Chapter III

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Chapter III
DATABASE AND METHODOLOGY

3.1 Introduction
The data is the backbone of any research. In order to study the change of spatial extent of growth and infrastructural facilities, SOI toposheets and IRS P6 LISS III and LANDSAT-TM data was used to generate different layers of years 1980, 1992, 1999, 2004 and 2008 respectively. Multi-temporal data has been used to monitor the urban sprawl. The census data of the city was integrated with the above mentioned data to identify the elements at risk associated with different forms of urban hazards.

Methodology of the work involves utilization of various methods, tools and techniques used to assessment of urban sprawl for fulfillment of the objectives. GIS techniques were used for utility planning in terms of sprawl. Remote Sensing data of the study area has also given spatio-temporal information on the urban landuse.

3.2 Database
The data required for the present study comprises topographical maps, Satellite Images, Census data and Utility services data details. For mapping, the extent of the urban area as it stood at the 1979-1980 level, Survey of India topographical maps were used. Apart from that extent of the urban area, this has details of built-up, drainage, water bodies, rail and road networks and administrative boundaries. LANDSAT ETM+ and IRS P6 LISS III data were used to map the extent of sprawl for 1980 to 2008. In this study the secondary data has been collected from various sources.
Table 3.1: Secondary Data details for the study area

<table>
<thead>
<tr>
<th>Segment</th>
<th>Type of Data</th>
<th>Centre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spatial data</td>
<td>Toposheets no. 47 F/14/2, 47/F/14/3, 47/F/14/6, 47/F/15/NE, 47/F/15/NW</td>
<td>Survey of India, Scale 1:25000</td>
</tr>
<tr>
<td></td>
<td>Ward wise Population data</td>
<td>PMC, PCMC and Census year book 2001</td>
</tr>
</tbody>
</table>

3.3 Methodology

This work covers Pune –Pimpri Chinchwad Municipal Corporation Area. To understand urban sprawl of the Pune and Pimpri-Chinchwad, the methodology adopted for the present study is divided in following phases.

3.3.1 Library work

Exhaustive literature survey of the topic of investigation has been undertaken. published literature, reports will be collected from various libraries, institutes; Govt. departments etc. Besides, relevant literatures like reference books, bulletins, review etc. were obtained through internet.
3.3.2 Pre field phase
This phase deals with the literature review for the understanding the complexity of a dynamic phenomena of urban sprawl and an urban environment. Literature referred to urban sprawl, extraction of sprawl, problems related upon agglomeration were collected to have some general understanding of the topic. Application of remote sensing technology have been identified and used as an important tool to monitor land use and surface changes. Satellite remote sensing collects multi-spectral, multi-resolution, multi-temporal data providing valuable information for understanding and monitoring the process of urban sprawl. As it is in the digital format, it can be brought into GIS, to provide a suitable platform for data analysis, update and retrieval. Land use can be captured both in terms of geographic location and absolute area. The growth profile obtained helps in formulation of development policies. (Patkar.V.N & Sampathkumar. D, cf. Shekhar S. 2005)

The collection of different types of maps includes satellite imageries and topographical maps. Collection of non-spatial data, utility services data details has been obtained from PMC and PCMC.

3.3.3 Field work
This phase includes visit to the study area and its fringe areas in different seasons, GPS surveys, instrumental surveys, photographs, questionnaire survey etc. it facilitated to understand the complexity of a dynamic phenomenon such as urban sprawl, land use changes, urban sprawl pattern.

3.3.4 Laboratory work
Includes sorting of data, digitization of various layers, preparation of maps and other GIS/RS techniques, like Georeferencing, Data attachment, area calculation, Overlay analysis, Unsupervised classification, Final layouts of different maps.

3.3.5 Synthesis of the data, Report writing and submission
The data generated during the field, and in laboratory was studied synthesized, interpreted have been produced in this thesis.
3.4 Data Processing Work

3.4.1 Scanning the Toposheets

Topographical maps of the study area have been obtained from Survey of India (SOI) Pune. These toposheets were scanned in .tiff (300 Dpi) format to have them into digital format, so that further processing should become easy.

3.4.2 Georeferencing the Toposheets

Scanned toposheets were then transformed to in ArcGIS 9.1 for georeferencing using 12 well distributed Ground Control Points and kept 3rd polynomial order. RMS error kept 0.4 which is below half pixel and resampled the image with WGS 84, 43 North Zone. After resampling and reproject in the same toposheets were converted from WGS 84 to UTM. The reprojection of toposheet is useful for area calculation.

3.4.3 Georeferencing the Images

After georeferencing of toposheets, next task was georeferencing of the IRS P6 LISS IV imagery of the same area. For the georeferencing of satellite imagery reprojected toposheets were used. 15 well distributed ground control points were used and RMS error was kept below half pixel.

3.4.4 Normalization of attribute data

Attribute data was mainly collected from secondary data sources. Using MSOffice 2003 this data was then converted into digital format. Degree of accessibility and application of database depends on the nature and systematic logical arrangement of data. Making efficient geodatabase data was normalized and unique id were generated for data attachment. The same unique Id field was generated in spatial data so as to facilitate easy attachment of all attribute data to the spatial data.

3.4.5 Generation of Geodatabase

The attribute data which was in hard copy format that was also converted into digital spreadsheet (.dbf) format. Due to unique Id, normalized attribute data became ready for attachment. In spatial data generation, a personal geodatabase in ArcGIS software for analysis purpose, the same unique Id field was also generated in spatial data. Due to this attachment of spatial and non spatial data has become easier.

3.4.6 Data Attachment
Attribute data saved in db IV format was then imported into attribute data table format in ArcGIS. Unique Id for spatial data was assigned and attached to all attribute data and the spatial data. It is the important characteristics of GIS in which one can see both spatial and non spatial data at a glance.

3.5 Processing on Toposheet

3.5.1 Area Calculation

The study of changing landuse pattern in urban area over period of time is important task for determining the trend of urban sprawl. In present scenario the study area was classified into various classes. Each class was then compared with the area obtained from satellite images of the different years. It gives a significant trend of urban sprawl.

3.6 Ward boundary map

Wardwise boundary map has been obtained from Municipal Council of Pune and Pimpri Chinchwad Using registration techniques in GIS environment, the map has been properly digitized and registered with SOI topographic graticule. This map has been used in the integration analysis to get Administrative ward wise information. Demographic data obtained from census records were linked to the wards coverage using unique item related to the ward code. All the thematic maps were digitized in GIS environment and integrated with spatial framework of Pune and Pimpri Chinchwad planning area. Area statistics were obtained for all the above-mentioned parameters considered for the study directly from GIS database.

3.7 GIS, Remote Sensing and Image Processing Techniques

GIS and remote sensing are very useful in the formulation and implementation of the spatial and temporal changes, which are essential components of regional planning to ensure the sustainable development. The different stages in the formulation and implementation of a regional development strategy can be generalised as determination of objectives, resource inventory, analysis of the existing situation, modelling and projection, development of planning options, selection of planning options, plan implementation, and plan evaluation, monitoring and feedback (Yeh and Xia, 1996). GIS and remote sensing techniques are quite developed and
operational to implement such a proposed strategy. The spatial patterns of urban sprawl on temporal scale is studied and analysed using the satellite imageries and cadastral data from Survey of India, mapped, monitored and accurately assessed from satellite data along with conventional ground data. The image processing techniques are also quite effective in identifying the urban growth pattern from the spatial and temporal data captured by the remote sensing techniques. These help in delineating the growth patterns of urban sprawl such as, the linear growth and radial growth patterns.

3.8 Satellite Image Processing

3.8.1 Landuse / Landcover Map

Landuse means, use of land for different purposes like built-up recreation, commercial, forest etc. Landcover means the area covered by various physical features like vegetation, hills, water bodies etc. remote sensing technology plays key role in landuse/landcover mapping of urban area.

3.8.2 Classification of Land Use/Land Cover

Land Use land cover is mainly classified in to following categories

Level I
1. Urban or Built-up Land
2. Agricultural Land
3. Forest Land
4. Water bodies
5. Wetland
6. Barren Land

3.8.2.1 Urban Built-Up Land

“All places with a municipality, corporation or cantonment or which are notified town areas, & all other places which satisfy the criteria of minimum population of 5000, at least 75% of whose male working population is non-agricultural & having a density of population of at least 400 per sq.km. are placed under this category” It includes;
Residential - It includes all the constructions used primarily for residential purpose. The residential areas include apartments, detached houses, row houses & farmhouses of different density groups.

Industrial - It includes all the constructions that are used for industrial activity. It include light manufacturing industries focused on design, assembly, finishing & packaging of products, to heavy manufacturing industries such as chemical plant, electric power generating stations, oil refineries, brick making plants, steel plants etc.

Transportation - This type of land is used basically for transportation activity. Major transportation routes such as roadways, railways, airways & waterways are included in this category. The roadways include major & minor roads, bridges & terminal facilities such as bus & truck terminals. The rail facilities include stations, parking lots, repair, & switching yards, tracks & related areas. The airways include all facilities directly connected with air transport. The areas include runways, intervening land, terminals, service buildings, plane hangars, navigation aids, fuel storage areas, parking lots & limited buffer zone. The water transportation includes those areas related to water transportations excluding the water. The major areas of this category are the port areas, docks, shipyards, dry-dock & lock.

Recreational areas - “It includes all the recreation facilities & areas which are devoted for recreation & basically on open land.” It includes incidental buildings such as shelters, toilets, beach change areas, etc.

Public and semi-public - “It includes all educational facilities such as schools, colleges & universities, religious places, health centers, cantonment areas & areas associated with the transport of gas, oil, water & electricity.”

Open spaces/Vacant areas - “It includes all the open spaces which are not used for any purpose & vacant land, both within & outside built-up areas”

3.8.2.2 Agriculture Land

“This is broadly defined as the land used primarily for production of food & fiber” This includes cropped areas, fallow lands & plantation areas.

Crop Land - It includes both cropped lands & un-irrigated crops grown under natural climatic conditions.
**Plantations** - It includes plantations such as coconut, areca nut, citrus, banana, cashew, casuarinas, eucalyptus, & other orchards/nurseries.

### 3.8.2.3 Fallow Land

It is basically an agricultural land but devoid of any crop at the time of collection of remotely sensed data.

### 3.8.2.4 Wasteland

“Lands which are capable or have the potential for the development of vegetative cover & are not being used due to different constraints of varying degrees are classified under this category.”

**Undulating upland with or without scrubs** - “This is the land which is prone to degradation & may or may not have scrub cover. Such land occupying topographically high locations & excludes plain, hill & mountainous terrain.”

**Sandy areas** - “Sandy areas other than beaches are composed primarily of dunes & accumulation of sand transported by the winds. Sand accumulations occurring in coastal plains, river flood plains or inland areas are included in this category.”

### 3.8.2.5 Water Bodies

“It include the areas that are persistently water covered.”

**Rivers/Streams** - “This category includes rivers, streams & creeks.”

**Reservoirs/Tanks/ Canals** - “This is artificial impoundment of water used for irrigation, flood control, municipal water supplies, recreation, hydro-electric power generation & so forth.”

**Lakes/Ponds** - “These are non-flowing, naturally enclosed bodies of water, including regulated natural lakes but excluding reservoirs.”

### 3.9 Urban sprawl assessment

The base maps prepared from toposheets (1979-80) and different years satellite imageries (1992, 1999, 2004 and 2008), the built-up area was calculated from same and Shannon’s entropy was applied to measure the urban sprawl.
3.10 Analytical Framework

Data

Spatial Data

Satellite Imageries
- LANDSAT ETM+ 1992 & 1999
- IRS P6 LISS-III 2004 & 2008

Georeferencing (Toposheet to Image)

Supervised Classification

Landuse/Landcover Mapping

Built-up area Mapping

Non-Spatial Data

Toposheet 1979-80

Transportation

PMC/PCMC Data

Hospital Data

Scanning

Georeferencing

Vectorization

Data base Generation

Attribute

Normalization

Data Attachment

Built-up

Landuse/Landcover

Civic Amenities
3.11 Conclusion

This chapter contains Database and Methodological approach for the monitoring and measurement of sprawl in study area. SOI toposheets (1979-80) and different years satellite data (1992, 1999, 2004 and 2008), were used for calculation of built-up area. For assessment of urban sprawl the Shannon’s entropy technique was used. Utility services like, multispecialty hospitals, public transportation and medium wise schools data were used.