CHAPTER III – STUDY AREA

The study area is located in Shillong, the capital of Meghalaya and headquarters of East Khasi Hills District (Fig. 1.1). The city is situated along the northern slopes and foothills of the Shillong peak at 25°34´N latitude and 91°53´E longitude at an average altitude of 1496 metres above mean sea level. Shillong is an important tourist destination in the northeast and is considered as one of the most beautiful and picturesque hill stations in India. It is often referred to as the “Scotland of the East” due to its striking similarity with the Scottish highlands. It is linked with Guwahati, the capital of Assam by National Highway 40 at a distance of about 100 km. Over a century, the tiny settlement of Shillong has grown to a striving city changing from a
hill resort to a multi-functional entity acting not only as an administrative-cum-tourist centre but also as an educational and commercial centre of the entire north-eastern region of India.

Shillong Urban Agglomeration, 1991-2011 covers an area of 70.4 square kilometer. It classifies the land resources of the city into five broad categories of developed, underdeveloped, developable, urban agriculture and forests and water bodies. The geographical area covered under each category and details of various land uses in Shillong Urban Agglomeration are provided in Fig.1.2. The developed areas of Shillong Urban Agglomeration consist of Madanrting, Mawlai, Nongthymmai, Pynthorumkhrah, Shillong Cantonment and Shillong Municipal townships.

Fig. 1.1: Location map of the study area
**Fig.1.2: Land use map of the study area**

**HISTORICAL GROWTH**

Legend has it that the capital city derives its name from the manifestation of the creator called SHYLLONG. During the British period, Shillong was a cluster of a few scattered hamlets. In 1863, the British administration shifted the headquarters of United Khasi and Jaintia Hills District from Bengal. In 1874 Shillong became the provincial headquarters of Assam. This resulted in rapid growth of population from 1363 inhabitants in 1872 to around 4000 in 1875. During this period, the Christian missionaries established various educational centres in the town. The post-independence period marked an accelerated growth due to influx of migrants from the neighbouring states as well as from other parts of the country. The population of Shillong in the year 2001 was 2318822 which was estimated to have touched a figure of 2934095 in 2010.

**TOPOGRAPHY**
The city is a part of Shillong plateau which is dissected in nature with well-developed valleys along which the streams flow. The region includes a series of hill ranges hillocks and rugged land surfaces that slope towards the central highland and following the gradient flow down. The city has a series of hills, which slope towards the north of River Umshyrpi at an elevation of 1400 and river Umkhrah at an elevation of 1300 m which passes through the Shillong township. The topographic cross section of the study area in southwest-northeast direction shows that the region has an irregular landscape (Fig.1.1).

**CLIMATE**

The climate of Shillong is typically humid sub-tropical found in the eastern part of the sub-continent. It is characterized by moderate warm wet summers with cool dry winters. The year can be divided into four distinct seasons: Winter- December to February; Spring- March to April; Summer- May to August and Autumn- September to November. Relatively high temperatures, occasional thunderstorm and high wind velocities characterize the summer season. Shillong receives most rains during summer (Fig.2.2). However, intermittent rain may occur till late autumn. The short autumn is characterized by sharp decline in temperature. Winter is the coldest season marked with quite low temperatures and considerable cloud/fog covers. The average maximum and minimum ambient temperature is 17°C and 7.5°C respectively. The average annual precipitation in Shillong is 2100 mm and the relative humidity is always more than 50% which exceeds above 80% during the rainy season.

The total annual rainfall was 2290.9 mm in 2001-2002 and 2569.5 mm in 2004-2005. The monthly variation in rainfall did not follow similar pattern during the two years. While during the year 2001-2002 rainfall gradually increased from March to June and followed by a steady decline till October. During the year 2004-2005 it did not peak in June and the months of
April, May, June July and August received almost uniform amount of rain (Fig.2.1). The winter season did not have any significant rain hence the streams remained at their base flows during these periods. Atmospheric temperature during summer was as high as 25°C, while the mean winter temperature was as low as 6°C. Winter was marked by the appearance of ground frost during night and early morning hours. Flashfloods and spates in the streams during the rainy season are quite frequent due to heavy rainfall.

Current velocity is considerably less along the banks, and almost negligible in pools. All the stations experience uniform flow excepting rainy season when flooding takes place. Discharge rate varied from 0.08 to 1.26 cusec in the river Umkrah and 0.12 to 0.33 cusec in the tributaries of Umkrah river during the dry season and from 0.34 to 6.89 cusec during wet season at the selected sites of Umkrah river and 0.78 to 1.94 cusec in the tributaries of the river. The mean depths and mean width of the river are given in Table1.2.

The substratum of the river has boulders and pebbles in upper and lower reaches while it is sandy with some content of silt and clay in middle part where gradient is not steep viz., Polo.
Fig. 2.1 Mean monthly variation in rainfall of the study area Source: Meteorological Department, Shillong

![Rainfall Chart]

Fig. 2.2 Mean monthly maximum and minimum air temperature of the study area Source: Meteorological Department, Shillong

DRAINAGE PATTERN

The Umshyrpi and Umkhrah rivers flowing through the Shillong township originate from the foothills of Shillong peak. Umshyrpi river flows in south-north direction. The major tributaries joining the Umshyrpi include, Wah Dienglieng, Dhanketi, Malki and Umjasai streams. Umkhrah river flows in East-West direction. The streams joining the Umkhrah river further down include, Refugee Colony (A), Shillong College (B), Polo Bridge (C), Opposite Jingthangbriew (D) and Opposite Mawpdang Bridge (E) (Fig.1.3).
Fig.1.3: Drainage pattern of Umkhrah river

LAND RESOURCES OF SHILLONG

The Master Plan of Shillong 1991-2011 prepared by the Directorate of Urban Affairs, Government of Meghalaya covers an area of 174 square kilometers which includes the Shillong Urban Agglomeration and thirty two other surrounding villages. In this Master Plan, the land resources of the city have been divided into five broad categories shown in Table 1.1.
Table 1.1: LAND RESOURCES OF SHILLONG TOWN

<table>
<thead>
<tr>
<th>Sl No.</th>
<th>Land use</th>
<th>Area (km²)</th>
<th>Percentage to total area (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Developed area</td>
<td>54.94</td>
<td>31.58</td>
</tr>
<tr>
<td>2</td>
<td>Underdeveloped area</td>
<td>15.73</td>
<td>9.04</td>
</tr>
<tr>
<td>3</td>
<td>Developable area</td>
<td>50.77</td>
<td>29.18</td>
</tr>
<tr>
<td>4</td>
<td>Urban agriculture</td>
<td>8.03</td>
<td>4.62</td>
</tr>
<tr>
<td>5</td>
<td>Forests and water bodies</td>
<td>44.51</td>
<td>25.58</td>
</tr>
<tr>
<td></td>
<td>TOTAL AREA</td>
<td>174</td>
<td>100.00</td>
</tr>
</tbody>
</table>

Source: Directorate of Urban Affairs, Govt. of Meghalaya, 1991

THE UMKHRAH RIVER

Umkhrah river originates at an altitude of 1600 m above mean sea level from a spring located in the Shillong Peak hill range near Demthring. Domestic wastewater from uphill dwellings also joins Demthring spring. The spring water at the point of origin of the river is collected and used for domestic purposes. The spring is surrounded by human habitation which affects the quality of the river water right at the site of its origin. A large stone and sand quarry also exists near the spring. Besides quarrying activities, tapping of ground water is also done near the point of origin of the river. The ground water is pumped into tankers and the water is sold in the city, thus reducing the quantity of water in the river particularly during dry seasons of the year.

From Demthring, the river attains the shape of a fast flowing stream as it flows through the foothills of Nongthymmai and Rynjah. Near Lapalang bridge, the river is joined by the Phud Raimut and the Phud Mawshbuit flowing from the eastern part of the catchment which is
primarily under the Military Cantonment at Happy Valley and its surrounding villages. Thus, while flowing through densely populated urban area, the river is joined by streams carrying runoffs from the nearby urban areas.

After Umpling bridge, the river flows through a relatively steep gorge which ultimately ends at the Kshaid Umkaliar (Spread Eagle Falls) near the office of the Garrison Engineer, MES, Shillong. At the foot of the falls, another stream, Wah Kdait flowing from the rural outskirts of Shillong, joins the river. From this point onwards, i.e. from Umkaliar, the river flows through a relatively plain area. At Demthring and Pynthorumkhrah, the northern bank is under agriculture and there are also several private cowsheds.

In Fourth Furlong and Polo localities, vast stretches of the river have been encroached. Retaining walls have been built, land-filling done and several residential and commercial buildings have been built on land which was once the bed of the river. The river has been reduced to a drain here and the silt and solid waste it carries gets deposited causing flash floods during monsoons. After Polo, the river flows through the densely populated localities of Lawmali, Wahingdoh, Raitsamthiah, Jaiaw and Mawlai. Several drains bringing wastewater from these localities join the river along the way. Mawpdang is the last accessible point of the river, as just a little downstream of this location the river flows into a deep gorge which ends at the Beadon Falls. Downstream of the Falls, the river is joined by the River Umshyrpi to form the river Ro Ro (Fig.1.1).

The Umkhrah river along its upper stretch mostly flows through forests dominated by *Pinus kesiya* accompanied by growth of various shrubs like *Lantana camara*, *Eupatorium sp.* etc. In the middle stretch it flows through agricultural and waste pasture lands. Hand digging and cow–dung manuring are important features of farming in the area. After this stretch it flows by
the side of an urban settlement along the whole stretch of the river system till it reaches the point of confluence with the Umshyrpi River and ultimately joins the Umiam Lake.

Shillong does not have a sewerage system. Most of the domestic and commercial waste water and storm runoff are carried in both open and closed drains which discharge either into the Umkhrah or the Umshyrpi. The drains are all gravity flowing but sometimes their flow is obstructed by dumping of solid waste into them. Many houses along the river do not have proper toilet with a septic tank or soak pit therefore, their waste are directly discharged into public drains. In areas outside the municipal limit, residences with dry latrines are still very common. Solid waste generated in the Shillong city as per an estimate made by the Meghalaya State Pollution Control Board was about 121 TPD. The Shillong Municipal Board collects the solid waste and general hospital waste from the municipal areas and dumps them at a trench ground at Mawiong located about 6 km outside the city. However, most of the waste from the surrounding townships do not have a proper mechanism for collection and are disposed into the drains and low lying areas landing in the Umkhrah and Umshyrpi rivers and eventually the Umiam Lake.

Umkhrah river flows right through the middle of the city with its catchment covers almost 80% of the Shillong Urban Agglomeration. Water of Umkhrah river has been used mainly for domestic, industrial and irrigation purposes since time immemorial. However, with the increase in population in the city and its unplanned growth, this river has been converted into a drain used for dumping almost all types of sewage. Domestic waste, direct discharge from latrines and slaughter houses, municipal solid waste and construction debris are the major solid and liquid wastes that degrade the water quality of the river.

A number of sources/activities contribute towards the pollution of river Umkhrah and its tributaries. These polluting sources can be broadly classified into i) Point Sources and ii) Non-
Point or Diffuse Sources. The Point Sources of pollution include the dry latrines located along the river Umkhrah and its tributaries that discharge raw sewage directly into these water bodies and effluents from hotels and restaurants, automobile workshops, hospitals and nursing homes, slaughter houses, vegetable, meat and fish markets situated in the catchments while the Non-Point Sources are indirect discharge of untreated sewage, municipal wastewater, dumping of solid wastes and other spoils and agricultural run offs (MSPCB-NEHU, 2004).

Sand and gravel quarrying, deforestation due to construction works, dumping of garbage and spoils from the construction sites and agricultural run-offs are certain other activities that contribute significantly towards the pollution of river Umkhrah. Quantitative data on pollution loads from these activities are however not available.

*Plate 1.1: Dumping of earth at Pynthorbah*
Plate 1.2: Wastewater discharge directly into the river
Plate 1.3: Washing of vehicles and a view of the quarry at Umkaliar

Plate 1.4: Toilet discharging directly into the river

Plate 1.5: Automobile workshop located nearby the river