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Landuse Change Detection through Image Processing and Remote Sensing Approach: A Case Study of Palladam Taluk, Tamil Nadu

M.Usha[1], K.Anitha[2] and Iyappan.L[3]
[1]Directorate of Technical Education, Chennai
[2]Department of Electronics and Communication Engg, P.T.lee.CN. College of Engg. and Tech., Kancheepuram
[3]Department of Civil Engineering, Tagore Engineering College, Rathinamangalam, Chennai

ABSTRACT

This study examines the use of image processing and remote sensing in landuse changes mapping for Palladam Taluk between 1972(Topographic sheets) and 2011(satellite images). The layers of landuse map (1972) were digitized by heads-up digitization method in Quantum GIS (QGIS) software environment. Similarly the layers of landuse map (2011) were developed by supervised classification of satellite imagery. The training site was created by referring ASTER (Advanced Space-borne Thermal Emission and Reflection Radiometer) satellite imagery with help of GPS (Global Positioning system) coordinates in QGIS environment. Supervised classification technique was adopted to classify the satellite image in SAGA GIS (System for Automated Geo-scientific Analyses) software environment. The classified image was converted into vector format and estimated the total area of each class by using geometry tools of QGIS software. The landuse changes between 1972 and 2011 compared and displayed in geographical or map format in 1:50000 scale.

***Keywords**:* Image Processing, Remote Sensing, Landuse changes, Open source GIS

1. INTRODUCTION

In this competitive world human migrates from rural area to urban area for various job opportunities and infrastructure facilities. Due to migration, there are huge changes in urban area or cities. It has increased the urban expansion problem all over the world. Growing cities are creating an alarming situation in all countries of the world. Due to the rapid process of urbanization, the haphazard growths of these major cities are one of the challenging situations in front of any country [1].

Due to landuse changes affects many parts of the earth's system (e.g., climate, hydrology), global biodiversity, and the fundamental sustainability of lands. Various estimates show that 50 percent of the ice-free land surface has been affected or modified in some way by human activities while a large fraction of the global net primary productivity has been captured by human land use activities [2].

Land use is very important knowledge as the country plans as the Nation plans to overcome the problems of haphazard, uncontrolled development, deteriorating environmental quality, loss of prime agricultural lands, destruction of important wetlands, and wildlife habitat [1].

Landuse data are useful in the spatial analysis of environmental processes and problems. Knowledge of the current distribution and area of such agricultural, water bodies, settlements, and reserve forest, as well as information on their changing proportions, is highly important for country planners, and state and local governmental officials to manage effectively.

During the past 30 years several surveys, studies, and other projects have successfully demonstrated that remote sensor data are useful for land use and land cover inventory and mapping. These surveys have contributed to our confidence that land use and land cover surveys of larger areas are possible by using remote sensor data bases. Using remote sensing techniques to develop land use classification mapping is an useful and detailed way to improve the selection of areas designed to agricultural, urban and industrial areas of a region [3].

In this study two different classification methods were used: Unsupervised and supervised classification. Unsupervised classification is the identification of natural groups, or structures, within multispectral data. Supervised classification is the process of using training samples, samples of known identity to classify pixels of unknown identity [4].

It has been long acknowledged that GIS data can be used as auxiliary information to improve remote sensing image classification. In previous studies, GIS data were often used in training area selection and post processing of classification result or acted as additional bands. Generally, it is accomplished in a statistical or interactive manner, so that it is difficult to use the auxiliary data automatically and intelligently. If the classifier does not request that the data have certain statistical characteristic, it is a simple and feasible way to use the auxiliary data as additional bands. But if the classifier requests certain statistical characteristics, the additional band method cannot be used because most auxiliary data do not meet the requirements of statistical characteristics [5].

2. STUDY AREA

Palladam taluk is a taluk of Tirupur district of the Indian state of Tamil Nadu (Figure 1). The latitude and longitude extension of the Palladam Taluk (Study area) is 10°50’23.28”N to 11°05’12.84”N and 77°08’34.76”E to 77°24’38.88”E respectively. It has an average elevation of 325 metres. The total land area of the study area is 474sq.km. The primary vegetation was cotton in the early 1970s and 1980s at the time of the textile boom. Later the town adopted the Maize crop with the boom in the Poultry industry thus aiding the industries with local supplies to compete with both quality and pricing. Agriculture has a great history in Palladam right from the introduction of modern farming in the early 1980s to the plantation of variety of medicinal and other trial based plantation till date. The people of Palladam taluk have always relied upon Agriculture like many other towns in India. The association with Agriculture has not largely diminished over the years due to the continuous involvement of community & the participation from the younger generation. The study area is included in Survey of India topographic sheet numbers 58E04, 58E08, 58 F/01 and 58F05 on 1:50,000 scale. According to the 2001 census, the Palladam taluk had a population of 393,171 with 200,709 males and 192,462 females. There were 959 women for every 1000 men. The taluk had a literacy rate of 72.56. The total number of households was 105,374.

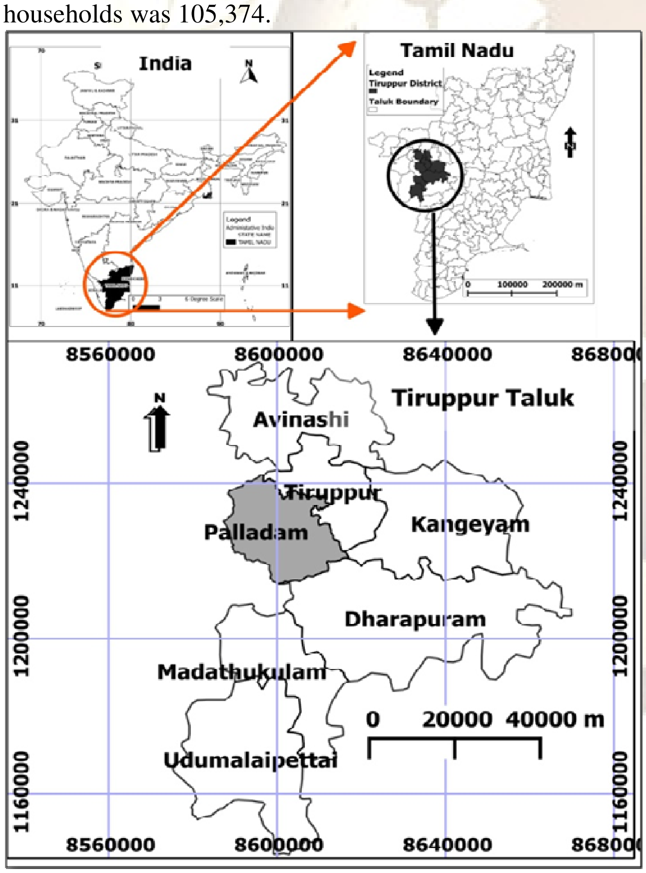

Figure 1: Study area map of Palladam Taluk

3. SOFTWARE USED

SAGA GIS has been designed for an easy and effective implementation of spatial algorithms; it offers a comprehensive, growing set of geo-scientific methods and also provides an easily approachable user interface with many visualization options. Quantum GIS (QGIS) is a powerful and user friendly Open Source Geographic Information System (GIS). Quantum GIS and SAGA GIS are Free Open Source Software (FOSS)[6]. SAGA's first objective is to give (geo-) scientists an effective but easy learnable platform for the implementation of geo-scientific methods [7].

METHODOLOGY

For this research, a true color image of ASTER was used to identify the study area. Remote sensing techniques using SAGA GIS software to process ASTER images for the area of interest will be used. Geographical Information Systems, or GIS for short, is a way of looking at data from our environment within a spatial context. GIS involves mapping data and interpreting the relationships among that data and making inferences [8].

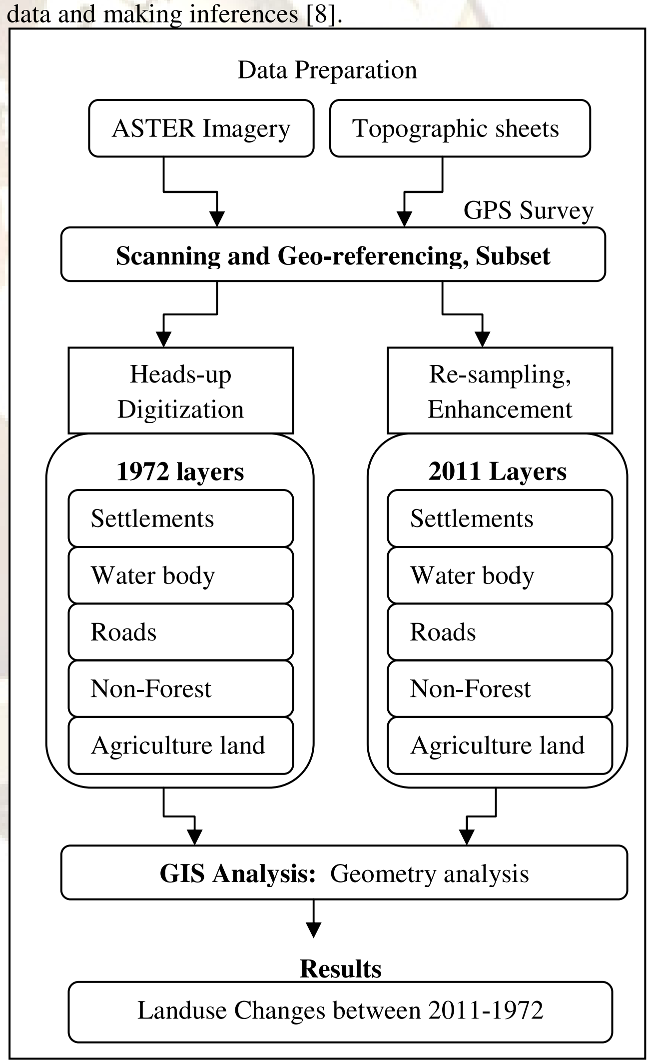

Figure 2: Methodology flow diagram for landuse changes detection

4.1 Data Preparation

The landuse change detection for the study was purely between Topographic sheets from 1988 and ASTER imagery from 2011. ASTER is the only high spatial resolution instrument on Terra that is important for change detection, calibration and validation, and land surface studies. ASTER data are expected to contribute to a wide array of global change-elated application areas, including vegetation and ecosystem dynamics, hazard monitoring, geology and soils, land surface climatology, hydrology, land cover change, and the generation of digital elevation models (DEMs). Topographic sheets were collected from survey of India, Chennai. ASTER Terra look image was collected from USGS Global Visualization Viewer. ASTER Terra Look permits users to create their own collections of geo-referenced JPEG satellite images. Terra Look images allow for visual interpretation and comparison without the need for complicated software. The geo-referenced Terra Look collections are compatible with most GIS and Web mapping applications.

4.2 Geo-referencing

Geo-referencing is the process of scaling, rotating and translating the scanned image or satellite imagery to match a particular size and position. It is the process of referencing a map image to a geographic location. A raster image is made up of pixels and has no particular size. This is in turn determined by the image resolution (DPI). This image sizing will usually bear no relationship with the dimensions of the drawing that the raster represents.

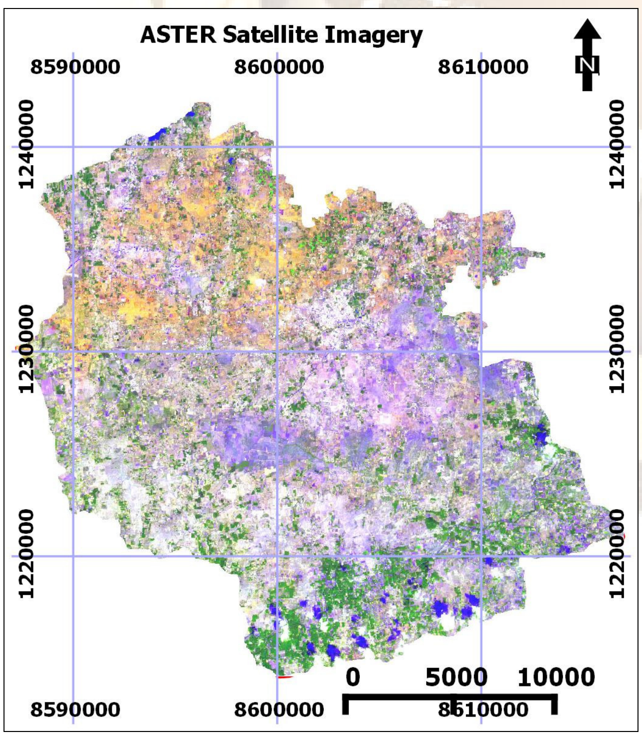

Figure 3: ASTER satellite imagery of the study area

Ground control points identifiable on the image and on the ground or a map are used to apply a known map projection to the image. Pixel values are interpolated onto a new grid registered to the known map projection through re-sampling. Scanned topographic sheets and ASTER image was geo-registered to a common coordinate reference system i.e., WGS84, Universal Transverse Mercator, Zone 43 north [9]. Geo-referenced satellite imagery is shown in figure 3.

4.3 Image subset and enhancement

Image enhancement is the improvement of digital image quality. The main aim of image enhancement is to improve the interpretability or perception of information in images for human viewers, or to provide `better' input for other automated image processing techniques. Image enhancement techniques can be divided into spatial domain methods (operate directly on pixels) and frequency domain methods (operate on the Fourier transform) of an image. In this study applied Fourier transform methods using SAGA GIS software environment. The enhanced image is shown in figure 3.

4.4 Head-sup Digitization

Heads-up digitizing is similar to manual digitizing, i.e., tracing of features by computer screen using the scanned raster image as backdrop. The feature of settlements, non-forested, water bodies, agricultural and transportation were digitized and stores in esri-shape file format (Table 1). The Landuse map 1972(figure 4) was created by using topographic sheets. Similarly landuse map 2011(figure 5) was interpreted by using ASTER satellite imagery.

Table 1: Landuse classification classes and description

Class Description	Description
Settlements	Includes all residential, Institutional, commercial, and industrial buildings, Airport etc.
Non-Forested	Includes all vegetation features that are not typical of forest, Scrubs, village woodlot, plantation pond side plantation, and canal side plantation
Water Bodies	Features includes Freshwater lakes, rivers, and streams, canal
Agricultural	Including agricultural and pasture grasslands, and recreational grasses,
Transportation	Features include State highways, National highways, District roads, Village roads and cart tacks.

4.4.1 Settlements

Settlements are comprised of areas of intensive use with much of the land covered by building structures. Features created in this category are cities, towns, villages, strip developments along highways, transportation, and Institutional area, industrial and commercial complexes by using QGIS software. Agricultural land, forest, wetland, or water areas on the fringe of urban or Built-up areas will not be included except where they are surrounded and dominated by urban development. Airport facilities include the runways, intervening land, terminals, service buildings, navigation aids, fuel storage, parking lots, etc.

4.4.2 Water bodies

The delineation of water areas depend on the scale of data presentation and the scale and resolution characteristics of the remote sensor data used for interpretation of land use and land cover. The Streams and Canals category includes rivers, creeks, canals, and other linear water bodies. Where the water course is interrupted by a control structure, the impounded area will be placed in the reservoirs category, rakes are non-flowing, naturally enclosed bodies of water, including regulated natural lakes but excluding reservoirs. Islands that are too small to delineate should be included in the water area. The delineation of a lake should be based on the areal extent of water at the time the remote sensor data are acquired [10].

.4.4.3 Non-forested area

The non-forested features are farm forestry (Trees along the farm bunds and in small patches), village woodlot (naturally growing or planted trees on community /private land), block plantation(compact plantations covering an area) , pond side plantation, and canal side plantation. These were digitized in GIS environment.

4.4.4 Agriculture area

Agricultural area may be land used primarily for production of food and fiber. On high-altitude imagery, the chief indications of agricultural activity will be distinctive geometric field and road patterns on the landscape and the traces produced by livestock or mechanized equipment. However, pasture and other lands where such equipment is used infrequently may not show as well defined shapes as other areas.

4.4.5 Transportation

The transportation network of the study area was created by using topographic sheets i.e., National highways, State highways, District roads, village roads and cart track.

4. RESULT AND ANALYSIS

The final product provides an overview of the major landuse features of the Palladam Taluk for 1972 and 2011 (Figure 4 &5). The area available in each of class has been calculated by using geometry and basic statistics tools of QGIS software environment and that has been graphically represented (Figure 6 and 7). Tabulations and area calculations provide a comprehensive data set in terms of the overall landscape and the types and amount of change, which have occurred (Table 2). Table 2 shows the estimated land use transitions based on the comparison of the image interpretation results for the 1972 and 2011 images. The results also show that settlement changed from 14.36sq.km in 1972 to 37.35sq.km in 2011. The increase is mainly due to the needs of settlements in Palladam town because its population has increased. New airport have also developed in the period. Figure 6 shows settlement area growth in case study area. In totally in Land use changes in 1972-2011, settlements have the maximum changes with 260 percent and minimum changes related to water body with 17 percent changes.

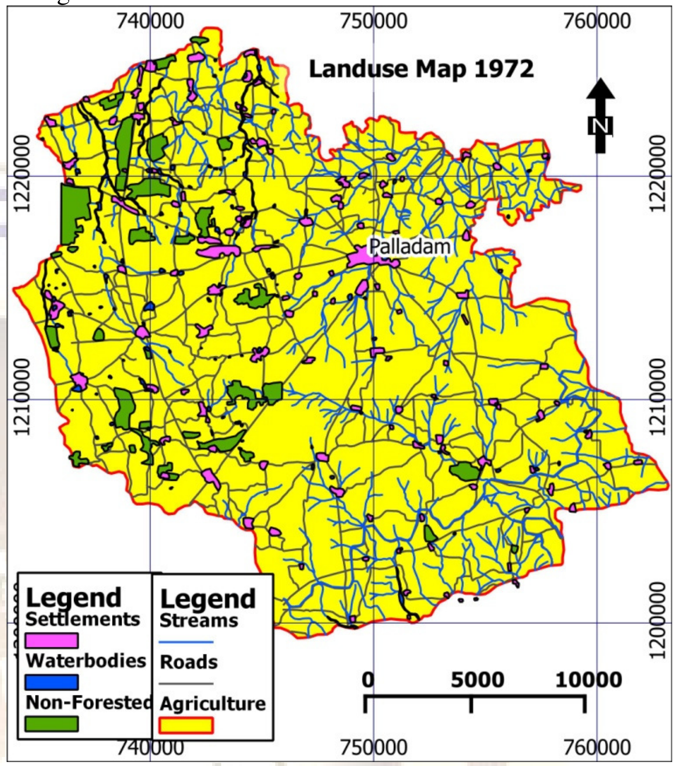

Figure 4: Study area Landuse map 1972

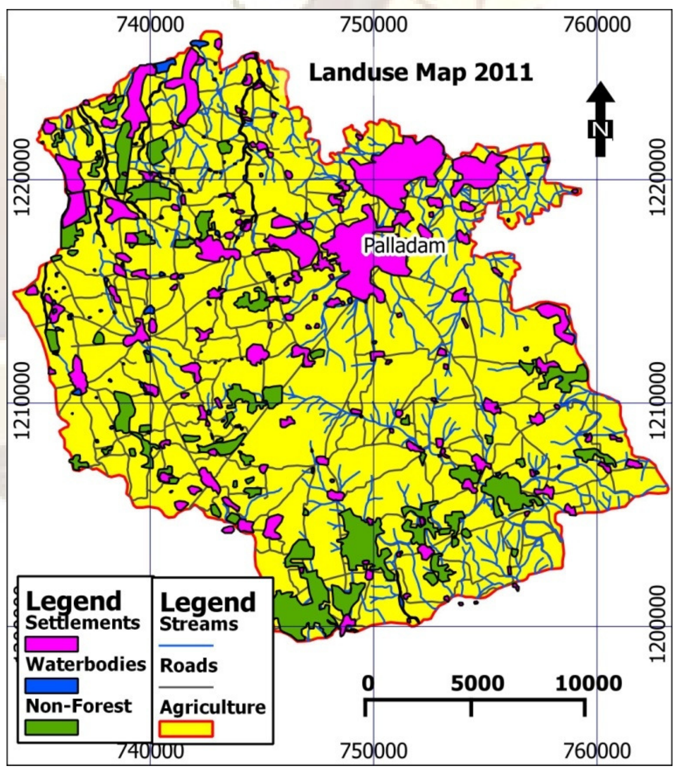

Figure 5: Study area landuse map 2011

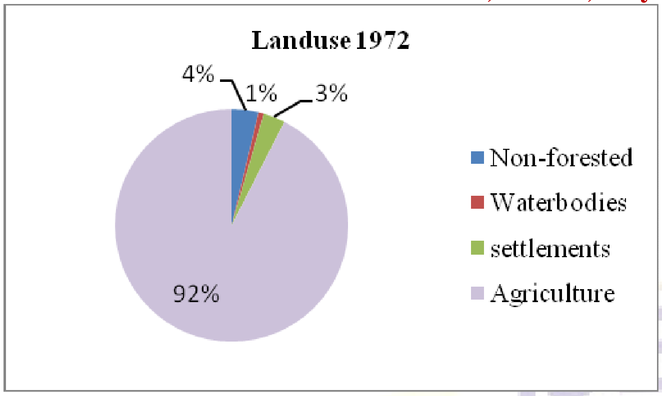

Figure 6: Distribution of landuse map 1972

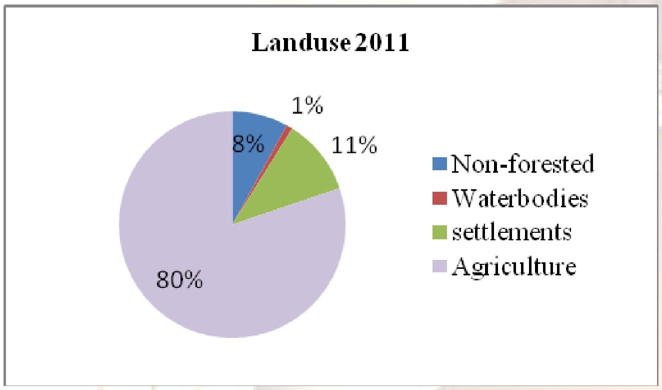

Figure 7: Distribution of landuse map 2011

Table 2: Summary of Landsat classification area statistics for 1972 and 2011

Landuse class	Landuse 1972 (sq.km)	Landuse 2011(sq.km)	Difference (sq.km)	Percentage changes
Settlements	14.36	51.71	37.35	260.0975
Waterbodies	3.51	4.13	0.62	17.66382
Non-Forested	17.58	37.89	20.31	115.529
Agriculture	438.56	380.27	-58.29	-13.2912

5. CONCLUSIONS

In this paper, using Topographic sheet in 1972 and ASTER Satellite image in 2011, land use changes in Palladam taluk, Tamil Nadu, India were evaluated using image processing and remote sensing. The main change observed for the time period of 1972-2011 was that the area of agriculture was decreased about 58.29sq.km, and Non-forested area was increased about 20.31sq.km. It is expected that during the urban development, the agricultural land about 58.29sq.km converted into the settlements about 37.39sq.km result to increase in land value which can be used for financing of the urban development. Due to rapid increase in population, the land values have gone high in and around Palladam town. The most important reason for this is that the migration from rural areas to urban areas. Similarly the water bodies also increased due to stagnant quarry water pools. There are no significance changes in new road development. The landuse map was prepared in the scale of 1:50000.

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