

Landuse And Landcover Change Detection Of Fringe Areas Of Imphal City,Manipur,India

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Abstract : *The decadal expansion of the Imphal city towards its fringe and ensuing land use /land cover changes have been identified to find out the changes in two different time periods (1989 and 2010). To assess changes in both city and its fringe areas, supervised classification was used and maps of the two study periods were prepared with the help of Remote Sensing and GIS techniques. Results indicate that built up areas have grown into the fringe areas of the city at the expense of other landuse categories with serious implications for socio-economy and environment of the region. Besides, questionnaire survey with 50 respondents of the fringes area corroborates the changes highlighted by the satellite data. The the survey also served to ground truth the findings from satellite data as well as providing other critical insights which helped in comprehending the complex socio-economic and demographic forces driving the land use changes in the Imphal City.*

Keywords: *change detection,haphazard growth,Imphal,LULC,remote sensing &GIS,urban dynamics*

I. Introduction

Background to the Study

Although more than half the humanity today lives in urban areas, urbanization, the dynamic process of transformation of society and landscape, is taking place with uneven rate across the world. Most of the advanced countries have almost all their population living in urban areas unlike developing countries, where the urbanization level is less than 50% in most cases(WUP,2011).As a result it is expected that urbanization of the future will mostly occur in developing countries like India, with rapid pace(Pradhan,K.C,2013).But, because of various structural and institutional constraints, and rapid population growth urban areas in these countries, expand haphazardly into fringe areas of the cities and will do so in future with serious economic, social and environmental implications.

Urban fringe may be defined as, those areas surrounding the cities within the daily commuting reach of the city core. Clear delineation of the urban fringe ranges in time (age), size of the urban center, variation in type and degree of zoning control of urban limits (Doytsher,2010). Urban fringe is characterized by mixed land uses, influenced by economic conditions of the city, demographic processes like migration originating from both within the city and outside the city. These give rise to differences in the social, economic and environmental concerns (Veronique,D 2007).Thus, urban fringe has a unique quality in that it has a wide mix of land uses ranging from a variety of commercial development, including out- of – town shopping centre's to the city services and industries and educational uses which are conveniently located at the margins. These new developments invariably occur at the cost of fertile agricultural land, vegetation and wetland found at urban fringe areas. In addition, population in urban fringes generally increase in new residential areas as the city dwellers also move outward due to increasing population, over-congestion in the city core as well as the existing city has no room for the new comers. Lower land prices than the city core in the urban fringe lands, their proximity to developed areas, and easy accessibility through private transport have added pace to this development. It is estimated that 1 to 2 million hectares of cropland is being converted into other urban land uses every year in developing countries to meet land demands for housing, infrastructure, industry and recreation(Arshad,A and Shahab,F 2012).

India has experienced rapid urban expansion in both planned and haphazard manners since independence(Ramachandran,R,2006).Imphal, the capital city of the north eastern state Manipur, is the only Class one city in the state. By Census definition a town with one lakh population or above is classified as class I city. There is general perception that the rapid urbanization in the Imphal city has increased built- up areas and consequently encroached into the fringe areas. This is believed to be because the pace of expansion has been much higher in fringe areas of the city. Urban fringes of Imphal are experiencing tremendous socio-spatial changes and the rate of conversion of agricultural land use to non- agricultural use should form the basis for the selection of the study area. People have witnessed transformation of fertile agriculture land into built ups constructed for various purposes (Schools,Office,Brick kilns,factories,commercial showrooms etc.)

So, to verify the perception with satellite data based analysis, the study makes an attempt to detect the land use and land cover changes that has been taking place within the Imphal city and its fringe areas over 20 years period (1989- 2010) by using remote sensing and GIS techniques.

Objectives

The broader objective of the study is to produce a land use and land cover map of Imphal city and its fringe areas for two different temporal interval periods (1989 and 2010) in order to detect changes that have occurred over the given period.

The following specific objectives will be pursued in order to achieve the aim:

- (i) To find out direction and magnitude of intercategorical Land use and Land cover (LULC) changes.
- (ii) To evaluate the socio-economic implications of the changes based on interview of city dwellers.

II. Study Area And Methodology

2.1 The Study Area.

The present study was carried out at Imphal city and its fringe areas which lies between 24°51'N and 24°52'N latitude 93°53'E and 94°3'E longitude. Being the only city in the state, Imphal enjoys a pre-eminent position in terms of economic activities, administrative services and even social influence in the lives people that inhabit the state (Deva,N 1998; Deva,N 2012). An important consequence of this primacy is the intense pull force that the city exerts, attracting activities from in and around the city leading to intensification of landuse within and without the city. The city is now the centre of gravity of the settlement system of Manipur by possessing all the premier functions of the State such as administration, economic, educational, cultural, political and judicial works. NH-39 connects the city with Myanmar in the East and Nagaland in the North.

Imphal city is rapidly expanding along fringe areas and getting urbanized. According to 2011(Census, 2001) Census, the total population of the city is 268,243 as against 250,234 in 2001 census(Census,2011). There are various built-up categories along the fringe areas. The study area of the present research occupies the northern, southern, western and north eastern fringes along the 3 highways i.e. NH-39, NH-150 and N -153 respectively. Some of the places like Chingmeirong, Mantripukhri, Khabam (northern side); Malom,Gari (south west) Thonju,Langthabal (southern side); Sagolband, Takyel, Langjing (western side); Lamlong, Chingarel Tejpur, Swombung, Yorbung (north eastern side) etc. are selected for the study. The fringe areas of Imphal are almost similar in terms of climate, temperature with the city area itself.

2.2 Methodology

Remotely sensed multitemporal Landsat datasets were used to achieve the primary objective of the study. However, field based primary data were also collected through questionnaire schedules (N=50) by interviewing residents of the fringe areas. The questions mostly pertained to eliciting answers regarding the reasons behind the processes inducing the dynamic changes in LULC of the study area. The study was carried out in the following steps

- i)Pre-field: Collection of available secondary data including both geographic data(Landsat 5) and attribute data(Census reports, research article, government reports etc.) to prepare an informed questionnaire .
- ii) Field: Collection of primary data through household survey by personal interviews and questionnaires by random sampling.
- iii) Post-field: Processing of the primary data, cartographic analyses.

Landsat 5 TM imageries (Table.1) of the study area was downloaded from (Earth explorer of USGS: <http://earthexplorer.usgs.gov/>).Since the downloaded images contained different types of bands, stacking was performed to get the composite images. Other image enhancement techniques like histogram equalization were also performed on each image for improving visual interpretability of the images. The subset images of Landsat 5 TM of 1989 and 2010 are presented in Figs. 2 and 3.

Image classification was performed on both the images based on a common LULC classification scheme (Table 2) adopted for the study. Furthermore, to determine the precise extent of intercategorical changes, two classified images of 1989 and 2010, were superimposed by using Matrix technique in Erdas 9.1 software generating a thematic map depicting class wise changes.

LOCATION MAP OF THE STUDY AREA

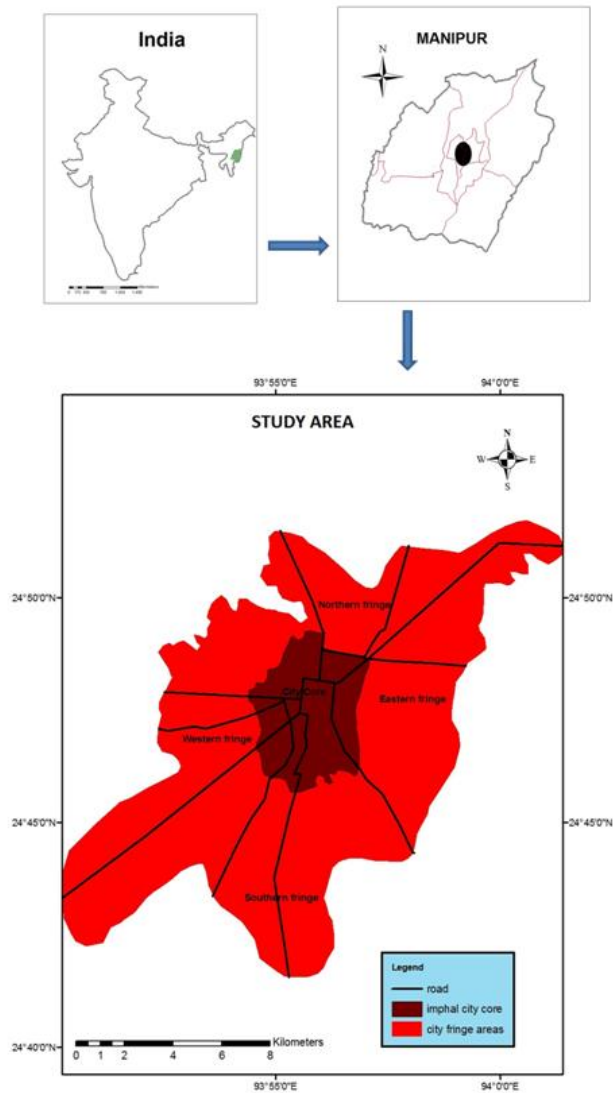


Figure.1 Imphal city and its fringe areas



Figure.2 Landsat 5TM image of the study area.1989



Figure 3. Landsat 5 TM image of the study area,2010

Table.1 Multi Temporal datasets used for the study

Dates (y/m/d)	Satellite/Sensor	Reference system/path/Row	Spatial Resolution	Temporal separation
1989/03/11	Landsat 5/TM	WRS-135/043	30 m	21 years, 2 months And 6days
2010/01/16	Landsat 5/TM	WRS-135/043	30m	

Table 2. LULC classification scheme (Anderson,J,1976)

CODE	LAND USE / LAND COVER CATEGORIES
1.	Farmland /Agricultural land
2.	Wasteland
3.	Built-up land
4.	Forestland / Rangeland
5.	Water bodies

III. Results and Discussion

Change detection analysis describes and quantifies differences between images of the same scene at different times (Liu,J.G and Mason,P, 2009).The classified images of the two dates can be used to calculate the area of different land cover and observe the changes that are taking place in the span of data. This analysis is helpful identifying changes that had occurred in different classes of land use like increase in built-up area or decrease in vegetation and so on. Besides, the data obtained from the field survey helped to verify the various changes. In addition, the household survey also revealed the causes, effects and the nature of change in the land use and land cover pattern of Imphal city and its fringe areas which were observed in the satellite imagery.

3.1 Land use/Land cover of 1989 and 2010

As evident from Fig. 4 and presented in detail in TABLE 3, Imphal and its fringe areas in 1989 had almost equal share of Built up (42.13%) and Farmlands (39.90%) landuse in terms of their spatial extent. Forestland (10.02%), waterbodies (5.02%) and Wasteland(2.93%) contribute the remaining area. While Imphal is the most densely populated part of Manipur, large share of farmland in the area reflects the importance of agriculture in local economy, which also is the mainstay of the state economy, and many in the fringe areas are farmers. Thus, urban landscape until 1989 had not encroached on the fertile lands at the margins of the proper city. By 2010 (Fig.5 &TABLE 4), the city had not only grown in its population but there have been significant changes in its economy, which is in turn reflected in the distribution and spatial pattern of land use. Built up category coverage, by 2010, had jumped to 51.55% which is an approximately 10% growth compared to 1989.

This means an additional 1390 hectares of land have come under built up category within a span of 21 years in Imphal city fringe areas. Farmland land area stands at 35.68% of the study area which means this category has seen a decline in its coverage by about 5% in relation to 1989 figure.Waterbodies, mainly lakes,ponds,swamps etc. which occupied 700 hectares of land in 1989, occupies only 277 hectares in 2010.This translates into 40% reduction in coverage. Most of the disappearances of water bodies have occurred in northwestern sector of the study area where lake swamps have been reclaimed for building government quarters. Other categories observed insignificant changes in their spatial extent during the study period.

3.2 Inter Categorical changes

Intercategorical LULC changes between 1989 and 2010 and spatial pattern of the changes in Imphal areas reflect the complex and dynamic interplay that exist between changing socio-economy and spatial processes (Fig.6).For instance, although built up category registered the largest change in absolute terms, the distribution of the change is not uniformly observed in the study area. At the city proper there is very little addition of new built ups whereas the periphery of the city core has seen large swath of newly added built ups. It is apparent from Fig.7 that north western, southwestern and southern sectors of the study area have witnessed the largest addition of new settlements.

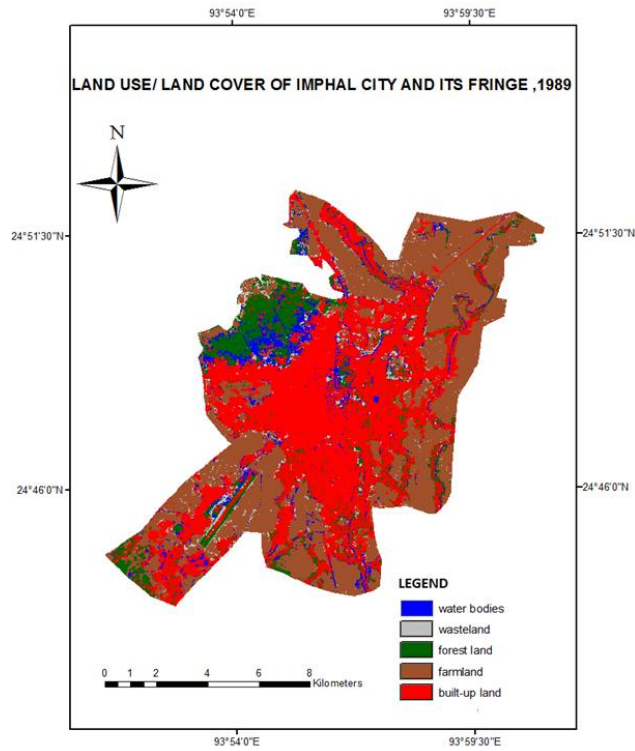


Figure 4. LULC of Imphal and fringe areas in 1989

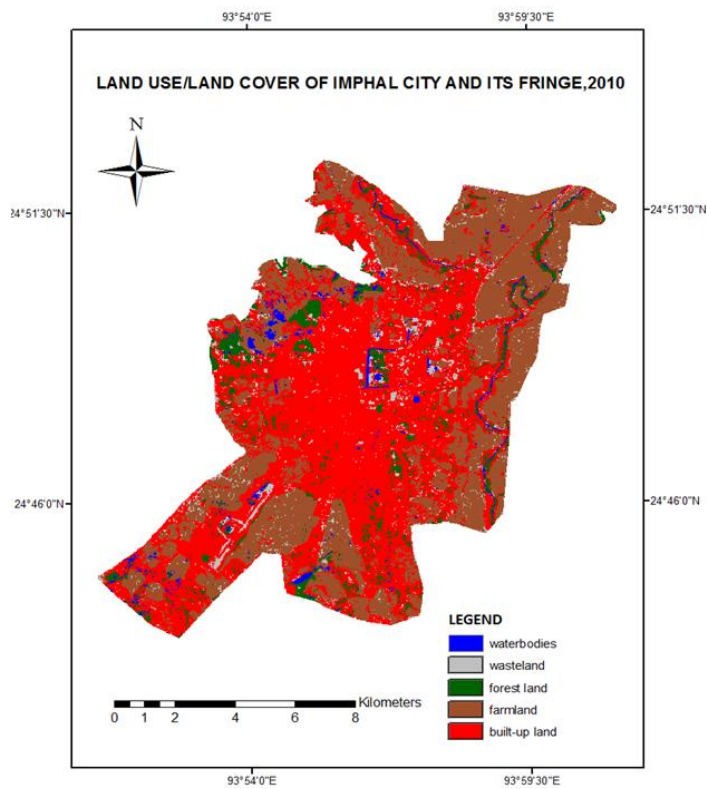


Figure 5. LULC of Imphal and fringe areas in 2010

Table.3 LULC,1989

LU/LC	Area in hectares	%
Farmland/Agricultural	5570.37	39.90
Wasteland	408.96	2.93
Built-up land	5880.96	42.13
Forestland/ rangeland	1399.68	10.02
Water bodies	700.56	5.02
Total	13960.53	100

Table.4 LULC,2010

LU/LC	Area in hectares	%
Farmland/Agricultural	4981.6	35.68
Wasteland	600.21	4.30
Built-up land	7196.4	51.55
Forestland/ rangeland	904.58	6.48
Water bodies	277.74	1.99
Total	13960.53	100

Most of these areas were once farmlands, forests and waterbodies but now occupied by built ups dedicated to multiple uses. For example, new dense built ups in northwestern sector are game village built to accommodate athletes of National Games which Manipur hosted in 1997. These new structures were erected by reclaiming a part of swampy areas as well as by clearing forested tracts along foothills.

Linearly trending built ups in the northeastern sector underlines the importance of accessibility along arterial roads in attracting new settlements away from the city core. Similar linear trends of settlements seen in the southwestern sector represent site of Imphal airport. The area has seen intensification of landuse over the past decade because of perceived business opportunities available in the area due to its proximity to the airport. Most of the new built ups are educational buildings, commercial establishments and residential colonies constructed by migrants from rural parts of the state. Once again the built up areas have followed the road, Tiddim road in this case, in spreading urban settlements in peripheral area underscoring the importance of ease of accessibility and connectivity in diffusing urbanization.

Imphal, a Class I city of immense importance in urban system of Manipur is thus, rapidly expanding into its fringe areas which, if left unchecked could gobble up valuable fertile lands and wetlands surrounding it. Moreover, haphazard expansion could also pose serious problems related to waste disposal, access to clean water, proper sanitation etc. to the inhabitants since municipal service will not be available in these areas as they lie outside the bounds of Imphal Municipality, which in itself is facing troubles of its own.

3.3 Peoples' Perception

Emergence of urban landuse in rural-urban fringe area brings with it concomitant changes not only in physical and morphological aspects of the area but also economic and social changes. (R. Ramachandran, 2006). Therefore, opinion of locals regarding their perception about the expanding urban character was elicited through questionnaire based survey in this study. In all 50 residents from as many households were interviewed from all sectors of the study area. All the respondents (N=50) agreed that there have been tremendous changes in landuse over past 20 years. Seventy percent of the respondents feel that infrastructural expansion by government have led to high rate urban spread. Another 16% were of the opinion that increased in population is driving the changes in fringe areas. It is worth noting here that some respondents believed that improvements in education has also prompted people from far rural areas of the state to come and settled near Imphal.

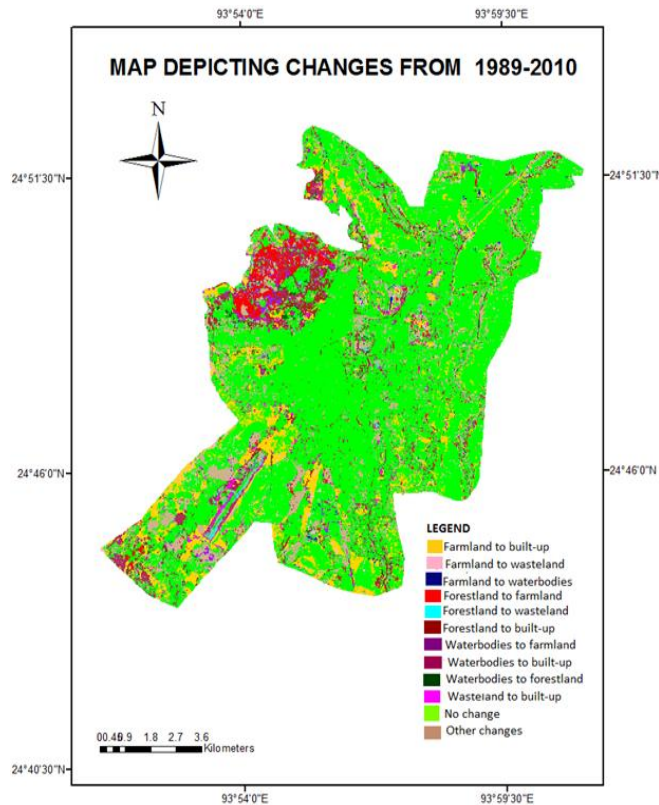


Figure 6. Inter Categorical LULC changes 1989 to 2010

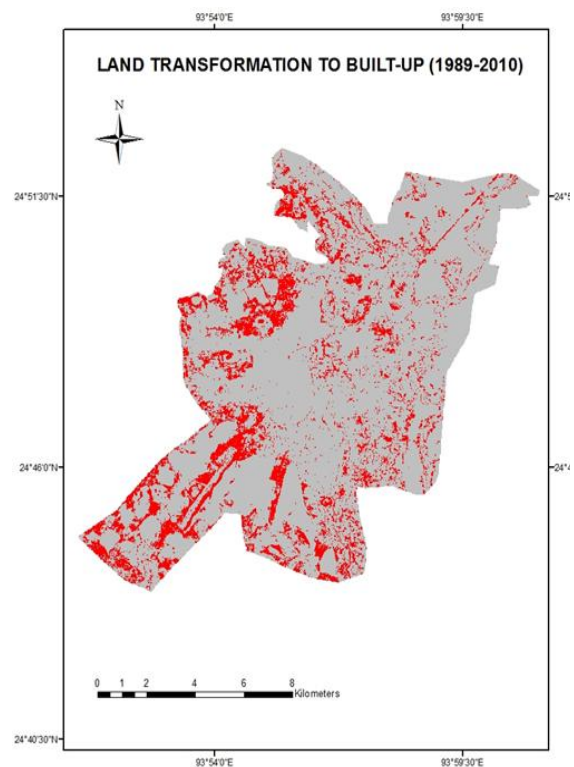


Figure 7. Built up areas since 1989

Many of the respondents actually are migrants who had either shifted to the fringe areas from city centre to avoid the congestion and many more were from rural parts of Manipur. Large numbers of rural migrants have constructed houses in fringe areas indicating that they are not migrant labourers who come near city in search of greater job opportunities. On the contrary, most of new residents are well to do families who aspire to adopt and avail urban facilities which are usually absent in their native rural places. Hence, it can be said that one of the major causes of new settlements emerging in fringe areas of Imphal lies in lopsided urbanization process of Manipur. That manifest in excessive concentration of facilities in Imphal and with almost no opportunities available in other villages and towns. Migrants who aspire for urban way of life and command wealth are forced to buy cheaper lands near Imphal city as lands in city centre are either exorbitantly costly or unavailable.

IV. Conclusion

It is apparent from the study that rapid growth of Imphal is encroaching into fertile lands in fringe areas largely because of unregulated constructions of built ups used for multiple purposes. The changes have not occurred uniformly in all areas of the Imphal fringe, as arterial roads have usually attracted more settlements than other areas. However, some areas have also lost swampy lands and waterbodies to government quarters. If the current rates of spread of urban structures continue unabated into the surrounding lands, Imphal city may stand to lose its spatial form and may perhaps morphed into large urban sprawl with city core. Such a situation will not be in line with the larger objective of making Imphal self-sustaining environmentally friendly city with well-knit networks of service provisions to the city dwellers. Therefore, state government needs to urgently formulate a coherent land use policy of the state which takes into consideration various competing interests.

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