



## Pattern of Landuse / Land cover and its Impact on Guwahati City, Assam, India

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### Abstract

*Rapid urban growth and economic development in some contemporary Indian cities are responsible for sharp changes in its landuse / land cover that eventually leads to various geo-environmental hazards. To mitigate these, it is necessary to formulate an appropriate landuse plan by monitoring the changing pattern of landuse / land cover. Guwahati, the capital city of Assam and the economic hub of the northeast India has been experiencing a high rate of urbanization with consequent changes in its pattern of landuse / land cover. Its unplanned growth and development has led to the environmental hazards, like flash flood, landslide, water pollution, health hazards etc. The current article examines the pattern of landuse / land cover changes of the Guwahati city as well as its environmental impact using geospatial technology along with other conventional data and thereby generates a reliable database for city planning and management.*

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### Introduction

Land is a fund resource with very high per unit value. Hence, it is essential to formulate an appropriate, flexible and accommodating policy in order to ensure its better utilization. Rapid population growth results in an increasing demand for fuel, fodder and food, which in turn increases the biotic pressure on the available land. Naturally, changes and deterioration in the landuse pattern due to rapid development of city disturbs the ecological balance of a city that eventually leads to the degradation of the urban environment. The physical factors of sub-surface geology, drainage and natural vegetation of a city area fundamentally condition its landscape. Currently, the socio-economic factors like traffic congestion, high incidence of crime, health hazards, homelessness and unemployment situation are occasionally

aggravated by urban poverty, environmental pollution, and overall lack of basic services including housing.

To mitigate these, planners requires a reliable and timely database/information to formulate the most feasible strategies. The traditional methods of urban mapping based on ground survey are extremely laborious, time-consuming and expensive and can be realistically afforded once every 15 - 20 years, too far apart to keep up with the rapidly changing urban environment. It is therefore, necessary to identify and delineate areas of interest in a way which is relatively inexpensive, quick and which allows frequent updating and monitoring (Deshpande et. al 1987). Mapping using temporal satellite data (Landsat Thematic Mapper imagery, etc) in a GIS platform has successfully demonstrated the utility

of integrating existing historic maps with remotely sensed data and related geomorphic information to monitor urban land dynamics of large metropolitan areas. These databases have proved to be very useful in identifying the pattern of growth and in understanding its impact on the landscape (Clapham, 2003).

### Objectives

The main objectives of this paper are to study the population growth in Guwahati city, to examine the land use and land cover changes in the area, and to identify the built-up area of the city.

### Methodology and Database

The study has been based on both primary and secondary information. The primary data has been collected randomly from the field by adopting interview method. A questionnaire has been designed for collecting the relevant data. The secondary data has been collected from Census of India, Assam Remote Sensing Application Centre, Guwahati Municipal Corporation Office and many other government offices. The analyzed data has been presented with the help of a series of maps, tables and graphs using different cartographic techniques. The whole process has been done with the help of Arc GIS software.

### Study Area

Guwahati is the capital city of Assam and forms the gateway to the northeast India (Fig. 1). It is located between 91°38' E and 91°51' E longitudes and 26°05' N to 26°12' N latitudes on the left bank of the Brahmaputra river with altitude ranging between 49.5 m and 55.5 m above m. s. l. Lying on a plain landscape, it is bounded by the Brahmaputra river in the north, a series of hillocks (an extension of Khasi hills) in the south and is surrounded in the west and the southwest by the Rani Reserve Forest. Currently, the city's Municipal Corporation consists of 60 Wards covering an area of 216 km<sup>2</sup> and having a population of 809,895 (2001) distributed quite unevenly.

### Analysis

Population growth is one of the most important factors causing geo-environmental degradation. It is significant because some of the other human

factors depend directly on it. The increasing population has resulted in an increased number of dwelling and commercial units, additional infrastructure, transportation arteries and networks, thereby increasing the impervious surface leading to little infiltration of rainwater. The growing demand for water has been leading to excessive uplift of ground water within the city. Guwahati registered a relatively fast growth in recent decades compared to the other cities and towns of Assam. The growing dominance of the city is reflected in its rising share (from 9.60% in 1971 to 23.22% in 1991) in the urban population of Assam. Further, the huge demographic growth over a relatively short period may be attributed to migration of families rather than lone male migration which is apparent from the rise in the gender ratio (measured as females/'000 males) from 638 in 1971 to 783 in 1991. One important fact is that the fast demographic growth of Guwahati has not been accompanied by an adequate economic prosperity.

In 1901, its population was 11,661. The decadal growth rates were 7.03% (1901–11), 32.04% (1911 – 21), 32.26% (1921 – 31), 35.79% (1931 – 41), 47.36% (1941 – 51), 130.90% (1951 – 61), 22.90% (1961– 71), 61.87% (1971 – 81), 188.25% (1981 –91), and 45.25% (1991 – 2001) (Table – 1). The pattern of growth kept pace with the pattern of socio-economic development. The significant development during the British period was the establishment of the cantonment at Paltan Bazaar, opening new lines of transport and communication and improvement of old ones. The trend demonstrates an accelerated growth since the 1940's. In 2001, population of the city was 809,895 which crossed 14 lakh as the recent studies revealed.

Population is a pre-requisite to development, but its excessive increase is a problem. Currently, Guwahati is in a state of overpopulation. The main factor behind this is migration (1951–1961, 1971– 1991), which is social and economic in nature. Poor people in rural areas facing extreme poverty and hardship come to Guwahati for survival, slightly better earning and a better life. Students in large numbers from rural areas, other towns and from some North Eastern states come to Guwahati expecting quality education. There is also a steady flow of people from

other states to earn their livelihood in different economic activities and to start their own venture. Women flock in large numbers to work as domestic help. The decade-long insurgency problem has raised the feeling of insecurity; a growing tendency is seen amongst the people of middle class to own a house in Guwahati. Recently, such tendency has also been observed among some affluent people of some northeastern states.

### Landuse

Landuse pattern of a city represents the interaction among the physical factors, historical factors and social and economic factors, with the character of the city dependant on the present landuse. This is how the shopping areas, industrial areas, offices and other areas fit in with the landuse for residential, public, semi-public, etc. (Rahman, 1981). The general shape, size and the plan of the city is influenced by the Brahmaputra river flowing due west along its northern boundary on one hand and the hills to the east, south-west and west on the other. The city has been sprawling in a curvilinear fashion and has developed a rough crescent shape. Such a spatial shape of Guwahati is a major problem creating an obstruction for its ideal morphological growth as well as planning of the city. The city's morphological expansion has resulted in the multiplicity of locations of the public utility centers as well as for the greater areal expansion of service zones, which is no doubt a factor responsible for a slow change in the pattern of internal structures of the city (Fig. 2).

Early settlements established along the southern bank of the Brahmaputra were confined between the river Brahmaputra in the north and the city high way to the south. The area beyond the railway line and the all low-lying areas came under human habitation and other uses later. Such expansions have given rise to the problems like deforestation, reduction of grassland, soil erosion and removal of topsoil during monsoon. The city has witnessed a rapid expansion to the south during the last decade; but the Khasi hills of Meghalaya has restricted it beyond Khanapara-Beltola.

The existing landuse pattern of Guwahati shows that the major development has taken place in a concentrated cluster (Fig. 3). In 1951, the area of the city was only 1.68 km<sup>2</sup> increasing to 14 km<sup>2</sup> in

1961 and currently, it is about 216 km<sup>2</sup>. Due to increasing land value in the plains, the hill slopes and small hills are gradually being encroached by the new settlements. This has created a lot of hazards especially during monsoon, e.g., waterlogging, flash floods, soil erosion, and landslides. Solid waste disposal is currently a major problem in Guwahati.

The city has expanded with an addition of 125 km<sup>2</sup> area within a span of only 80 years. Most of the newly built-up areas have come up at the cost of agricultural and forest lands, resulting in the decrease of waste disposal sites and recharge area for ground water, thereby disturbing the ecological balance and human health.

In 2002, landuse/ land cover pattern was built up land 38.27%, water bodies including riverine sand 22.65%, and wasteland 14.14%. The plains are mostly occupied by built-up area / residential areas. Out of the total built up land, residential area tops the proportion (29.61%) (Gogoi, 2012). The total built-up area of Guwahati has grown from 7.0 km<sup>2</sup> in 1911-12 to 121.93 km<sup>2</sup> in 1990 and 135.48 km<sup>2</sup> in 2002 (Fig.13). Since the scope of lateral expansion of the city is restricted by its unique geographical situation, the increase in residential area has been observed to be slower between 1990 and 2002. The economic structure of the city is not uniform. Spatial variation in economic structure is distinctly present in industrial activities, transportation network and commercial activities.

Although the city has a great potential for in industrial development, it is yet to establish itself as a major industrial center, primarily due to poor private investment, inadequate transport facility, non availability of skilled and technical personal, lack of infrastructure like electricity, developed land, etc. (Bhattacharya, 1981). Except Bamuni Maidum, no area has been earmarked for industries. Hence, industries are mostly located in a haphazard manner in the residential and business areas. Such unplanned development has led to unusual congestion, traffic snarl and environmental pollution.

In the old Guwahati Municipal area, no major industrial units are located except printing presses and other service based industries. Three flour mills on the G. S. Road and an ice factory on the R. G. Barua Road were established in areas which

were in the periphery of the city in the 1960's. The Assam Industrial Estate is located at Bamuni Maidum in the eastern part of the city. In the northeastern part are located the Guwahati Refinery, India Carbon and Oil India Pumping Station. Further east, the Assam Carbon, PVC pipes, Assam Asbestos and Luit Assam Hardboard are located on the city fringe. Growth of stone quarries in the Satgaon, Panjabari, and Bagharbari is a recent phenomenon.

At present, the industrial pattern in the city is showing a new trend. There has been a locational shift of the growth of industries from the east to the south and southwest along the north bank and also the NH-37 from the Khanapara point. Many warehouses are under construction along with some medium scale industries. Availability of land at a comparatively cheap rate is the main factor for such location. On the western periphery, a few medium scale industries have come up. Industrial units of Assam Caffeine, PVC pipe, Vanaspati plant, Paper mill, Biscuit factory, Ispat, etc. have come up along the NH 31 towards the north bank. Number of large and medium scale industries have grown from only 19 in 1970 to about 669 in 2011. Of these, 30% belongs to the Govt. sector and about 20% are metal-based which are environmentally unsafe.

### Transport and Communication

Guwahati is the gateway to the northeast India, being connected by roadways, railways, airways and inland waterways. However, road and railway play a very significant role. The NH - 37 links Guwahati with other parts of the state and the rest of India. The recent extension of the broad gauge line to Guwahati has considerably increased the volume of the railway traffic. The international airport at Borjhar has direct flights to New Delhi, Kolkata and other important cities including those in the northeast. Compared to these, river transport is not properly developed. Excepting the GNB Road, MG Road, AT Road, VIP Road, the remaining ones are very narrow (<10m wide). About 50% of city's roads are under Municipal Corporation which has been facing acute financial constraints since the last decade (Fig. 4).

At present traffic congestion has become a regular feature in the absence of suitable parking lots and plying of large numbers of slow moving

vehicles. Existing roads of the city do not present any particular geometric form or pattern. Although in certain areas a grid pattern is noticed, there is no link between one another. This is more so in the hilly areas of Krishna Nagar, Jyotinagar, Noonmati, Botahghuli, Panjabari, Madgharia and Natabama area. Moreover, all residential areas have their separate road pattern, without any link with one another. Furthermore, there is no uniformity in the widths of the city roads. On the other hand, the railway line passing through the city creates a barrier for free north-south movement, although there are three over bridges and seven flyovers (three of them are yet to be completed). The major bus terminals of ASTC are located in Paltan Bazaar, Maskhowa and Dispur. The public bus stations in Garpandu and Paltan bazaar. The Garpandu and Paltan Bazaar have grown to be the busiest traffic terminals of the northeast India in the past couple of decades. Besides, there are numerous private bus stands along the roads.

The main railway stations are - Guwahati City and Kamakhya. The New Guwahati Railway Goods Terminal-cum-Transit center is the recent addition. There is no well-organized truck terminal in the city. The Gutanagar truck terminal remains mostly unused because of its locational disadvantages. Small terminals are spread all over the city viz, Athgaon, MG Road, AT Road, New Guwahati and along the NH-37.

### Expansion of Built up Area

As population grew, built-up area has increased in the city. Between 1951 and 1961, settlements have come up rapidly along with the establishment of High Court, Railway Headquarters, University Campuses, Engineering Colleges, Medical Colleges, Saraighat Bridge, Oil Refinery, Military Cantonment, Industrial Estates, Central and State Government Offices and Institutions.

In 1972, about 20000 people migrated to Guwahati from Shillong due to shifting of the capital. As new settlements came up, so also the transport network and thus, increased the built-up area. The pattern of growth and expansion of the city of Guwahati is governed to a large extent by its variegated physical features like hills, hillocks, the Brahmaputra river, marshes and other water bodies, cultural features like road, railways and



service centers. Civic amenities also act as a controlling factor in this respect. Early settlements established along the south bank of the Brahmaputra were confined between the river in the north and the railway line in the south. Later, the city expanded beyond the railway line and the low lying areas came under human habitation and other uses.

The city has witnessed a rapid expansion toward south upto Khanapara - Beltola during the last decade. The Guwahati Master Plan covers an area of about 262 km<sup>2</sup> of which only 62% is developable. The unculturable wasteland mainly comprises hills, scrublands, water bodies and low lying areas. However, in the last decade the huge influx of migrant population has led to residential development in the piedmont zone and also in the low lying areas. The Assam Remote Sensing Application Centre (ARSAC), Guwahati has carried out a detailed landuse survey based on satellite imagery (Fig. 2).

### Analysis

The city witnessed a phenomenal change in its landuse pattern since 1911: built-up area increased by about 93%, open forest decreased by almost 99% and wet land decreased by 3%. The resulting environmental impact is havoc, particularly on landuse, economy, water quality, wildlife and society. Urbanization involves several kinds of construction and development activities that directly affect the natural and human landscapes. Unplanned development has led to depletion of forest and fertile land and silting of storm water reservoir and natural drainage channels (Fig. 5). Thus, the city environment steadily degraded. The hills are experiencing deforestation due to human encroachment for residence, thereby facilitating soil erosion and filling up of the natural low lying areas. The major natural wetlands in an around the city (e.g., Deepor Beel, Sola Beel, Silsako Beel, etc) are now heavily silted. Hence, water stagnation in the city particularly during rainy season is a common phenomenon in the newly developed areas, like Ganeshguri, Bamuni maiden, Kahilipara, Gitanagar, Zoo Road, and etc. Similarly, air pollution is rampant in the busy pockets of the city.

Rapid growth of built-up area accelerates the problem of solid waste disposal in the city. The

garbage disposal bins provided by the Guwahati Municipal Corporation are often lacking or inadequate to cope with the huge volume of waste generated. They are usually placed along the busy roads at inconvenient locations where huge piles of dumped rubbish often obstruct traffic movement and spread foul smell. The waste generation and disposal data from five randomly selected sample wards give an overall per capita generation of solid waste of 250 gram/day that lies below the acceptable level (= 300 – 600 gm/day) for the major cities of India. But the disposal of these waste pose a threat to the city environment.

The spectrum of social impacts is very broad and some of them are intangible, e.g. social structure, social stress, community relation, population pattern, unemployment trend, cultural pattern, health, education and public utilities. Generally, the social impacts are long-ranged and secondary in nature. Influx of people in search of jobs from the suburbs and other parts of the country is responsible for crisis in housing. The people of lower income group are compelled to live in slums where social stress often develops.

### Conclusion

The present study effectively assesses the changing pattern of landuse/ land cover during the past three decades from the satellite data and also the changing pattern of the built-up area from conventional data collected from the authentic sources. It reveals that there is a continuous decrease in the forest area, wetlands and cultivable land, while there has been tremendous increase in built-up area that has degraded the city's life and environment. The unplanned growth and development of the city has led to an increase of various geo-environmental issues. The study has also generated a strong database for the planners and decision maker.

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**Table - 1: Growth of Guwahati in relation to Urban Growth of Assam**

Year	Population ('000)	Gender Ratio (females/'000 males)	Decadal Growth Rate (%)	Share in State's Total Urban (%)
1901	11.6	500	-	15.13
1911	12.5	534	7.03	13.43
1921	16.5	528	32.04	12.97
1931	21.8	503	32.26	13.44
1941	29.6	567	35.79	14.22
1951	43.6	558	47.36	12.65
1961	100.7	497	130.90*	12.89
1971	123.7	638	22.90	9.60
1981	200.3	755	61.87	11.24
1991	557.6	783	188.25	23.22
2001	809.9	840	45.25	23.55

\* Extension of municipal boundary



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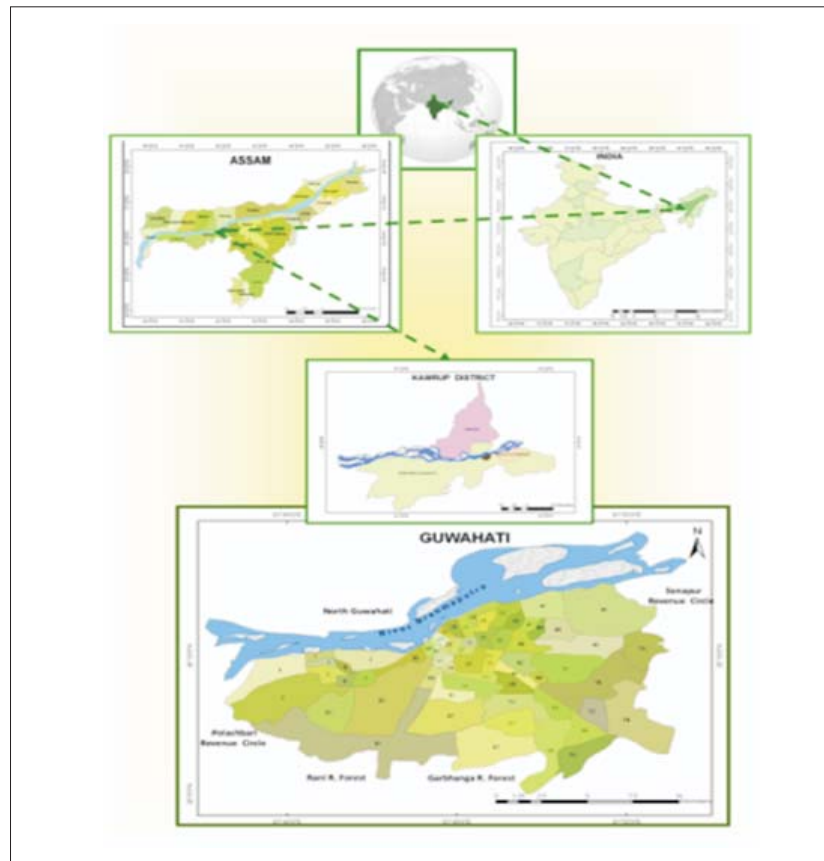


Fig. 1 : Location Map of Guwahati City

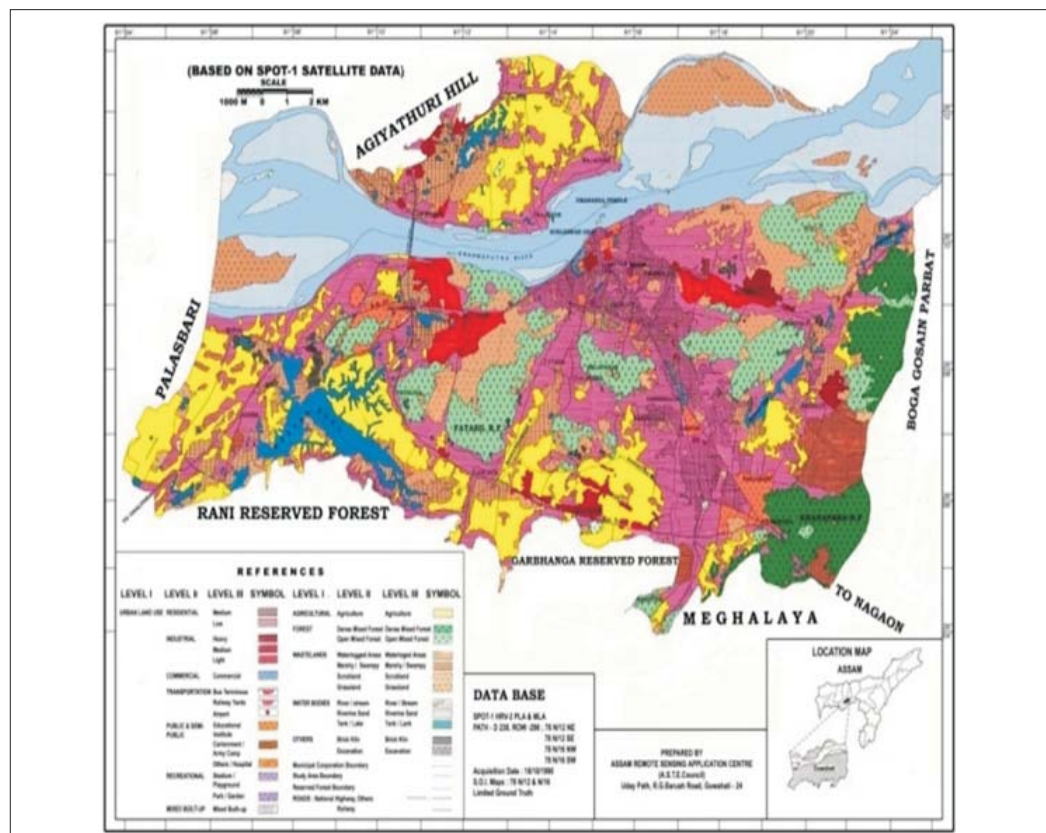


Fig. 2. Landuse Map of Guwahati City (after ARSAC)

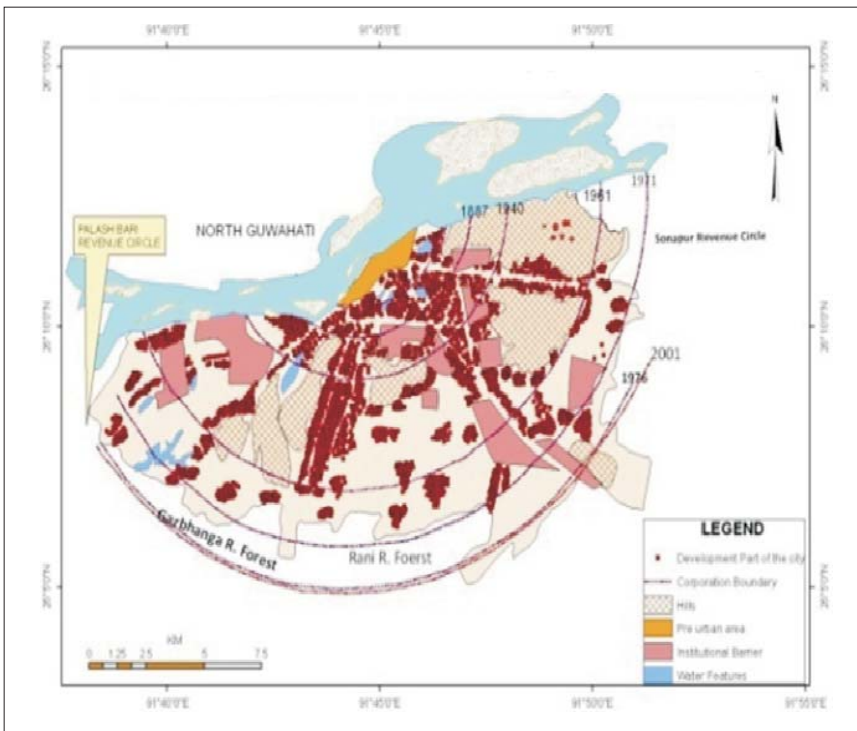


Fig. 3. Development of Concentric and Sectoral Forms

Fig. 4. Transport Network of Guwahati City

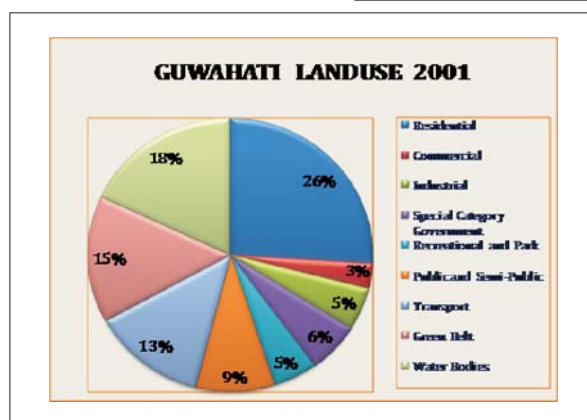


Fig. 5. Landuse Pattern of Guwahati City, 2001