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Landuse Pattern, House Design and Health in Imphal Valley

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Abstract

In the present study it is observed that Imphal city is undergoing high urban sprawl similar to many cities elsewhere. The new settlements are restricted to low lying plains areas because of mountainous terrain to north of the city and due to this they are vulnerable to water-borne and communicable diseases. Commissioning of the reservoir for hydel-power generation has resulted in the increase of surface-water area of the Loktak lake in the valley. The increase in the surface-water area is causing environmental disturbances to the local ecosystem. The study of relationship between human health and land use/ house design indicated that the communicable diseases have direct relationship with concentration of water bodies in wetland dominated areas. However in hilly areas, the high prevalence of tuberculosis is related to the design of the housing unit.

Keywords: Imphal Valley, Manipur, landuse pattern, house design, health.

Introduction

Altering ecosystem leads to large-scale land degradation and change in the ecology, and influences human health making it more vulnerable to infections (Collins 2001). Such changes determine the vulnerability of human-environment systems to climatic, economic or socio-political perturbations (Ezzati et al. 2002, Turner et al. 2003). Hence, landuse decisions are human health decisions (Xu et al. 2007). Understanding landuse transition is crucial for understanding its impact on human health (Mustard et al. 2007). Apart from landuse, human health is also related to indoor environmental quality. The indoor environment is related to pollutant sources (*chulhas* for cooking, smoking, volatile organic carbon, Pb based paints etc.), ventilation (dilution

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effect for air pollutant or germs), humidity, sun light exposure and congestion. Hence, house design plays an important role in controlling the indoor air pollutant and germ concentration and subsequently human health. The present paper looks at the critical linkage between landuse, house design and human health in Imphal Valley.

Area of Study

Manipur, a Northeastern state of India, is surrounded by Myanmar in the east and south-east, Assam in the west, Nagaland in the north, and Mizoram in the south-west. The study area is mainly confined to the Imphal valley, also known as Manipur valley, which lies in the central part of the state. The study area lies between 24°16'N and 25°02'N latitudes and 93°41'E and 95°09'E longitudes and covers an area of about 1300 sq.kms (Fig.1). This valley is an elongated, oval shaped, intermontane valley with elevation ranging from 746 m to 850 m above the mean sea level (MSL) with an average elevation of about 780 m above the MSL and has a southward gradient.

The Imphal valley is traversed by important rivers of Manipur namely Imphal River, Iril River, Thoubal River, Wangjing River, etc. The Imphal River flows from north to south and is joined by its tributaries namely Iril River, Thoubal River, Sekmai River at different places. These rivers along with private and community ponds of varying sizes dotting the valley landscape provide important sources of surface water for use in domestic and municipal purposes.

The Imphal valley, lying within the Dishang-Barail Flysch Basin, was originated as a result of the tectonic and structural evolution of the Indo-Myanmar Range (Ibotombi 1993). The valley does not contain any lithounit except the Quarternary Alluvium deposits of 40-50 m thick and are of fluviolacustrine origin (Ibid). The sediments are derived from the surrounding Dishang and Barail hills and mainly contain dark-grey to black clay, silt and sandy deposits. Clay, sand, gravel, pebble and boulder deposits are also found in the foothills of the old river terraces.

The climate of Imphal valley is sub-tropical to temperate but there is appreciable spatial variation with contrasting weather conditions in various seasons. High temperature of about 30°C-35°C is recorded during south-west monsoon and minimum average temperature of about 4°C is recorded during winter (December-January). The average annual precipitation varies from 150 cm to175.8 cm with maximum intensity in July-August. But, since rainfall is associated with monsoon, there is irregularity in seasonal rainfall.

Materials and Method

Change in landuse pattern has been studied by using various temporal Landsat images. Satellite imageries of multiple scenes and demographic details were obtained from various secondary sources and subsequent field checks, which form the main sources of data for this study. The geo-referenced satellite imageries of Landsat series were used for detecting the urban expansion and areal variation of the open water surface of Loktak and its surrounding marshy areas during last three decades using Landsat-MSS image acquired in 1977, Landsat-TM image acquired in 1990 and Lansat-ETM+ images acquired in 2000. These Landsat data are made available under the NASA Space sponsored GLCF acquirable from website. The Landsat data and Geoeye data are used in this study because of free and easy access to the temporal images of Manipur in October, which is the clearest month in the season. The image acquired in October 1977 (MSS, 1977) has 78 meter resolution, whereas 1990 Landsat TM October image and 2000 Lansat-ETM+ October Image have 30 meter resolution. The latest (GEOEYE) image acquired in October 2010 has 1.5 meter resolution. The 2010 Geoeye 2010 image is acquired from Google Earth and afterwards the image is geo-referenced using geo-coordinate of prominent place and road cross sections. The satellite imageries were studied in the GIS environment using Geomatica V.9.1.0 as well as visually interpreted for delineation of the urban sprawl and the changes in the open water body of Loktak and the surrounding swamps.

The demographic details were obtained from different census records. The health condition data of the Imphal valley was collected from the Medical Directorate, Government of Manipur. Microsoft Excel Program was used to execute the various statistical analyses.

Results and Discussion

The Imphal valley is more densely populated than the hilly region. So, change in landuse dynamics is more pronounced in the valley. Changes are noticed in the built-up area of Imphal city, change in the area of the open water body of Loktak, landuse/ habitat design and relationship with disease pattern. The aerial changes can be seen from the Landsat imageries for urban built-up areas and open water body of Loktak taken during different time periods. The present study is aimed at the first two aspects of the landuse dynamics because these two aspects have important bearings on the environment and health conditions of the people in the valley.

Change in the Built-up Area of Imphal City

For the present study, series of remote sensing satellite data obtained through Landsat and Geoeye imageries of 1977, 1990, 2000 and 2010 were accessed. The imageries were visually observed for evaluating the built-up areas in the valley especially around Imphal city. This increase in city area is due to the ever increasing population growth including migration from surrounding areas for economic and socio-political reasons. The data on urban sprawl were obtained through Landsat imageries for 1977, 1990 and 2000, which gave the aerial extent of the area of Imphal city as 4.29 km^2 in 1977, 19.02 km^2 in 1990, 27.04 km^2 in 2000 and 34.2 km^2 in 2010 (Fig. 2) and the corresponding population of the same area was 431,773 in 1971, 711,261 in 1991, 833,312 in 2001 and 967,344 in 2011 (Table1). The northward extension of the settlement in Imphal valley is restricted due to the presence of hills. So built-up areas expand mainly to the south and south-western parts of the valley, but the 2010 imagery shows expansion of the urban areas towards southeast direction as well.

Change in the Aerial Extent of the Open Water Body of Loktak Lake

There is also significant change in aerial extent of the open water body of the Loktak Lake (Fig. 3). The data for this was obtained through Landsat imageries, which showed that in 1977 the extent was 51.29 km^2. The aerial extent of water body increased to 65.57 km^2 in 1990, 71.73 km^2 in 2000 and 73.42 km^2 in 2010 (Table 2). The increase in the aerial extent of the open water body of Loktak is due to the transformation of the lake into a permanent reservoir since the commissioning of Loktak Hydro Electric Power Project (LHPP) in the year 1983. For proper functioning of the LHPP, maintaining the water level of 768.5m above the mean sea level is necessary. The working water level of the lake is maintained largely by routing the water of the two rivers, Imphal River and Khuga River into lake through the Khordak channel by constructing the Ithai barrage in the downstream direction of the confluence of these two rivers, in the south of Keibul Lamjao. Thus, the commissioning of LHPP in 1983 made the lake into a permanent reservoir. The Keibul Lamjao is an important national park which houses the world renowned, very rare and endangered deer species, locally known as Sangai (*cervus eldii eldii*).

The impoundment of water in the lake resulted in spread of water cover over a large area in the vicinity of the lake and inundated a large area of cultivable agricultural land amounting to about 20,000-80,000 hectares

(Ibotombi 1993) mainly on its eastern side. The lake area used to fluctuate from 55 km^2 during the dry season to 300 Km^2 during rainy season (Singh 1992), but the construction of Ithai barrage and the commissioning of the LHPP in 1983 has affected the sinking and floating cycle of the wild vegetation mat, locally called *phoomdis*. The phoomdis sank during dry season and came in contact with the soil. This process facilitated the fresh growth of vegetation including Kambong, *zizania caduciflora*, the natural plant-feed of the Sangais. But now the phoomdis are a permanently floating vegetation mat except near the shallow shore, hindering the growth of the wild vegetation. The lack of the growth of kambong affects the population of the already endangered Sangais, which feed on it. The Sangais started straying into populated areas in search of their food and are exposed to hunting leading to gradual dwindling of number and slow extinction.

Influence of Landuse Pattern and House Design on Human Health

Changes in landuse patterns are having impact on environment and health conditions of the people. The expansion of settlement and related activities in the formerly marshy areas and swamps through reclamation and without proper plan for sanitation and infrastructure development has created ecological imbalance and unleashed a slew of health related problems. Common health problems in the areas are diarrhoea, cholera, and respiratory infections like tuberculosis and influenza. Table 3 gives district-wise prevalence of some common diseases in Manipur based on 2001 figures. The most common diseases prevalent in the state are Acute Diarrhoea Diseases (ADD), Acute Respiratory Infections (ARI), Pneumonia, and Enteric Fever. The infection percentage is 3.682 for ADD, 3.950 for ARI, 0.169 for Pneumonia, 0.855 for Enteric Fever, 0.086 for Viral Hepatitis and 0.006 for Tuberculosis (TB) in Thoubal district. In Imphal district the infection percentage is 0.797 for ADD, 0.583 for ARI, 0.032 for Pneumonia, 0.071 for Enteric Fever, 0.012 for Viral Hepatitis and 0.025 for TB. For Bishenpur district, the infection percentage is 1.711 for ADD, 1.648 for ARI, 0.105 for Pneumonia, 0.036 for Enteric Fever, 0.025 for Viral Hepatitis and 0.022 for TB.

Based on the above results, it is found that the prevalence of communicable diseases is most acute in Thoubal, followed by Bishenpur and Imphal districts. The reason for difference in prevalence rate is the difference in the landuse pattern among these three districts. Thoubal district with the highest population density has the highest number of scattered lakes, marshes and swamps covering about 17,216 hectares of the district. Bishenpur district

has 24,139 hectares of its total area under lakes and marshes, major chunk of the area being covered by Loktak. Imphal district has only 957 hectares of its total area as wetlands. Most of the people in Thoubal and Bishenpur districts are engaged in agriculture, fishing and handloom cottage industry. The people in these two districts are concentrated around scattered marshes and swamps which form repository of the vectors which cause water- and air-borne communicable diseases like malaria, diarrhoea, influenza and tuberculosis. Thus, Thoubal and Bishenpur districts of the Imphal valley have greater prevalence rate of communicable and other diseases.

The spatial variation shows that the hill districts of Ukhrul, Churachandpur and Chandel have comparatively high prevalence of tuberculosis. It is directly related to house design which, in the hills, prevents free air circulation from outside. This causes less dilution of the indoor pollutants generated by fire burning for cooking and warming of the houses. Smaller size of the house also compels the residents to live in close proximity of one another and thus the transfer of the pathogenic bacteria and virus are facilitated. Thus, poor housing design also affects the condition of human health. The density of population helps in spreading the virus and bacterial infection in human habitation.

A comparative picture of the population growth rate in Delhi and Aligarh situated in semi-arid environment and town and villages around the lake in humid region is given in Table 4. The data shows an average growth of 1.86 %/yr in ecologically sensitive area in the semi-arid region of Loktak. A comparative GIS analysis of the growth of the towns and villages around Loktak region is given in Figure 2. The habitat facility factors are limited in these areas because of the dependence over the lake and other wetland resources, but still the area is growing and population density is increasing in those villages and towns. The high density and close proximity to open water in the region may serve the epidemics in the future. The higher density at certain locations along the lake also causes sewage contamination and high siltation in the lake.

Conclusion

The above study reveals that the urban area of Imphal is increasing at the same rate as in the Gangetic plains. It is also evident that the wetland area is also increasing in and around the city due to artificial reservoir for electricity generation, water supply, etc. The study also indicates that there is high occurrence of communicable diseases in the areas located near the wetlands.

Apart from the relationship of diseases with landuse the housing design is also important factor in the hilly areas. The inefficient air circulation causes indoor pollution in such small houses and close proximity of the residents facilitates easy spreading of diseases in such areas.

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Table1: Built-up area against population, 1977-2011

Year	Built-up area (Km^2)	Population (in Census years) of the Imphal Districts
1977	4.29	431773
1990	19.02	711261
2000	27.04	839258
2010	34.2	967344

Table 2: Open water body area, 1977-2000

Year	Open water area of Loktak (Km^2)
1977	51.29
1990	65.57
2001	71.73
2010	73.42

Table 3: Normalized district-wise prevalence of diseases in 8 districts (2001) of Manipur State and their relationship with land-cover.

Name of the District	Diseases						Total	Population	Population density	Physiography	Water bodies
	ADD	ARI	Pneu	EF	TB	VH					
Thoubal	3.659	3.926	0.168	0.850	0.006	0.086	8.695	366341	713	valley,plain	many
Imphal	0.802	0.588	0.033	0.072	0.025	0.012	1.532	833312	679	valley,plain	many
Bishenpur	1.166	1.123	0.072	0.025	0.015	0.017	2.417	305907	415	valley,plain	many
Ukhrul	0.652	0.616	0.114	0.045	0.033	0.008	1.469	140946	31	hilly area	few
Chandel	0.486	0.520	0.022	0.091	0.054	0.022	1.195	122714	37	hilly area	few
Churachpur	0.399	0.514	0.027	0.019	0.049	0.065	1.073	228707	50	hilly area	few
Senapati	0.218	0.102	0.011	0.017	0.008	0.020	0.376	279214	116	hilly area	few
Tameng long	0.307	0.290	0.000	0.088	0.011	0.012	0.707	111496	25	hilly area	few

ADD Acute Diarrhoea Diseases including Gastro-enteritis and Cholera
ARI Acute Respiratory infection including Influenza
Pneu Pneumonia
EF Enteric Fever
TB Tuberculosis
VH Viral Hepatitis

Table 4: Density and population growth rate around Loktak Lake

City Name	Growth %/year	Density inh./km²
Aligarh	2.08	1007.1
Delhi	1.93	11296
Habitats Near Loktak Region		
Kumbi	1.87	1909
Kwakta	2.55	2493
Moran	1.07	2606
Bishnupur	2.54	1660
Nithong	1.47	2309
Nambol	1.6	2006

(Based on data available at www.citypopulation.de)

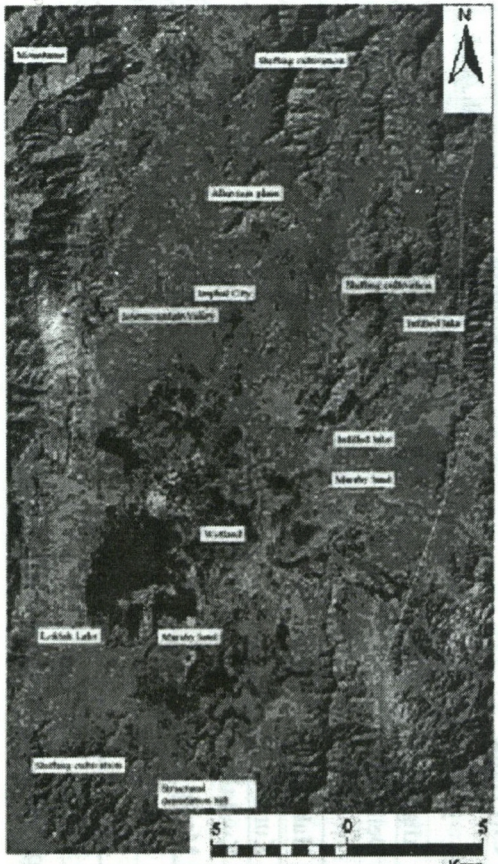

Figure. 1: Location map and general geomorphological features of Imphal valley (www.googleearth.com)

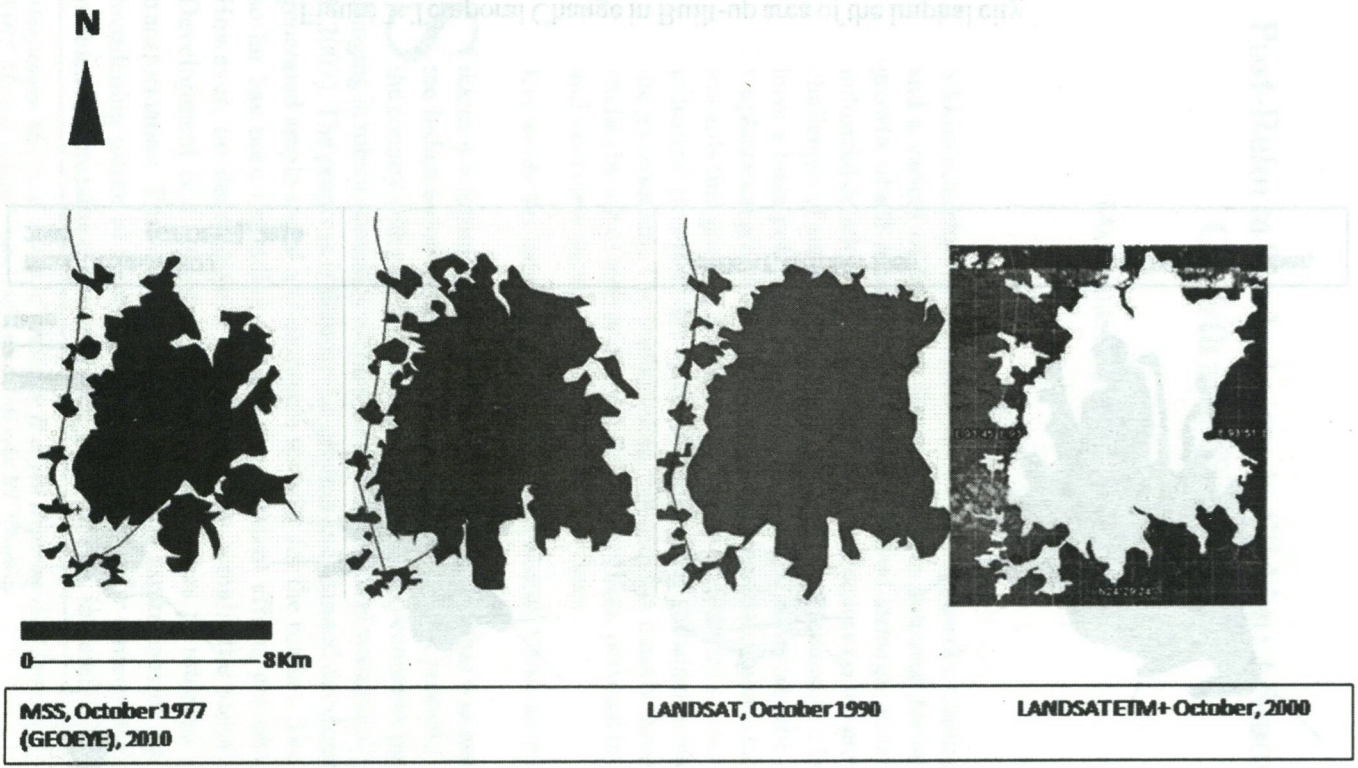

Figure 2: Growth of human habitats in Loktak lake area in Imphal valley, 1977-2010

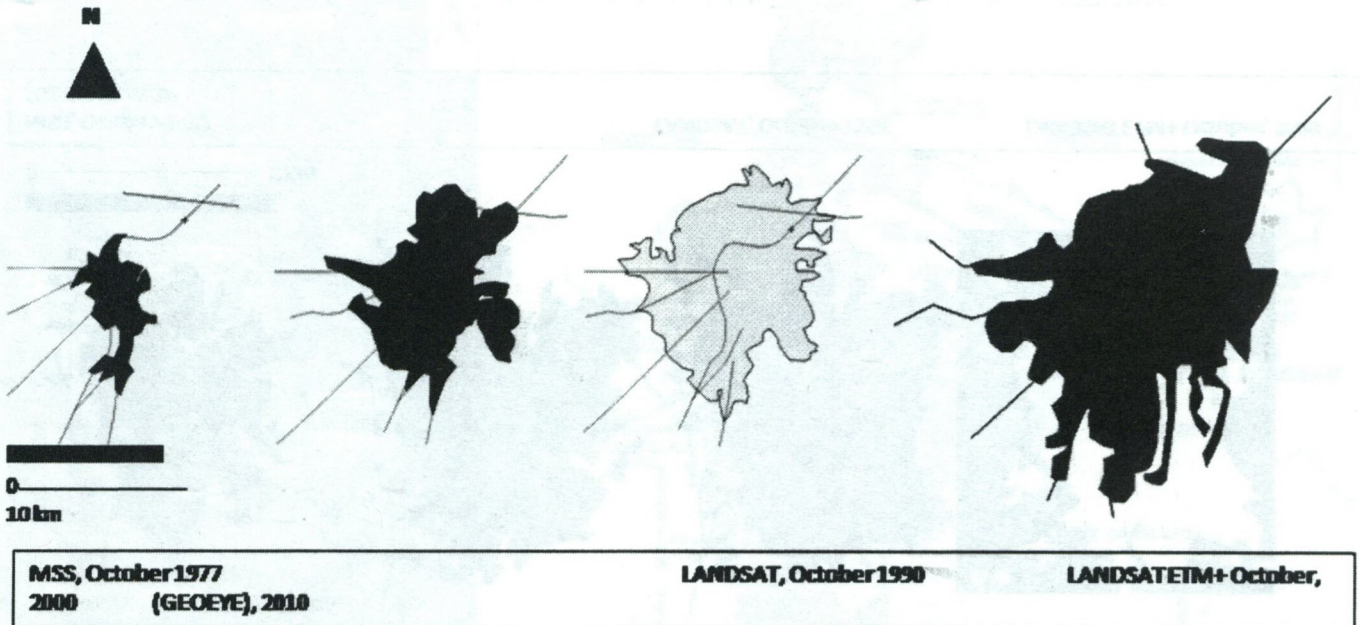

Figure 3: Temporal Change in Built-up area of the Imphal city