CHAPTER 2

REVIEW OF LITERATURE

2.1 GENERAL

In the rapid urbanization process, the optimized and planned use of land is very much lacking. In developing countries like India, this unplanned growth has widely affected the development of urban cities. The importance of land utilization in an organized way is realized throughout the world and recorded in many forum and occasions. Importance of land utilization is expressed by Raymane (2001) as land is one of the most important resources which play a key role in determining the economic, social and cultural progress of human beings. Land use is the surface utilization of all developed and vacant lands on a specific space, at a given time. Lands are used for cultivation, development of forests, pasture, mining, transportation, gardening and recreation, industrial, commercial and residential purposes. In the study, the need of land use map at periodic intervals is highlighted. Land use or land cover is one of the main boundary conditions which directly or indirectly influence many hydrological systems. Rapid industrialization and close access to city is the factor that alters land use scenarios periodically. Such intrinsic growth requires periodic preparation of land use / land cover maps in order to detect change in land use systems and to further avoid over exploitation of natural resources from different land units, in the controlling of landscape beyond sustainable development limits.
Change detection analysis by coupling Remote Sensing data with Geographic Information System (GIS) is a well proved methodology. Satellite Remote Sensing and GIS Technologies are the potential tools in exploring changes in land cover (Mariappan and Surendaran 2006). In a study conducted by Sinha and Dudhani (2004), it was felt that the knowledge of both land use and land cover is important for the socio-economic planning of a region. They have clearly distinguished that, while land use relates to residential, institutional, commercial and recreational activities, land cover relates to various types of features present on the surface of the earth. For proper planning exercise, information on both the above aspects should be available separately. The Remote Sensing digital data available from satellite imageries are found to be useful for change detection analysis (Sinha and Dudhani, 2004).

2.2 STATE OF THE ART

The growing pressure of population coupled with increasing variety of demands made on land resources have brought extra pressure on the available land resources all over the country. Hence, in order to use land optimally, it is not only necessary to have the information on existing land use / land cover, but also the capability to monitor the dynamics of land use resulting from changing demands of increasing population, particularly in urban areas.

In a study conducted by Rajeshwari (2006), the study of changes in the urban land use pattern in conjunction with modern technologies such as Remote Sensing and GIS was emphasized. The planning and management of urban environment require huge amount of information regarding almost all aspects of natural and man-made features of that area. Until lately, such a study could be achieved through days of exhaustive surveys, map generation and tedious calculations. Remote Sensing provides huge temporal database
for an area and GIS serves as a powerful tool for spatial and non-spatial analysis of remotely sensed data. Urban environment basically consists of built-up area, i.e. buildings, roads, industries, business areas, parks, etc. and natural features such as vegetation cover, soil and water inside urban activity zones. From the study it was found that modern technologies can be used in the study of urban sprawl and its growth trend, updating and monitoring using repetitive coverage of urban environment, especially land use and land cover.

Chou et al (2005) made a clear observation on the essentiality of urban land use planning. According to them, changes in land use can involve pressing and complex issues that urban areas need to resolve. Construction of a land use or land cover mechanism is an essential way of dealing with those problems, based on the difficulties that occur in the investigation of land use.

2.2.1 Geographic Information Technologies (GITs) – Remote Sensing, GIS, GPS

Geographic Information Technologies (GITs) are a few among the rapidly developing technologies in the present day. Advances in these technologies have created efficient possibilities of collecting and managing large amounts of data from earth resource processes in various forms and scales. Remote Sensing and Global Positioning System (GPS) technologies are offering a great deal of potential to capture data through a variety of earth observation platforms. GIS is used to integrate / relate them through their common spatial denominator. It also offers appropriate methodology for spatial data management, information extraction, routine manipulation, visualization and operations.

Early GIS was based mainly on conventional cartography. By combining new upcoming data capturing technologies such as Satellite Remote Sensing and GPS with modern day GIS, a new technological field
with a wide variety of applications has been explored. In the past, this technology was applied only in government offices, advanced academic institutions and by a few enterprises. However, as information has become more and more readily available, this form of technology has been applied to all trades and professions, as well as the daily lives of average citizens.

Geographic Information (GI) Technologies in society are subsets of the larger concern of technology in society. There are numerous popular texts on the implications of Information Technology in society. Goodchild (1998) equated Geographic Information Technologies to three technologies, viz., Global Positioning Systems, Remote Sensing and Geographic Information System. These tools need to be placed in their proper context to yield appropriate results to solve complex management problems. Hence, it has now become indispensable to apply these technologies in one way or the other to solve managerial problems. In particular, these technologies are effective tools to build proper land use plan of any urban area.

Remotely sensed imagery from aircrafts and satellites represents one of the fastest-growing sources for raster GIS data. While Remote Sensing technology has been around for decades, recent technological advances and legislative changes have led to a dramatic increase in the types of imagery available. Availability of high resolution satellite imageries allow the study of temporal changes on the land surface that occur even on one or two days.

Remote Sensing and Geographic Information System have the capacity to provide valuable and timely information about natural resources, urban change and the extent of environmental change as an important basis for sustainable planning, land management and decision making. While both the devices can serve as effective tools for decision makers, they are important geometric tools, which are used extensively in land management. With the type of problems currently faced by land administrators in the State
of Lagos coupled with the rapid pace of urbanization leading to environmental decline Osei et al (2006), a GIS and Remote Sensing approach is a highly favoured approach to the effective management of land use and land resources in the state.

Remote Sensing data is now available with high resolution such as 50 cm panchromatic (Digital globe 2007).

Early Bird 1 was launched for Earth Watch Inc. in 1997. It included a panchromatic camera with a resolution of 93 m and a multispectral camera with a resolution of 15 m. Early Bird 1 was the first commercial satellite to be launched from the Svobodny Cosmodrome. QuickBird, launched on October 18, 2001, was built in partnership with Ball Aerospace and Orbital Sciences, and launched by Boeing Delta II. It is in a sun-synchronous orbit at an altitude of 450 km, the inclination being –98°. Ball Aerospace built WorldView-1. It was launched at 18:35 GMT on September 18, 2007 from Vandenberg Air Force Base on a Delta II 7920-10C. Launch services were provided by United Launch Alliance. The National Geospatial-Intelligence Agency is expected to be a major customer of WorldView-1 imagery. Ball Aerospace is currently building WorldView-2. It is scheduled for launch in mid-2009. Digital Globe has partnered with Boeing for launch of the World View satellites on Delta II.

Highest resolution available from a commercial satellite is given below.

- 500 mm (1.6 ft) panchromatic – WorldView-1
- 610 mm (2 ft) panchromatic – Quick Bird
- 2440 mm (8 ft) multispectral – Quick Bird

Largest image swath collection size is

- 17.6 km (10.9 mi) width at nadir – WorldView-1
- 16.5 km (10.3 mi) width at nadir – Quick Bird
The use of Global Positioning System (GPS) technology for accurately and efficiently storing locations of map features along with attributes has become a widely accepted method for collecting data for GIS. The New Jersey Department of Environmental Protection (NJDEP) standard for the collection of spatial data using GPS technology demands acceptable spatial accuracy. This level of accuracy is routinely achieved if the correct GPS receiver hardware, field data collection method and post data management procedures are employed (http://www.gpsinformation.net/waasgps.htm).

In some surveys, it is of interest to record geospatial data such as coordinates for housing unit locations, road networks, agricultural field boundaries and water body boundaries, as part of the survey data collection process. These data objects are represented as shape data, that is, point, line and polygon. Geographic Information System software can be used to record shape data, but the differences between a GIS software environment and that of a standard computer-assisted survey instrument are substantial (http://www.fcsm.gov 05 papers / nusser - 1xA).

Distance and location are important determinants of many choices that economists study. While these variables can sometimes be obtained from secondary data, economists often rely on information that is self-reported by respondents in surveys. These self-reports are used especially for the distance from households or community centres to various features such as roads, markets, schools, clinics and other public services. There is growing evidence that self-reported distance is measured with error and that these errors are correlated with outcomes of interest. In contrast to self-reports, the Global Positioning System can determine almost exact location (typically within 15 metres). The removal of selective availability (S/A) from May 2000 and
falling costs of GPS receivers have made the collection of GPS information increasingly feasible in household surveys; yet many household surveys still do not use this technology Gibson et al (2007). The integration of GPS-GIS technologies together can be achieved by a variety of ways and their applications are numerous (Kiruthivasan 2006).

GPS data collection systems complemented with GIS packages provides a means for comprehensive analysis of environmental concerns. Environmental patterns and trends can be efficiently recognized with GPS / GIS data collection systems and thematic maps can be easily created. GPS data can be quickly analyzed without the preliminary requirement for field data transcription into a digitized form. Accurate tracking of environmental disasters such as fires and oil spills can be conducted more efficiently. GPS receivers mounted on buoys track the movement and spread of oil spills. Helicopters use GPS to map the perimeter of forest fires and allow efficient use of fire fighting resources. Precise positional data from GPS can assist scientists in crystal and seismic monitoring. Monitoring and preservation of endangered species can be facilitated through GPS tracking and mapping (http://gps.gov/applications/environment/index.html).

Most of the cost involved in establishing and maintaining a GIS lies in the acquisition of data, both spatial and attribute. GPS has emerged as an effective tool in the ongoing process of improving data capture efficiency and accuracy. Positions are collected by the receiver along with attribute information, the extent of which is dependent upon the sophistication of the receiver, the data logging device and the needs of the user. Positions are collected using a variety of receivers and methods such as walking, driving and flying. (Ashby, 2003)
Positions collected by the GPS receiver are converted to cartographic features like,

- Points: Collecting positions while a receiver remains stationary.
- Lines: Joining of positions in a time sequence; each position acts as a vertex while the receiver is in motion during data collection.
- Polygons: Joining of positions in a time sequence with the last position being connected to the first position logged and thereby closing off a line segment.

Along with these spatial features, some GPS data collectors give the user the ability to record tabular data that can be entered and linked to features by using data dictionaries that are customized to fit the specific requirements of a survey. After post-processing, these features can be exported to a number of GIS formats and used for analysis with other spatial data (Brilis 2003).

GPS and other new information technologies are making it relatively easy to generate large sets of site-specific data. Decision makers wanting to derive information from these data sets require a Geographic Information System to assist them in assembling and integrating (or filtering) them, especially as they accumulate and grow larger. A GIS enables the user to relate otherwise disparate data (measure of fact) into a meaningful information base, based on their spatial references and provides the basis for what can be called a Spatial Decision Support System (SDSS). The effectiveness of such a system can be measured in terms of the degree in which it enables its users to turn raw data into management information for better decision making. (http://www.sstdevgroup.com).
GIS is an information system designed to capture, model, analyze and display data referenced by geographic coordinates. GIS provides the ability to overlay data fields and represent them visually (in the form of a map) to the user. Understanding and interpreting information that is displayed in a map format may be easier for several reasons. GIS provides the ability to break apart complex information into several pieces and to present data in a spatial layout, which offers a great deal of information at a glance. Also, as users become more skilled in using GIS, a considerable amount of time can be saved during points of critical decision making. Currently, GIS is extensively used in the fields of environment, energy and geographical surveys, but the social policy planning communities are quickly discovering the benefits of GIS as well. Once the GIS package integrates the spatial and non-spatial attributes, the planner has a powerful tool, which can be used for analyzed information circulation or transformation. The user can access the attributes at its fingertips (National Resource Centre and Child Welfare Data and Technology, 2003).

GIS can be used as an effective tool for civic administration. However, till date most of the organisations are manually creating and utilising a variety of maps in their daily activities. With the ever exploding population, the basic infrastructures in urban and rural areas could crack down in the absence of an adequate planning due to these analogue maps. GIS tools can effectively be used as front ends, if designed appropriately for the use of novice officers in the administration. Property management is a sensitive area for a large section of Government administration and appropriate controls at multifaceted locals have to be generated.

The spatial data and non-spatial data together with the developed application tool with GIS interface can help the District Administration in various useful respects. The quality and accountability of services can be
improved by graphically presenting resource allocation patterns. With Geographic Information Systems, accurate details on services by geographic location are available in a matter of minutes. GIS is a relatively new technology that provides better information and better tools for policy planning and management.

GIS enables many different types of analysis that can aid administration, management and planning. GIS can be used to create map-based inventory of services or other information of interest. Also, administrators may be able to see differences in community characteristics or differences in local procedures for providing effective services.

A GIS map can be used to monitor trends and to forecast service demand changes resulting from policy changes. This knowledge may also help with efforts to allocate funds by providing visually appealing evidence of need for resources.

The Ministry of Environment and Forests has included Ernakulam district of Kerala State among other places in the country for the implementation of the Geographical Information System based emergency planning and response system. The National Informatics Centre (NIC), Govt. of India has come up with a software package for supporting emergency planning and response efforts at the district level. This package has been developed using the GIS platform. The GIS software has many useful features that are critical for emergency planners and managers, who can refer to all the information by the click of a button rather than having to look up a number of voluminous documents. Outcome of all possible emergency scenarios is preprogrammed and stored in the database (The Hindu 2006). It is realized that GIS is a powerful tool to battle the obstacles of change and welcome the potential of the future Raymond et al (2006).
Perez, analysed the land use change and its determinants in one community ("Comayagua") of Honduras using remote sensing and GIS technology. He examined the land use changes occurring from 1987 to 2001, describe dchronological sequences and identified systematic patterns of change in land use.

The amount of data generated by the government in this digital era is phenomenal. Attempts to process the data and rendering it as readily usable information by application of a powerful integrated approach such as GIS are not widespread. Contemporary decision making is complex and involves a wide spectrum of knowledge sourced from diverse fields. The impacts of a decision thus made over an even more complex social fabric necessitate the use of sophisticated Decision Support Systems (DSS). The unique capability of a Geographic Information System is that not only can it act as a database, but also as a powerful tool, wherein complicated operations can be performed with greater ease and better quality information gleaned. When incorporated in this environment, Decision Support Systems can become flexible and fortified. Ushering in such systems in the administrative scenario has become nearly mandatory, to meet the challenges of management in the digital era.

In the present system of administration, the administrator or decision maker really depends on hierarchy for relevant information, which results in delay and gives room for errors. In the conventional data retrieval system practices, because of near impossibility of data verification, likelihood of errors in the decisions made is high. Therefore, quicker and reliable data access and efficient processing tools are in demand. While attribute data computerization is an ongoing process, a GIS database that invokes both map and tabular data should follow logically to maximize benefits. In fact, the work can be cited to have reached its logical and evolutionary perfection once the entire output is made available in the World Wide Web (www).
Since its inception, Geographic Information System technology has been an integral component of environmental management and decision making. GIS links geographic location (spatial) information with attribute data, such as laboratory results and field measurements, allowing complex analysis for planning and compliance purposes. While GIS technology has been used in the remediation of industrial sites for over a decade, only recently have solutions become available to make vast amounts of site information available to decision makers in real time without high levels of GIS competence and training. These GIS based Decision Support Systems (DSS) can reduce the cost of environmental remediation and result in higher quality decisions.

Menecke and Crossland (1996) have categorized the core GIS functions into four ways, viz., spatial visualization, database management, decision modelling and design and planning. A brief discussion on each of them is given below:

- Spatial imaging (visualization) refers to the fundamental GIS capability of representing data and information within a spatially defined coordinate system (e.g. a road map).

- The database management function represents the capability of GIS to store, manipulate and provide access to both spatial and non-spatial data.

- The decision modelling function represents the GIS capability to provide analytical tools that can be used to support decision making, and

- The design and planning function represents those GIS tools that can be used to plan and design any system.
Quiambao (2001) studied a network model that can stimulate many real systems like roads, distribution networks etc. Networking has become a very useful tool in GIS analysis. Now-a-days, networks from the infrastructure of the modern world community occur through definable network systems, transportation, distribution of goods, communication, delivery of resources etc. In network analysis, optimal results can be found for the distribution of resources. Queries like near by service providers, travelling time, shortest path etc., can be answered by network models.

2.3 LAND USE / LAND COVER

2.3.1 International Status

Forster (1980) developed an approach to quantify urban impervious surfaces as a continuous variable by using multi-sensor and multi-source datasets. Subpixel percent impervious surfaces at 30-meter resolution were mapped using a regression tree model.

GIS has been applied for mapping and delineation of Digital street network files (arterial roads), such as Statistics Canada’s Area Master File (AMF) (Milazzo et al 1984).

Akpan (1987) highlighted the traditional land use pattern of the Ibidio people of Southeastern Nigeria. It consisted of fenced compounds interspersed with intensively cultivated farmland. Beyond this mosaic of houses and farms lay the wider expanse of inter village fallow. This zone formed the economic base of rural settlements.

Even though the land use and land cover classification using high resolution Remotely Sensed Imagery has been shown to be quite successful over the last years, it has become clear that using an approach to assess large areas on a regular basis ends up yielding prohibitive computational and
financial costs. As an alternative, several authors have proposed the exploitation of the rich temporal information contained in sequence of freely available coarse resolution satellite data (Holben and Shimabukuro 1993, Bouzidi et al 2000 and Meirelles et al 2003). Nowadays data from NASA’s (US National Aeronautics and Space Administration) MODIS (Moderate Resolution Imaging Spectroradiometer) sensor is also available, featuring better spatial resolution (up to 250 m) and superior standards of calibration. Many researchers have started to apply this kind of data for land cover assessments (Strahler et al 1999 and Wessels et al 2004).

Meyer et al (1994) proposed a framework that extends current understandings of relationship between land use change and livelihoods by treating social relations of power as the entry point into this complex relationship in the context of social change in South Africa and Ghana.

Ikuhuria (1995) studied the urban land use characteristics of the cities Benin, Warri, Ekpoma and Uromi in Nigeria. Semi-controlled aerial mosaics were used to identify, take a stock of inventory and map the urban land use characteristics of two major urban centres and two medium sized urban centres. The general patterns of land use characteristics were examined and the results showed that the major urban centres have distinct land use specializations while that of the medium urban centres are just emerging. The data generated were useful for urban planning and land use modelling.

Kam (1995) integrated GIS and Remote Sensing techniques for analyzing the urban land cover and land use patterns in Brunei-Muara district of Brunei Darussalam. He developed a relatively simple but accurate automated land cover and land use classification technique using a microcomputer based imagery analysis and Geographic Information System.
Kline and Alig (1999) conducted a study on the effect of land use planning on the conversion of forest and farm lands. The results of the study suggested that Oregon’s land use planning programme has concentrated on development within urban growth boundaries since its implementation, but its success at reducing the likelihood of development on resource lands located within forest use and exclusive farm use zones remains uncertain.

Arthur et al (2000) evaluated the land use dynamics of Chester County, Pennsylvania, U.S.A, using a satellite Remote Sensing data. The potential for using satellite data for regional planning was highlighted by them. Urban planners and environmental agencies can use the demonstrated techniques to monitor the changes in the micro-climate, bearing in mind its implications for human comfort and the creation of sustainable living conditions.

Fang and Xu (2000) conducted a study on land cover and vegetation change in the Yellow River Delta Nature Reserve. LANDSAT Thematic Mapper Data was used for the study. It was found that the study area has undergone significant landscape changes and environmental improvement after 1992.

Loveland et al (2000) analysed LU/LC changes between 1980 and 1999 in Samsun, Turkey, using satellite images in which a remote sensing technology, post classification technique was used based on a hybrid classification approach (unsupervised and supervised).

Reid et al (2000) studied land use and land cover dynamics in response to changes in climate, biological and socio-political forces in southwestern Ethiopia. They have evaluated the scale of the causes and consequences of land use / land cover change varied from the local to the sub-
national (regional). At the landscape scale, each cause affected the location and pattern of land use / land cover differently. The impact of land use and land cover on hydrological regime has been discussed in the studies conducted by Jennings and Jarnagin (2002), De Roo et al (2001), Lahmer et al (2001) and Acreman (2000).

Optical satellite observations provided changes in forest area and (to some degree) forest density. However, the ultimate objective was to estimate changes in carbon stocks resulting from deforestation and degradation with “compensations” referring to accurate and credible carbon credits. There were no internationally agreed upon methods for mapping forest biomass on regional scales. Remote sensing methods like LIDAR and lang-wave RADAR had some potential for direct biomass measurements but were not operational for national monitoring (Rosenqvist 2003).

Theobald and Hobbs (2000) developed a model that forecasts land use change in both urban and rural areas and a simulation environment that allows alternative land use planning actions, both regulatory and incentive-based. This allows the planners to have alternative approaches in managing sprawl, including rezoning, transfer of development rights and conservation of reserve areas.

Traci et al (2000) analysed LU/LC changes in Chester Country, Pennsylvanian using satellite images in which a remote sensing technology, post classification technique was used based on a hybrid classification approach (unsupervised and supervised).

Weber (2000) developed a software programme (Pheno-Clac) that allows the user to choose remotely sensed imagery for analysis of land cover change, providing the data on which growing degree days and / or precipitation accumulation has been matched.
A path finding algorithm that takes into account the overall level of services and service schedule on a route to determine the shortest path and transfer points for a transit network was proposed to handle the special characteristics of transit networks, e.g. time-dependent services, common bus lines on the same street, and non-symmetric routing with respect to an origin/destination pair (Zhang 2000).

Zhan et al (2000) considered Dijkstra’s algorithm to reduce the response time for online queries for the single source single target shortest paths problem in large sparse graphs.

Karanth (2001) defined both conversions from one land cover class to another and changes of the Normalized Difference Vegetation Index (NDVI) calculated from LANDSAT 5 and LANDSAT 7 data. It was reported that Sisaket, one of the poorest regions of Thailand having the lowest household income growth from 1975 to 1997, has undergone significant land conversion, most of which were conversions from forest land to agriculture and degradation of the southern forest areas. It was reported that the mean NDVI decreased from 0.25 in November 1990 to -0.10 in March 2000.

Lambin, et al (2001) conducted a study on the causes of land use and land cover change. They found that the population growth, poverty and infrastructure rarely provide an adequate understanding of land change. Opportunities and constraints for new land uses are influenced by markets and policies, increasingly influenced by global factors. Extreme biophysical events occasionally trigger further changes. Various human environment conditions react to and reshape the impacts of drivers differently, leading to specific pathways of land use change. It is precisely these combinations that need to be conceptualized and used as the basis of land change explanations and models.
Rajan and Shibasak (2001) conducted a study on a GIS based integrated land use / land cover change model to understand agricultural and urban land use changes. They have developed a national scale, integrated, dynamic time-series simulation model called the ‘Anthropogenically Engineered Transformations of Land Use and Land Cover’ (AGENT-LUC) model, which simulates two major land classifications namely, agricultural and urban. The land use transformations are due to the interaction of the biophysical drivers and human drivers. Model outputs are the changes in the cropping pattern of the agricultural land area, the expansion of the agricultural lands, rural – urban migrations and the spread of the urban areas. The model was applied to the Royal Kingdom of Thailand.

Stefanov et al (2001) developed an expert system for monitoring urban land cover change. The expert system was constructed to perform post-classification sorting of the initial land cover classification using additional spatial data sets such as texture, land use, water rights, city boundaries and native American reservation boundaries. Pixels were reclassified using logical decision rules into 12 classes. The overall accuracy of this technique was found to be 85 per cent. Individual class user’s accuracy ranged from 73 per cent to 99 per cent, with the exception of the commercial / industrial materials classes. The performance of this class was found to be poor with an accuracy of about 49 per cent due to the similarity of sub-pixel components with other classes.

Chen (2002) focused on acquiring remotely sensed data and applied GIS techniques for the spatial analysis of land cover dynamics. Land cover change derived from this multi-temporal satellite data was used for impact classification of land cover change in the west coastal zone of Korea. Results from this study provided useful information to local government in decision making and policy planning.
Daniel et al (2002) developed a model for the detection of land use and land cover changes in the test sites located in the Stony Brook Millstone River watershed in New Jersey. Nine land use and land cover classes were selected for analysis, namely dense urban, residential, turf and grass, agriculture, deciduous forest, coniferous forest, water, wetland and barren land. Twenty three possible classes were identified.

Huffaker and Pontius (2002) conducted a study on reconstruction of the historical land cover in the Ipswich watershed. The details of land use changes in the study area were presented in the paper.

Alig (2003) discussed on land owner behaviour which is a major determinant of land use and land cover changes. It is an important consideration for policy analysts concerned with global change.

Darwish et al (2003) emphasized the need for updating urban land cover information for urban planning and management. However, with the traditional surveying tools, especially in large metropolitan cities, maintaining it is a time-consuming and expensive task. This necessitates the need to classify remotely sensed data to extract urban land cover information.

Lambin et al (2003) carried out a study on dynamics of land use and land cover changes in tropical regions. They highlighted the complexity of land use / land cover change and proposed a framework for a more general understanding of the issue, with emphasis on tropical regions. The review summarizes recent estimates on changes in crop land, agricultural intensification, tropical deforestation, pasture expansion and urbanization. Climate driven land cover modifications interact with land use changes. Land use change is driven by synergetic factor combinations of resource scarcity leading to an increase in the pressure of production on resources, changing
opportunities created by markets, outside policy intervention, loss of adaptive
capacity and changes in social organization and attitudes. A restricted set of
dominant pathways of land use change was identified. Land use change can
be understood using the concepts of complex adaptive systems and
transitions. Land use change can be understood using the concepts of
complex adaptive systems and transitions.

Roberts et al (2003) summarized their findings on land cover, land
use and biophysical properties of vegetation from the Large Scale Biosphere
Atmosphere (LBA) experiment in Amazonia. LBA is an international
research programme developed to evaluate regional function and to determine
how land use and climate modify biological, chemical and physical processes
there. Remote Sensing has played a fundamental role in planning, land cover
mapping and in long term monitoring of changes in land scales from regional
mapping to local scales that cover only a portion of a LANDSAT scene.

Yang et al (2003) developed sub-pixel imperviousness change
detection (SICD) approach to detect urban land cover changes using
LANDSAT and high resolution Imagery. The sub-pixel per cent
imperviousness was mapped for two dates (9 March 1993 and 11 March
2001) over western Georgia using a regression tree algorithm. Brown and
Duh J.D (2004) conducted a study on spatial simulation for translating from
land use and land cover.

Meirelles (2004), developed a methodology based on multitemporal
analysis of surface area reflectance data for systematic land use/land cover
classification on a regional scale, with emphasis on a low cost and highly
automatized approach. The methodology was also seen to be quite successful
in identifying areas of deforestation, which is of particular interest for the
monitoring of land use and land deforestation, which is of particular interest
for the monitoring of land use and land use change in the region.
Peterson et al. (2004) made a study on ‘Identifying Historical and Recent Land Cover Changes in Kansas Using Post Classification Change Detection Techniques.’ The found that the land cover of Kansas changed drastically since European settlement. Over 48 per cent of the land was found to be cultivated and native vegetation types such as tall grass and short grass prairie were reduced dramatically in the area.

Zacharias et al. (2004) conducted an integrated survey to identify land use changes and related hydrological alterations that have taken place in the last 40 years in the semi-mountainous sub-catchment of Trichonis lake basin in western Greece.

Lu and Weng (2005) studied urban classification using full spectral information of LANDSAT ETM+ (Enhanced Thematic Mapper Plus) Imagery in Marion County, Indiana. Rwetabula and Smedt (2005) prepared a land use and land cover map for Simiya catchment (Tanzania) using Remote Sensing data. They used satellite imagery of LANDSAT 7 ETM+ of 3.4.2001 and 12.5.2001. The imageries were processed using the image processing software IDRISI 3.2. Six major land use classes were identified and mapped for the study area, viz. mixed short grasses with / or bare land, dense tall grassland, bush land, cultivated land, medium size grassland and surface water.

Xiaojun and Zhi (2005) reported that use of satellite imagery and GIS methods is very useful for assessing land use and land cover changes and related human role to influence these changes. Their study had two major sections. The first part was dedicated to the development of an improved method for coastal land use and land cover mapping, which was built upon hierarchical classification and spatial reclassification. The second part focused on the analysis of the spatio-temporal dynamics of estuarine land use and land cover changes by using post classification comparison and GIS overlay techniques.
Alpahn and Yilmaz (2006) reported that the Remote Sensing in land use / land cover change studies become widely recognized as an effective method of change analysis. Nathan et al (2006) reported that land use and land cover changes can result in direct ecosystem loss, as well as fragmentation causing reduction in wetlands. They investigated the wetland quality changes resulting from land use and land cover alterations at a watershed scale. Landscape matrices were generated to examine changes in wetlands characteristics between 1978 and 2000 in the Muskegon River Watershed, Michigan, and USA.

Bello Malami et al (2006) studied the integrated land use and land cover assessment in grazing reserves in northwest Nigeria. Cropland expansion in the largest grazing reserves in northwest Nigeria was documented with multi-sensor data for the period 1965- 2002. Natural vegetation lands in 1999 were mapped from a land cover classification of LANDSAT ETM+ data.

Hudson et al (2006) concluded from their study that land use / land cover classification is highly dependent on recent satellite imagery. But this does not preclude consideration of older historical and prehistoric influences. Thus by considering relationships between land use / land cover and geomorphology, the results of the study have implications to improving floodplain management, particularly for flood hazards.

Mustafa et al (2007) analysed LU/LC changes between 1980 and 1999 in Samsun, Turkey, using satellite images in which a remote sensing technology, post classification technique was used based on a hybrid classification approach (unsupervised and supervised).
Correlation between land use change and pollution helps researchers establish positive or negative trends that indicate whether pollution control strategies have been successful. With this information, policy makers, resource managers, and the public can make appropriate changes for the future, USGS (1999).

Meirelles et al (2004), developed a methodology based on multitemporal analysis of surface area reflectance data for systematic land use/land cover classification on a regional scale, with emphasis on a low cost and highly automatized approach. The methodology was also seen to be quite successful in identifying areas of deforestation, which is of particular interest for the monitoring of land use and land use change in the region.

2.3.2 National Status

According to Suresh (1973), land use intensity implies extracting maximum output from a particular parcel of land by growing crops more than once a year. The land use intensity, in its simplest form, depends on the intensity of cropping pattern.

Singh (2003) made a study on ‘Modelling Land Use / Land Cover Changes using Cellular Automata in a Geo-spatial Environment.’ He integrated non-spatial information with spatial information using GIS and Cellular Automata concept. It was found to be a useful tool for change detection analysis.

Sinha and Dudhani (2004) conducted a study on “Fuzzy Neural Network Modelling of Land Use / Cover Using IRS – 1D Satellite Imagery.” The satellite image of Tehri-Garwal region was analysed using the modelling
approach. The study demonstrated that the data from Indian Remote Sensing Satellite (IRS-1C) can be used to map and monitor land use and land cover details rapidly at different levels. This provides more consistent and accurate base line information than any of the conventional data sources. The availability of spatial information at village / cadastral level is a major step for planning at the micro level.

Ranasinghe et al (2008) selected the study area covering seven Divisional Secretariat Divisions in the Eastern province and identified land suitability for housing. The natural environment, visibility, closeness to water bodies, green wild territory, and proximity to sea coast were considered as parameters of common preferences.

Mani Murali et al (2007) studied the landuse / landcover pattern of Paradip Port, and its surroundings, East Coast of India, using IRS IC LISS III data. The land use/land cover patterns were visually interpreted and digitized using ERDAS IMAGINE software.

Babykalpana (2010) identified that the traditional method of change detection are not suitable for high resolution remote sensing mages. To overcome the limitations of traditional pixel-level change detection of high resolution remote sensing images, based on georeferencing and analysis method, the author presented a unsullied way of multi-scale amalgamation for the high resolution remote sensing images change detection.

Sen (1986) and Sharma(1986) studied about the land use pattern in the hills of Uttar Pradesh. It was found that existing land use pattern in the hills is the cause for the deterioration of the ecosystem. An appropriate change in the land use on ecological basis is urgently needed. It was
suggested that the land unsuitable for cultivation of food grain crops should not be used for regular cultivation but can be put under permanent vegetation like orchards and other perennial crops. Natural vegetation should be preserved on the land that has not yet been terraced for cultivation. Oak and other broad leaved forest species should be planted in the areas most susceptible to erosion. Scientific grass land management involving improved grass species with controlled and regulated grazing should be introduced.

Sethi and Pandey (1987) conducted a study on the Urban Land Use Changes in the Union Territory of Delhi. The study was aimed at finding the urban land use changes under different categories from 1958 to 1981. The changes in the case of the industrial, residential, commercial and transport corridors were found to be quite significant. Urban growth during the period from 1958 to 1981 has affected the land use change in different categories. Significant changes occurred as a result of increase in the number of residences, government offices including defence establishments, playgrounds and parks, public and semi-public facilities, and industrial and commercial establishments.

Sharma et al (1990) prepared a land use / land cover map of Rajasthan. The LANDSAT False Colour Composite (FCC) of rabi season for the years between 1973 and 1975 was used. A total of 25 LANDSAT scenes were interpreted on 1:1 million scales to prepare the map. On the basis of information obtained from the LANDSAT data, it is possible to prepare a land utilization map of a large area showing actual spatial distribution of different land use / land cover categories. It was concluded that Satellite data such as of LANDSAT, IRS, SPOT, etc. is perhaps the only source to prepare a land utilization map of an area as large as Rajasthan in a short period and at a very
low cost. Due to the advantage of repetitive coverage, a land utilization map of different seasons could also be prepared for better planning and utilization of land resources.

Sharma (1991) prepared a land use / land cover map of Madhya Pradesh using the False Colour Composite (FCC) of LANDSAT MSS data for the years 1971 and 1977 during the rabi season. A land utilization map of a large area showing actual surface distribution of different land use / land cover categories could be prepared with the help of remotely sensed data from space-borne vehicles, such as LANDSAT, IRS, SPOT, etc. A land utilization map of different seasons could also be prepared with the help of satellite data owing to the advantage of its repetitive coverage.

Chaursia et al (1996) conducted a study on Watershed Land Use Study in Siwaliks. The land use / land cover in the block to a large extent was controlled by parent material, physiographic and climate. Five major land use classes were identified, viz. crop land, forest land, hill forest, and wasteland and built up land by aerial photo interpretation.

Jaiswal et al (1999) emphasized the need to have information on the rate and kind of change in the use of land resources for proper planning, management and regularizing the use of resources. Traditionally, the methods of monitoring changes in the land use were field methods which are time consuming and expensive. Satellite Remote Sensing technology has emerged as an efficient and powerful tool in providing reliable information on various natural resources of a region.
Panda (2000) studied the land use / land cover pattern of the Rukshikulya basin. The present land use / land cover patterns were found as fallow, built-up land- 0.02 percent, agricultural land- 50.65 percent, forest- 43.20 percent, wastelands- 5.33 percent, and water bodies- 0.81 percent.

Chowdary et al (2001) used the LISS II (Linear Imagery Self Scanning Sensor) data of 1988 and 1996 for their study. Classified and Normalized Difference Vegetation Index (NDVI) outputs of pre-and post-monsoon periods were compared to derive information, on changes that occurred over a period of time in the watershed. The study revealed an increase in the area under cultivation, water bodies, plantation and tree cover as a result of watershed management.

According to Rayamane (2001), land use is the surface utilization of all developed and vacant lands on a specific space at a given time. Lands are used for forests, cultivation of crops, pasture, mining, roads and transportation, gardening and playgrounds, recreational activities, settlement (residential), industrial and commercial establishments, etc., whereas uncultivable wasteland, barren and fallow lands are unused lands. There were five land use classes identified in Belgaum District, viz. net sown area, forest, fallow land, cultivable waste, barren and uncultivable waste land, for the periods of 1979-80, 1989-90 and 1999-2000.

Prasad et al (2002) emphasized the importance of visual imagery interpretation of satellite based standard false colour composite (FCC) imagery for small areas. They developed a rule based expert system for application in visual imagery interpretation of IRS-1B based FCC Imagery, for land use and land cover mapping. The system was used to identify land cover on FCC imagery of an area of Vaishali District in Bihar.
According to Singh (2002), land use is a dynamic process and so is the trend in land covers. The pattern of land cover influences the global climate, biogeochemistry and biodiversities. The nature of land surfaces, its roughness, albedo and other properties modify the basic patterns of weather and climate. Different cover types have different ecosystem structures, community composition, biomass content and degree of nutrient fixations with important bearings on terrestrial ecosystems. In fact, land use and cover changes are implicated in almost all environmental issues.

Phule and Badade (2003) studied the changes in the agricultural land use for the period 1970-71 to 1994-95. Rapid increasing population was found to affect the agricultural land use pattern. The dynamics of land use and land cover may change due to many factors. Land use reflects a complex correlation between natural, historical and socio-economic factors. The agricultural land use pattern changes according to the changing need of the human being.

Sikdar et al (2004) conducted a study on Land Use / Land Cover Changes and Groundwater Potential Zoning in and around the Raniganj Coal Mining Area of Bardhaman District in West Bengal using GIS and Remote Sensing techniques. It was found that over a period of 26 years, conversion of land use has taken place in an area of about 99.6 sq.km which accounts for 34.9 percent of the total area.

Mohan (2005) reported that the cheap land is one of the important factors responsible for the dispersal of urban settlements and industries from Delhi to Faridabad district. Based on the dynamic urban land cover / land use analysis for different periods, a number of land management strategies were
formulated for the spatial growth of urban and the diffusion of economic activities in the Faridabad district.

Mariappan and Surendran (2006) conducted a study on Remote Sensing based land use / land cover change scenario of Vellore district in Tamil Nadu. LANDSAT TM data for the year 1991 was employed for Remote Sensing analysis using ERDAS IMAGINE software. Supervised classification was followed to produce 13 land use / land cover classes for the study area. In order to generate a consolidated overview, 8 classes were recognized.

Rajeshwari (2006) analysed the urban land use and land cover of Dehradun City using Remote Sensing and GIS technology. IKONOS data was studied by using visual interpretation techniques to identify and delineate different objects related to urban area and Digital Imagery Processing (DIP) techniques were used for the classification of satellite data. Ward wise land use / land cover map was prepared for the study area.

Suzanchi et al (2006) stated that most land use changes occur without a clear and logical planning with little attention to their environmental impacts. It was reported that in the last four decades, urban growth in Delhi has occurred rapidly without scientific planning that destroyed valuable agriculture lands in its surround. Different change detection approaches (such as post classification comparison and spectral change detection techniques) were used for analyzing the imagery of Delhi during the period 1973 to 2001.

According to Ranade (2007), use of Remote Sensing technology to generate reliable land cover maps is a valuable asset to find the impact of mining on environment. He studied land use / land cover status around a 10 km radius of open cast limestone mine area and the subsequent impacts on environment and society.
2.4 NETWORK ANALYSIS

The movement of people, the transportation and distribution of goods and services, the delivery of resources and energy, and the communication of information all occur through definable network systems. Networks form the infrastructure of the modern world. The form, capacity and efficiency of these networks have a substantial impact on our standard of living and affect our perception of the world around us.

A fundamental problem addressed by network analysis is finding in the shortest or least-cost manner to visit a location of services in a network.

The cost may be determined by any attribute of the network competence that is expressed in numeric terms. For example, distance or travel time may be used to compute the shortest path in a transportation network, or a combination of factors may be used to calculate a monetary cost value.

2.4.1 International Status

Capability to determine the route choices under two alternative criteria was suggested by Wardrop (1952) and Beckmann et al (1956):

(1) Drivers individually choose to follow their shortest time routes from their origins to destinations, leading to the situation that all used routes have equal travel time and no unused route has a lower travel time. Such a route pattern is called user optimal or user-equilibrium, since it corresponds to Nash equilibrium.
(2) Drivers are centrally directed to use routes that result in the total travel time being minimized. This route pattern is called system-optimal.

Considerable empirical studies on the performance of the shortest path algorithms have been reported in the literature (Dijkstra 1959, Dial et al 1979, Glover et al 1985, Gallo and Pallottino 1988, Hung and Divoky, 1988, Ahuja et al 1990, Mondou et al 1991, Cherkassky, et al 1993, Goldberg and Radzik, 1993.) There is no clear answer as to which algorithm, or a set of algorithms runs fastest on real road networks. In a recent study conducted by Zhan and Noon (1996), a set of three shortest path algorithms that run fastest on real road networks has been identified. These three algorithms are:

(1) The graph growth algorithm implemented with two queues,

(2) The Dijkstra algorithm implemented with approximate buckets and

(3) The Dijkstra algorithm implemented with double buckets.

The computation of shortest paths is an important task in many network and transportation related analyses. The development, computational testing and efficient implementation of the shortest-path algorithms have remained important research topics within related disciplines such as operations research, management science, geography, transportation and computer science (Dijkstra 1959, Dial et al 1979, Glover et al 1985, Ahuja et al 1990, and Goldberg and Radzik 1993).

In the past decades, many methods have been proposed to generalize road networks. Among them, Graph Theory is widely used in road network generalization (Mackaness and Beard 1993, Mackaness 1995, Thomson and
Richardson 1995, Jiang and Claramunt 2004, Jiang and Harrie 2004.) A lot of concepts and parameters, for instance, connectivity, minimum cost spanning tree, shortest path spanning tree, were borrowed from Graph Theory to facilitate structural analysis and road selection in road networks.

Another approach based on perceptual grouping was adopted by Thomson and Richardson (1999). They developed a method to group road segments into “strokes” based on good continuation principle and to generalize road network by ordering and selecting strokes. From a functional point of view, shortest path analysis is an essential precursor to many GIS operations.

Barnsley et al (1989) used a technique which involves classification of the images into broad land-cover types and grouping the classified pixels into discrete land-use categories on the basis of both the frequency and the spatial arrangement of the land-cover labels within a square kernel was applied to monitor urban land use.

Zhan et al (1996) has worked on this concept and explored the use of fast shortest path algorithms on extensive road networks.

Crowson et al (1997) developed a geographic information system that includes the street maps for the three-country service region, the route system, and the bus stop locations. Morisset and Ruas (1997) took use of agent system to simulate the amount of road use and proposed a method to select roads of high frequency usage by means of an agent-based simulation. Research has been conducted in generating (Brinkhoff, 2002 Pfsor and Theorodidis, 2003), indexing (Frentzos, 2003, Pfoser, 2002), modelling (Vazirgiannis and Wolfson, 2001) and querying (Shahabi et al 2001) network based moving objects.

A lot of approaches have been presented regarding shortest path. Akgun et al (2000) determined a dissimilar path set by measuring the spatial dissimilarity between any two paths in the past set. The dissimilar paths are calculated by choosing some paths from the paths set in a way that the minimum of distance between any two paths is maximized.

Peng and Huang (2000) presented a web-based transit information system design that uses Internet Geographic Information Systems (GIS) technologies to integrate Web serving, GIS processing, network analysis and database management.

According to Cara Lauder et al (2001), road layers often contain information that describes the road characteristics. Additional information on the curvature of the roads can be obtained from calculating the sinuosity of the road arcs in the network. A process for calculating sinuosity and estimating road travel speeds was described.

Kam et al (2002) describe how physical accessibility for a mountainous district in northern Vietnam is optimized. They also described how the outputs are used to analyze the spatial pattern of access of rural communities to basic facilities such as markets, schools, health centers, etc. Indicators include equity index (i.e. the distance or travel cost/time to the
nearest facility), covering index (i.e. how many facilities can be reached within a certain distance or travel time) and average travel cost (i.e. how far or how long it takes, on the average, to get to a number of facilities for the villages in Cho Don district of Bac Kan province.

Gerke et al (2003) presented a system for automated update of road databases using Digital Image Processing for the extraction of roads from aerial imagery and topological analysis in order to optimize the whole process in terms of reliability and efficiency. In their context, updating comprises of road data verification and change acquisition.

Borruso (2003) focused on the problem of definition and visualization of network geography and network spaces at different scales. Different approaches were used to obtain the two indices: a grid–based analysis and a spatial density estimator based on Kernel Density Estimation. The two methodologies were analysed and compared using point data for the urban road network junctions and street numbers as house location identifiers in the Trieste Municipality area in Italy. The density analysis is also used on road network junctions data for the city of Swindon (UK) in order to test the methodology on a different urban area.

Matisziw et al (2003) proposed a methodology through which transportation analysts and policy makers can use spatial optimization to support strategic planning, with the goal of extending existing service networks. This is vital for agencies interested in extending transit networks to accommodate urban growth and development. This is especially true in public transit applications, such as bus route planning, as the future of bus-based public transportation depends on the success of route expansion and
modification. The developed approach is applied to the transit system in Columbus, Ohio.

Steven (2003) used a genetic algorithm to optimize a bus transit system serving an irregularly shaped area with a grid street network. The total cost function is minimized subject to realistic demand distribution and street pattern.

Boyce and Xiong (2004) discuss the solutions to the route choice problem for assumptions of user-optimality and system-optimality for the road network of the Chicago region. Region wide results show that the decrease in total travel time during the morning peak period is about 5%. Zhan and Noon (1998) provided an objective evaluation of 15 shortest path algorithms using a variety of real road networks. Based on the evaluation, a set of recommended algorithms for computing shortest paths on real road networks was identified. This evaluation should be particularly useful to researchers and practitioners in operations research, management science, transportation, and Geographic Information Systems.

Steenberghen et al (2004) showed the usefulness of GIS and point pattern techniques for defining road-accident black zones within urban agglomerations. One-dimensional (line) and two-dimensional (area) clustering techniques for road accidents were compared. Advantages and drawbacks were discussed in relation to network and traffic characteristics. Linear spatial clustering techniques appear to be better suited when traffic flows can be clearly identified along certain routes. For dense road networks with diffuse traffic patterns, two-dimensional techniques make it possible to identify accident-prone areas in Belgium.
Liu and Zhu (2004) presented an integrated GIS approach to accessibility analysis, which provides a general framework for integrated use of GIS, travel impedance measurement tools and accessibility measures to support the accessibility analysis process, including formulating the concept of accessibility, selecting or developing accessibility measures, specifying the accessibility measures, deriving the accessibility values using the selected or developed accessibility measures and presenting and interpreting the accessibility values.

Van de Weghe et al (2004) developed an approach called “Qualitative Trajectory along a road Network” (QTCN). It started with the assumption that two objects were moving continuously towards each other or away from each other. Since the distance between two objects was measured along the shortest path, specific attention was given to changes in the shortest path, and more specifically, changes in the direction of the velocity vector of an object with reference to the shortest path between two objects. A conceptual neighbourhood diagram was presented, that forms the basis for a representation of a conceptual animation.

Zhang (2004) emphasized the special value of density differences and regular patterns in road network generalizations. Main patterns in road networks were identified and their properties, analyzed. Based on those properties, methods to model, identify and generalize network patterns were proposed. A case study on density differences indicated that the explicit description of network structures favours the maintenance of the overall characteristics of road networks.

Cao et al (2004) developed a two-step method for the extraction of road network from space-borne SAR (Synthetic Aperture Radar) Imagery. It
was found that classification of fused infrared and microwave SAR Imagery effectively reduces the noise in the edge detection process and also eliminates the possible confusion with other objects.

Dahlgren (2005) presented the first phase of the development of a new proximity analysis tool. The hypothesis of this research was that it is possible to develop an effective proximity analysis tool by letting a single functionality, namely proximity analysis of large source datasets, to influence the whole design of an application. The main focus of the research project was to improve the performance on an existing application used in production.

Johnson et al (2005) presented a procedure for assigning zone data to links in the context of a Geographic Information System environment. The full procedure consisted of splitting of links into shorter segments that either is fully located within one zone or act as a border between the same two zones for their entire length, identifying the link segments either adjacent to or inside each zone, and allocating the zone attributes to the links associated with each zone, according to attributes of the zones and the links, as well as other information describing the area.

Zhang et al (2005) defined road network generalization aims to simplify the representation of road networks by reducing details, while maintaining network connectivity and overall characteristics. They presented a method to select salient roads based on connection analysis. The number of connections is counted at each junction, which acts as a parameter indicating the association between salient roads.

Ma and Zhang (2005), proposed an index called economy-network diameter index (ENDI), which was employed to evaluate the development of
network and the contribution to regional economy of Gansu Province, China with the data of 2002 transportation network and the economic statistics in the Statistical Year book.

Lim and Kim (2005) proposed a link-based shortest path algorithm to generate dissimilar paths for the travel information in real road network where turn prohibitions exist. The main merit of the proposed model is to provide efficient alternative paths under consideration of overlaps among paths to alleviate the path similarity. Another merit is that it does not require extra nodes and links for expanding the network. Thus it is possible to save the time of network modification and of computer running.

Jenelius and Mattsson (2006) developed the methodology of vulnerability analysis for road networks and to illustrate how this methodology can be used for generating a basis for the decision-making process concerning alternative actions related to investments, operations and maintenance of the road network.

Khan et al (2006) who focused on road network analysis of Liverpool City, reported that a multi-criteria based analysis of urban road network routes and spatial layouts enabled local accessibility of the road network for the set criteria, global accessibility of the road network and the finding of optimum path between two points in a network. Multi-criteria analysis has been defined in different ways.

Roy (1996) defined multi-criteria analysis as a decision-aid and a mathematical tool that allows the comparison of different alternatives or scenarios according to many criteria, often contradictory, in order to guide towards a ‘good’ decision.
Dahlgren and Harrie (2007) presented an ongoing work of developing a proximity tool specially designed for handling large dataset and methods for improving the performance of the network search.

Nagar and Tawfik (2007) presented an approach for modelling and analysing urban road network routes based on multiple criteria, such as spatial quality, transportation cost and aesthetics, in order to evaluate the quality of road network usage. A prototype was developed to analyse routes and accessibility in road layouts from a number of design and user related perspectives.


Touya (2007) developed a generic process for road network selection based on data enrichment and structure detection. The first step is to detect significant structures and patterns of the road network like roundabouts or highway interchanges. The next step is the selection of roads in rural areas thanks to Graph Theory techniques. After that, urban roads are selected by means of a block aggregation complex algorithm. Finally, some previously detected structures are typified to maintain their properties in the selected network.

Zhan (2001), identified three algorithms such as the graph growth algorithm implemented with two queues, the Dijkstra algorithm implemented with approximate buckets, and the Dijkstra algorithm implemented with double buckets to compute the shortest paths over a network.
Wagner et al (2003), considered Dijkstra’s algorithm to reduce the response time for online queries for the single source single target shortest paths problem in large sparse graphs.

A path finding algorithm that takes into account the overall level of services and service schedule on a route to determine the shortest path and transfer points for a transit network is proposed to handle the special characteristics of transit networks, e.g., time-dependent services, common bus lines on the same street, and non-symmetric routing with respect to an origin/destination pair (Zhong-Ren Peng et al 2000).

Lilian et al (2006), used an alternative approach in path finding algorithm, which uses exact cell decomposition algorithm in which an optimal path computation model is built dynamically upon automatic extraction of topology from base map features.

2.4.2 National Status

Guruswamy (2000) used the GIS techniques for route optimization. Chennai city network was used for finding out the optimal route for emergency services and the time taken for emergency service.

Pathan (1994) evaluated the possibilities of optimization in which the optimum routes, travel time, travel distance and cost for defined paths and for the optimum paths were determined for a few transport services.

Santhakumar et al (2003) studied the effect of the Transportation System Management (TSM) on a road network. The Madurai Local Planning Area (LPA) was selected for study of TSM measures. GIS was used to the study the effect of TSM measures. Conversion of one-way streets, diversion
of traffic, odd-even vehicle restrictions, parking management, effect of ring roads, and overall improvement in the network were studied with the help of GIS.

According to Advani et al (2005), the application of GIS to a diverse range of problems in Transportation Engineering is now well established. It is a powerful tool for the analysis of both spatial and non-spatial data and for solving important problems of networking.

2.5 OBJECTIVES OF THE PRESENT STUDY

The objectives are

- To evaluate land use / land cover map of Coimbatore for the years 1995, 2000 and 2002, from remote sensing data.

- To detect the changes in urban land use / land cover during the above periods and explore the reasons for the changes in the land use using correlation analysis.

- To analyse the road network to identify shortest path, closest facility and service area for the study area.

- To identify the areas suitable for urban development within the corporation limits based on a GIS model