CHAPTER III
GEOENVIRONMENTAL SETTING OF THE STUDY AREA

Guwahati, the capital of Assam and a major city in North Eastern Region is situated on the southern bank of the River Brahmaputra. Southwards it extends up to northern fringe of the Meghalaya massif. The Jalukbari-Azara plain constitutes the western boundary of the city. Formerly Guwahati was known as Pragjyotishpur. It is the headquarter of the Kamrup district of Assam and the hub for political, administrative, industrial, educational, commercial and many other activities in the entire North East India. Guwahati became a municipal town in the year 1865 when Municipal Board was established and in 1974 it became the first city in North East India when Municipal Corporation was established. The city began to expand in all fronts at a tremendous rate when the capital of Assam was shifted from Shillong to Dispur in 1974.

This chapter provides a detailed background of the study area with respect to location, communication, physiography, geology, climatic condition, as well as demography to understand the physical as well as socio-economic aspects.

LOCATION AND EXTENT

Guwahati the capital city of Assam represents a fast growing major metropolitan area of North East India situated in the southern bank of the River Brahmaputra (Figure 3.1). It is the gateway to the north-east of India and ranks 44 among the 5230 urban centers of India (Census Report of India, 2001) and is bounded by
Figure 3.1 Location map of the Study Area shown in the context of Assam (in the background CARTOSAT-I Imagery).
latitude 26° 05' N to 26° 10' N and 91° 30' E to 91° 50' E longitudes. It falls under Survey of India (SOI) Topographical map no 78 N/12 and 78 N/16. Amongst the 63 selected cities of India, Guwahati is included under the City Development Plan of the Government of India for planned development of the urban sector, under the aegis of Jawaharlal Nehru National Urban Renewal Mission (JNNURM). The Guwahati Municipal Corporation (GMC) covers an area of 216.7 sq.km. while the Guwahati Master Plan area indicates an area of 261.77 sq.km. The Master Plan for Guwahati was adopted in the year 1965 under section 10 of Assam Town and Country Planning Act, which divides Guwahati into 60 wards of which 21 numbers either partially or fully hilly region (Figure 3.2). Besides the Guwahati Municipal Corporation Area (GMCA), the Guwahati City now also includes North Guwahati Town Committee area, Amingaon and some revenue villages (City Development Plan Report, JNNURM, 2006).

**DRAINAGE**

The major natural drainage system of the city is the river Brahmaputra which flows along the northern boundary of the area and its width is only 1.5 km near the city. The streams running through Guwahati and its neighboring regions are Digaru, Amchong, Bharalu, Mora Bharalu, Borapani, Khanajan and Bondajan (Figure 3.3). Bharalu, a small tributary of the river Brahmaputra in its southern bank serves as natural drainage for the large part of the city and it meets the river Brahmaputra at Bharalumukh. The river originates from the foot hills of Meghalaya and enters Guwahati through the south eastern corner of the city and flows in the northerly direction. The river is known as Bahini or Bihini in its upper reaches. A small
Figure 3.2: Ward Map draped on top of the Shaded Relief Map.

Figure 3.3: Drainage Map of the Study Area.
channel, known as Mora Bharalu, coming out from a beel near Kalapahar, meets Bharalu near Chabipul. River Basistha, coming from the hills of Meghalaya, flows into Deepar beel and ultimately discharges into river Brahmaputra via Khana river which meets river Brahmaputra near Garigaon. Besides these, there are a number of small streams and nalas which drains Guwahati city. Some of these streams are perennial and some are seasonal.

PHYSIOGRAPHY

The city is a crescent shaped basin, surrounded by lofty hills, which are outliers of Meghalaya Plateau. Physiographically, the study area is divisible into three units consisting of low to moderately high denudational hill ranges, alluvial plains with few inselbergs and areas of negative topography represented by swampy or marshy lands and beels. Availability of digital maps and elevation data, remotely sensed data as well as softwares designed to visualize terrain conditions in three dimensions; help in visualizing any terrain condition in two forms, namely, overview visualization showing regional set up and individual site visualizations (Kuntala and Goswami, 2010). The former provides map like illustrations (Figure 3.4) and allows visualizing an area from different perspective with ease. The average elevation of the plain areas of Guwahati is 56.52 meters above the mean sea level (msl). The important hills of Guwahati city are, 1) Nabagraha-Sunsali hill series situated in extreme north eastern corner 2) Japorigog hill situated in the extreme east, 3) Sonaighuli-Jutikuchi situated in the south, 4) Narakashur hill with Birubari-Dispur-Kacharibasti in the north eastern side and Jatiya -Kahilipara- Odalbakra in the south and southwestern side 5) Kamakshya hill situated in west central, 6) Fatasil hill
Figure 3.4: Terrain condition of the Study Area as viewed from different directions. (LANDSAT -TM FCC image draped on DEM of the Study Area).
situated in south-west with Santipur-Gotanagar-Teteliya in the north western side, Fatasil Ambari-Ganeshpara-Katabari in the eastern side and Garchuk-Teteliya at its southern side and 7) Jalukbari hill in the extreme south western corner of the city. The general trend of majority of the hill ranges is E-W having almost similar height. Some of the hillocks have fairly dense, mixed jungle while others are deforested for construction activities or quarrying, while wetlands, beels and low lying back swamp areas support marsh vegetation and aquatic life (Shukla et al., 1989). There are several low lying areas and beels scattered within the city. The Deepar beel situated in the south-western part of the city is the major one. In the extreme northeast corner of the city lie several small beels, namely, Raja beel, Ghuguli beel, Hahsara beel, Susuki beel, Pata beel and Patni beel. In the east lies Damal beel, Silsako beel and Tepor beel and in the central part lies the Borsola and Sarusola beel. Though the fluvial processes and weathering have played the dominant role in shaping the landscape of the area, the impact of human activity in modifying the landscape for urban settlement, industrial growth, irrigation and agricultural practices cannot be ruled out (Shukla et al., 1989).

GEOLOGICAL SETTINGS

The hills within Guwahati are part of the Precambrian terrain of the Shillong Plateau which is tectonically detached from the rest of the Indian Peninsula (Sarma and Dey, 1996). The Shillong Plateau is principally composed of gneisses and schists with intrusive granite. In the Brahmaputra Valley, these rocks, at places are covered by alluvium. In the greater Guwahati area two dominant rock types are exposed, namely, Quartzo-Feldspathic-Gneiss (QFG) and Grey Porphyritic Granite. Already a
number of workers have done detailed geological mapping of the Guwahati area (Maswood and Goswami, 1974, Maswood 1981, Barman 1984, Shukla et al., 1989 and Sarma and Maswood, 1998). The detailed lithology worked out on the basis of field data and lithology by the previous workers are as follows,

- **Quaternary Sediments**: A more than 135m thick sequence of loose to semi consolidated sediments unconformably overlying the Archaean Gneisses constitutes the Quaternary Group. It is subdivided into older alluvium and newer alluvium sequences on the relative consolidate of sediments, degree of oxidation and field relation.

- **Porphyritic granite of late Proterozoic age (480-690 MA: Ghosh et al., 1991)**, grey and pink granites are the late intrusive into the host gneissic rocks.

- **Archaean Gneissic rocks**: The Archaean gneisses included biotite gneisses, granite gneisses, biotite schists which are intercalated with amphibolite, quartz-hornblende schists, calc-silicate rock, pyroxene granulite, porphyritic granite, fine to medium grained grey and pink granite, pegmatite, aplite and other vein rocks (Maswood and Goswami, 1974, Maswood 1981, 1982, Shukla et al 1989 and Sarma and Maswood, 1998). In Khanapara and other southern parts of the area, these rocks form the fringe of Meghalaya Plateau. However, in the main Guwahati area, they occur as isolated hills in the surface and as basement of the Quaternary in the subsurface (Pathak and Rao, 1998). By and large the area belongs to a gneissic terrain characterized by amphibolite facies condition of metamorphism where migmatisation has played a vital role in transforming some of the key structures of the initial configuration. Both pink and grey varieties of gneiss are present. Outcrops
of gneiss are seen at Fatasil Ambari, Dispur-Kacharibasti, Nabagraha, Sunsali and Sarania hill. A belt of pink granite gneiss from Kharguli to Sunsali runs more or less parallel to the Brahmaputra River (Masood, 1981). Grey porphyritic granite is present in Narakashur hill, Sonaighuli hill, Kamakhya hill and Jalukbari hill. Pink granite has limited outcrop and occur along a narrow belt from Kahilipara to Odalbakra and to its south and west at Kalapahar and Ganeshguri respectively (Masood, 1981).

In the plain areas of the city, the Precambrian basement is overlain by Quaternary alluvial deposits of Pleistocene to Recent age. Previous workers have divided alluvium in to two groups of older and younger alluvium. The older alluvium is 40m to more than 140m in thickness forming extensive alluvial surface over which most of the Guwahati city is situated. It consists of horizontally bedded layers and lenses of brown clay, sand, gravel and pebbles. The clay is brownish to grey, silty to sandy in nature and is dominant constituent of the older alluvium. The sand is brownish as well as grayish, micaceous, coarse to medium grained. The newer alluvium disconformably overlay the older alluvium in a narrow channel of present Brahmaputra River, flood plain deposits in the flood prone areas and stream banks, in the low lying areas or in the depressions. The exposed thickness is 5m to 10m. It consists of loose, grayish micaceous fine to medium sand which occurs in the channel as bars.

**STRUCTURAL SETTINGS**

The structural complexities in and around Guwahati area is very well documented by numbers of researchers. The area was lithostructurally mapped by Maswood (1982).
who established two phases of deformation. In Narengi area, the rocks depict four phases of deformation and they are essentially identified by folds, cleavage, lineations of different generation (Sarma and Dey, 1997). Based on geometry, orientation, and interference behaviour of the folds, planar and linear structures, three generations of ductile deformations and one brittle deformation have been deciphered giving birth to three generations of fold, cleavage and lineation and the last phase is marked by large scale fracturing and small scale faults of both contractional and extensional type (Sarma and Dey, 1997). The folds of first phase of deformation have axial planes showing moderate to low dips either towards NW or SE; axial planes of folds of second phase of deformation dips towards NW at a steep to sub vertical angles while axial planes of folds of third phase of deformation dips towards SW at a steep angle (Devi et al., 2002).

SOILS

The soils of Assam are mainly of two types, i) residual and ii) transported. Residual soils are derived in situ and are the weathered product of rocks of Archaean age while the transported soils are brought in by the flowing river water from various parts. The soils of the study area are variable due to diversity of rock types and physiographic setting. Alluvial soils are mainly found in the plain areas. The hilly areas are mostly covered by red hill soil and are found in and around exposures of gneisses and granites. Sandy soil, which are the weathered product of granites are found in and around the exposures of granite. Heavy rains, high temperature and good drainage conditions leaches out some materials from residual soils and high
iron content are left behind. This has led to the formation of lateritic soils found in the area (Goswami, 1993).

During the monsoon season numerous isolated water bodies are found covering the low lying areas of the city, which are utilised for Boro paddy cultivation during the spring. In these areas naturally adopted aquatic plants grow abundantly during monsoon and also in spring where water is available. The submerged soils in these areas are generally dark in colour, highly acidic and rich in organic matter (Pathak, 2001).

**CLIMATE**

North East India falls in sub-tropical belt having south east Asiatic monsoonal climate. Barthakur (1986) classified the North East India into four climatic regions. These are, 1) the cold humid monsoon climate of the frontier hilly region (above 2000m), 2) wet sub-tropical monsoon climate (covering southern Arunachal, Western Nagaland, Manipur and Mizoram), 3) humid mesothermal monsoon climate with heavy monsoon showers (covering Brahmaputra valley, Meghalaya, The Barak valley and Tripura and 4) mesothermal sub-tropical monsoon, with heavy rains which includes stations like Cherrapunji and Mausinram, recording highest rainfall in the world (more than 1000cm). The climate of Guwahati is similar to that of the entire Brahmaputra valley which means it experiences typical monsoon climate. However, some variations are noticed due to the uneven topography with a number of hills and low lying areas. The Tropic of Cancer runs across the state, and hence Guwahati and the entire state of Assam experience a warm and humid Tropical
Type of climate. The average temperature during the summer season ranges between 24.7°C and 31.5°C and from 12.5°C to 24.9°C during the winter season. The area experiences high precipitation from April to September due to the tropical monsoons with the mean total rainfall varying between 142 cm and 353 cm (Source: Regional Meteorological Centre Guwahati). The prevailing wind direction of Guwahati is from north-east to south-west during winter and during summer, it is in reversed direction. The salient features of the climate of Guwahati may be summarized below: (Source: Regional Meteorological Centre Guwahati)

1. Average annual rainfall at Guwahati is 162 cm.
2. Highest relative humidity varies from 67%-92%.
3. Average relative humidity ranges between 76%-82%.
4. Average temperature ranges between 24°C – 30°C.
5. Month of highest temperature on the average ranges from June- August.

VEGETATION

The vegetation type of Guwahati area can be classified mainly under the tropical rain forest and this includes mainly semi evergreen and mixed deciduous types of forests. Hills and hillocks distributed in different part of the area have their own dominant species. Grasslands are widely spread over the riverbank and hill slopes. Social forestry plantations in hills and hillocks, riverbanks and roadsides are another type of vegetation. Herbs, shrubs, trees and climates are spreads over both hills and plains. The total area under forest cover within the Guwahati municipal area is 39.37sq.km representing 29.60% of the total area of the city (Goswami 1993). There are several Reserve Forests (RF) in and around Guwahati under the administrative
control of the divisional Forest Officer, Kamrup (East), these are Khanapara RF, Fatasil RF, Gotanagar RF, Sarania RF, South Kalapahar RF, Jalukbari RF, Hengrabari RF, and Rani-Garbhanga RF (Dutta and Gowami, 2007). However there is practically no big forest or jungles in the urban area of Guwahati, only the surrounding hill ranges and hillocks are covered with scattered trees, shrubs and grasses (Dutta and Gowami, 2007). As per the working Plan for the Reserve Forest of the South Kamrup Division the composition of the forest crops are categorized into following six classes (Dutta and Gowami, 2007),

i) Eastern Hill Sal Forest: This type occurs mainly in the hilly areas of Rani-Garbhanga RF.

ii) Moist Plains Sal Forest: This type of forest has limited distribution and is found in some parts of Rani-Garbhanga RF.

iii) Moist Mixed Deciduous Forest: In Sal dominated reserves this type of forest is characteristic of the drier slopes and ridges of the hills with conspicuous absence of Sal in patches and groups.

iv) Evergreen Forest: This type of forest is only of vary local occurrences. They occur in patches mainly in the hill slopes along banks of perennial streams and in shady moist pockets along nalas, mostly situated in locations far from habitations and not subjected to any kind of biotic interference in the form of jhuming, grazing, fire etc.

v) Secondary Moist Bamboo Brakes: This type of bamboo brakes occur along the moist mix deciduous forest in hill area, along the perennial stream and nalas etc.
vi) Secondary Euphorbiaceous scrub: This type has very limited occurrences only in abandoned jhum areas.

COMMUNICATION

The city has direct road, rail and air connections with rest of the country. National Highway (NH) 31 connects Guwahati with rest of the country while other National and State Highways link the city with the state of Tripura, Mizoram, Meghalaya, Manipur, Nagaland and Arunachal Pradesh besides other areas of Assam. The NH 37 connects Guwahati with rest of India and other parts of the state. The city is also directly connected by air with major cities of the country as well as state capitals of North Eastern Region. It also has international connectivity with few places.

POPULATION

Guwahati forms the largest urban agglomeration in North East India, and its influence in business, commerce, educational, political and cultural activities, extends to the entire North Eastern Region. As such, there is a rapid increase in population over the last few years. The population growth of Guwahati Municipal Corporation area is given below (Table 3.1). There was no census in 1981; however, the population was projected by Town and Country Planning Organization, Govt. of Assam for 1981 as 4, 51200 persons. According to 1991 census, the population was 5, 84,342 with a density of 2695 persons per sq.km (Census Report, 1991). The provisional population totals for the year 2001 (Census Report, 2001) is 8, 08,021 persons with a population density of 3727 persons per sq.km. The city has
Table 3.1: Population growth of Guwahati Area
(Source: Census of India, 2001)

<table>
<thead>
<tr>
<th>Year</th>
<th>Population</th>
<th>Growth Rate (%)</th>
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<tbody>
<tr>
<td>1872</td>
<td>11,492</td>
<td>-</td>
</tr>
<tr>
<td>1881</td>
<td>11,695</td>
<td>+1.76</td>
</tr>
<tr>
<td>1891</td>
<td>11,420</td>
<td>-2.35</td>
</tr>
<tr>
<td>1901</td>
<td>11,661</td>
<td>+2.11</td>
</tr>
<tr>
<td>1911</td>
<td>12,481</td>
<td>+7.03</td>
</tr>
<tr>
<td>1921</td>
<td>16,480</td>
<td>+32.04</td>
</tr>
<tr>
<td>1931</td>
<td>21,797</td>
<td>+32.26</td>
</tr>
<tr>
<td>1941</td>
<td>29,598</td>
<td>+35.78</td>
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<tr>
<td>1961</td>
<td>16,6695</td>
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</tr>
<tr>
<td>1971</td>
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<tr>
<td>*1981</td>
<td>4,51,200</td>
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</tr>
<tr>
<td>1991</td>
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<td>+29.51</td>
</tr>
<tr>
<td>2001</td>
<td>8,08,021</td>
<td>+38.79</td>
</tr>
</tbody>
</table>

* Projected values in the city area

Witnessed a population growth of 131% during 1971-1991 and 39% during 1991-2001. The city has a cosmopolitan type of population comprising people from different parts of the country. The literacy rate is about 77% although 31% of people are below the poverty line.