Dynamics Of Land Use Land Cover For Sustainability: A Case Of Shillong, Meghalaya, India

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Abstract: - Land use/land cover change in urban area is a complex and dynamic process that involves both natural and human systems. At present, urban area in developing nation is experiencing rapid urbanization and undergoing physical transformation. It is therefore, essential that urban planners and managers understand the past and present land use land cover changes in order to predict its impacts on the society, economy and environment of the cities. This present study aims to explore and assess land use land cover changes in Shillong, India which has experienced significant increase of population during the last three decades mainly due to the growth in service and educational sector. The study monitored land use land cover changes since 1972 in order to assess the development of services activities and its impact on physical transformation. Urban built-up area is an uncontrolled phenomenon with unplanned nature of development. However, urban expansion intensity index in the study area revealed that high speed of land use land cover transformation also occurred sporadically throughout the outskirt of the tribal town also after the state bifurcation in 1972 that perhaps it is a cause of concern to planners.

Index Terms: - Assessment, Dynamics, GIS, Land use, Land cover, Urban, Sustainability

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1 INTRODUCTION

LAND USE is referred to "man's activities and the various which are carried on land" LAND COVER is referred to "natural vegetation , rock/soil artificial cover and other noticed on the land". (NRSA 1989). Since both land use and land cover closely related and are not mutually exclusive are interchangeable as the former can be inferred based on the land cover and on the contextual evidence. The terms Land Use/Land Cover (LULC) are often use simultaneously to describe maps that provide information about the types of features found on the earth's surface(land use) and the human activity. Land Cover is an important input parameters for a numbers of agricultural, hydrological and ecological models which constitute necessary tools for development, planning and management of the natural resources in the territory. Land use/land cover map is not new concept but it has been prepared since quite a long time with the help of conventional methods which consume rather a long time. In the present era of all round development where pressure on exploitation of earth's resources is accelerating at fast pace, there is no urgent need for speedy acquisition of new information and updating the existing one. In this respect Remote Sensing technology provides an effective additional tool for speedy acquisition of information at regional and district level. The information on land use in the form of maps and statistical data is very vital for the spatial planning ,management and utilization of land for agriculture, forestry, urban industrial, pasture ,environmental studies , economic production and etc. today with the growing population and low man land ratio and the increasing land degradation, the need for the optimum land utilization assumes much greater relevance. The information requirements for land use mapping comprise reliable up to date and comprehensive data on physical, ecological and socio- economic resources. Remote sensing are particularly suited to provide suitable information, the hallmark of physical data requirements as it is essentially agreed by remote sensing specialist that it has the potential to make the most significant contribution in the area of land use data collection. It refers to "mans" activities on land which are directly related to land. Land is the most important natural resources which embody soil, water and associated flora and fauna involving the total system. The growing pressure of population coupled with increasing demands on land resources has brought extra pressure on the available land. (Roa et al 1996) In order to monitor and evaluate dynamic land use/land cover changes, GIS and remote sensing can effectively be used (Harris and Batty, 2001; HU Zhao-ling et al., 2007). Remote sensing has the capability to acquire data timely at regular interval and becomes useful data source for land use monitoring (Yeh and Li, 1997). In addition, GIS that has the capabilities to manipulate and analyze spatial and temporal data can be used to map, monitor and identify driving forces and measure the intensity of land use/land cover transformation (Sui and Zeng, 2001; HU Zhaoling et al., 2007). Both will provide the understanding on the dynamic process of urban land use/land cover transformation and plan towards sustainable urban development.

2.1 Study Area

Shillong the district Headquarter of East Khasi Hills, the capital city of Meghalaya is located at 25° 35' north latitude and 91° 53' east longitude occupying a valley called Shillong valley of about 45 sq km in area. It is about 103 km to the south of Guwahati and is located at altitude of 1500 above mean sea level. It is an agglomeration of the six urban centers. Shillong Municipality, Shillong Cantonment, Madanriting, Mawlai, Nongthymmai and Pynthorumkhrah. It has a population of about 267662 according to the 2001 census. Shillong owes its importance due to its administrative function and about 55% of the total workers of the town are engaged in non-agricultural activities. The percentage of workers engaged in industry is 10.5% in trade and commerce 17.7% and in transport, communities, etc. Shillong is also a very important educational center in North East India as a whole and it is a place of attraction for tourism industry. The study area, therefore, is suitable for such kind of studies in order to evaluate the impact of these activities on land use land cover changes in the past thirty years. So far as morphology of the city is concerned it is found that the residential areas accounts for 74% of the total area of the city and defense14%. The commercial area occupies 3.5% of the city. The main co mmercial areas of the city are Barabazar and Police bazaar. Late 1990's saw other areas such as Laitumkhrah, Polo, etc emerge as secondary commercial centers. Invariably all the towns of Shillong Urban

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Agglomeration (UA) developed their respective commercial nodes.

2.2 OBJECTIVES

The following broad objectives are:

- To map urban land use/land cover of Shillong from 1970-2000
- To analyze the change detection of various land use/land cover over the said period
- To evaluate the change of land use/ land cover of Shillong

2.3 DATA BASE & METHODOLOGY

The data used for this present work are both primary and secondary data

1) The primary data are:-
- The SOI (Survey Of India) Topo sheet number of 78.O/14 with R:F 1:50,000 of 1968
- IRS-1C LISS III digital data of January 2000 with 23.5 m spatial resolution
- Land sat TM digital data of 8th March 1991 with 30 m spatial resolution
- Land sat TM digital data of 26th March 1986with 30 m spatial resolution

2) The secondary data includes information collected through books, journals, through internet and the unpublished thesis. For the identification of the land use types the raw map is scanned. Then geo- referencing is done using MAP INFO.7.8 after which the area of interest is marked (the study area). Then digitization is done one after the other (SOI) Topo sheet 78 0/14 of 1964, Land sat TM digital data of 26th March 1986, Land sat TM digital data of 8th March 1991, IRS-1C LISS III digital data of January 2010) where separate land use like the residential areas, commercial area, water bodies, roads, vacant land, forest etc were considered and kept in separate files. After this the different maps were superimposed one after the other for studying and analyzing the comparative land use of Shillong.

3) For evaluating urban expansion in the study area, the following formula has been used:

$$B_{i,t+n} = \left[\left(U_{i,t+n} - U_{i,t} \right) T_i \times 100 \right]$$

where,

$B_{i,t+n}$ = the annual expansion intensity index of spatial unit i,

$U_{i,t+n}$ = urban area in the spatial unit i at time $t + n$,

$U_{i,t}$ = urban area in the spatial unit i at time t, and

T = the land area of spatial unit i.

Annual expansion intensity index and its grade.

Value	Grades
$B_{i,t+n} > 1.92$	High-speed expansion
$1.05 > B_{i,t+n} > 1.92$	Fast-speed expansion
$0.59 > B_{i,t+n} > 1.05$	Medium-speed expansion
$1.05 > B_{i,t+n} > 0.28$	Slow-speed expansion
$B_{i,t+n} < 0.28$	Slow expansion

Source: HU Zhao-ling et al. (2007).

2.4 Results and Discussion:

Human activities such as agriculture, tourism, transport infrastructure and urban development have significant influence on land use/land cover (Carsjen and van Lier, 2002). In Service sector attracts population increases from year to year which affects urban development in Shillong and in turn shapes and transform land use land cover. The broad land use land cover categories in Shillong have been outlined as under:

Table 1: Major land Use land cover categories and its description used for the Study

Land Use/Cover Classes	Description
Build-up area	Residential, urban built-up,
Vacant land	Shrub, Construction site
Forest	Reserved forest, Protected forest

The land use land cover of Shillong since 1970's embraces a general trend of land use land cover categories (See Table 1).

Table 2: Growth of Population in Shillong (1971-2011)

| Year	Total Population	Decadal variation	Decadal Growth rate
1971	1,22,752	+20,354	19.88
1981	1,75,180	+52,428	41.08
1991	2,23,336	+47,570	27.85
2001	2,67,881	+44,545	19.94
2011	3,54,325	+86,444	32.26

Sources: Census of India, 1971, Meghalaya, PartII-A
Census of India, 1981, Meghalaya, partI of 1981, Vol II

Census of India, 1991, Meghalaya
Census of India, 2001, Meghalaya
Census of India, 2011, Meghalaya, Provisional Paper

From the table above it is observed that there is population increase since 1970s to the 2011 in Shillong which indicated that the increase of its population resulted in the transformation of land from other uses to urban built-up in order to cater for growing demand in housing and service sectors. The study area has undergone significant transformation since the 1970s. The town was once covered by nearly 90 percent of evergreen pine trees because of its location is quite far from the mainland India and its hilly topography. However, it is very rich in culture heritage and natural beauties which compelled the Britishers to convert the study area into summer station. Gradually the study area became the desirable destination for migration for other people from far and nearby places (other states of India and from Bangladesh and Nepal) and these factors later contributed towards population congestion which change the land use land cover of Shillong. It is timely, therefore, to assess the impact of such development on local environment. This includes evaluating land use/land cover changes and measure annual urban expansion intensity index from 1970s to present. It will provide significant indicators to assess the

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sustainability of tourism development in the island. The study monitored land use changes in from 1971 to 2011 in order to evaluate the impact of increase of population. Time series data were gathered from various sources such as maps, tables, field survey and reports Land use land cover was divided into broad three categories as shown in Table 3 below. This classification was used in order to ensure uniform category of all land use land cover maps.

**Table 3: Land Use land Cover and its Area from 1970-2011**

Category	1970 Sq Km (%)	1986 Sq Km (%)	1991 Sq Km (%)	2010 Sq Km (%)
Built up area	27.240 (31)	37.242 (28)	38.043 (29)	42.4127 (36)
Vacant/Barren land	30.051 (34)	48.930 (36)	39.9026 (30)	34.0961 (26)
Forest	31.884 (35)	48.375 (36)	54.68 (41)	54.63 (42)
Total	89.1753(100)	134.5483 (100)	132.6263(100)	130.9718 (100)
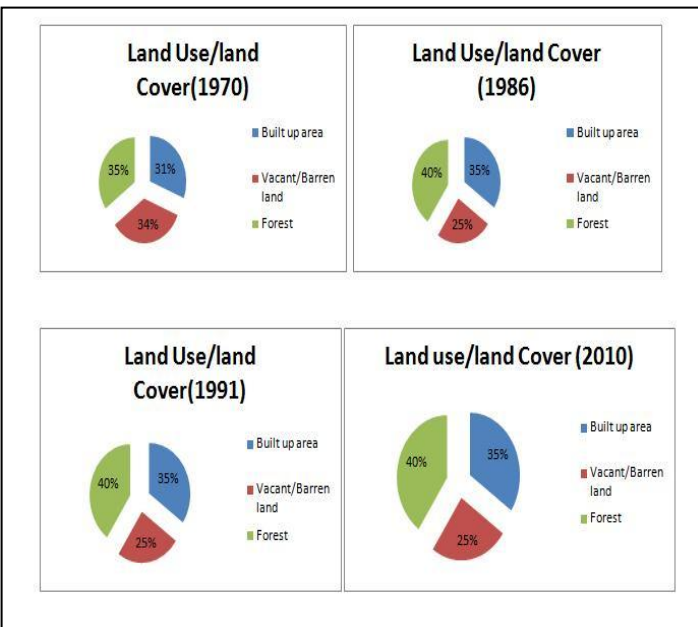
Fig:1

Table 3 and the figure above shows land use/land cover changes from 1970 to 2010. Built-up area category increased quite significantly where this land use land cover activity covers only 27.24 sq km in 1970; it increased to 38.04 sq km in 1991. By 2010, additional 4.37 sq km of built-up area was recorded. Areas undergoing significant changes mostly centered around Mawlai, Pynthorumkhrah, Madanrting area and near existing population centers such as in Laitumkhrah, Laban. Urban built-up areas centered around IGP, Laitumkhrah, area, which is an administrative, commercial cum residential for the study area. Evaluation on annual urban

expansion index, however, revealed more interesting results. This index shows the speed of urban expansion per unit area. This statistics showed that many parts of the study area experienced high-speed of annual urban expansion (see scale in Methodology). Between 1970 and 1986, few areas of Shillong experienced high speed of urban expansion which included Laban, Laitumkhrah, and Mawkhar (Fig: 2). This period (1970-1986) was the period of Impact of State Bifurcation from Assam where administrative set up played a major role in carving a new town in transition. Land use/land cover transformation during that era was related to mainly on changing forest to urban area in order to house new service centre. During 1986-91, fast speed to medium speed urban expansion took place in which rural migration plays a major role in influencing the rate of change in Shillong.
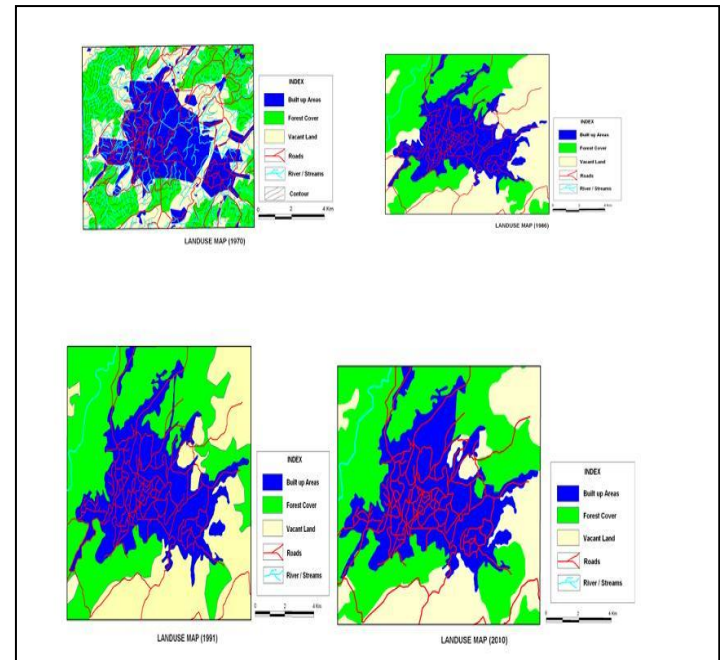
Fig:2

With time, the study area is experiencing more population due to administrative and educational set up. In 2010 it is seen that city expansion has reached saturation point that a corridor to the east of the study area has been developed to form a new place of urban development (Mawdiangdiang) and it is generally termed as *New Shillong.* However, apart from built-up area, other types of land use land cover categories did not change much in the last thirty years. As shown in Table 3, vacant land area decreased after 1986 from 48.930 sq km to 39.9026 sq km in 1991 to approximately 34.0961 sq km in 2010. On the other hand, the area under forest does not reveal much change since Shillong is a tribal town, so rules and regulations prohibits people to cut trees indiscriminately. it is seen that forest in 1970 covered 31.884 sq km increases to 48.375 sq km in 1991 and further increased to 54.68 sq km and remained constant till 2010 except for a decrease of .05 sq km.
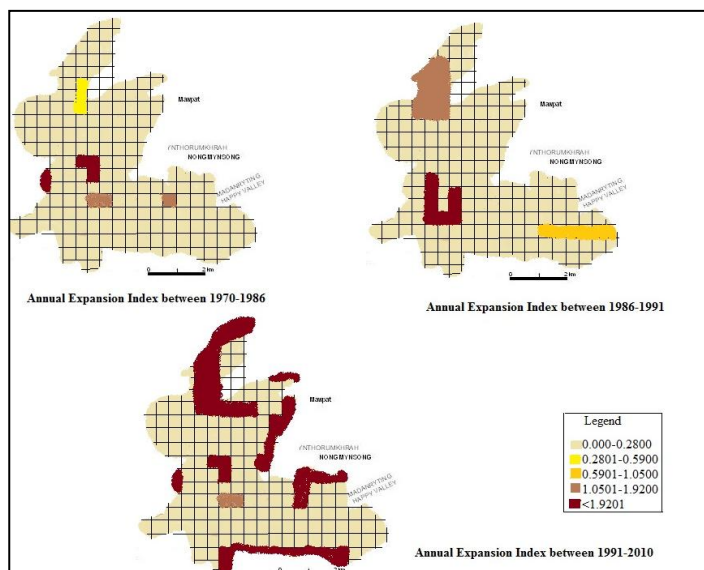
Fig:3

Assessing the Dynamics of Land Use Land Cover for Sustainability

Assessment of land use land cover changes in Shillong during 1970 and 2010 revealed that the speed of expansion was quite worrying. Although the government policy intended to direct urban built-up area to New Shillong (Mawdiangdiang). The annual urban expansion intensity index calculated at the size of 1km2 suggested that high speed of urban development in many parts of the study area including in the forested areas. Such development needs to be monitored and controlled in order to ensure sustainability in urban development. The study was undertaken where land use/land cover was divided into three broad categories. Therefore, land use/land cover changes at this scale could only show the statistics and area experiencing land use land cover transformation. Nevertheless, the study briefed the phenomenal change that occurred in urban Shillong which should be monitored closely in order to have sustenance in urban Shillong.

3. Conclusion:

Shillong had undergone significant land use land cover transformation in the last thirty years. The topography is hilly and rugged and the urban development was undertaken in a unplanned manner. The evaluation on annual urban expansion index, however, revealed that many part of the study area experience high-speed of urban development between 1991 and 2010. It is, therefore, essential that urban planners and policy makers evaluate and monitor land use/land cover changes from time to time in order to ensure that this transition does not harm the society, economy and environment although Shillong developed on an unplanned city development, nevertheless concerted efforts can be taken to curb further unplanned and un co-ordinate urban planning.

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