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The Potential Contribution of Public Primary Schools in Attaining Ten Percent Tree Cover in Kenya

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Abstract

Purpose: This paper demonstrates the influence of school land-use practices on tree population in public primary schools in Kisumu County.

Methodology: A descriptive cross-sectional research design was employed and systematic random sampling used to select 124 schools (20% of 615). Primary data came from self-administered questionnaires to school heads and harmonized using focus group discussions with teachers and pupils. Further, key informant interviews, observation, photography and desk studies were also used.

Results: From the study, the average land size of a public primary school is 3.26Ha with approximately 23.7% unused spaces. 32.26% of the schools do not have a documented land use plan hence rely on sheer instincts and ad hoc decisions of the administration or Board of Management (BoM) for space allocation to any land cover. There is a significantly positive correlation between school land-use practices ($r^2=0.843$) and tree population. Out of the common land use practices identified; forestry ($p=2e-16$), tree nursery ($p=2e-16$) and kitchen gardening ($p=0.017$) had a significant positive influence on the total tree population in schools. The findings show that land use practices positively influence tree population in public primary schools.

Unique contribution to theory, practice and policy: The study demonstrates that school administration should take advantage of the unused spaces to provide adequate room for establishment of woodlots and gardens to facilitate the achievement of the 10% forest cover.

Key Words: *Land cover, Land use practices, Public Primary schools, school land size, tree population*

INTRODUCTION

Forests remain critical national, regional and global assets especially in the current age where global temperature continues to rise towards a tipping point due to the high concentration of anthropogenic carbon dioxide (Ambus, D'Arcy, & Tyler, 2007). Unfortunately, forest cover is constantly shrinking in response to natural patterns and human activities (Food and Agriculture of the United Nation, 2007); (Laura, Alain, & Anne-Marie, 2010) leaving only an approximate 31% forest cover globally (93% being naturally occurring and 7% planted) as of 2010 based on a World Bank report.

Kenya shares with other African countries the problem of having small, fragmented areas of forests which are also under pressure from encroachment and overexploitation (Food and Agriculture of the United Nation, 2007). In 2018, Kenya was classified among countries with the lowest forest cover as closed-canopies stood at about 2% compared to the African average of 9.3% and a world average of 21.4% (FAO, 2015). General forest cover was at 4%, against the recommended national minimum of 10% (Government of Kenya, 2018). Similarly, with greater potential of increasing tree cover based on its ecological conditions, Kisumu County had 0.44% forest cover by 2018 (County Government of Kisumu, 2018). Therefore, woodlots and other trees out of the forest are increasingly important sources of woody biomass. The trees also serve a critical role of soil and water conservation and correct the imbalance in various land uses (Emmanuel & Davison, 2010; Blaes, et al., 2013; Deakin, Kshatriya, & Sunderland, 2016). Hence the need for studies aimed at identifying new lands outside forests for tree cover or woodlots establishment.

Emmanuel & Dickson (2010) established that any sustainable plantation or woodlot establishment plans and activities would need to begin with a clear understanding of land resource use practices. AAR group, 2014 sustainable report revealed that substantial land resources existing under local government institutions like schools and if sustainably managed, can support a wide range of forest ecosystems. In the 1970s and 80s, countries built huge schools with the expectation of providing a more comprehensive curriculum (Sanoff & Walden, 2016). According to Kenya's Education Act (2012), it is a requirement that any primary, secondary or college should have at least 0.202 Ha. For this reason, Sustainability – COP Report (2014) recommended growing trees on school grounds for aesthetic values, to increase tree cover and enhance better understanding of tree growth. Furthermore, greening of school grounds requires relatively little financial investment and school administrator(s) have more control over school lands, as they can make decisions about school ground greening or work with the surrounding communities to implement other greening initiatives (Browning & Rigolon, 2019). However, Ailin & Nirmala (2017), in a study, established that evaluation of school learning environments traditionally focused on the technical and infrastructural performance of the facilities and wished to go further. Therefore, this study adventured not only on identifying various school land uses as per the school designs but also their influence on the population of trees within the school compound.

LITERATURE/THEORICAL FRAMEWORK

The outdoor environment provides a suitable setting for reinforcing curriculum, entrenching practical learning and socialization among learners across abilities and ages (Merike, Emer, & Cliona, 2010). Chawla et al., (2014) found out that contemporary school activities involve more than simply listening or writing and that schools with green, attractive exterior in which children take on an active role outside of the classroom encourage experiential learning with lasting effects on the learners. However, Sanoff & Walden (2016) established that educational reform, has largely focused on what is taught and how it is taught with the consequence of strengthening curricula, improving instructional strategies, and learning materials. However, the role of the physical environment which present an opportunity for experiential learning has been given little attention

According to Evergreen (2002), public primary schools have different ways of making or contributing to environmental greening. Presently, the need to plant trees on farms is increasing yet it is difficult for smallholders to access the trees that they want to plant (Food and Agriculture of the United Nation, 2007). Mborra, Lillesø, & Ramni (2008) provides that to meet present and future demand for planting material, it is necessary to promote on-farm and community tree nurseries that can be owned and managed by schools or a range of other local institutions. This approach would provide income-generating opportunities, act as models for further nursery development, provide seedlings more cheaply to planters, and raise the particular species of interest to the local people

Tree planting is also a practical way of introducing and integrating Environmental Education in schools (Temu, Chamshama, Kung'u, Kaboggoza, Chikamai, & R., 2008). As established by Miriam, Ochieng, & Agnes (2015), setting up tree nurseries within the school compound and transplanting the seedlings will equip learners with appropriate knowledge, skills and techniques they can apply to promote agroforestry even out of school. Furthermore, according to Bekel et al. (2015), making the school compounds green and clean, which involved regular site selection, land preparation, digging holes, planting the seedlings, mulching, weeding, and watering, can take place without interrupting the class schedule.

However, Darmody, Smyth, Doherty (2010), affirmed that current school design guidelines make provision for ball courts and play areas but are generally much less specific on aspects of outdoor space than on indoor space. The study shows that school designs in many countries, including Kenya (as evident from primary school design guidelines), seem to only concentrate on the structural development and design of these facilities. One of the major recommendations given in Merike et al., (2010) is the need for guidelines to incorporate school garden and other green habitats as many respondents strongly complained about the absence of mature trees in the school compounds, among other things. Therefore, this research sought to understand how school land use practices and priorities influences number and distribution tree in primary schools.

This study was based on the possibility of forest cover dynamics being captured in a time dimension, theorized as the *forest transition theory* (FT), and introduced by Mather in 1992. The U-shaped curve model consists of two trends or periods: forest decline due to conversion of forested lands to agriculture, settlement and other land uses (Wolfers et. al. (2015). The other is forest recovery resulting from reforestation and afforestation. Mather explains that after soil

fertility decline, people will relocate to new areas and the left areas used for reforestation. However, this study assumed that the population pressure in Kenya allows for insignificant chances for relocation, and new lands identification for tree cover establishment is most appropriate. Therefore, the use of public primary school land for tree cover establishment comes in at stage two. Their contribution is aimed at lifting the country to stage three, where there is a recovery in forest cover using tree cover as supplement.

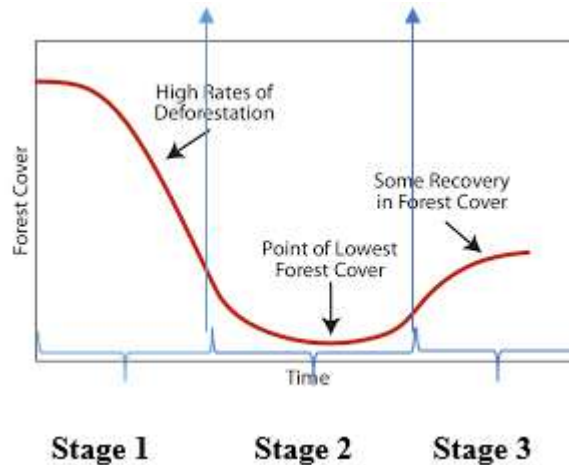


Fig 1: Forest transition theory

MATERIALS AND METHODS

This paper documents the results of a study carried out in Kisumu County in the Nyanza region, Kenya. The County (208,600Ha) has two gazetted forests; Karateng' (25Ha) and Koguta (400Ha) forests (County Government of Kisumu, 2018) and is lying between longitudes 33° 20' E and 35° 20' E and latitude 0° 20' S and 0° 50' S. As at 2018, there were 615 public primary schools and 153 private ones, 222 public secondary schools and 19 Vocational Training Institutes (VTI) in the County.

Descriptive survey research design was used for this study. Using Mugenda and Mugenda (2003), 20% (124 schools) of the 615 were randomly selected in a systematic manner (every 5th school) for the study. Land use practices and tree population in the selected public primary schools were observed in situ, without manipulation. The process's observation was also guided by knowledge from experience and theoretical review

All participants in the study consented to the process of interviewing and questionnaire administration. Responses obtained through administered questionnaires were harmonized using focus group discussions (FGDs) with teachers, upper primary pupils and lower primary pupils from 10% of the sampled schools per sub-county selected using simple random sampling technique. Further, key informant interviews were used to get professional points of view from education, forestry, administrative (area chiefs) sectors and PTA (Parents Teacher Association) representatives.

Content validity and item analysis reliability tests were used to validate the data collected before analysis. Qualitative data on land use practices and tree population was organized into themes and categories using manual codes, then the trends and relationships established. Simple descriptive statistics was used to analyse the trends of the quantitative data collected on; size of school land covered by various land covers and number of trees from the identified land use practices. In addition, product-moment correlation and linear regression analysis were used to determine the relationship and make predictions on land use practices and tree population in schools. The results and findings on land use practices and tree population were presented in text for qualitative data and tables, graphs and charts for quantitative data.

RESULTS AND DISCUSSION

Public primary school land sizes and Land covers

Public primary schools in Kisumu County cover between 0.03 Ha and 8.2 Ha. The mean size of land occupied by the sampled public primary schools was 3.26 Ha. The majority (50.81%) of schools land size ranged between 2.00Ha and 3.99Ha. Cumulatively, all the 615 public primary schools in Kisumu County cover a total area of 2004.9 Ha. This observation confirms Sustainability – COP (2014) and AAR (2015) Sustainability reports, which revealed that substantial land resources exist under public institutions including schools.

It was discovered that 32.26% (40) of the schools did not have a school layout plan but instead used instinct or BoM decisions to allocate space for their land covers. The common land cover across the public primary schools include buildings, playgrounds, assembly, gardens and woodlots. Though few (4.84%), other schools had teachers' quarters and water points (boreholes and wells). All the identified land covers are deliberately managed and modified to achieve a purposive land use outcome. The common land use practices in public primary schools were identified as summarized as in figure 1 below.

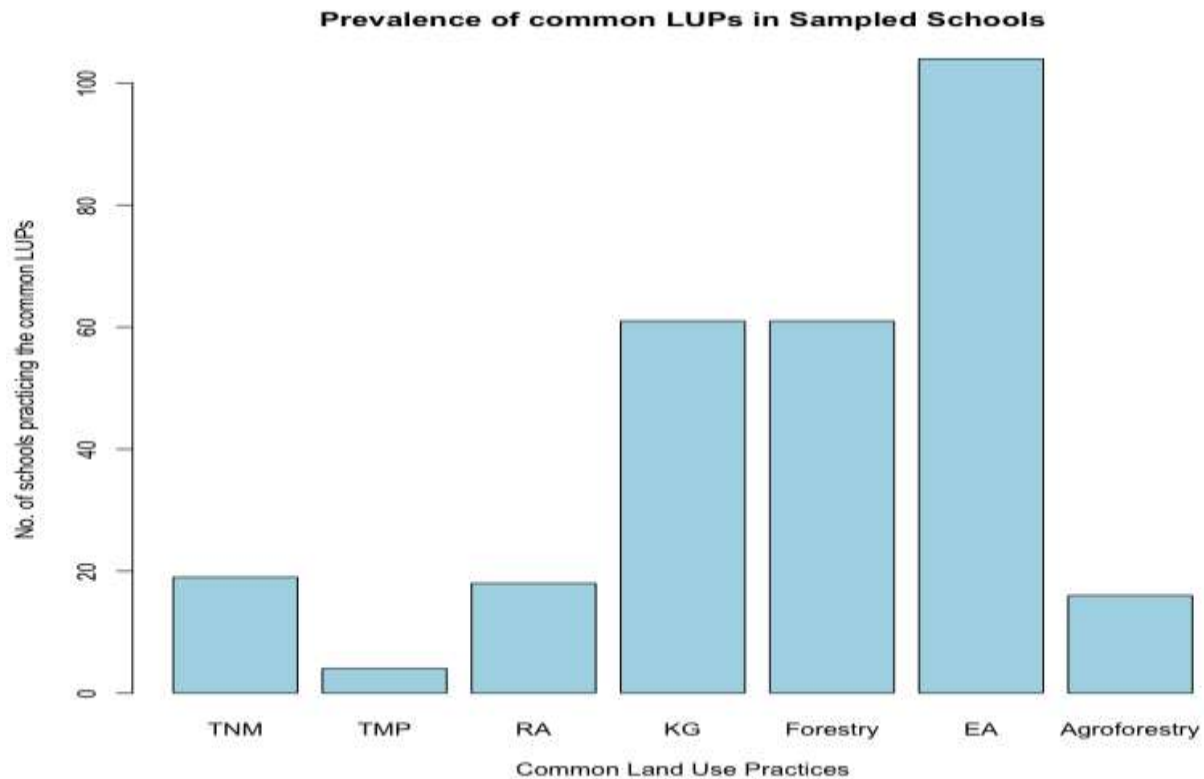


Fig. 2. Prevalence of common land use practices in sampled public primary schools in Kisumu County

The study shows that land use practices are done on specific land covers for certain purposes with specific aims or objectives. Whereby, forestry is done in woodlots; educational activities (EA) is directly associated with the structurally built areas; agroforestry and kitchen gardening (KG) in gardens; recreational activities (RA) in the playgrounds and tree nursery management (TNM) in the tree nurseries. Even though tree management practice (TMP) came prominently in 4.96% of the sampled schools, it is a general practice which could be done to either clustered, scattered or linearly arranged trees within the school compound hence could not be attached to a single land cover.

Space occupied by land covers and contribution of Land use practices to tree count in schools

Apart from water points and tree nurseries whose spaces are extremely negligible, the amount of space occupied by each land cover was assessed to identify areas within the schools where various land use practices were done as summarized in Table 1 below.

Table 1: Percentage space occupied by various land covers in public primary school

Range of school land sizes	Built area & assembly	Garden	playground	Woodlot	Total %used
<i>0.00-1.99</i>	23.97	12.745	26.545	16	71.3
<i>2.00-3.99</i>	34.16	3.3	34.675	9.82	83.5
<i>4.00-5.99</i>	37.805	2.05	31.75	10.855	82.6
<i>6.00-7.99</i>	43.585	1.05	23.415	9.2	72.65
<i>8.00 and above</i>	33.3	0.25	30	10	73.6
Average	31.7	3.12	28.2	10.14	76.3

The above table shows that schools with land sizes below 1.99Ha and those with above 6.00Ha had almost similar measures of used spaces as they had less than 80% of their land occupied by various land covers. Schools with between 2.00Ha and 3.99Ha have the highest percentage of space occupied. The average used spaces for all the schools in Kisumu County is 76.3% while 23.7% is unused. Further, it was observed that quantifiable space within the schools which could have trees were the gardens and woodlots, given that trees could not be planted on structurally developed spaces nor grown in a playground. However, in some occasions trees are scattered within the open spaces in the built areas or grown along the boundaries but they were difficult to quantify and in most cases negligible. Therefore, it could be said that 63.04% of school land is occupied by structures and playgrounds, while 13.26% have different forms of greening from trees to crops. It was also established that schools with less than 1Ha preferred to have buildings and assembly than any other land use including playgrounds. However, it was also not obvious that schools which had more than 6Ha would have a higher percentage of space occupied by green land covers. Therefore as Ailin & Nirmala (2017) established, school greening activities begin with prioritization of land uses.

Apart from the above mentioned land covers, public primary schools had a total of **25354** trees scattered within the compounds, others arranged in a linear pattern or clustered in woodlots and gardens. 99.19% schools had mature or young trees in the ratio of 3:1 while the rest had seedlings. The small number in schools with seedlings was attributed by the period within which the study was conducted which was just after a long holiday break. Therefore, school activities had not been running for some time and the majority of schools had not yet started their ground greening initiative for the year. Across all the sub-counties and the category of land sizes, there are a significantly higher number of exotic trees as compared to indigenous trees. Trees present in the designated spaces for various land covers were physically counted and to represent trees resulting from the land use practices done in these spaces. Table 2, bellow gives a summary of the resultant trees from these land use practices.

Table 2: Resultant trees from land use practices in public primary schools in Kisumu County

Land Use Practice	Land Size (Ha)					Total	Contribution (%)	Mean
	0.00-1.99	2.00-3.99	4.00-5.99	6.00-7.99	8.00 and above			
Forestry	609	2473	4455	513	509	8559	33.76	140
Educational activities	0	1030	86	4	0	1120	4.42	11
Tree nursery	0	550	0	0	0	550	2.17	29
Kitchen gardening	28	253	103	75	17	476	1.88	8
Agroforestry	0	73	80	0	0	153	0.6	10
Recreational activities	0	34	31	0	0	65	0.26	4
Total	637	4413	4755	592	526	10923	43.08	

Although 100% of the schools had educational activities, these activities could not result in tree planting and management in all of these schools, a fact which is consistent with Gibb, (2016) and Mitchell & Fisette, (2018) findings, hence the mean (11 trees). Similarly, recreational activities, found in 96.77% schools contributed to the least number of trees compared to all the practices. This could be explained by the nature of the two land use practices which allowed for minimal space for trees. However, woodlots which were present in 43.55% and covered an average of 10.14% contributed the highest number of trees. Agroforestry and kitchen gardening in school gardens covering an average of 3.12% contributed to 8 and 10 trees respectively. The two and tree nursery practice which contributed to the second largest number of trees despite occupying legible spaces, were the only ground greening land use practices identified. The greater means obtained by the three was because of the nature of the land covers which lent more to tree planting and management. This was a confirmation of findings recorded by Oduol, et. al,(2006); Mirriam et. al. (2015) & Gibb (2016)

Generally, land use practices in public primary schools contribute to 43.08% (10923 trees) of the total tree count. Apart from agroforestry and forestry, the number of trees from land use practices peaked in schools with 2 to 4 hectares of land then gradually reduced as the sizes of land increased. With respect to school land sizes, the number of trees from land use practices increase from schools with less than 2Ha of land up to those with 4Ha to 6Ha then reduce as the land sizes increased. Further, with respect to the mean number of trees per land use practice; educational activities, forestry, tree nursery and agroforestry contribute to at least 10 trees per school. Therefore, apart from recreational activities, land use practices contribute greatly to the population of trees in public primary schools and hence can help in solving various physical, social, economic and environmental problems (Zinck, et. al. (2013), Kyule, et.al. (2015) and Sivarajah, et al. (2018)).

Relationship between resultant trees from land use practices and tree population in schools

To effectively understand the influence of land use practices on tree population in public primary schools, preliminary analysis on school land sizes and total tree count was conducted. The analysis shows that there was a significantly weak positive correlation between the land size of public primary schools and tree population ($r=0.192$). At intercept of 36.916, simple linear regression showed that for every increase in 1ha of school land size, an increase of 85 trees would be expected. The analysis revealed that land size ($p=0.03<0.05$) significantly influence tree cover in public primary schools as trees require space to grow, hence can only exist where there is one. Therefore, given the land sizes of schools visited (mean=3.26Ha); as established by Evergreen (2002); public primary schools have great opportunities to contribute significantly to overall community sustainability by making or contributing to environmental greening.

Further analysis to establish the relationship between land use practices identified and tree population in public primary schools was carried out as in table 3 below.

Table 3: Relationship between trees from land use practices and total tree population and that between spaces occupied by land covers and tree count

Regression on resultant trees from land use practices and total tree population					
Variable	Estimates	SE	t-value	Pr(>/t/)	
Intercept	151.387	24.5859	6.157	1.07e-08***	
Educational activities	-0.279	0.453	-0.616	0.539	
Kitchen gardening	7.992	3.311	2.413	0.017*	
Agroforestry	7.739	5.812	1.332	0.186	
Recreational activities	0.364	5.012	0.073	0.942	
Forestry	1.946	0.169	11.492	<2e-16***	
Tree nursery	8.897	0.761	11.695	<2e-16***	
Regression on space occupied by land covers and tree count					
Variable	Unstandardized coefficient	SE	Standardized coefficient	t-value	P-value
Buildings	1.315	1.671	0.064	.787	0.433
Field	22.123	34.928	0.052	.633	0.528
Garden	377.967	178.997	0.174	2.112	0.037*
Woodlot	432.688	86.141	0.420	5.023	4.53e-05***

Notes: Significance codes- 0 '***' 0.01 '*'

From the analysis, trees from land use practices have a highly significant positive correlation with the total tree count in public primary schools ($r^2=0.843$ & $p=1.07e-08$). The value of r^2 showed that 84.3% of the total trees present in public primary schools could be explained by the trees from various land use practices in these schools. This means that apart from the school land size, the modifications and management practices done is a major factor in determining the number of trees

in the sampled schools as earlier alluded. Further, forestry ($p=2e-16$), tree nursery ($p=2e-16$) and kitchen gardening ($p=0.017$) have a significant correlation with tree population in the sampled schools. For every 1Ha increase in space for garden and woodlot, there would be a statistically significant increase in the total number of trees in public primary school ($P<0.05$) by 378 and 433, respectively. The high significance level of correlation for forestry and tree nursery could be explained by the fact that these land use practices purely deal with tree planting and management and that their major output is trees. Therefore schools which had woodlots and tree nurseries would do various management practices to ensure success, which is pegged on the resultant number of trees. Besides, kitchen gardening ($p=0.017$) and sizes of these gardens ($p=.037$) also have significant positive correlation with tree count. Generally, forestry, tree nursery and kitchen gardening were the major ground greening practices hence the significance. As Evergreen (2002), Mbora, et.al (2008) & Kyule, et. al. (2015) put it, setting up woodlots, tree nursery and kitchen gardening are the major ways schools contribute to environmental greening; meet present and future demand for planting material and equip learners with appropriate knowledge, skills and techniques they can apply to promote agroforestry even out of school

On the other hand, educational activities and recreational activities done in built areas and fields have insignificant correlation with the number of trees ($p>0.05$). Subsequently, space in hectares for buildings and fields were found not significantly correlated with the total number of trees. This is because of the nature of their land covers-buildings and playgrounds- which allows for minimal consideration of trees as output. Even though agroforestry is a ground greening land use practice, it had insignificant relationship with the total number of trees. This could have been because of its frequency, priority and difficulty to access right trees (Food and Agriculture of the United Nation, 2007).

As previously stated schools have an average of 76.3% of their land occupied by various land covers and 23.7% is unused. Assuming that part (10%) of the total school land size is to be used for tree cover establishment while the rest (13.7%) left for other school developments, the following increase in number of trees would be achieved respectively.

When the 10% is added to garden:

When the 10% is added to garden:

$$\text{Additional trees from garden} = 0.1 \text{ of SLS} * 0.174 \dots\dots\dots \text{Equation 1}$$

When the 10% is added to woodlots:

$$\text{Additional trees from woodlot} = 0.1 \text{ of SLS} * 0.42 \dots\dots\dots \text{Equation 2}$$

Where SLS is the school land size

Since the size of the school garden and woodlots were distinct and positively significant in determining the number of trees in public primary schools. They were the only land covers which could be manipulated to increase tree population in schools. As much as tree nursery management also had a significant relationship with tree count, the sizes of tree nurseries encountered were negligible with respect to the total school land size.

CONCLUSION AND RECOMMENDATION

The study showed that there is a significant correlation between the land size of public primary school and tree population. This means that, however not strongly, total school land size is a determinant factor while making decisions on school ground greening. Therefore, given the recorded land sizes and availability of unused spaces, public primary schools have great opportunities to contribute significantly to overall community sustainability by making or contributing to environmental ground greening. Further, a positive correlation between school land use practices and tree population shows that the choice of land cover and management practices done in schools significantly influence tree population in these institutions, to be specific, forestry and gardening among the other land use practices. Therefore, with reference to availability of unused spaces and significant relationship between size of land occupied by woodlots and gardens and number of trees, there is a possibility of increasing tree cover. It can then be said that increasing space under trees-woodlots and gardens- have a potential increasing the total number of trees in public primary schools. Therefore, with proper record keeping, public primary schools should set aside part of their unused spaces to establish active woodlots and gardens to purposely increase tree cover in these institutions.

AREAS FOR FURTHER RESEARCH

The researcher recommends a similar study which goes beyond determining influence of land use practices on tree population to influence of these practices on actual tree cover. That is, application of actual measurement of individual tree canopy with respect to land covered and then obtaining its relationship with the land use practices.

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