CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

Coastal environment has caught the attention worldwide since it is an important indicator of energy balance on the earth. With growing importance on global warming, study on costal configuration and coastal ecosystem has gained significance attention of researchers worldwide, especially in India. An increase in the pollution level caused by physic-chemical pollutants in coastal area has severe impact on its ecosystem and form causative factor for multitude effects on environment. Coast acts as a source and sink for energy and any imbalance would result in adverse impact on the environment and in turn, future resources available for mankind. Such an imbalance may be well assessed by assessing and monitoring coastal ecosystem. Coastal ecosystem supports many species of flora and fauna that form an instrument for coastal economy and thus significant both in terms of economy and environment. This in turn, leads to the understanding that assessing and monitoring of coastal ecosystem is paramount not only to monitor environment but to understand their vulnerability as well. Similarly, studies related to global warming, a phenomenon due to climate change, has shown that rising of sea levels from 20 cm to 90 cm in the next century (Wigley and Raper, 1992). A small tidal level rise along the coast may cause immeasurable damage to land and water resources denying mankind its quality and wealth. Coastal floods and coastal erosion due to various reason including human activities and climate change may affect many low lying coastal area affecting million of people their settlements and livelihood. All these pointers attribute to the coastal vulnerability for which continuous monitoring of coast ecosystem is a pre-requisite.

Previously, few decades back, studying coastal ecosystem is an arduous task involving huge man power and energy. Even to collect certain baseline information such as physical extent of a coastal habitat, type, extent of interaction between tide and land and seasonal changes in their physical extent over time is next to impossible.
With the advent of satellite remote sensing, it has become relatively easier to understand the regional setting of a coastal terrain, extent of its interaction with tide, and seasonal variation in the extent of coastal habitats and in turn, their effects on flora and fauna. Moreover, a baseline database may also be generated using Geographic Information System (GIS). The interpretation and information derived on coastal ecosystem may be stored as GIS database, their spatial extent may be estimated and changes in their pattern may be monitored studying temporal satellite data.

In the present study, such an integrated approach using remote sensing satellite data and GIS is employed applying a suitable methodology. Coastal wetland and landform units are interpreted from remote satellite data with limited field checks and integrated in GIS environment. Moreover, remote sensing satellite data covering the study area – Pulicat lagoon and Kalveli lake – are analysed for two periods so as to highlight temporal changes if any occurred in the area. A methodology catering such requirement needs a thorough understanding on the remote sensing and GIS techniques including the data type and their character, which is carried out in the following sections.

### 3.2 SPECTRAL PROPERTIES AND REMOTE SENSING

Remote sensing attributes to data gathering technique without having any physical contact with the objects of interest and exploits the interaction between the sun’s energy and the terrain objects. It records the reflected energy emanating from various objects on the earth in a specific spectral region based on the principle that all matter reflects, absorbs and refracts electro-magnetic radiation (emr) or electromagnetic spectrum (ems) from the sun. The interaction mechanism between object and the ems allows the sensor to detect energy from objects under various portions of ems. Such type of detection of energy naturally emitted by the objects is termed as ‘passive remote sensing’ since, it records energy passively without applying is own energy. On the other hand, when the sensor generates its own energy and detects objects using longer wavelengths, in microwave region, they may be termed as ‘active remote sensing’ and Radarsat is an example for active remote sensing. Remote sensing
satellites used for resources inventorying are passive remote sensing and satellites such as Landsat TM (Thematic mapper), SPOT (Spatial Probatoire de la Terre) and IRS (Indian Remote sensing Satellite) belong to this category.

Remote sensing technique is implied as multi-concept technique since it is capable of:
1. Multi-spectral
2. Multi-sensor
3. Multi-temporal
4. Multi-platform
5. Multi-scale
6. Multi-spatial, and
7. Multi-thematic applications.

The multitudes of remote sensing technique, synoptic view and repetitive coverage under uniform illumination has made it a formidable tool in resource inventorying, understanding the terrain condition, disaster mitigation and recently an integral part in environmental impact assessment. For this purpose, an understanding on the interaction between matter and electro-magnetic spectrum (ems) is required and discussed in the following section.

3.2.1 Object and Electro-Magnetic Spectrum (ems)

Energy when incident upon an object on the earth’s surface undergoes either reflection or refraction or otherwise absorbed. These effects may not happen in a perfect proportion and objects may show partial refraction or reflection or partially absorbing the energy. This interaction between energy and object is controlled by the inherent constituent elements of an object and accordingly the degree of such interaction varies. Because of such varying reflection or refraction or absorption, each object may show unique spectral value that could be recorded at different spectral wavelengths of ems, which would eventually generate multi-spectral information about an object (Figure 3.1).
The fundamental concept applied in remote sensing technique is recording of spectral values of objects at known spectral regions, usually visible spectrum ranging from 0.4 µm to 0.7 µm and near-infrared region 0.7µm to 1.1 µm (Figure 3.2). The energy thus emitted by objects is recorded by suitable sensors on-board in a satellite in specific spectral bands of some regular width and stored as information. The gathered data are then processed carefully applying various corrections such as atmospheric correction, radiometric correction and geometric correction, so that a compatible primary data is generated and stored in digital format.

<table>
<thead>
<tr>
<th>UV</th>
<th>VISIBLE</th>
<th>IR &amp; Thermal IR</th>
<th>Microwave (RADAR)</th>
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<tr>
<td>&lt;0.4 µm</td>
<td>0.4 – 0.7 µm</td>
<td>0.7 µm – 1 mm</td>
<td>&gt; 1 mm</td>
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Figure 3.2 Spectral Regions used in Remote sensing

The recording of energy emanating from various objects in analog signal is later converted to a digital format by Analog → Digital (A-D) converter on-board of remote sensing satellite. These are then stored in a specific format such as Bands
Sequential Format (BSQ), Bands Interleaved by Lines (BIL), and Bands Interleaved by Pixels (BIP). The machine readable digital format may be directly used for image processing for specific application or produced in hard copies (False Color Composite, FCC) for visual interpretation.

The spectral value or the reflectance value (after refraction or absorption) of an object is termed as the "spectral signature" and it is unique for each object depending upon its composition, surroundings and association elements. This may be explained by considering an example, leaf that looks green because the chlorophyll in that leaf absorbs blue and red spectra and reflects only the green spectrum. Like this, each and every mineral or compound on the earth has its own predominant reflecting or absorbing factors that determines the spectral characteristic of that object, or in other term known as spectral signature. Spectral value or DN (digital number) value of an object may be relatively high or low in a specific spectral band compared to its surrounding objects, giving color and tonal contrast and allowing the user to identify that object from the other objects in an image. These image characteristics such as color, tone, texture, shape and association aid in interpretation of remote sensing satellite data to identify specific features.

The elaborate discussion on the interaction between ems and object and the spectral values of objects helps the researcher or an analyst to understand the behavior of objects in different spectral region. The selected remote sensing satellite data may be analysed to extract information on desired themes correlating image elements observed in the satellite image to the terrain features and supported by limited field checks. A description on the image elements that leads to the further processing of satellite data for specific thematic application is discussed in the following section.

3.2.2 Remote Sensing Image (RSI) Elements

Relevant to the present study, it would be appropriate to have a brief discussion on the image elements that help in interpreting objects to prepare a thematic map or extracting information about objects and their environment.
Based on the spectral reflectance value, RSI shows some basic image elements that help in interpreting the image for specific application. They are color, tone, texture, size, shape and association elements. In a FCC satellite image, with the help of color, features may be discriminated and identified. For example, red color indicates presence of vegetation and blue color indicates presence of waterbodies. Even in this, different shaded of red color may indicate different species of flora or vegetation and similarly intensity of blue denotes depth of the water column. Tone may indicate the uniformity of particular color or color shade and may be termed as smooth tone, medium tone and coarse tone and each may signify different status of objects and helps to discriminate them. Texture may be defined as the fabric of color elements and its smoothness indicate density of a particular object and medium to coarse texture indicate a relatively scattered presence of a particular object. Size and shape are helpful in identifying an object, for example, an agricultural field shows geometrical pattern in an image. Lastly, association is an important image element that helps in conclusively identify an object. For example, agricultural field and salt pan both show geometrical pattern and may show same color and tone. But association of such elements along a coast, near an estuary or a creek or a lagoon may help in identifying the object as salt pan instead of object agricultural field.

It is appreciated that an object is recognized naturally based on the above image properties which is a representation of its physical, chemical or biological environment setting. But, at the same time, nature also imposes hard restriction on identifying such objects with ease because of overlapping of objects providing a heterogeneous dimension. This heterogeneous nature of objects poses a great challenge to researcher to extract features in remote sensing satellite image and gives scope to employ different combinations of techniques to suit specific thematic application. Thus, the analysis of remote sensing satellite data involves thorough consideration of all the above explained image elements together along with carefully planned field visit to verify the interpreted features. In the present study, an analysis of the selected data is carried out using image processing techniques and visual interpretation as well. A detailed description on the relevant image processing techniques adopted in the study and image characteristic and related terrain
characteristic using visual interpretation to prepare thematic maps are discussed in the following sections.

3.3 SATELITE DATA ANALYSIS

Remote sensing data analysis involves examining images for the purpose of identifying objects and assessing their significance through correlating image characters with terrain characters either interpreting visually or by employing image processing techniques. It involves certain logical process to detect, measure and segregate similar objects into classes and evaluating their pattern for spatial relationships among them. The image is also studied to extract hidden information of a region or terrain through inferences obtained from the pattern and arrangement of features. A brief description on image processing techniques and image elements for visual interpretation are given below.

3.3.1 Image processing techniques

Digital Image Processing may be described as a variety of techniques to enhance and manipulate satellite image in its digital format using some standard mathematical operations (Goetz et al., 1975; Sabins,1980). In the context of present study, it may be explained to handle and manipulate spectral values (DN values) of objects in multispectral bands of remote sensing satellite image to enhance and bring out information, which may otherwise be ignored or overlooked. It may also be useful in extracting and understanding pattern recognition at regional level and infer physico-chemical changes in information (Sing, 1989) pertaining to specific features especially coastal wetlands at local level and shoreline changes (Coppin et al., 2004; Zang et al., 2005).

It is to be understood that the raw data received from the sensors on the remote sensing satellite contains errors due to sensor, earth rotation, atmospheric particles so on. Many of the system errors will be rectified by the receiving station and produced as corrected image. This is later corrected for geometrical precision by the end user or
may opt for available geocoded image too. Based on this, image processing of satellite data involve three broad steps.

They are:

- Pre-processing
- Enhancement techniques
- Information extraction through various analyses

**Figure 3.3 Flow chart showing general procedure adopted for the study**

A general procedure involving image processing technique adopted for the study may be amply illustrated through a flow chart as shown below in Figure 3.3.
Digital image consists of discrete picture elements called pixels. Associated with each pixel is a number represented as DN (Digital Number) that depicts the average radiance of relatively small area within a scene. The size of this area is called the spatial resolution of the sensor controlling the details within the scene. As the pixel size is reduced more scene detail is preserved in digital representation. Satellite digital data processing as shown in Figure 3.3 involves pre-processing operation such as geometric correction, which is then used to study pattern of various objects using image processing techniques. The processed output data thus generated from digital image processing helps to bring out information on coastal habitats and ecosystem present in the selected sites pertaining to this study and may be used for similar application studies.

Digital enhancement techniques include edge enhancements, band ratio, and classification techniques (unsupervised and supervised). Among these, enhancement techniques are used to delineate contrast between varying features on the earth, and classification methods are used to bring out variations on the surface of the earth due to rock types, structure, landform, soil condition, agriculture and other landuse.

Apart from enhancing DN values using enhancement techniques, the satellite may also be used to classify pixels to represent various wetland categories of the ecosystem of the selected coastal area. This may be carried out by applying procedures that primarily either does not involve any training samples or involve training samples to classify wetland units in the coastal ecosystem. The former is called as “unsupervised classification”, where prior knowledge of the spectral values of terrain features is absent of the latter which is termed as “supervised classification” that involves prior knowledge of spectral characteristics of terrain features.

In the unsupervised method, as the name implies, pixels in the digital image is segregated to group pixels of similar DN values in all the selected bands with some basic parameter such as statistical parameter (mean, median and standard deviation) or distance among “like or similar pixels” such as minimum distance, euclidian distance and cubical distance. In these methods, pixels are unified or grouped based on the spectral intensity or DN values.
The *supervised classification* method functions on the basis of previous knowledge of terrain features or spectral characters of terrain features. The *priori* knowledge of the features is used to train samples or generate sample sets locally so that it can be applied to whole image to classify pixels into groups or classes akin to the training samples. Training samples representing certain specific terrain features are based on the knowledge of the user and the whole classification is supervised by the user to gain maximum accuracy of information.

In the present study both unsupervised and supervised procedures are implemented to understand the spectral behavior of coastal landform units and flora including algae present in study area.

### 3.3.2 Visual interpretation

The visual interpretation, contrary to digital image processing, involves appreciation of image elements of the FCC (False Color Composite), a hard copy format of the acquired satellite image. It is based on the intrinsic knowledge of the interpreter to collectively recognize image elements and correlate them to delineate terrain features. A vast knowledge on the application domain is also a pre-requisite to carry out visual interpretation.

Visual interpretation allow the user to physically interpret image elements such as color, tone, texture, size, shape, and association elements to delineate various features in the terrain. Of the above image elements, “association” plays a crucial part since some specific features are associated to specific environment (Lillesand and Kiefer, 1994). For example, *beach*, *dune* and *lagoon* are closely associated to coastal area; linear pattern in urban environment may imply either road or canal and a similar pattern in a hard rock terrain may indicate structural deformation.

### 3.4 REMOTE SENSING DATA AND ITS APPLICATIONS

Remote sensing satellites with their voluminous and steady stream of data provide an opportunity to study a terrain for different thematic applications under the same
illumination condition. Its repetitive coverage encourages to utilize them for monitoring dynamic phenomena such as landuse, mining, flood zone, agriculture, forest mapping, environmental monitoring and above all in coastal zone studies.

The multi-temporal nature of remote sensing satellite data, repetitive coverage of an area at a regular orbital interval, allows the user to select data acquired during appropriate period or season over different periods so that any changes in the landuse pattern or condition of some specific landform units, both qualitatively and quantitatively, may be analysed and monitored. To cite few examples, dynamic phenomena such as coastline oscillation, flood zone mapping, disaster zones and mitigation measures, environmental impact assessment, agriculture and urban landscape landuse may be possible using multi-temporal satellite data. Apart from that, because of its synoptic view and sun synchronous showing terrain under uniform illumination, remote sensing data of larger spatial resolution could be used to study the terrain details at local level. Hence, information of an environment may be extracted from regional level to local level.

Some of the major thrust area where Remote sensing satellite data plays a significant role include i) Geology and mineral exploration, ii) Hazard assessment, iii) Disaster mitigation, iv) Oceanography, v) Agriculture and Forestry, vi) Coastal wetland, vi) environmental monitoring, vii) Urban mapping and so on.

Sensors of the satellite are designed in such a way that each spectral band could highlight and discriminate objects of specific nature. Because, objects in nature are heterogeneous and discerning them from satellite image is a formidable task. That is, each thematic application has specific demands so that they could be optimally identified in specific spectral resolution or spatial resolution or temporal resolution. For example, panchromatic satellite image representing collection of energy from objects in a single broad range of visible wavelength may not be so sensitive to vegetation stress as that of relatively narrow spectral bandwidths or red and infra-red in a multi-spectral satellite data. Similarly, spatial resolution refers to the discernable details in a satellite image. Local level information requires relatively larger resolution whereas regional studies could be carried out using small resolution data.
Lastly, temporal resolution of the remote sensing satellite data refers to the time interval taken by the satellite for its successive visit at the same point on the earth surface. There are many applications that depends on the temporal resolution of satellite data such algal bloom in sea, oil spill, forest fire and sea ice monitoring. Apart from these, seasonal variations in landuse pattern, crop identification, extent and type of forest and coastline oscillation are few where temporal data plays a significant role as a monitoring tool and especially in environment monitoring.

Application of thematic information may be generated using suitable data satisfying all the three broad parameters stated above. For example, thematic map of landuse pattern and its change over a period of time requires multi-spectral data with reasonable spatial resolution and for different seasons over a period of time. For example use of multi-spectral satellite of reasonable resolution such as Landsat TM and IRS LISS III to understand and study coastline oscillation, coastal wetland and ecosystem mapping along the coast. Appreciating the significance of remote sensing application in resource assessment, monitoring, and planning, it is applied to study the coastal ecosystem of selected sites – Pulicat and Kalveli – representing lagoon and lacustrine ecosystem respectively. The remote sensing satellite data used for the study and methodology adopted for the present study is discussed in detail in the following sections.

3.5 STUDY OF COASTAL ECOSYSTEM USING REMOTE SENSING DATA

Coastal ecosystems of a region are very complex and change continually due to floods, river interaction and tidal influences. Mapping and monitoring them is very difficult since their access may be difficult and hence the use of remote sensing plays a paramount role in understanding the complex issues of ecosystems and their landforms. They are highly dynamic modifying and creating spatially complex features due to tidal influences and terrestrial inputs from rivers and creeks. Wetland features and turbidity of coastal waters of both coastal (lagoon) and lacustrine waters (coastal-riverine) could be well studied using remote sensing satellite data.
Significance of remote sensing in identifying coastal features and coastal waters including inference on physico-chemical quality, to some extent, is possible to provide information on coastline configuration, sea water – fresh water interface besides inference on biotic information. Advances in information extraction procedures are making remote sensing systems a powerful tool in research of coastal ecosystems such as wetlands, lagoons and estuaries (Klemas, 2011).

Multispectral images acquired on different dates (June 2002 and August 2006) are used in the present study to delineate and map different coastal wetland features and to study changes in their pattern over a period of time. Remote sensing data set used for such purpose and its spectral significance are discussed in the following section.

3.5.1 Remote sensing Data used for the Study

In the present study, Landsat Thematic Mapper (TM) data are used to study the coastal ecosystem comprising various wetland features habituating significant flora and fauna. Landsat TM has 30 m spatial resolution and has seven spectral bands. First four spectral bands operate in the visible range of electromagnetic spectrum with fifth band showing near-Infra Red (NIR), sixth Thermal Infra Red (TIR) and seventh Infra Red (MIR) region of electromagnetic spectrum. A description on various spectral bands and their significance to various application studies is given in Table 3.1

<table>
<thead>
<tr>
<th>Spectral Characteristics of Landsat TM Satellite</th>
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<tbody>
<tr>
<td><strong>Bands</strong></td>
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<tr>
<td>Band 1</td>
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<tr>
<td>Band 2</td>
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<tr>
<td>Band 3</td>
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<td>Band 4</td>
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<td>Band 5</td>
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<td>Band 6</td>
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<tr>
<td>Band 7</td>
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</tbody>
</table>

The present study considers Landsat TM satellite data acquired on Jan 2002 and July 2006 to study the lagoon ecosystem and lacustrine ecosystem depicted at selected study sites – Pulicat and Kalveli - along the northern coast of Tamil Nadu, India.

3.5.2 Remote sensing Analysis of Lagoon Ecosystem

Lagoon ecosystem along the Pulicat coast and its environs encouraged development of many wetland features such as *tidal flat, mudflat, marsh, spit, sand bars* and *beach*. They are highly productive and act as habitats for a variety of plants, fish, shellfish, and other relate marine organisms.

The lagoon ecosystem of Pulicat acts an important economic factor of the local communities in the form of fishing and salt harvesting and also acts as a protective barrier during storms and floods. In the present study, analysis of various wetland features of lagoon ecosystem near Pulicat is carried out using remote sensing satellite data of two periods viz., 2002 and 2006. The data is considered for their contribution in understanding the physical details of various wetland features of the study area and also contribute to observe pre- and post-tsunami scenario along the lagoon coast of Pulicat, Tamilnadu.
The lagoon supports a rich growth of algae, particularly filamentous algae including species of *Cyanophyceae*, *Chlorophyceae*, *Rhodophyceae*, and *Bacillariophyceae*. Some of the prominent algal species are *Caulerpa* sp., *Ulva* sp., *Entromorpha* sp., *Acetabularia* sp., *Gracilaria* sp. apart from *Spirulina major*, *Oscillatoria* sp., *Anabaena* sp., *Sargassum* tenerrimum etc. (Anon, 1978; Krishnamurthy and Joshi, 1970). Besides, large area along the lagoon is observed with *Prosopis juliflora*, *Saueda* grass and some halophytes.

The lagoon supports many marine organisms with commonly seen fish species such as *Mugil cunnesius*, *M. jerdoni*, and *M. cephalus* besides, *Tetradon nigropunctatus*, *T. leopardus*, *Barbus dorsalis*, *Sardinella fimbriata*, and *Chanos chanos*. It also supports a wide variety of resident and migratory waterfowls, pelicans, herons and

![Flow chart showing procedure for the study of Lagoon ecosystem](image.png)
egrets, storks, flamingos, ducks, shorebirds and gulls. A comprehensive analysis of Pulicat lagoon ecosystem is carried out as shown in the flow chart (Figure 3.4).

The selected satellite data of two sites are studied for spectral significance using various image processing techniques. Enhancement techniques such as spectral, radiometric and spatial enhancements, principal component analysis, normalized distribution of vegetative indices (NDVI), color inversion and clustering techniques are applied on the data set to understand the spectral significance in extracting information on coastal lagoon ecosystem.

A detailed discussion the resultant images are carried out bringing out relative significance of these techniques highlighting various wetland features of the Pulicat lagoon ecosystem. The information thus derived form basis for further investigation employing visual interpretation techniques. Image interpretation elements are compared with wetland features of the ecosystem and an interpretation key is prepared. Based on that, maps of Pulicat lagoon ecosystem showing various wetland features are delineated with limited field verification. Changes in the pattern of such features are appreciated and discussed for comparative assessment between two dates (2002 and 2006) of multi-temporal data. A similar approach is applied for lacustrine ecosystem near Kalveli of Tamil Nadu coast, south India, which is discussed in the following section.

3.5.3 Remote sensing Analysis of Lacustrine Ecosystem

Lacustrine ecosystem near Kalveli is developed owing to the intense interaction between coastal and riverine water leading to development of coastal habitat with their typical wetland features such as mudflat, marsh, marsh vegetation, lagoon, saline area, coastal dune and salt pan. The lacustrine ecosystem of Kalveli acts as an excellent source of livelihood to the local people with their fishing source and salt pan activities. The landform setting also helps to regulate interaction between sea water and river evolving excellent ecosystem supporting varied flora and fauna. It also acts as a barrier to natural calamities such as storms and floods.
Kalveli, similar to Pulicat area, supports algae and form a nourishing ground for many flora and fauna. Algae such as *Enteromorpha intestinalis* (Krishnamurthy and Joshi, 1970) along with *Typha angustifolia*, sedges, tall grass, also in the marshy area presence of *Suaeda* grass and some halophytes. Invasion of weeds such as *Ipomea carnea* is also seen in some parts.

Presence of micro-organisms and aquatic living things in the Kalveli ecosystem encourages rich presence of many waterfowls, ducks, storks, herons, egrets, pelicans, ibis, dabbling ducks (*Anna sp.*) and other shore birds apart from many other migratory avian fauna. Because of this reason, the Kalveli area has caught the attention of many ecologists to develop it as bird sanctuary. Moreover, proximity to sea and natural inlet of sea water during high tide, encourage *saltpans* activities in the study area.

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**Figure 3.5 Flow chart showing procedure for the study of Lacustrine ecosystem**

Remote sensing Satellite Data

Temporal Data (Date 1) --- Temporal Data (Date 2)

Image processing Analysis

Visual Interpretation

Field verification

Final Maps / output images

Lacustrine Ecosystem of Kalveli
The above flow chart depicts the general procedure adopted for the study of lacustrine ecosystem (riverine and coastal) near Kaliveli Lake. The ecosystem is also significant since the landform constitutes a lagoon / estuary together forming one of the last high-quality lagoon and estuarine systems on the east coast of south India. The ecosystem supports wide variety of migratory waterfowl such as hundreds to thousands of pelicans, herons, egrets, storks and ibises. This may indicate the ecological significance of the study area. Similarly, principal vegetation (flora) in this region includes wide variety of sedges and grasses interspersed with barren sandy areas and muddy margins. During the monsoon period and floods dynamic interaction between both fresh water and tidal water is witnessed encouraging germination of numerous aquatic plants. Area inundated with brackish water is observed with many species of algae and among them Enteromorpha intestinalis is common. There are extensive reed and sedge beds in the less saline areas. The abundance of halophytic plants is greatest in the northeast, near the estuary. Marshy vegetation including Suaeda spp is also seen in the study area.

3.5.4 Integrated GIS Analysis of Coastal Ecosystems of the study sites

The visual interpretation of the satellite data leading to the generation of coastal wetland features of selected two periods are analysed to study the changes in their spatial pattern in Geographic Information System (GIS) environment. The maps thus generated from the multi-temporal satellite data are transformed and geo-referenced in the GIS environment. Using the intersection operator, two maps are merged and changes among the features are derived as explained in the flow chart as shown in Figure 3.6. The resultant interpreted maps thus obtained from the remote sensing satellite data showing various features of selected coastal ecosystems – Pulicat lagoon and Kalveli lake – are analysed for their changes in the spatial pattern revealing conditions of wetland features and in turn the respective ecosystem between the selected two periods (2002 and 2006). The changes in their spatial pattern are also discussed for the seasonal influence and emphasize laid upon any significant changes in the existing wetland landform features of both the lagoon ecosystem around Pulicat and the lacustrine ecosystem around Kalveli.
3.6 SUMMARY

In the present chapter description on remote sensing data, its character and significance are lucidly explained so as to appreciate the significance of its utility in studying coastal ecosystem selected for the study – Lagoon ecosystem and Lacustrine ecosystem. The interaction among energy and the derived spectral values from the objects illustrated the importance of image processing of the selected satellite data so as to understand the spectral significance of various coastal wetland features of the ecosystem. Later, the knowledge thus derived from the image analysis helped to visually interpret these features to prepare thematic maps – lagoon ecosystem of
Pulicat and lacustrine ecosystem of Kalveli – with limited field checks. Comparison of multi-temporal data is carried out in GIS environment so that changes in the spatial pattern of various features in the study area are brought out. The method adopted for information extraction of features of both the ecosystem using image processing and visual interpretation are explained through flow chart including the spatial integration of these features to study their spatial changes between the two periods. A discussion on the lagoon ecosystem using both image analysis and visual interpretation are discussed in the following chapter.