

The Nature, Extent and Intensity of Land Use and Land Covers Change and Its Implications on Fringe Development in Eldoret Municipality, Kenya

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Abstract

In the rapidly growing urban areas of the developing countries, land use activities are changing at unprecedented rates. These continuous changes have resulted in the degradation of environmentally fragile resources, occupation of hazard-prone areas, loss of cultural resources, open space and prime agricultural land and excessive urban sprawl. This paper seeks to investigate the nature and extent of land use and land cover changes. The study was carried out in Eldoret Municipality, Land use and land cover data of Eldoret Municipality were interpreted for a 20-year time period from aerial photographs taken in 1973, 1985 and 1993. Each set of photographs was first assembled for pre-view so as to prepare a temporary classification system as well as assess the quality of the photographs. The study draws a conclusion that the built-up environment has generally increased. This refers to the land under commercial, industrial, institutions and residential facilities. The major explanation for this is the growth of urban population. This analysis is expected to promote environmental quality of the study area and also guide the land use planners in the study area. The information obtained can also be applied to other urban areas with similar environmental problems.

Keywords: Nature, Extent, Intensity, Land Use, Land Cover Change

1. Introduction

Lillesand and Kiefer (1987) define the term land cover as any type of feature present on the earth's surface, which may include forest, water and buildings. They also define land use as any human activity associated with specific piece of land such as residential, industrial, commercial or transportation.

Problems associated with unplanned land use changes and urban growth, are the issues currently faced by the urban environmental planners. Rapid increase in population is an issue that demand close attention especially considering the demand and provision of basic facilities. Eldoret town is not an exception since its population, which is currently approximately 250,000, is projected to be 300,000 by the year 2001 (Republic of Kenya, 1997).

1.1 Land Use and Land cover Change

The rapid rate at which land use and land cover types change in towns of developing countries is one of the greatest challenges facing the world today. This change is strongly related to the issue of urban sprawl. Kivell (1993) claims that land use changes in European urban areas have raised concerns about limiting urban growth in order to maintain environmental and social qualities of life.

Many patterns and trends of land use changes can be explained in terms of broad economic and social changes. In London, the Dock land developments of nineteenth-century wave of industry and commerce, led to changes not only in terms of land use, but also in terms of environmental aesthetics and community structures (Brindley, 1989).

The changes in land use are attributed to increase in urban population which generates a rapid rise in demand for urban land, especially for the purposes of industrial, residential and commercial establishments (Bernstein, 1994). According to the World Bank (1992) the urban population stood at 1.3 billion in 1991 and is expected to grow by 160 percent by the year 2030. FAO (1989) remarks that due to increase in population and aspirations, land becomes increasingly scarce while at the same time land use has to change in order to meet the new demands.

Bernstein (1994) goes further to explain that the increase in urban population contributes to rapid expansion of industries which in turn exert pressure on the surrounding ecosystem. However, Bluden (1992) seems to disagree with the above, as he suggests that both social and economic changes accelerate the new patterns of land use and settlements.

Kivell (1993) points to transport developments as the most powerful processes prompting changes in urban land use patterns. Young and Schoolmaster (1985) in the study of Dallas Fort Airport distinguished both the negative

and positive effects of airport on urban land use location. On the negative side, noise distracted the location of schools and residential sites near airports. While on the positive side, airports attracted population increase hence prompting commercial, retail and industrial projects.

The Central Business District of cities is also important in influencing land use change. Bourne (1967) argues that distance from the CBD is important in determining the potential for land use change. However, Muller (1981) suggests that the argument is difficult to sustain since the structure of the city changes from homocentric to polycentric.

Suburbanization and decentralization from the inner city also have considerable land use implications. This happens due to the diminishing attractiveness of land in the inner city and the growing demand for land on the urban fringe. Cohen (1973) pointed to the radical restructuring of metropolitan America which was a function of decentralization of both commerce and industry. According to Herrington (1984) suburbanization brings about the concept of a rural-urban fringe. This is an area which has a distinctive characteristic which is only partly assimilated into the growing urban complex but is still partly rural. Carter (1995) noted three important aspects for this area namely:

- (i) The notion of the fringe as a distinctive physical region of the city primarily designated by characteristic land use associations.
- (ii) The notion of the fringe as that area where urbanisation impinges on rurality and where conflict between ways of life is generated.
- (iii) The impact of urban expansion on agricultural land.

Wehrwein (1942) describes the urban fringe in USA as an 'Institutional Desert' due to its unpleasant and noxious establishments. This is true especially if the cause of the fringe development is industrial expansion.

Land use in the third world countries is wholly a function of rural to urban migration. Obudho (1992) reported that urbanization and land use changes in Kenya are at a fast rate due to increase in population resulting from rural to urban migration.

2. Materials and Methods

Land use and land cover data of Eldoret Municipality were interpreted for a 20-year time period from aerial photographs taken in 1973, 1985 and 1993. Each set of photographs was first assembled for pre-view so as to prepare a temporary classification system as well as assess the quality of the photographs. The first pre-survey made was to confirm the adequacy of photographs in providing the required data.

To suit the study, Anderson (1976) classification system was modified to aid in interpretation and formulation of the legend. Modification of the Anderson (1976) system involved the merging up of the three levels of classification to one and the expansion of its categories into nineteen.

Using a mirror stereoscope, the photographs were interpreted run by run while applying photo image characteristics such as tone, texture, pattern and association to differentiate the features. The delineations of land use and land cover types from each run were recorded on a transparent sheet of paper which was superimposed on the photographs. These transparent sheets of paper for different runs were later assembled on the light table and compiled into a composite map of land use and land cover type and mapping units.

A second phase of field check was undertaken where the compiled drawings of land cover types were crosschecked for verification, completion and recording of the polygons which were not clear from the photographs. Fair drawings of the land use and land cover maps for the three set of years were completed.

Since the fair drawings of maps were not geo-referenced, three sets of topographic maps (1:50,000) covering the entire area of Eldoret Municipality were used to geo reference the spatial data obtained. Certain features/areas appearing on both the fair drawings and topographic maps were identified and their co-ordinates recorded to obtain the control points.

This analogue data was now ready for digitization. The features to be digitized were assigned the feature codes and digitized in Cartalinx Software. This was the most crucial exercise that led to a GIS Database generation from which analysis could be done. Digital data produced were edited using both interactive and batch modes. The resultant data was then coded before being exported to Idrisi programme for analysis.

Data analysis and presentation relied mainly on the three maps produced. Using Idrisi Software (version 2.01), the maps were compared and manipulated through overlays. This was meant to; quantify the changes, obtain their percentages and determine the nature, extent and intensity of changes.

Environmental problems related to land use and land cover changes were identified using various techniques. First, they were identified from doing a cross-classification analysis, which involved the running of a CROSS-TAB command from Database query of Analysis module in Idrisi for Windows.

The cross-classification, which can be described as a multiple overlays, shows all combinations of logical operation. The image attributes for 1973 were first expanded to match with those of 1993. After this, cross-classification analysis was run and this resulted in a new image as well as a table showing the location of all combinations of the categories in the original images. ASSIGN module was used to filter all the areas which were identified as problem areas. ASSIGN created a new image by linking geographical attributes of features defined in the first image file with attributes defined in an attribute values file. This resulted in a map showing the location of some of the problems in the study area.

3. Results

3.1 Land Use and Land Cover Changes between 1973, 1985 and 1993

Table 1 shows a comparison of land use and land cover types between the three years. It shows that there has been a general change in most of the land use and land cover types since 1973. The results of these changes are presented in table 2. The changes between them are considered to represent the changes in environmental status.

The three major land use and land cover types being the built environment, forest cover and agriculture have generally increased since 1973. This indicates that the urban environment has expanded so as to engulf the forest and agricultural lands. Continuous expansion of the built environment will eventually lead to clearance and conversion of forest and agricultural lands for creation of space for expansion. The area under agriculture row-crop for instance had increased by 4867.3 hectares in 1993.

The wetlands have also decreased by 28.6 hectares between the year 1985 and 1993 which is possibly due to the expansion of built-up environment. This change will eventually lead to loss of biodiversity. The built environment occupied 758.7, 2090.7, 3060.2 hectares for the years 1973, 1985 and 1993 respectively. This represents an increase of 175.5% and 303.3% by 1985 and 1993 respectively. Agricultural land represented about 358.7 hectares, 1591.2 hectares and 5604.3 hectares in 1973, 1985 and 1993 respectively. The open urban land covered 804.4, 1754.7 and 2350.6 hectares for 1973, 1985 and 1993 respectively. The forest cover and wetlands which occupied 558.3, 1458.5 and 3424 hectares in the years 1973, 1985 and 1993, respectively indicates an urban expansion to cover areas occupied by wetlands as this shows an increase of 161.2 and 514 hectares by 1985 and 1993 respectively. With time, these wetlands will be drained away so as to create space for the expansion of the built-up environment

3.2 The Nature, Extent and Intensity of Land Use and Land Cover Change for the Years 1973, 1985 and 1993

The results are illustrated in tables 3 and 4. The land use and land cover change between the three years are shown in hectares as well as increase in percentages. Table 6 indicates that there has been an increase in built-up environment which implies that the natural environment has decreased. The built-up environment which includes all types of residential areas, commercial and service facilities, industries and institutions increased from 758.7 hectares in 1973 to 2090.9 and 3060.2 hectares in 1985 and 1993 respectively. This is about 175.5% and 46.4% increase in the respective years.

The low-density residential area was about 256.5 hectares in 1973 and increased up to 439.4 hectares in 1993. The medium density residential area occupied about 289.9 in 1993 and 1135.6 hectares in 1993 while the high-density residential area, which represents slum areas, indicates a drastic expansion from 29.9 hectares in 1973 to 421.8 hectares in 1993. In addition, commercial and service institutions have also increased from 161.5 hectares in 1973 to 882.8 hectares in 1993. Other increments are recorded for recreational and institutions. Lastly, quarries appear to be recent developments in the study area since they don't appear in 1973 but occupy 1.2 hectares in 1985 that increased up to 25.3 hectares in 1993.

Table 1: Hectares of Land use and Land cover types in the three Years (1973, 1985 and 1993)

Land use and Land Cover	1973 ha	1985 ha	1993 ha
Residential Low Density	265.5	409.4	439.4
Residential Medium Density	289.9	372.4	1135.6
Residential High Density	29.9	57.1	421.8
Commercial and Services	161.5	167.4	882.8
Industries	2.4	25.8	51.0
Airstrip	21.6	21.6	21.6
Dumping Site	-	21.9	21.9
Institutions *	9.5	26.5	129.6
Recreational * *	3.9	4.7	8.2
Agriculture row crop	301.7	1411.7	5171.0
Agriculture field crop	55	179.5	433.3
Open urban land	804.4	1754.7	2350.6
Dense forest	147.3	152.2	779.1
Forest medium density	62.8	84.0	782.0
Forest open trees	89.4	380.6	168.8
Forest clear-cut	186.3	665.8	1550.8
Wetlands	72.5	175.9	147.3
Quarry	-	1.32	25.3
Ridges and bare rock	198.7	39.3	250.8
Total	2516.3	59551.7	14770.9

* Only the area covered by institutional buildings

* * Both public and institutional recreational facilities

Table 2: Land Use and Land Cover Changes Between 1973, 1985 and 1993 in Hectares & Percentage increases, Derived from aerial photographs of 1973, 1985 and 1993

Land use and Land Cover	1973-1985	% increase	1985-1993	% increase	1973-1993	% increase
Residential Low Density	152.9	59.6	30	44.7	182.9	71.3
Residential Medium Density	82.5	28.5	763.2	229.5	854.7	294.8
Residential High Density	27.2	91.0	391.9	734	419.1	1401.7
Commercial and Services	5.9	3.7	715.4	1263.2	721.3	446.6
Industries	23.4	975	25.2	290	48.6	2025
Airstrip	0	-	0	-	0	-
Dumping Site	21.9	-	0	-	21.9	-
Institutions *	17	178.9	103.1	453.3	120.1	1264.2
Recreational * *	0.8	20.5	3.5	91.5	4.3	110.3
Agriculture row crop	1108	364.8	3759.3	344.8	4867.3	160.7
Agriculture field crop	124.5	226.4	253.8	210.8	378.3	687.8
Open urban land	950.3	118.1	595.9	88.1	1546.2	192.1
Dense forest	4.9	3.3	626.9	415.1	631.8	428.9
Forest medium density	21.2	33.8	698	856.2	719.2	1145.2
Forest open trees	297.2	332.4	-211.8	22.4	85.4	95.5
Forest clear-cut	479.5	257.4	885	205	1364.5	732.4
Wetlands	103.4	142.6	-28.6	101.3	178.2	245.8
Quarry	1.2	-	24.1	2108.3	25.3	-
Ridges and bare rock	19.6	99.5	211.5	588	231.1	1173.1
Total	34195	2935.5	8897.1	7735.2	12391.2	9816.4

* Only the area covered by institutional buildings

* * Both public and institutional recreational facilities

Table 3: Extent of the built-up environment for the years 1973, 1985 and 1993 in the study area (In Hectares and percentages) Derived from Interpretation of 1973, 1985 and 1993 aerial photographs

Land use and Land Cover	1973			1985			1993		
	Hectares	%	% increase	Hectares	%	% increase	Hectares	%	% increase
Residential Low Density	256.5	10.19	-	409.5	6.88	59.6	439.4	2.97	44.7
Residential Medium Density	289.9	11.52	-	372.4	6.26	28.5	1135.6	7.69	229.5
Residential High Density	29.9	1.19	-	57.1	0.96	91	421.8	2.86	734
Commercial and Services	161.5	6.42	-	167.4	2.81	3.7	882.8	5.98	1263.2
Industries	2.4	0.10	-	25.8	0.43	975	51.0	0.35	29
Institutions	9.5	0.38	-	26.5	0.45	178	129.6	0.88	453.3
Total	758.7	29.8	-	2090.9	17.79	1335.8	3060.2	20.72	2753.7

Table 4: Extent of Forested Land and Wetlands for the years 1973, 1985 and 1993 in the study area (In Hectares and percentages) Derived from Interpretation of 1973, 1985 and 1993 aerial photographs.

Land use and Land Cover	1973			1985			1993		
	Hectares	%	% increase	Hectares	%	% increase	Hectares	%	% increase
Dense Forest	147.3	5.85	-	152.2	2.56	3.3	779.1	5.27	415.1
Forest Medium Density	62.8	2.50	-	84.0	1.41	33.8	782.0	5.29	856.2
Forest Open Trees	89.4	3.55	-	380.6	6.39	332.4	168.8	1.14	22.4
Forest clear - Cut	186.3	7.40	-	665.8	11.19	257.4	1550.8	10.5	205
Wetlands	72.5	2.88	-	175.9	2.96	142.6	147.3	1	101.3
Total	558.3	22.18	-	1458.5	24.51	739.5	3428	23.2	1500

4. Discussion

4.1 Nature, Extent and Intensity of Land Use and Cover Changes for the Years 1973, 1985 and 1993

Given the analysis done in the preceding sections, it is clear that the built-up environment has generally increased. This refers to the land under commercial, industrial, institutions and residential facilities. The major explanation for this is the growth of urban population. The population growth rate of Eldoret Municipality is due to the natural increase of urban population, migrants from other urban areas as well as rural areas in search of employment and expansion of boundaries which incorporate the surrounding rural communities. With the increase in population, the demand for more social amenities and infrastructural facilities increases and hence the expansion of the built environment. As built-up environment increases so will demand for ballast or stone aggregates for various construction purposes. This in turn gives rise to a number of unrehabilitated quarries in the study area. In addition to this, the high demand for land for expansion will raise the land price which in turn increases house rent and this encourages settlement in slums which are associated with several environmental problems.

Eldoret Municipality has benefited from the implementation of the development centre policy which involved the government investments in both the economic sector and social amenities. This investment has in turn attracted private investment which have helped to stimulate the development of the commercial and industrial sectors and hence the general built-up environment. Nyakaana (1996) recognized that between 1974 and 1984, about 45% of government expenditure in Eldoret was in the economic sector (industry, water, power and housing). This means that the growth of industries in the study area mainly took place during this period and therefore attracted more people to come and settle in Eldoret.

The recent development of some of the infrastructural and educational facilities has also contributed to the increase in the built environment in the study area. Some of these facilities which have played a role in the recent past include Eldoret International Airport and Moi University and its branches. Though the two do not physically fall within the study area, they have had influence in the expansion of the built environment since most workers for the two institutions reside in Eldoret town.

Originally, the study area was an agricultural collecting centre. The surrounding communities practice cultivation of crops and livestock keeping. With the advent of boundary expansion in 1973 and 1988, much of this agricultural plan fell within the municipal boundary. It is noted in this study that between 1973 and 1993 vast areas of agricultural and forest land cover types have fallen within municipal boundary.

5. Conclusion

The objective of this study was to examine the extent, nature and intensity of land use changes in the Eldoret Municipality. The study utilised GIS generated data mainly which provided the area of each land use and land cover types for each of the three years. These results were further subjected to sample size type of statistical test in order to obtain the extent and intensity of the land use changes.

The results indicate that most of the land use and land cover types have experienced both temporal and spatial increases in the study area. This include; the built-up environment, forests and agriculture. The wetland cover type has recorded some decrease while quarries appear to be a recent development in the study area.

6. Recommendations

The write recommends that the government should seriously consider re-introducing the funding for the Governmental Estates Development Fund which in the past was instrumental in availing land for urban development. This will facilitate the timely provision of housing. Excessive urban expansion on important ecological areas such as forests, wetlands and agricultural lands should be discouraged.

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