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LAND USE DYNAMICS IN URBANIZED AREA: A CASE STUDY OF SUNYANI (GHANA)

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ABSTRACT

The dynamics of land use changes in an urbanized area within the concept of land use planning were investigated, with Sunyani (Ghana) as a case study. A comparative research approach was adopted to obtain the data, which was analysed for the change distribution, relationships, values, and directions. Discrepancies between plans and corresponding physical development or implementation outcomes, and associated underpinning factors were identified for redress. Regarding land use distribution, residential land use correlated negatively with commercial land use (- 0.12) and public open space (- 0.24), but positively with education land use (0.51). Residential land use lost more land (19.9 %) to the other uses, whereas public open space was the most vulnerable to change. Areas with high land values experienced less land use changes, while extensive land use changes occurred on the outskirts. To address the challenges, the town and country planning officials, authorities and other regulatory agencies, ought to implement and enforce the appropriate bye-laws on land use plans in the urban area.

1. INTRODUCTION

The contention between planning theory and practice resurfaces with resurgence of urban problems, such as congestion, non-conforming land uses, loss of open spaces [1, 2]. Experience in planning practice, especially in Africa, shows that in many cases, plans are either not implemented or physical outcomes vary widely from the plans after implementation [3]. The phenomenon has led to a situation where land uses were not based on the actual prepared plans, such that areas allocated as public open spaces, recreational areas, etc., had been compromised. In most cases, such situations of unauthorized development have tended to create slums and congestion as every parcel of land is built up [4].

While land use plans attempt to manage and control spatial development, economic and social factors are considered the critical determinants of land use in an urban area [5]. The land use plans reflect public interests in relation to health, safety, convenience, economy and amenity, but economic determinants of land use are controlled by market forces, land value and price paid or decision on highest yielding alternative land use [6]. Social determinants of land use dwell on human values, behaviour, and social interactions, but issues such as urban politics and profit motive, decisions by people and for people rather than unseen ecological forces dominate the urban development landscape [7], thereby causing changes in planned land uses in the long run. Therefore, without effective land use control systems, physical outcomes will vary widely from the plans.

Land use change has become a topical issue, especially in relation to urban sprawl or peri-urban development, transportation and urban pollution as the urban area spreads outwardly from the center [8 - 11]. Land use is considered to be the most stable component of urban dynamics, but a change can modify the urban structure over a long period of time [10]. Notwithstanding such recognition, land use potency and the internal dynamics of urban land use leading to changes in the urban structure, have not been thoroughly and comprehensively studied to address the challenges.

Analyses of land use dynamics in urbanized Sunyani (Ghana), within the concept of development planning by comparison of plans and the physical/implementation outcomes are presented in this paper. In addition, the factors contributing to changes in land use are also discussed. The findings of the study would provide information for the planners and other regulatory authorities to appreciate the dynamics of land use changes, the causes and compliance to ensure the physical outcomes conform with the respective development plans.

2. RESEARCH METHODS

A multi-dimensional comparative research design was adopted to collect and analyse data on development plans and the physical outcomes of Sunyani. The key variables investigated were land use distributions, relationships, valuation, changes and change directions. Specific to the issues, primary data on land values, magnitude and directions of change, and secondary data on planning schemes and accompanying reports were obtained.

2.1. Study Area

Sunyani is both Regional and Municipal capital of Brong Ahafo Region and Sunyani Municipality respectively, occupying a land area of 829.3 km^2. The population of Sunyani in 2010 was ~ 86,604, growing at 3.4 % [12].

Sunyani has long experience in formal planning, as the Master Plan shown in Fig. 1 was prepared more than 55 years ago. Upon attainment of Regional status in 1959, a Regional Town and Country Planning Department was established to oversee planning activities in the region. Over the years, several planning schemes, redevelopment schemes, and rezoning have been undertaken and implemented which have influenced the shape of Sunyani.

The planning officers exerted diverse control and management protocols that in turn influenced the plan preparation, adherence to regulations and implementation of the plans. Owing to increased workload on the Regional Department and population increase, a Municipal Town and Country Planning Department was created in 1997 to concentrate on the development activities in Sunyani.

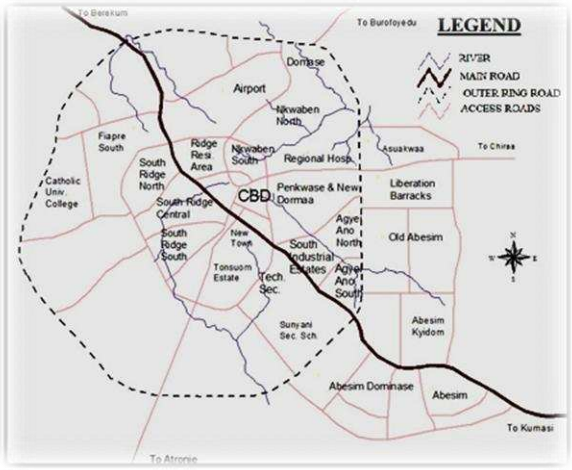

Fig. 1. Map of Sunyani Municipality [13]

2.2. Field Survey

Field surveys were conducted by physical observation of land use changes, followed by interviews of land users and key informants. Specific to the land user surveys, 50 out of 480 identified land users, representing sample percentage of ~ 10.4 %, were purposively selected and interviewed with semi-structure questions on land use changes and valuations to obtain responses on major land use patterns in residential, commercial, industrial, education, civic and cultural, open space/recreational, sanitation and road systems. Also, physical reconnaissance was undertaken to collect data on the dynamics of land use changes.

The surveys were conducted between July and August 2010. The main challenges encountered were that certified original copies of the land use plans were obtained for the field observation, but rather, photographs of the needed plans were taken and used for the field observations.

2.3. Evaluation of Planning Scheme

Eleven planning schemes were evaluated to estimate the acreages of specific land uses earmarked. Printed copies of the schemes were taken to the field for the physical surveys and the physical outcomes were compared with the plans. The changes were recorded in double-entry system of gain from other land uses and/or corresponding loss to other land uses [14]. Similar method has been used to observe changes among land uses in Iran [15]. The responses from land users and the physical observations were validated by interviewing the Officers from the Lands Commission, Town and Country Planning Department and Survey Department. Other stakeholders, such as the Building Inspectors, Traditional Authorities, and South Industrial Estates Association were also interviewed to obtain additional data on causes of land use changes in Sunyani.

2.4. Data Analysis

Pre-tested questionnaires were administered to land users and other key stakeholders to obtain data on purpose of land use, reasons for choice of location, length of usage of land, market price of land, observed changes in land uses, reasons for changes, etc. Fifty responses were received and the quantitative data were analysed using Statistical Package for Social Sciences (SPSS v.16), while the qualitative observational data on the changes were analysed manually by matching changes with reasonns offered for such changes.

The analyses were based on comparing the plans and the physical outcomes. The relationship among the land uses were statistically determined by coefficient of correlation determination. The Pearson correlation coefficient (r) was calculated using the formula [16]

$$r = \frac{\sum XY - \frac{(\sum X)(\sum Y)}{N}}{\sqrt{\left[\sum X^2 - \frac{(\sum X)^2}{N}\right]\left[\sum Y^2 - \frac{(\sum Y)^2}{N}\right]}} \quad (1)$$

where X is independent variable (i.e. residential land), Y is dependent variable (other land uses), N is number of sectors demarcated, and r^2 represent the coefficient of determination. A sample calculation and corresponding data are given in Table A1 of the Appendix. Note, while r^2 is expressed as decimal, the value is interpreted as proportion of the variability of Y accounted for by X (in percentage value).

3. RESULTS

Data of land use dynamics on distribution, changes, values, and change factors were analyzed.

3.1. Land Use Distribution

The official planning scheme shown in Table 1 indicated the land area of Sunyani to be 6731.2 acres, demarcated into residential land use covering 52.3 %, civic and culture 10.3 %, education 5.6 %, commercial 2.3 %, and public open spaces and recreation covering only 0.5 %. The effects of high road/circulation land use manifested in very low vehicular traffic and the convenience in moving around the municipality without congestion.

Table 1. Land use distribution in Sunyani (and designations of demarcated land uses)

Land Uses	Sunyani	
	Acres	%
Residential (R)	3525.3	52.3
Education (E)	373.9	5.6
Civic and Culture (CC)	691.9	10.3
Commercial (C)	156.8	2.3
Industrial (I)	112.2	1.7
Public Open Space/ Recreation (POS/Re)	36.9	0.5
Sanitary Area (S)	23.8	0.4
Road/Circulation (R/C)	1810.4	26.9
Total	**6731.2**	**100**

The Pearson correlation data shown in Table 2, indicated diverging relationships between residential and other land uses.

Education, commercial and POS/Re land uses had significant (> 0.01) correlation with residential land use. Also, education land use had a positive and highest correlation of 0.51, meaning that with increasing residential land use provision, educational land use also increased. In addition, the co-efficient of determination showed that about 26 % of the increases in educational land use were caused by increases in residential land use. The explanation for the relationship might be that in the plan preparation, the planners provided sites for day care centers and primary schools in the predominantly residential areas.

Table 2. Correlation relationships in land use distributions between residential use and other uses

Description	Residential (X)		
	Education (Y)	Commercial (Y)	POS/Rec. (Y)
r	0.51	- 0.12	- 0.24
r^2	0.26 (26 %)	0.014 (1.4 %)	0.058 (5.8%)

Contrary to above observation, commercial and POS/R land uses correlated negatively with residential land use. Thus, unlike education, increases in residential land provision in plan preparation rather resulted in decreased commercial and POS/Re land uses; the extent of correlation was greater for POS/Re (- 0.24) than commercial land use (- 0.12), as indicated by the coefficient of determination. Thus, increase in residential land use provision influenced about 5.8 and 1.4 % decrease in POS/Re and commercial land uses respectively. Alternatively, the land use inventory indicated that a decrease in residential land use might also lead to increases in commercial and POS/Re land uses.

By encroachment, most open spaces in Sunyani had been changed for other uses, such as civic and culture, residential and commercial uses.

3.2. Change Directions

There were 196 changes among the land uses, classified in terms of land use gained or lost. Educational, civic, culture and commercial land uses gained from the land use changes, while residential, industrial and POS/Re lost as shown in Table 3.

The 44 losses in residential land use were highest of all the land use change, out of which 26 went to commercial uses, such as shopping centers, markets, hotels or hostels as observed at the Central Business District, South Ridge North and Tonsuam Estates.

Correlating negatively with residential land use, commercial land use gained substant-

Table 3. Land use change directions

Loss / Gains	R	E	CC	C	I	POS /Re	S	R/C	Total Losses
R	-	6	7	26	4	0	1	0	**44**
E	0	-	1	1	0	0	0	0	**2**
CC	3	3	-	1	0	0	1	0	**8**
C	1	0	3	-	1	0	0	0	**5**
I	0	0	4	17	-	0	0	0	**21**
POS/ Re	1	0	8	3	0	-	0	1	**13**
S	0	0	1	1	2	0	-	0	**4**
R/C	0	0	0	0	0	0	1	-	**1**
Total Gains	**5**	**9**	**24**	**49**	**7**	**0**	**3**	**1**	**98**

ially from residential land use loss, while residential land use gained only one out of the 5 losses in commercial land use. Therefore, if an area was converted to predominantly commercial land use, there was less likelihood of reverting to residential land use.

Similarly, 17 out of the 21 losses in industrial land use were gained by commercial uses, mostly at South Industrial Estates where land allocated for industrial workshops were converted to students' hostels. Civic and culture land use (basically church) gained the remaining 4 losses of the industrial land use.

POS/Re was the most vulnerable to change and recorded 13 losses and never gained from any other land use. The 13 losses were gained by civic and culture (8), commercial (3) and residential (1) land uses. The losses by POS/Re were outcome of encroachment, as expressed by key informants, and were worrying since the municipality was losing green landscape and parks.

Commercial land use gained highest 49 (26 from residential) where houses had been converted to shops; followed by civic and culture (24), and education (9) land uses. The trend of commercialization of residential areas was outcome of poor plan preparation, as the uses were not critically assessed and provided in the master plan. Hence, other uses, especially residential were changed into commercial and educational usesas the township grows. POS/Re did not gain from any other land use; not even a single house was pulled down or market was converted to an open space, indicative of poor attitude of the inhabitants towards recreation.

3.3. Land Values

The gaps or differences between plans and the physical outcomes are shown in Table 4. The highest land use change of 28.6 % occurred in South Industrial Estates where many workshop plots had been converted to students' hostels, followed by Penkwase/New Dormaa, and CBD with 19.4 % and 17.3 % changes respectively. The lowest land use changes occurred in the Ridge Residential area (1.0 %) and South Ridge North (5.1 %).

Table 4. Changes in land uses

Areas	Changes	%
Penkwase & New Dormaa	38	19.4
Nkwaben & New Dormaa Extension	30	15.3
Ridge Residential	2	1.0
South Ridge North	10	5.1
Central Business District (CBD)	34	17.3
New Town & Tonsuom Estate	26	13.3
South Industrial Estates (Magazine)	56	28.6
Total	**196**	**100**

There was a dynamic relationship between land use change and land values in the municipality. Areas with high land use changes were South Industrial Estates (28.6 %) and Penkwase/New Dormaa (19.4 %) which also recorded low land value of $3,270 per 80 x100 ft plot size, but with the highest average annual increase of 7.4%. Nkwaben/New Dormaa extension recorded 15.3 % changes at land value of $2,920, almost one-third of value at the CBD/Ridge Residential area.

The high land use changes occurred in areas with relatively low land values as indicated in Table 5. In major Ghanaian cities, such as Accra and Kumasi, high land values in the CBDs compelled many developers to move to the outskirts [17], but soon experienced high land use change over time.

Table 5. Land values in Sunyani

Area	Market value* ($)	Annual % increase
Penkwase/New Dormaa & Magazine	3,270	7.4
New Town & Estate	5,600	6.1
Nkwaben & New Dormaa extension	2,920	5.0
CBD & Residency	9,670	3.8
South Ridge north area	2,730	5.0

*Per 80 x100 ft plot size

The CBD and Ridge Residency had the highest land value of $9,670 and recorded

lowest change in land use (18.3 %). In the Ridge Residential area, only two changes (1.0 %) were recorded, because the area was restricted, serving as the residence for key government officials; and indication that effective control or restriction measures could minimize development changes in land use.

3.4. Change factors

The outcomes of physical development did not conform with the planning schemes, as the study revealed 196 unauthorized changes. The few authorized changes occurred because of uncompleted rezoning process. The land use change factors were rezoning, human intervention, ineffective implementation, weak enforcement and market forces.

The approved rezoned areas did not reflect on the land use plans, causing differences between plans and the physical outcomes; creating difficulties in effective tracking of unauthorized changes.

The human factor encouraged unauthorized changes on the grounds that development should not be at the detriment of people, thereby compromising restrictions on land use in water ways, encroachment, sub-division of plots, and erection of structures at unapproved locations, although considered inappropriate. A typical example was the location of a liquefied gas filling station close to the State Transport Corporation Yard, which unfortunately exploded in August 2010.

Ineffective approach to plan implementation was caused by absence of programmed schedules of monitoring and control, which provided opportunities for conversion of public parks, open spaces, clinic sites, etc. to other unapproved uses, such as shops. The municipal assembly was weak in enforcing the planning bye-laws and provisions due to interference from interested groups leading to selective enforcement and non-compliance. For instance, controls on development by religious bodies and traditional authorities were ambivalent, as compared to actions taken against commercial entities.

Planning failure and market forces were key factors on land use changes at the South Industrial Estates. While workers were expected to commute to the estates, the trends were that the workers created residences within the small workshop plots. Also, rooms in the estates were converted to residential facilities or hostels for students because of the lucrative economic gains by the owners.

4. POLICY IMPLICATION

The impact of the negative change factors on physical development of the municipality has exposed the operations of the Town and Country Planning Department to public criticisms. In particular, the approval of siting of the exploded liquefied gas plant was attributed to unprofessional practices.

Other aspects of land use changes which presented challenges for planning and development control were the conversion of residential land use to increasing commercial use, especially in areas with relatively lower land value. The POS/Re land uses were most vulnerable to the changes.

The ineffective plan implementation and control, coupled with the negative change factors had serious policy implication for development of the municipality. Adequate consideration must be given to each land use during plan preparation. In the past, commercial, civic and culture, and education land uses were not adequately provided for, and with urbanization, POS/Re and residential have been taken over by other land uses.

Development control in the municipality should be intensified in the relatively low land valued areas to minimize unauthorized changes, as developers move out of the high land values in the urban centers to the outskirts or suburbs.

Appropriate modern techniques for monitoring and evaluating physical development, such as Geographic Information Systems should be employed to generate computerized data base, as the traditional methods of monitoring physical development in urban areas are slower in relation to the pace of development. The regulatory agencies must be discret in rezoning and control of development schemes, and enforcing the planning regulations to the letter, without interference and influence which compromised professionalism of the planning officers, so that public confidence in the planning schemes would be restored [18].

5. DISCUSSION

Rapid urbanization has been cited as

the major cause of land use changes which impact on the spatial environment and agriculture land use [8, 13, 19, 20]. The study found that high land use changes occurred in relatively low valued land areas, and that residential areas lost more land through such changes. To make up for loss in residential land uses, many developers have turned to low valued land areas and without effective and systematic urban development control, failures would lead to creation of urban sprawl [8, 17].

The pattern of land use change indicated that higher valued lands, such as residential and commercial gained in the urbanized land use changes [13], but from the findings of the study, residential areas rather lost land to commercial land use. The difference appears in the classification of land values, for residential is viewed as higher land valued activity only in relation to location, specifically, in relation to the urban center or CBD. Land values vary inversely with the reciprocal of distance from the major radial thoroughfares converging on the center and thus influences the value of residential land [6]. Apart from issues on residential land uses, the observation that POS/Re and industry were vulnerable to lose lands to other land uses is confirmed by findings of other report [13].

Dynamics of land use relating to the broader ecological concept of invasion and succession explain how inner concentric zones take over each other [7]. The case of South Industrial Estates where commercial land use, for construction of students' hostels, invaded the industrial land confirmed the observation.

In general, residential land use reduces in proportion terms as a town becomes more urbanized [8]. For instance, residential land use change was very high in Sunyani as compared to Kumasi (44.0 %), with a larger population. Road land use or circulation covered 1810.4 acres (26.9 %), which was the next highest land use and found to be relatively high compared to Kumasi (13.6 %). Kumasi has greater proportion of open spaces (11.5 %) than Sunyani.

6. CONCLUSIONS

The various dynamics of land use change reflected the comparison between plans and the physical outcomes. Areas of high land values experienced fewer land use change, contrary to high land use changes in the outskirts of the urbanized area, and thereby creating urban sprawl. Residential land use correlated negatively with commercial, education and POS/Re, implying that increasing or decreasing residential land use has opposite effects on the other uses. Furthermore, residential land use was more susceptible to lose land to other uses, especially in high land valued area.

Public Open Space was the most vulnerable land use, losing land to other uses without gaining from any. Commercial land was very effective in the invasion and succession processes of land use changes.

The negative factors influencing unauthorized land uses were the outcome of lapses in development control by the relevant regulatory agencies. The changes did not only pose physical development challenges in the urban area, but also the peri-urban development. Therefore, appropriate land use provisions should be made to manage and reduce the frequent and arbitrary changes in the future.

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APPENDIX: Computation of Pearson coefficient (r) and Coefficient of determination (r^2)

Table A1. Land use distribution among 11 sectors of Sunyani

Areas	Resid (X)	Com (Y)	Educ. (Y)	POS/ Re (Y)
Penkwase & New Dormaa	508.1	9.5	47.2	0.8
Nkwaben & New Dormaa Extension	802.1	17.3	79.3	2.5
Ridge Residential Area	218.5	0.4	87	9.8
South Ridge North	328.7	11.9	12	2.4
South Ridge Central	389.9	11.2	37.1	4
Central Business Dist.	202.9	15.8	14.7	8.8
New Town	289.1	12	28.4	0
South New Town and Tonsuam Estate	188.6	7.6	13.8	0.2
South Industrial Estates	73.9	38.8	34.1	2.9
Agyei Ano North	207.6	13.9	4.9	3.5
Agyei Ano South	315.9	18.4	15.4	2
Total	**3525.3**	**156.8**	**373.9**	**36.9**
Mean	**320.48**	**14.25**	**33.99**	**3.35**

(i). From Table A1, and using equation (1),

$$r = \frac{\sum XY - \frac{(\sum X)(\sum Y)}{N}}{\sqrt{\left[\sum X^2 - \frac{(\sum X)^2}{N}\right]\left[\sum Y^2 - \frac{(\sum Y)^2}{N}\right]}} \quad (1)$$

the Pearson correlation coefficient r for residential and commercial land uses was calculated as

$$r = \frac{46742.99 - \frac{(3525.3)(156.8)}{11}}{\sqrt{\left[1518007 - \frac{(3525.3)^2}{11}\right]\left[3145.36 - \frac{(156.8)^2}{11}\right]}} = -0.12.$$

Coefficient of determination, $r^2 = (-0.12)^2 = 0.014$ i.e. 1.4 % of variability in residential land use could be accounted for by commercial use.

(ii). For residential and education,

$$r = \frac{\mathbf{147205.9} - \frac{(3525.3)(373.9)}{11}}{\sqrt{\left[1518007 - \frac{(3525.3)^2}{11}\right]\left[\mathbf{20242.81} - \frac{(373.9)^2}{11}\right]}}$$

$= 0.51$

$r^2 = (0.51)^2 = 0.26$, i.e. 26 % of variability in residential land use could be accounted for by education use.

(iii). For residential and POS/Rec,

$$r = \frac{10297.46 - \frac{(3525.3)(36.9)}{11}}{\sqrt{\left[1518007 - \frac{(3525.3)^2}{11}\right]\left[\mathbf{226.83} - \frac{(36.9)^2}{11}\right]}}$$

$= -0.24$

$r^2 = (0.24)^2 = 0.058$, i.e. 5.8 % of variability in residential land use could be accounted for by POS/Re use.