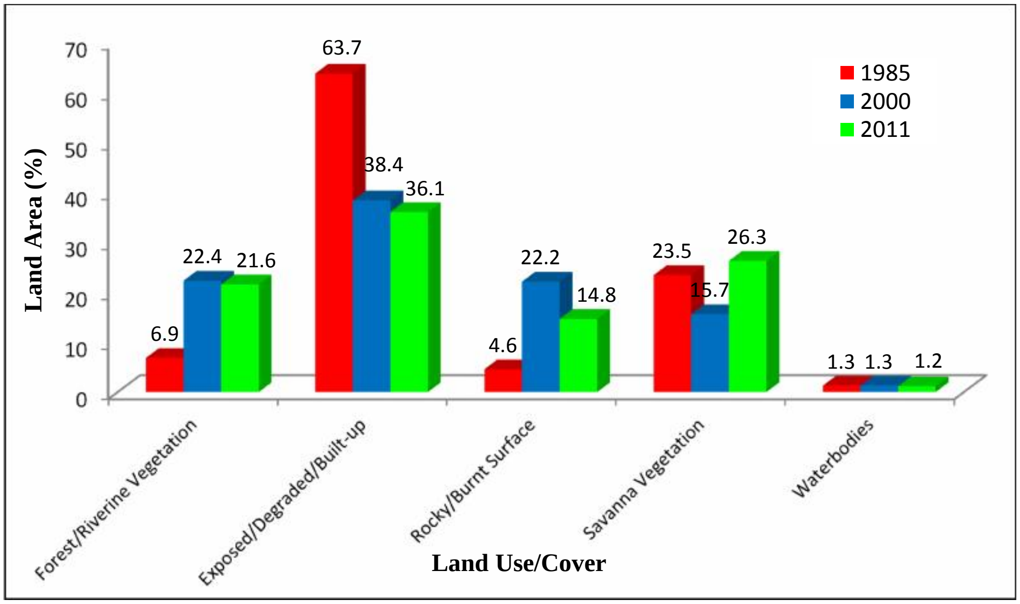

FIGURE 4: Percentage area of land use/cover (1985, 2000 & 2011)

Perception of households on Changes in Land Use/land Cover

Socio-Economic Characteristics

Respondents captured in this study comprised 66 (61.1%) male and 42 (38.9%) female opinion leaders (elders and chiefs), household heads, traditional medical practitioners and farmers who are knowledgeable in traditional medicine (Table 1). Their ages range from 20 to 50 years and above. The age bracket with the highest frequency is 40 to 49 years; another 28 respondents each represented the next highest whilst the 20 to 30 age bracket had the least of 7 respondents.

With regard to the respondents' association with medicinal plants, the results indicate that the vast majority (82%) of the interviewees have been using medicinal plants for more than 15 years. A further 17 (15%) respondents have also used medicinal plants between 5 and 14 years, whilst the least of 3 (3%) respondents have used medicinal plants for a period between 1 and 4 years. Finally, the survey reveals that medicinal plants in the area have been disappearing. This is confirmed by the majority (78/72%) of the respondents who say they do not have access to medicinal plants they used to harvest. Only 30 (28%) of the respondents affirm that they still have access to the most common plants (appendix A).

TABLE 1: Socio-Economic Characteristics of Respondents

Variables	Background Variables	Frequency	%
Age	20-29yrs	7	6
	30-39yrs	28	26
	40-49yrs	45	42
	50yrs +	28	26
Status in Community	Opinion Leaders (Chiefs/Elders)	24	22
	Household Heads	18	17
	Traditional Medical Practioners	38	35
	Farmers	28	22
Duration of use of Medicinal Plants	1 – 4yrs	3	3
	5 – 9yrs	9	8
	10-14yrs	8	7
	15-19yrs	20	19
	20yrs +	68	63
Availability of Medicinal Plants	Yes	30	28
	No	78	72

Source: Field survey, 2014

Analysis of Background Variables on Land use Changes and Availability of Medicinal Plants

The results of the multiple linear regression analysis presented in Table 2 show that the overall model is statistically significant (F=438.5, p-value=0.000). The Beta values observed under the unstandardized coefficients at 0.05 per cent confidence level have three of the background variables showing statistical significance with regard to land use changes and the disappearance of the medicinal plants. These variables include citrus farming (mango farming), constructional activities and financial issues.

The coefficient of 0.362 for citrus farming shows an estimated change on land use changes when the other independent variables are held constant. Because the p-value for the estimated coefficient is 0.000, there is sufficient evidence to conclude that citrus farming activities (mainly mango farming) in the area has increased, thus bringing about rapid changes in land uses and resulting in the disappearing of most of the medicinal plants. This relationship between citrus farming and land use changes is positive (B=0.356), and based on the t-value (5.63), it can be concluded that the relationship is statistically significant.

TABLE 2: Multiple Regression Analysis of Background Variables on Land use Changes and availability of Medicinal Plants

Background Variables	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	t	Sig.
Age of Respondents	0.004	0.024	0.007	0.147	0.883
Status in Community	-0.005	0.017	-0.011	-0.274	0.785
Duration Of Use Of Medicinal Plants	0.002	0.019	0.004	0.082	0.934
Citrus Farming	0.356	0.063	0.362	5.633	0.000
Public Policy	-0.069	0.052	-0.040	-1.318	0.191
Constructional Activities	0.083	0.030	0.070	2.806	0.006
Financial Issues	-0.608	0.053	-0.601	-11.525	0.000
Crop Farming	-0.050	0.038	-0.053	-1.326	0.188
Constant	1.285	0.124		10.335	0.000
R Squared = 0.973, Adjusted R Squared = 0.970	F = 438.5				

Source: Field survey, 2014

Using the same reasoning, it is noticed that two other independent variables; constructional activities and financial issues, are also significant predictors of land use changes with p-values<0.001. However, whilst the former (B=0.083) has a positive relationship with changes in land uses; the latter, financial issues (B= - 0.608) has a negative relationship. This negative coefficient for the financial issues indicates that rich land-owners in the area are less likely than those less rich to exchange land for money. Conclusively, this has brought about massive sale of lands for construction activities (housing and other tourists' infrastructural facilities) hence, contributing to rapid changes in land uses in the area. The other background variables; age of respondents, status in the community, duration of use of medicinal plants, public policy and crop farming were all found to be statistical insignificant. These variables have no significant influences on the changes on land uses in the area, and therefore the disappearance of these valuable medicinal plants.

DISCUSSION

The study has examined the main causes for changes in land use patterns. Three main variables were identified; expansion of citrus farming (mainly mango plantations) and construction activities (housing developments and tourist infrastructures), and financial challenges of some of the households in the study. These variables are responsible to a great extent to the rapid changes in the land uses observed. These activities have reduced the savannah vegetation which used to cover the area into other forms of vegetation. The analyses from the study confirm that these activities have increased significantly thus reducing the extent of the natural vegetation which used to cover the area. By studying the dynamics and trajectories that characterize the changes in the land uses, it was observed that other land uses, such as mango farming or mango plantations, tourism infrastructure and some public facilities have surfaced on the landscape. The availability of such facilities, which are expanding rapidly in the area, has thereby brought about changes in the former land use patterns. It was observed that as these facilities keep on expanding, areas or lands which used to be covered with medicinal plants are gradually reducing in extent, hence the disappearing of most of the important medicinal plant species. Of greater importance is the contribution of public policy towards the preservation of land use patterns in the area. The result shows that public policy is statistically insignificant. The implication is that it does not have any influence on the rapid increase in land use changes as pointed out by the majority of the respondents. The argument here is that public policy is being used to preserve and control land use patterns. It was noticed that lands are being reserved to halt the excessive sales by individual households, families and stools. Therefore the inability to access medicinal plant species by the vast majority of the respondents may be in part due to this public policy. Because in the year 2000, forest vegetation reserved was increased by 22.4%, using 1985 as a base year, but reduced to 21.6% in 2011. Using the same base year, savannah vegetation reduced from 23.5% to 15.7% but increased to 26.3% in 2011. However, exposed/degraded/built-up areas continuously declined during the same period.

Annexation of vacate lands to existing reserved lands means bringing more lands under reserves of which their management comes directly under the Forest Commission.

Access to the reserved forests or savannah is restricted by policy and indigenous belief system which is manifested in socio-cultural practices of the people in the area (Appiah-Opoku, 2007). Culturally, it is forbidden for one to harvest any plant species within the reserve because it is regarded as sacred. Unfortunately, such belief by indigenous societies is being lost due to increasing population, migration, education and introduction of christianity (Kroma, 1995; Appiah-Opoku, 2007). This situation has also contributed to the disappearance of medicinal plant species in the area.

CONCLUSION

A policy of community-based medicinal plant farms should be encouraged to deter land owners desist from selling of their lands rich in medicinal plants. As a means of conserving the biodiversity, this policy will also provide sustenance for the people and alleviate poverty which had been the cause for the indiscriminate sale of lands in the area. Additionally, upholding our cultural belief systems by incorporating them into our primary and basic educational curriculum would go a long way to preserve the environment.

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APPENDIX

Appendix A: List of Tree Species Observed during Field Survey

Species Name		Abundance	
Common Name	Scientific Name	Forest Area	Degraded Area
Mahogany	*Khaya senegalensis*	10	0
Neem	*Azadirachta indica*	19	1
Leucena	*Leucena glauca*	14	0
Cassia	*Cassia siamea*	0	4
Fagara	*Zanthoxylum zanthoxyloides*	3	0
Parkia	*Parkia clappertoniana*	0	1
Mango	*Mangifera indica*	0	28
Citrus	*Citrus sinensis*	0	4
Morinda	*Morinda lucida*	0	1
Moringa	*Moringa oleifera*	0	1
Baobab	*Adansonia digitata*	1	1

Appendix B: Availability and uses of medicinal Plants

Common Name	Scientific Name	Species Form	Medicinal uses	Availability	
				Forest area	Degraded area
Lippia	*Lippia multiflora*	Shrub	Hypertension, Fever	Not Available	Not Available
Capparis	*Capparis erythrocarpos*	Shrub	Rheumatoid Arthritis	Not Available	Not Available
Fagara	*Zanthozylum xanthozyloides*	Tree/ Shrub	Cough, Toothache	Available	Not Available
Pileostigma	*Pileostigma thonningii*	Shrub	Chicken pox , Snake bite	Not Available	Not Available
Neem	*Azadirachta indica*	Tree	Anti-Malarial	Available	Available
Bridelia	*Bridelia ferruginea*	Tree/Shrub	Diabetes, Arthritis	Not Available	Not Available
Maytenus	*Maytenus senegalensis*	Shrub	Convulsion, Dyspepsia	Not Available	Not Available
Nauclea	*Nauclea latifolia*	Shrub	Anti-Malarial	Not Available	Not Available