RESEARCH ARTICLE OPEN ACCESS

Land Use and Land Cover Change Detection and Urban Sprawl Analysis of Panamarathupatti Lake, Salem

T.Subramani[1], V. Vishnumanoj[2]
[1]Professor & Dean, Department of Civil Engineering, VMKV Engineering College, Vinayaka Missions University, Salem, India.
[2,] PG Students of Environmental Engineering, Department of Civil Engineering, VMKV Engineering College,Vinayaka Missions University, Salem,

ABSTRACT
Land use and land cover change has become a central component in current strategies for managing natural resources and monitoring environmental changes. Urban expansion has brought serious losses of agriculture land, vegetation land and water bodies. Urban sprawl is responsible for a variety of urban environmental issues like decreased air quality, increased runoff and subsequent flooding, increased local temperature, deterioration of water quality, etc. In this work we have taken Panamarathupatti lake salem city as case to study the urban expansion and land cover change that took place in a span of 36 years from 1973 to 2009. Remote sensing methodology is adopted to study the geographical land use changes occurred during the study period.
Landsat images of TM and ETM+ of Panamarathupatti lake salem city area are collected from the USGS Earth Explorer web site. After image pre-processing, un-supervised and supervised image classification has been performed to classify the images in to different land use categories. Five land use classes have been identified as Urban (Built-up), Water body, Agricultural land, Barren land and Vegetation. Classification accuracy is also estimated using the field knowledge obtained from field surveys. The obtained accuracy is between 73 to80 percent for all the classes. Change detection analysis shows that Built-up area has been increased by 372.28%, agricultural area has been decreased by 65.16% and barren area reduced by 60.98%. Information on urban growth, land use and land cover change study is very useful to local government and urban planners for the betterment of future plans of sustainable development of the city.\

Keywords: Urban sprawl, Land-use and land-cover change, geographic information system, Change detection analysis

I. INTRODUCTION

Land-use and land-cover change, as one of the main driving forces of global environmental change, is central to the sustainable development debate. Land use and land-cover changes have impacts on a wide range of environmental and landscape attributes including the quality of water, land and air resources, ecosystem processes and function, and the climate system itself through greenhouse gas fluxes and surface effects. The land use/land cover pattern of a region is an outcome of natural and socio-economic factors and their utilization by man in time and space. Land is becoming a scarce resource due to immense agricultural and demographic pressure The change in land cover occurs even in the absence of human activities through natural processes where as land use change is the manipulation of land cover by human being for multiple purposes- food, fuel wood, timber, fodder, leaf, litter, medicine, raw materials and recreation. So many socio-economic and environmental factors are involved for the change in land use and land cover. Land use and land cover change has been reviewed from different perspectives in order to identify the drivers of land use and land cover change, their process and consequences.

Urban growth, particularly the movement of residential and commercial land to rural areas at the periphery of metropolitan areas, has long been considered a sign of regional economic vitality. But, its benefits are increasingly balanced against ecosystem impacts, including degradation of air and water quality and loss of farmland and forests, and socioeconomic effects of economic disparities, social fragmentation and infrastructure costs. Geographical information systems (GIS) and remote sensing are well-established information Technologies, whose applications in land and natural resources management are widely recognized.

Current technologies such as geographical information systems (GIS) and remote sensing provide a cost effective and accurate alternative to understanding landscape dynamics. Digital change detection techniques based on multi-temporal and multi- spectral remotely sensed data have demonstrated a great potential as a means to understanding landscape dynamics to detect, identify, map, and monitor differences in land use and land cover patterns over time, irrespective of the causal factors.

Recent improvements in satellite image quality and availability have made it possible to perform image analysis at much larger scale than in the past. Satellite imagery has been well utilized in the natural science communities for measuring qualitative and quantitative terrestrial land-cover changes. Landsat data are most widely used for studying the Land use and Land cover changes. K. C. Seto, C. E. Woodcock, C. Song, X. Huang, J. Lu And R. K. Kaufmann, have monitored the land-use change in the Pearl River Delta using Landsat TM. J. Li and H.M. Zhao have studied the Urban Land Use and Land Cover Changes in Mississauga using Landsat TM images.[2] Tamilenthi1, J. Punithavathi1, R. Baskaran1 and K. Chandra Mohan have studied the dynamics of urban sprawl, changing direction and mapping using a case study of Salem city, Tamilnadu, India. H.S. Sudhira, T.V. Ramachandra and K.S. Jagadish , studied about Urban sprawl metrics, Land cover dynamics and modelling using GIS for Udupi Mangalore.[4] M. Turker and O.Asik studied Land Use Change Detection At The Rural- Urban Fringe Using Multi-Sensor Data In Ankara, Turkey. All the researchers identified that urban environments are most dynamic in nature. Information on urban growth, land use and land cover change study is very useful to local government and urban planners for the betterment of future plans of sustainable development of any area.

II. STUDY AREA

Panamarathupatti Lake is a Natural Lake situated near a Village called Panamarathupatti. Situated very near to the suburbs of Salem City.Its coordinates 11°35′05″N 78°10′37″E in salem city**.** As of 2001 India census,Panamarathupatti had a population of 8051. Males constitute 51% of the population and females 49%. Panamarathupatti has an average literacy rate of 60%, higher than the national average of 59.5%: male literacy is 68%, and female literacy is 52%. In Panamarathupatti, 13% of the population is under 6 years of age.. This lake is used to meet the water needs in some parts of southern suburbs of Salem City, and as well as for the agricultural lands around the lake. The total area covered by this lake is around 500acres. Tourists are attracted by the scenic features of the lake. This lake is even called as Vedanthangal of Salem District, as the lake attracts many birds during the season.PanamarathuPatti has frequent bus services from Salem Old bus Stand. A drive will also be a good idea. It takes around 20–30 minutes to reach this place from Salem City.

A deviation from Namakkal road-NH7 takes to Panamarathupatti.The main source of water is the spring. The configuration and change detection study of the lake is done using remote sensing and geographic information system (GIS). Global Positioning System (GPS) is used for water depth point positioning, depth was measured using sounding method and Google Earth high resolution satellite imagery is used as the basic data source for this research. The lake depth map and 3D Mesh diagram has been generated using field depth data, which serves as the additional data source. The surface change detection is performed using Google Earth newly provided historical imagery options. Panamarathupatti lake and its adjacent area landuse map is derived from Google Earth imagery. In addition, surface elevation profile in different directions of lake, bathymetric mapping with bottom topographic profile, lake surface area and lake water volume has also been calculated using remote sensing and GIS techniques.The city's population is expected to increase to 16.5 lakh by 2021.With ever increasing population and unprecedented growth of urban area the city's landscape is undergoing unwanted changes.

The increased runoff is inundating the low lying areas of the many parts of the city even from the normal spell of rainfall. This is mainly due the impervious nature imparted to the land surface because of the urbanization. Urban Heat Island is one of the upcoming urban climatological problems developing in the city. Build up of such excess heat in the urban area due to reduced vegetative cover and increased built-up surfaces with concrete, asphalt, etc. Because of these phenomena certain parts of the urban area of the city are becoming extremely hot during day time and particularly during summer seasons, causing lot of discomfort to the citizens as well as causing loss of lives of elder people. The city is facing severe land use problems like scarcity of disposal sites for garbage whose daily production is around 600 metric tons. Urban noise pollution is also increasing in the city due to high vehicular traffic which is experimentally evaluated. With the above mentioned problems related to the unplanned growth of the city the study on land use and land cover as well as the urban sprawl analysis will definitely throw some light in the direction of better management of the city. The geographical location study area of Panamarathupatti lake and salem city is shown in Fig 2.1

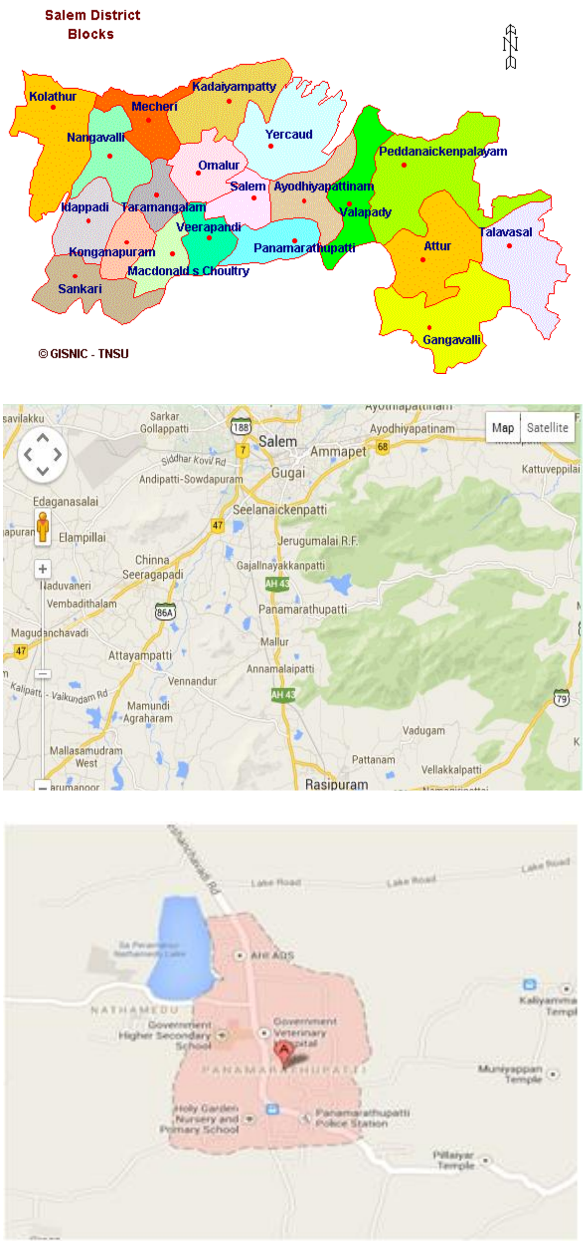


Fig.2.1. Location of the study area

III. METHODOLOGY

The present study involves the collection of Toposheets from Survey of India and city map from relevant authorities. The required satellite imagery for the study area is to be down loaded from the USGS Earth Explorer. Processing the imagery and image interpretation for development of Land use and Land cover maps is to be done in ERDAS Imagine software. The obtained maps are studied and analyzed to detect the change in urban expansion and urban sprawl. The methodology adopted in detail is shown in the Fig.3.1

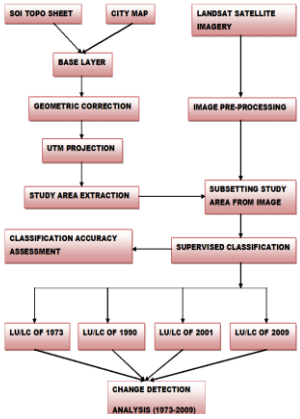


Fig.3.1 Methodology adopted in this work

3.1 DATA COLLECTION

Cloud Free Landsat satellite data of four dates available in the past four decades has been downloaded from USGS Earth Explorer website. All the data are preprocessed and projected to the Universal Transverse Mercator (UTM) projection system. The satellite data collected are shown in the Table.1.

Table3.1 Details of Landsat data collected from USGS

No	Date of Image	Satellite/ Sensor	Reference system/Path/ Row
1	26-02-1973	Landsat1 /MSS	WRS-1/153/49
2	10-11-1990	Landsat5 /TM	WRS-2/142/49

3.2Data acquisition

The data used for the study included subset of two Landsat images of 30 meter spatial resolution captured in 1988 and 2008. One image was obtained from the enhanced thematic mapper plus satellite (ETM+) and the other was from the thematic mapper (TM). The images were ordered and downloaded from the United States Geological Survey (USGS) website. Landsat images were chosen because they covered the period of the intended study and they have high spatial resolution suitable for the USGS Land cover classification system level 1 (Campbell, 2002; Jensen, 2000). The selection of the images was restricted to similar season to avoid seasonal differences in reflected radiation due to vegetation senescence. In addition, sample land cover information was collected with reference to the 2008 ETM+ image during field work in January 2012. Therefore the land cover map accuracy assessment was executed for only this image. The field work was also used to measure coordinates of known ground points for geo-referencing of the two images. The geo-referencing was executed with the ArgGIS software from Environmental Systems Research

Institute (ESRI). Also digital line maps were obtained from the Survey Division of the Lands Commission, Ghana. In order to draw inferences with relevant environmental variables, precipitation and temperature data was obtained from the Metrological Agency of Ghana.

3.3 Reference data

Reference data were developed for each of the four years and then randomly divided for classifier training and accuracy assessment. Due to the retrospective nature of our study, it was necessary to employ a variety of methods to develop reference data sets for training and accuracy assessment. Large scale (1: 9600) black and white aerial photos acquired in 1987 were used as reference data for the 1986 classification. Stratified random sampling was used for selecting samples. More specifically, the TCMA was divided into 19 columns and 18 rows resulting in 342 cells, and a 600600 m site was randomly sampled from each cell. The aerial photos corresponding with the sample sites were then interpreted and 1044 polygons of cover types were delineated. These polygons included approximately 1.66 % of the total TCMA pixels; 63% were used for training and the remainder for accuracy assessment

3.4 Agricultural

Stabilization and Conservation records of crops. A systematic, stratified sample of 72 sections was used as the reference data for training and accuracy assessment. Reference data for other cover types were not limited to these sections and were obtained from random sampling of a combination of aerial photography, a 1990 Metropolitan Council land use map, and National Wetland Inventory (NWI) data for the wetland classes. The classes of all training and accuracy assessment data were also checked against digital orthophoto quadrangles (DOQs). The polygon was deleted if the cover type identification was questionable. For example, some areas that were wetlands according to the NWI, looked like farm fields on the 1990 DOQs and these were not used as reference data for the wetland class. The reference data included 931 polygons with 1.91 % of the total pixels; 67% were used for training and 33% for accuracy assessment.

The reference data for 1991 were used to examine the field and spectral response patterns of the corresponding 1998 TM imagery to derive reference data for 1998 land cover classes. Each area used for training signatures and accuracy assessment for 1991 was checked against the 1998 TM imagery sets and 1997 DOQs to be certain that the general land cover class was the same. Areas that had changed between the years were discarded from the reference data if the 1998 cover type could not be identified with certainty. Approximately 1.73% of the total pixels, in 929 polygons, was available for training and accuracy assessment with 76% used for training and 24% for accuracy assessment.

The reference data for the 2002 classification were acquired from three sources. The primary data was a field verified set of reference sites collected in the fall of 2002. This data set was created by collecting cover type information for a stratified random sample of 300 points with 60 points per level 1 class (excluding extraction and water). The strata were from a previous classification of 2000 Landsat TM imagery (Yuan et al., 2005). At each sample point a field computer with ArcPad GIS and GPS was used to digitize a polygon of the area of the 2002 cover type identified, along with other cover types in the vicinity of the randomly generated point. This procedure resulted in 646 reference sites. The second source of data was a randomly selected forest cover type data set with 425 additional polygons, created and field verified during the summer of 2002 by Loeffelholz (2004). The third source was 30 small grain fields derived from interpretation of high-resolution color DOQs acquired in the summer of 2002. The 1101 potential reference sites were buffered by 30 m to avoid boundary pixels, leaving 672 polygons (0.75% of the total pixels) from which 354 sites were selected for training and 318 for testing. 3.3. Image classification Our classification scheme, with seven level 1 classes (Table 1), was based on the land cover and land use classification system developed by Anderson et al. (1976) for interpretation of remote sensor data at various scales and resolutions. A combination of the reflective spectral bands from both the spring and summer images (i.e., stacked vector) was used for classification of the 1986, 1991 and 1998 images.

Table 3.2 land cover classification scheme

Land cover class	Description
Agriculture	Crop fields, pasture, and bare fields
Grass	Golf courses, lawns, and sod fields
Extraction	Quarries, sand and gravel pits
Forest	Deciduous forest land, evergreen forest land, mixed forest land, orchards, groves, vineyards, and nurseries
Urban	Residential, commercial services, industrial, transportation, communications, industrial and commercial, mixed urban or build-up land, other urban or built-up land
Water	Permanent open water, lakes, reservoirs, streams, bays and estuaries
Wetland	Non-forested wetland

The 2002 classification used the brightness, greenness and wetness components from the tasseled cap transformation. A hybrid supervised–unsupervised training approach referred to as ‘‘guided clustering’’ in which the level 1 classes are clustered into subclasses for classifier training was used with maximum likelihood classification (Bauer et al., 1994). Except for the extraction class, training samples of each level 1 class were clustered into 5–20 subclasses. Class histograms were checked for normality and small classes were deleted. Following classification the subclasses were recorded to their respective level 1 classes. Post-classification refinements were applied to reduce classification errors caused by the similarities in spectral responses of certain classes such as bare fields and urban and some crop fields and wetlands. Parcels classified as agriculture within the boundaries of a residential and commercial mask generated from the Metropolitan Council land use maps were changed to grass using a rule-based spatial model in ERDAS Imagine.

The eight National Wetland Inventory (NWI) Circular 39 classes (Shaw & Fredine, 1956; O¨ zemi, 2000) that exist in the TCMA (bogs, deep marsh, seasonally flooded basin, shallow marsh, shallow open water, shrub swamp, wet meadow, and wooded swamp) were extracted and used as a wetland mask. Wetlands were separated from the crops by applying the following rule in the ERDAS Imagine spatial modeler: pixels in an agriculture class were reclassified to wetland if they fell within the NWI lowland mask. In addition, areas identified as extraction were delineated manually using 1987 aerial photos, 1990, 1997, and 2002 digital orthophoto quads (DOQs), and Metropolitan Council land use maps for 1984, 1990, 1997, and 2000. An additional rule-based procedure was used to differentiate urban from bare agriculture land in Anoka County in the 2002 classification. The 2002 summer Landsat image was earlier in the season than those for the other years and in Anoka County some relatively bare crop fields were misclassified as urban. Specifically, an agriculture mask of Anoka County was created using the 2000 Metropolitan Council land use map and 2003 color DOQ imagery and pixels classified as urban were reclassified as agriculture if they were located in the agriculture mask. Finally, a 3_3 majority filter was applied to each classification to recode isolated pixels classified differently than the majority class of the window.

3.5 Image Registration

Image registration is executed to assign real world coordinates to images. This is to correct for geometric errors associated with the satellite images due a variety of reasons. These include instrumental errors, attitude of the sensors with respect to the rotation of the Earth and swath width of the sensor etc. Also image registration is executed to assign coordinates systems and projections to images. Image registration ensures that the features and process found on the satellite image are allocated their correct dimensions and positions. This is very important for change detection since we only compare the same geographic location at different times.

The image registration in this study was executed with the ArcGIS software from ESRI. The images were registered to the 1984 World Geodetic System Universal Transverse Mercator (WGS '84 UTM) Zone 30 North Projection. Although the images were already geo-referenced to the UTM '84 zone 30 N, they were re-projected to ensure that they are allocated their correct ground coordinates. This is normally referred to as geometric correction.

3.6 IMAGE PREPROCESSING

All the downloaded images contain different types of bands and stacking is performed to get the composite image. Other image enhancement techniques like histogram equalization are also performed on each image for improving the quality of the image. With the help of Survey of India Toposheets of 1:50000 and city plan map obtained from Vijayawada Municipal Corporation, the study area has been delineated. The base layer so formed is used to subset the Landsat image. The subset image of Landsat 5 TM image of 1990 is shown in Fig. 3.2

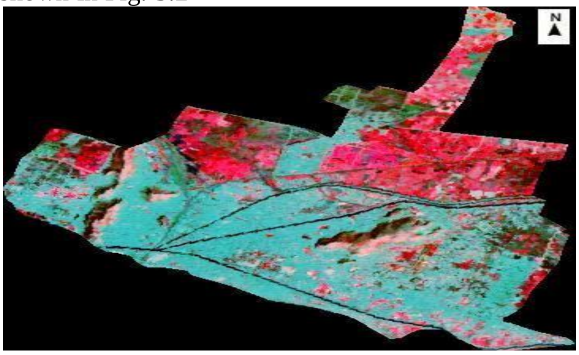


Fig.3.2 Landsat 5 TM image of 1990

IV. LAND COVER CLASSIFICATION

Image classification is performed to identify and assign real world thematic classes to the image pixels. In this study image classification was done in two stages, first by performing an unsupervised classification to assist in colleting additional training samples for the supervised classification. The maximum likelihood classification algorithm was selected because it has the ability to incorporate the statistics of the training samples before assigning the land covers to each pixel.

The training samples obtained during fieldwork in January 2014 were used together with those collected after unsupervised classification. The landsat image bands used for the classification were the visible, near-infrared, middle and far-infrared. After image classification the land cover maps generated were filtered with the majority filter to remove the "salt-and-pepper appearance" (Lillesand and Kiefer, 2000) and to enhance the cartographic presentation. The landcover classes generated were built-up, grassland/shrubs, forest/farm lands, rivers/lakes/lagoons and sea. See Table 1 for the display of the nomenclature used for the land covers.

Table 4.1: Land cover classes nomenclature

Code	LULC Classes	Description derived from USGS Level I
1	Built-up land	Urban residential, commercial, industrial, transportation and services
2	Grassland/shrubs	Grasses, shrubs,bushes
3	Forests/farm lands	Forests, palm, rubber plantations,coacoa farms
4	Water	Rivers, streams, lagoons, bays, estruaries, wetlands, lakes, dams
5	Sea	Sea water in the Atlantic Ocean

V. ABOUT LAND USE AND LAND COVER

Land use is the human use of land. Land use involves the management and modification of natural environment or wilderness into built nvironment such as fields, pastures, and settlements. It also has been defined as "the arrangements, activities and inputs people undertake in a certain land cover type to produce, change or maintain it and use practices vary considerably across the world. The United Nations' Food and Agriculture Organization Water Development Division explains that "Land use concerns the products and/or benefits obtained from use of the land as well as the land management actions (activities) carried out by humans to produce those products and benefits." As of the early 1990s, about 13% of the Earth was considered arable land, with 26% in pasture, 32% forests and woodland, and 1.5% urban areas.

Land cover is the physical material at the surface of the earth. Land covers include grass, asphalt, trees, bare ground, water, etc. There are two primary methods for capturing information on land cover: field survey and analysis of remotely sensed imagery. Land cover is distinct from land use despite the two terms often being used interchangeably. Land use is a description of how people utilize the land and socio-economic activity - urban and agricultural land uses are two of the most commonly known land use classes. At any one point or place, there may be multiple and alternate land uses, the specification of which may have a political dimension. The origins of the 'land cover / land use' couplet and the implications of their confusion are discussed in Fisher et al. (2005). One of the major land cover issues (as with all natural resource inventories) is that every survey defines similarly named categories in different ways. For instance, there are many definitions of 'Forest', sometimes within the same organization, that may or may not incorporate a number of different forest features (stand height, canopy cover, strip width, inclusion of grasses, rates of growth for timber production). Areas without trees may be classified as forest cover if the intention is to re-plant (UK and Ireland), while areas with many trees may not be labelled as forest if the trees are not growing fast enough.

There is no doubt that human activities have profoundly changed land cover in the Panamarathupatti lake Salem city area during the last half century. Land is one of the most important natural resources. All agricultural, animal and forestry productions depend on the productivity of the land. The entire eco-system of the land, which comprises of soil, water and plant, meets the community demand for food, energy and other needs of livelihood. Viewing the Earth from space is now crucial to the understanding of the influence of man's activities on his natural resource base over time. In situations of rapid and often undocumented and unrecorded land use change, observations of the earth from space provide objective information of human activities and utilization of the landscape.

5.1 CHANGE DETECTION ANALYSIS

Change detection analyses describes and quantify differences between images of the same scene at different times. The classified images of the four dates can be used to calculate the area of different land cover and observe the changes that are taking place in the span of data. This analysis is very much helpful to identify various changes occurring in different classes of land use like increase in urban built-up area or decrease in vegetation and so on.

VI. RESULTS AND DISCUSSIONS

6.1 LAND USE/LAND COVER IMAGES

The classified images obtained after preprocessing and supervised classification which are showing the land use and land cover of the Panamarathupatti lake salem city are given in the following figures. These images provide the information about the land use pattern of the study area. The red colour represents the urban built-up area, dark green colour shows the agricultural area, blue colour shows the water bodies tan colour shows the barren land and light green colour shows the vegetation like shrubs and grass land.

6.2 Urban Sprawl Analysis

To evaluate the level of dispersion of the urban development in the study area, the Shannon entropy index was calculated for the two dates studied. The study area is a coastal city hence the area of the sea was removed from the land cover maps before the sprawl analysis was done. The land cover maps of the two dates (1988 and 2008) were reclassified into built-up and non-built-up and crossed with 2 km buffer zones whose centre start from the city centre.

Figure 6.1 show the build-up and non-built-up lands in 1988 and 2008 respectively. The area of built-up in each zone was calculated and the Shannon entropy was determined for each zone as well as the entire study area. The Shannon entropy for the study area ranged from 0.59 to 0.62 in 1988 and 2008 respectively. This is an indication that sprawling in the study area has not increased substantially between the two dates despite a massive (more than 263%) increase in built-up areas

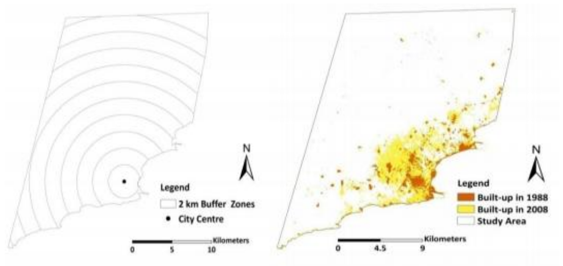


Figure 6.1a)Buffer zones in panamarathupatty and b) Built-up areas in 1988 and 2008

The fact that the city is less scattered therefore makes provision of services and infrastructure such as electricity, water, schools, hospitals and roads less complicated in terms of their spatial distribution. However, by inspecting the entropies for each zone it is revealed that the values for zones 6 km to 10 km from the city centre had the highest values for both the 1988 and 2008 land cover maps. This together with field evidence shows that some of the sections of the study area are more fragmented than others. For example new neighborhoods in the north eastern part of the study area, behind Kansaworado, Anaji Namibia and Ntankoful communities are scattered. There are many uncompleted buildings within a few completed residential ones. It is therefore imperative that urban planning methods that suit all these sections of the city be adopted for a sustainable utilization of the limited land resources in the study area. It is also important that plans are made to safeguard the agricultural lands in the outskirts of the city. The result of the study indicates that this can be done since the city has only few isolated settlements.

6.3 CLASSIFICATION ACCURACY ASSESSMENT

Each of the land use and land cover map was compared to the reference data to assess the accuracy of the classification. The reference data was prepared by considering random sample points, the field knowledge and Google earth. During the field visits a hand held GPS (Global Positioning System) is used to identify the exact position of the place under consideration with Latitude and Longitude and its type by visual observation. The ground truth data so obtained was used to verify the classification accuracy. Over all classification accuracy for 1973, 1990, 2001 and 2009 are 75%, 76%, 80% and 73.33% respectively. The Kappa coefficient for 1973, 1990, 2001 and 2009 images are 0.62, 0.68, 0.71 and 0.51 respectively. The results of the accuracy assessment are presented in Table6.1

Table 6.1 classification accuracy assessment

LAND COVER CLASS	ACCURACY FOR 1973		ACCURACY FOR 1990		ACCURACY FOR 2001		ACCURACY FOR 2009	
	PRODUCER'S	USER'S	PRODUCER'S	USER'S	PRODUC	USER'S	PRODUCER	USER'S
BUILT UP AREA	100%	50%	87.50%	70%	100%	66.67%	100	72.73%
AGRICULTUR AL FIELDS	100%	75%	100%	80%	100%	100%	---	---
VEGETATION	---	---	100%	75%	33.33%	100%	50%	50%
WATER	---	---	100%	100%	50%	100%	---	---
BARREN LAND	83.33%	83.33%	16.67%	100%	100%	100%	40%	100%
OVER ALL ACCURACY	75%		76%		80%		73.33%	
KAPPA STATISTIC	0.62		0.68		0.71		0.51	

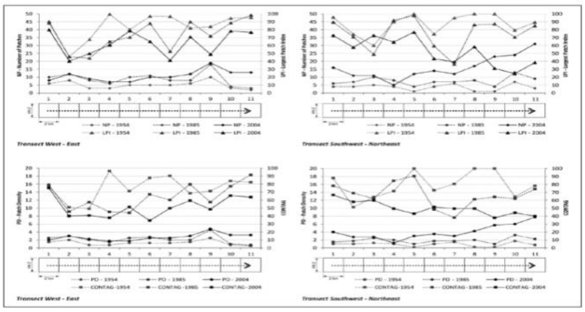


Figure 6.2 - Spatio-temporal changes in the blocks along the W-E and the SW-NE transect for NP, LPI, SHDI and PD metrics in the three different time periods investigated (1954, 198,2004)

6.4 CHANGE DETECTION ANALYSIS

RS data, opportunely processed and elaborated, can be really useful in change detection tasks to monitor the differences of LC at different times [Singh, 1989]. Thus, starting from the above described dataset of multi-temporal classified images, the process of digital change detection developed has allowed to determine and describe changes in LC between four fundamental intervals: 1954÷1975, 1975÷1985, 1985÷1993 and 1993÷2004.There are many methods of change detection available [Lu et al., 2004] and each has variations depending on the imagery type, final purpose for the change image and the type of change to be detected. In the case-study here described, the methodology followed has been the “Post-classification comparison” [Jensen et al., 1987; Dimyati et al., 1996; Ward et al., 2000]. Such approach allows to determine the difference between independently classified images from each of the dates in question and it is the only method in which “from” and “to” classes can be calculated for each changed pixel. This method offers the advantage to allow the creation and the update of GIS databases, as class/categories are given, and quantitative values of each class can be determined.

Jointly with “Post-classification comparison”, a GIS approach [Taylor et al., 2000] has been combined, to efficiently integrate LC maps and to quantitatively reveal the change dynamics in each category. The advantage of GIS techniques it’s not only linked to exploitation of database capabilities, but also to the ability to manage different LC maps by means of typical vectorial operators like “intersect” and “union”, in order to easily evaluate the amount of change [Petit and Lambin, 2001].Such approach, comparing the LC data, has allowed to make directly available the tables containing the spatial information of each class (area, perimeter, etc.) and the information about amount, location, and nature of change. Hence, comparing each classified map with the successive, it has been possible to determine the changes in LC at different years from 1954 to 2004.

In addition to ERDAS Imagine, ESRI ArcGIS Desktop (v. 9.3) has been used to analyse and integrate LC maps and extract the GIS layers describing changes and dynamics of land cover .
Subsequently, in order to perform the accuracy assessment on the change detection procedures, has been followed the approach proposed by Congalton and Macleod

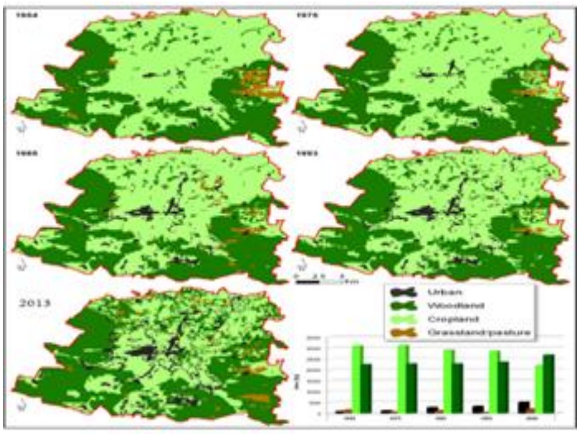


Figure 6.3 - LC maps for panamarathupatty the five time periods defined.

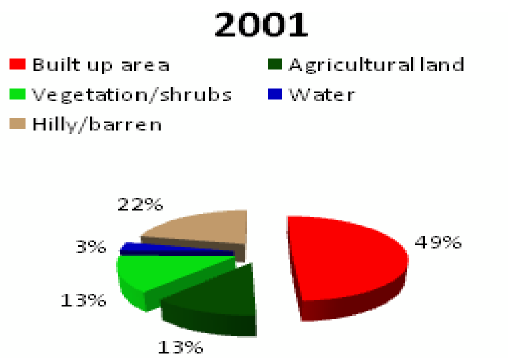
[1994], in which the error matrix normally used for the single-dateclassification is purposely modified. This new matrix has the same characteristics as the single-date classification error matrix, except that it also assesses errors in changes between two time periods and not simply a single classification. For example, considering the classes defined in this case-study, the single classification matrix is of dimension 4x4, whereas the change detection error matrix is 16x16 (the size of the number of categories squared): in fact this matrix concern a change between two different maps generated at different times in assessing change detection (between time 1and time 2) and not simply a single classification [Congalton and Green, 2009].

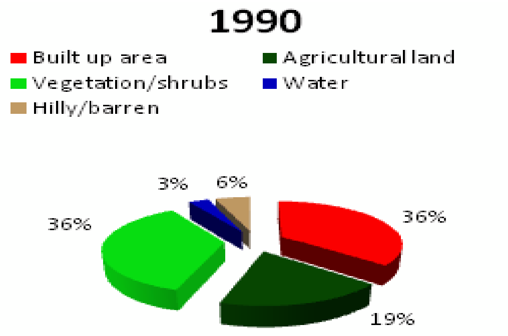
Moreover, the change detection error matrix has been simplified by collapsing into a *no-change/change* error matrix: the upper left box reports the areas that did not change in either the classification or reference data; the upper right box indicates the areas that the classification detected no change and the reference data considered changed. Those collapsed *no-change/change* error matrices have been produced for the reference periods 1975÷1985, 1985÷1993 and 1993÷2004 (LC maps extracted from Landsat data) and the relative values are reported in Table 7. 2.Finally, the previous described results of change detection task have been combined to produce the transition matrices with LC change by time for every reference periods. The quantification of change for the categories analysed is given in Table, where are reported the relative statistics, aggregated for each class. The values (in hectares) reported along the diagonal express the area of the unchanged LC types; the other cells contain the measurement of the areas that have bore a transformation from a LC type to another class. The column on the right sum up the LC areas at the beginning of all the intervals examined, while the last row sums up the LC areas at the end.

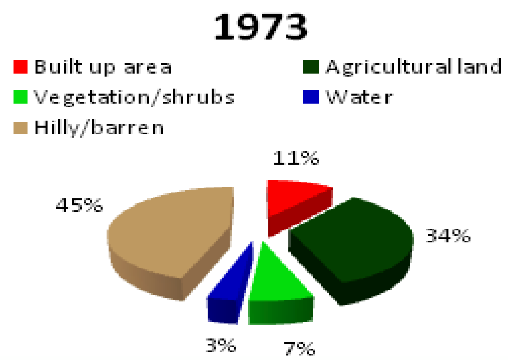
Table 6.2 - *No-change/change* error matrices for the change-detection technique

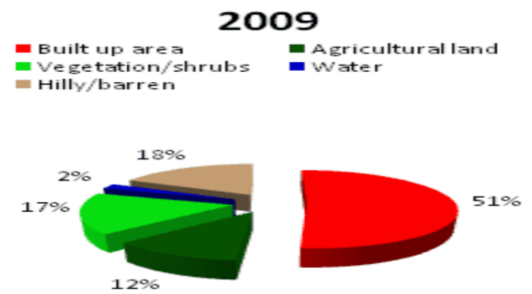
1975÷1985				1985÷1993				1993÷2004			
	NC	C	Total		NC	C	Total		NC	C	Total
NC	**181**	56	237	NC	**179**	54	233	NC	**188**	34	222
C	6	**12**	18	C	9	**14**	23	C	14	**20**	34
Total	187	68	**255**	Total	188	68	**256**	Total	202	54	**256**
Overall accuracy			*75.7%*	*Overall accuracy*			*74.5%*	*Overall accuracy*			*81.3%*

salem The urban change analysis presented in this paper was based on the statistics extracted from the four land use and land cover maps of the Panamarathupatti lakecity. The changes in land cover during the study period (four dates) can be observed clearly from the pie diagrams shown in Fig.9 to Fig.12.









The built-up area as well as agriculture area has been changed drastically from 1973 to 2009. Built-up area has been increased by 372.28%, agricultural area has been decreased by 65.16% and barren area reduced by 60.98%. The increase in built-up area has many reasons. Increase in merchant establishments and industrial areas are contributing o the loss of agriculture area. There is an increase in vegetation or shrubs by 135.61% over the study period. The reason for this increase in light vegetation is that large amounts of agricultural area are converted in to land for real estate sales. These lands appear as greenery because of the grass grown on them. It was observed that Eutrophication phenomena is taking place in all the lakes and small water bodies are disappeared because of the deposition of sediments and indiscriminate dumping of solid waste. The results of change detection analysis are presented in the Table 6.3.

Table 6.3 Land use statics of panamarathupatti lake salem city,1973-2009

Class	**Area in hectares**				**Change in percentage area**			
	1973	**1990**	**2001**	**2009**	**1973-1990**	**1990-2001**	**2001-2009**	**1973-2009**
Built up area	617.63	2057.19	2800.15	2916.99	+233.07%	+26.53%	+4.17 %	+372.28%
Agricultural fields	1951.35	1075.09	706.81	679.86	-44.90	-34.25	-3.81%	-65.16
Vegetation/shrubs	408.07	2066.77	762.09	961.47	+406.47%	-63.12	+26.16 %	+135.61%
Water	189.09	182.	187.2	126.2	-	+2.78	-	-
Barren land	2602.77	320.27	1223.17	1015.38	-87.69 %	+281.91%	-16.99 %	-60.98 %

6.5 Landscape Metrics Analysis

Today, cause of the widespread recognition that landscape is a dynamic entity, one of greatest challenge confronting landscape pattern analysis is quantifying temporal variations in landscape pattern metrics [Cushman and McGarigal, 2008]. Landscape metrics (also referred as landscape indices or as spatial metrics) are one of the key factors of modern landscape ecological research [Uuemaa et

Table.6.3 Land use statistics of Panamarathupatti lake salem city, 1973-2009

al., 2009] and in landscape planning. The landscape or spatial metrics, which have been used to quantify spatial patterning of LC patches and LC classes of the study area, can be defined as quantitative and aggregate measurements showing spatial heterogeneity at a specific scale and resolution [Herold et al., 2003].The basis of the spatial metric calculation is a thematic map representing a landscape comprised of spatial patches categorised in different patch classes. In particular, spatial metrics have the capability to describe composition and spatial arrangement of the LC types in a landscape. Therefore, they can be used to describe landscape patterns and structures. When applying spatial metrics, the spatial unit used is called patch, defined as a relatively homogeneous area that differs from its

surroundings [Forman, 1995]. A major value of landscape metrics lies in their usefulness for comparing alternative landscape configurations, for example in evaluating the same landscape at different time periods [Gustafson, 998]. The approach pursued combines RS and landscape metrics to understand spatial-temporal patterns of LC, like urban-rural gradient analysis [Luck and Wu, 2002; Ji et al, 2006]. Starting from the above described information about LC and its changes, three fundamental dates have been chosen to perform landscape metrics analysis: 1954, 1985 and 2004. Logically, 1954 and 2004 have been chosen because are placed at the start and at the end of the overall period of analysis, while the intermediate step has been fixed at 1985 because this date is more significant for the LC changes happened within the area (few years after the
1980 earthquake), rather than a mere choice of the mid-term year.

To detect the gradient of landscape patterns, a series of analyses have been conducted along two transects (W-E and SW-NE directions), outlined within the study area and centred on the main settlement of Avellino: each transect is formed by one row and subdivided into eleven 2 km x 2 km blocks. The spatio-temporal dynamics of the landscape mosaic of the study area have been detected by means of a set of landscape metrics, chosen and calculated for the two defined transects .

Table 6.4 - Total LC changes for the types defined: dynamics from 1954 to 1975 (A), from 1975 to 1985 (B), from 1985 to 1993 (C) and from 1993 to 2004 (D). Area values are expressed in [ha].

A - Dynamics 1954÷1975	Urban	Grassland pasture	Cropland	Woodland	**1954**
Urban	893,45	0,00	0,00	0,00	**893,45**
Grassland/pasture	28,77	561,88	837,25	159,61	**1587,51**
Cropland	342,21	42,06	29347,26	1238,67	**30970,19**
Woodland	29,11	23,09	1002,13	21399,38	**22453,71**
1975	**1293,53**	**627,03**	**31186,64**	**22797,67**	**55904,86**
B - Dynamics 1975÷1985	Urban	Grassland pasture	Cropland	Woodland	**1975**
Urban	1256,84	0,00	0,00	0,00	**1256,84**
Grassland/pasture	30,06	425,13	137,54	34,48	**627,22**
Cropland	1482,36	649,65	28516,42	573,14	**31221,57**
Woodland	45,05	162,97	435,72	22155,50	**22799,23**
1985	**2814,31**	**1237,76**	**29089,67**	**22763,12**	**55904,86**
C - Dynamics 1985÷1993	Urban	Grassland pasture	Cropland	Woodland	**1985**
Urban	2754,19	0,00	0,00	0,00	**2754,19**
Grassland/pasture	30,35	433,72	622,02	181,78	**1267,87**
Cropland	584,30	3,71	27327,98	1193,36	**29109,35**
Woodland	21,56	9,61	569,83	22172,45	**22773,45**
1993	**3390,42**	**447,04**	**28519,82**	**23547,58**	**55904,86**
D - Dynamics 1993÷2004	Urban	Grassland pasture	Cropland	Woodland	**1993**
Urban	893,45	0,00	0,00	0,00	**893,45**
Grassland/pasture	103,83	347,23	738,76	397,69	**1587,51**
Cropland	3933,91	994,97	19017,35	7023,96	**30970,19**
Woodland	173,26	663,59	2179,54	19437,33	**22453,71**
2004	**5104,44**	**2005,79**	**21935,66**	**26858,98**	**55904,86**

The software package FRAGSTATS raster version 3.3 [McGarigal et al., 2002] has been used to calculate the selected landscape metrics with the patch neighbour 8-cell rule option both at landscape and at class level. The results of metric analysis are dependent upon the input spatial resolution; in this study, the pixel size of 30 m has been chosen.

After Cushman et al. [2008], the following landscape metrics have been selected: Contagion (CONTAG); LPI (Largest Patch Index) index for large patch dominance component; Patch Density (PD), NP (Number of Patches) for subdivision and spatial configuration of the landscape.NP is a simple measure of the extent of subdivision or fragmentation of the patch type. In particular, NP illustrates the diffuse sprawling development and the fragmentation of rural areas. NP is simply the total number of patches and is a measure of landscape configuration and is closely related to spatial scale of analysis and to the extent of the landscape. Therefore, this metric is more meaningful for comparing the same landscape or landscape with similar size and characteristics. NP and PD reveal the landscape fragmentation process [Botequilha Leitão et al., 2006] and they serve as good fragmentation and heterogeneity indices when used to compare the same landscape in different time periods. On the other hand, PD facilitates comparisons among the sub-plots defined in terms of fragmentation caused by urbanization process.

The Largest Patch Index (LPI) indicates the percentage of class accounted for by largest patch and is a simple measure of the dominance of a LC type. Contagion (CONTAG) measures the degree to which patch types (class) are distributed in a clumpy manner instead to being dispersed in many smaller fragments. In other words, this metric is a measure of landscape configuration and texture and refers to the tendency of classes to be spatially aggregated. CONTAG provides an objective means for quantifying the spatial pattern differences between landscapes [Botequilha Leitão et al., 2006].

Therefore, this index is meaningful in order to compare spatial and temporal dynamics in the same landscape in different times. CONTAG approaches 0 when the patch types are maximally disaggregated, 100 when they are maximally aggregated [McGarigal and Marks, 1995; Botequilha Leitão et al., 2006].

VII. CONCLUSION

SALEM is the largest city in TAMILNADU and commercial capital for the state. It is experiencing a rapid urbanization. The urban sprawl is seen as one of the potential threats to sustainable development where urban planning with effective resource utilization and allocation of infrastructure initiatives are key concerns. This study attempted to identify such urban sprawls change for 1973-2009. Remote sensing has the capability of monitoring such changes, extracting the change in information from satellite data.

In this work we have taken Landsat images of Panamarathupatti lake salem city collected from USGS earth explorer web site. The images of 1973 MSS, 1990 TM, 2001 ETM+ and 2011 ETM+ which are, rectified and registered in Universal Transverse Mercator (UTM), are obtained. The land use land cover maps of the study area are developed by supervised classification of the images. Five land use classes have been identified as Urban (Built-up), Water body, Agricultural land, Barren land and Vegetation. Over all classification accuracy for 1973, 1990, 2001 and 2009 are 75%, 76%, 80% and 73.33% respectively. Change detection analysis shows that Built-up area has been increased by 372.28%, agricultural area has been decreased by 65.16% and barren area reduced by 60.98%. Information on land use / land cover and possibilities for their optimal use is essential for the selection, planning and implementation of land use schemes to meet the increasing demands for basic human needs and welfare. This information also assists in monitoring the dynamics of land use resulting out of changing demands of increasing population further proceeding maps has driven out for the changes took place in the study area and finalized with extra accuracy.

Land cover and its changes in the Salem have been successfully mapped using satellite remote sensing techniques. The techniques adopted generated acceptable accuracies. The land cover changes in the study area have changed drastically since 1988. The urban area has more than doubled, while the forest areas have decreased by more than 10%. Also the areas covered by grasslands have increased. This means the percentage of impervious surface areas have increased tremendously raising the vulnerability of sections of the community living near rivers.

Furthermore, urban sprawl analysis showed that Panamarathupatty has not witnessed substantial sprawling between 1988 and 2008. However, sections of the city especially between 6 km and 10 km from the centre have high sprawling. The results of this study further indicate the importance of remote sensing to urban environmental monitoring and management especially in Africa. The city authorities in Panamarathupatty can use the data generated to aid their future development plans that also protects agricultural lands in the outskirts. Also since land cover affects the climate, it is important that the land cover in the city is managed so as to protect the citizens from phenomenon such as urban heat island effects and floods.

REFERENCES

[1]. C. Seto, C. E. Woodcock, C. Song, X. Huang, J. Lu And R. K. Kaufmann,(2002), *Monitoring land-use change in the Pearl River Delta using Landsat TM, Int. J. Remote Sensing*, Vol. 23, No. 10, 1985–2004.

[2]. J.Li and H.M.Zhao, (2003), *Detecting Urban Land Use and LandCover Changes in Mississauga using Landsat TM images*, 2(1), 38-47.

[3]. S.Tamilenthi1, J. Punithavathi1, R. Baskaran1 and K. ChandraMohan(2011), *Dynamics of urban sprawl, changing direction and mapping: A case study of Salem city*, Tamilnadu, India, Achieves of Applied Science Research, 3(1): 277-286

[4]. Shdhira, T.V Ramachandra and K.S. Jagadeesh(2004), *Urban sprawl: metrics, dynamics and modelling using GIS*, International Journal of

[5]. Applied Earth Observation and Geoinformation,5,29-39

[6]. M. Turker and O.Asik,(2005), *Land Use Change Detection At The Rural- Urban Fringe Using Multi-Sensor Data In Ankara*, Turkey, International Journal of Geoinformatics, Vol.1, No.3.

[7]. Bassam Saleh and Samih Al Rawashdeh(2007),*Study of Urban Expansion in Jordanian Cities Using GIS and Remote Sensing*, International

[8]. Journal of Applied Science and Engineering,5,1:41-52

[9]. K.Sundara kumar,(2011), "*Assessment of Urban Noise Pollution in Panamarathupatti lake salem city, A.P, India*", International Journal of Earth Sciences and Engineering, 4(6): 459-463