# Integrated Land use / Land cover Analysis of Surat District, Gujarat by Using Digital Classification Technique.

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The Deccan Geographer
Vol. 52, No. 1, June, 2014, Pp. 9-16
(ISSN-0011-7269)

# INTEGRATED LANDUSE/LANDCOVER ANALYSIS OF SURAT DISTRICT, GUJARAT BY USING DIGITAL CLASSIFICATION TECHNIQUE

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## Abstract

(Revised Version Received Nov., 2013)

The knowledge of land use and land cover is important for many planning and management activities and is consider an essential element for modeling and understanding the earth as a system. The scope of the present study is to prepare the thematic layers of land use / cover pattern, their assessment, spatial distribution and extent, using remote sensing and GIS techniques for Surat district of Gujarat on 1:2, 50,000 scale. Surat district is located in western part of India at the Gujarat State. Total geographical area covered by the surat district is about 7232 Sq. Km. It had a population of 60,79,231 of which 79.68% were urban as of 2011. Surat experiences tropical savanna climate (Köppen: Aw), moderated strongly by the Sea to the Gulf of Khambhat. RESOURCESAT (IRS P6) AWiFS standard False Color Composite (FCC) satellite images, SOI Topo-maps and previous cycle database of Land use / Land cover for same area were used to execute present study. To generate final land use/cover map of Surat district, thematic maps were prepared using NDVI, Supervised and unsupervised classification technique. Major five land use / land cover classes and 12 sub classes were recognizes on satellite image. Agricultural land has observed over around 56 percent area following forest (19 percent), wasteland (15 percent) water body (8 percent) and built up area covers around 2 percent area of entire Surat district. Availability of irrigation facility from the Tapi river flowing through the central part of study area helped to improve area under agriculture class.

## Introduction

Landuse/landcover inventories importance is increasing in various resource sectors viz. agricultural, forestry, industries and mining perspective study. Landuse refers to man's activities and the varied uses which are carried over the land and land cover refers to natural vegetation, water bodies, rock/soil, artificial cover and others noticed on the land (NRSA, 1989). Landcover, defined as the assemblage of biotic and abiotic components on the earth's surface .It is one of the most crucial properties of the earth system. Landuse/landcover changes permits identification of long term trends in anticipation of the problems that accompany change in the land use. Introduction on Landuse/landcover also provides a better understanding of the wasteland and surface water bodies, which, is vital for the development and planning. The timely accurate and up-to-date information on Landuse/landcover can be

obtained from various Remote Sensing satellites on a cost effective basis at the shortest possible time. The scope of the present study is to prepare the thematic layers of landuse/ landcover pattern, their assessment, spatial distribution and extent, using remote sensing and GIS techniques for Surat District of Gujarat on 1:2, 50,000. landuse/landcover analysis performed using Remote Sensing satellite data to know about landuse/landcover pattern of Surat district.

## Study region

Surat is a district in the state of Gujarat, India with Surat city as the administrative headquarters of this district. It is surrounded by Bharuch, Narmada (North), Navsari (South) districts and Tapi (east) district, To the west is the Gulf of Khambhat. The location of the Surat District of Gujarat is geographically bounded by $20^0$ 48' 27.93'' N to $21^0$ 34' 12.82'' N Latitude and $72^0$ 35' 15.49''E to $74^0$ 19' 52.72'' E longitude. Total geographical area covered by the surat district is about 7232 square kilometres. It had a population of 60,79,231 of which 79.68 percent were urban as of 2011. Surat has a tropical savanna climate (Köppen: Aw), moderated strongly by the Sea to the Gulf of Khambhat. The summer begins in early March and lasts till June. April and May are the hottest months, having average maximum temperature being 37 °C (99 °F). Monsoon begins in late June and the city receives about 1,200 millimetres (47 in) of rain by the end of September, with the average maximum being 32 °C (90 °F) during those months. October and November period retreat of monsoon and a return of high temperatures till late November. Winter starts in December and ends in late February, with average mean temperatures of around 23 °C (73 °F) and negligible rain. Tapi is the major river flowing from east to west and meeting to Arabian sea at the Gulf of Khambhat. Surat also has an identity as a port city due to its location which is situated on the banks of Tapti river at Arabian coast. Damming of Tapti caused the original port facilities to close and the nearest port is now in the Magadalla and Hazira area of Surat Metropolitan Region.

## Objective

The objective of this paper is to prepare landuse/landcover database for the period 2006-07 for three seasons (Kharif, Rabi and Zaid) satellite data.

## Database and methodology

The present study and analysis of 'Surat District of Gujarat' has been done using three types of data for more accuracy, which are satellite images, SOI Topo-maps and Previous cycle Database of landuse / landcover for same area. For delineation and mapping of landuse / landcover, multi-temporal orthorectified AWiFS data acquired during Kharif, Rabi and summer seasons have been used. IRS-P6 satellite imagery for three season's viz., Kharif, Rabi and Zaid dated August 2006, February 2007 and May 2007 respectively were used. Satellite data selection for the interested area is an essential task in the study. Data should be

cloud free, mostly this problem faced in the monsoon season as well as data should error free in both cases Radiometric and Geometric. The methodology attempted here is based on the digital classification of geo-referenced RESOURCESAT (IRS P6) AWiFS standard False Color Composite (FCC) generated using band 2, 3, and 4 respectively.

## Digital classification

(a) **Normalised difference vegetation index (NDVI) :** NDVI is very extensively used transform for vegetation. It can vary from –1 to +1 depending on the relative value of Red and Infra Red (IR) reflectance.

Formula for NDVI-

$$NDVI = (IR - R) / (IR + R)$$

Using above NDVI formula vegetation can be extracted from all 3 Multi-temporal Satellite data.

(b) **Maximum likelihood classification (MXL) :** The maximum likelihood classifier quantitatively evaluates both the variance and co-variance of the category, spectral response patterns when classifying an unknown pixel. To do this, assumption is made that the distribution of the cloud of points forming the category training data is Gaussian (normally distributed). The assumption of normality is generally reasonable for common spectral response distribution. The distribution of a category response pattern can be completely described by the mean vector and the covariance matrix. We may compute the statistical probabilities of a given pixel value being a member of a particular land cover class. The resulting belt shaped surfaces are called probability density functions and there is one such function for each spectral category. The probability density function is used to classify an unidentified pixel by computing the probability of the pixel value of the belonging to each category. After evaluating the probability in each category, the pixel would be assigned to the most likely class (highest probability value) or labeled unknown if the probability values are all below a threshold set by the analyst.

(c) **Unsupervised classification :** Unsupervised classifier does not utilize training data as the basis for classification. Rather, this family of classifiers involves algorithms that examine the unknown pixels in an image and aggregate them into a numbers of classes based on the natural grouping or clusters present in the image values. The basic premise is that value within a given cover type should be close together in the measurement space, whereas data in different classes be comparatively well separated. There are numerous clustering algorithms that can be used to determine the natural spectral grouping present in the data set. The common forms of clustering are the "K means" and the "ISODATA (Iterative Self-Organizing Data Analysis)" approach.

(d) **Preparation of thematic layers :** The satellite data was classified using Digital Classification Technique. The classified output was segregated into various thematic layers for further processing, using recode tool and different models.

(e) **Data integration:** The different thematic layers were integrated later to get the final classified image. The Land Use / Land Cover statistics of the study area was calculated for each class.

## Results and discussion

Surat District is geographically located between 20$^0$ 48' 27.93" north to 21$^0$ 34' 12.82" north Latitude and 72$^0$ 35' 15.49"east to 74$^0$ 19' 52.72" east longitude in southern part of Gujarat State. In the present study total 7231.88 sq.km area has been analyzed for landuse / cover of Surat district. After classification 12 different Landuse / cover categories were found which enabled to map on Satellite data. Area under different Landuse / cover categories within study area are computed in Table–1. In the present study double/ triple crop is having largest area, it comprises an area 2873.37 sq.km (39.73 percent). While other wastelands contribute only 0.33 percent of total area (24.19 sq.km), this is the smallest area compare to other categories. Tapi river is one of the major feature in the study area. It runs through the central part of study area hence, plays a vital role in the Llnduse / cover of an area. One reservoir comes under study area constructed on Tapi River, which helps to increase an area under water bodies. Following are the major landuse /cover classes obtained from digital classification also shown in Fig 1.

## Built-up and agricultural land

It is defined as an area of human habitation developed due to intensive non-agricultural use and that has a cover of building, transportation and communication, utilities in association with water vegetation and vacant lands. The residential areas (settlement), road and rail confined within the study area is estimated as 122.57 sq.km (1.69 percent) (Table–1). Area under agricultural land use is largely dependent upon agro-climatic conditions prevalent in the area, type of soil, availability of irrigation facilities and physiography of region. Different agricultural patterns have been observed in the study area. The present Land use appears to be well adapted to topography, soil and rainfall pattern. In the present study the cropland category includes standing cropland in Kharif and Rabi and Summer season. Highest area comes under agricultural land use category which is around 3559.58 sq.km (56 per sent)(Fig.1), which include area under Kharif, Rabi, Zaid and Double/ Triple crop (Kharif + Rabi/ Kharif + Rabi + Zaid) area and covers 417.93, 158.19, 42.33 and 2873.37 sq.km area respectively. In the study area 485.69 sq.km. area is under fallow land contributing 6.72 % area of the total study area. The spatial extent of the same is presented in Fig. 1 and Table–1.

Forest These are the areas bearing an association predominantly of trees and other vegetation types (within the notified boundaries) capable of producing timber and other forest

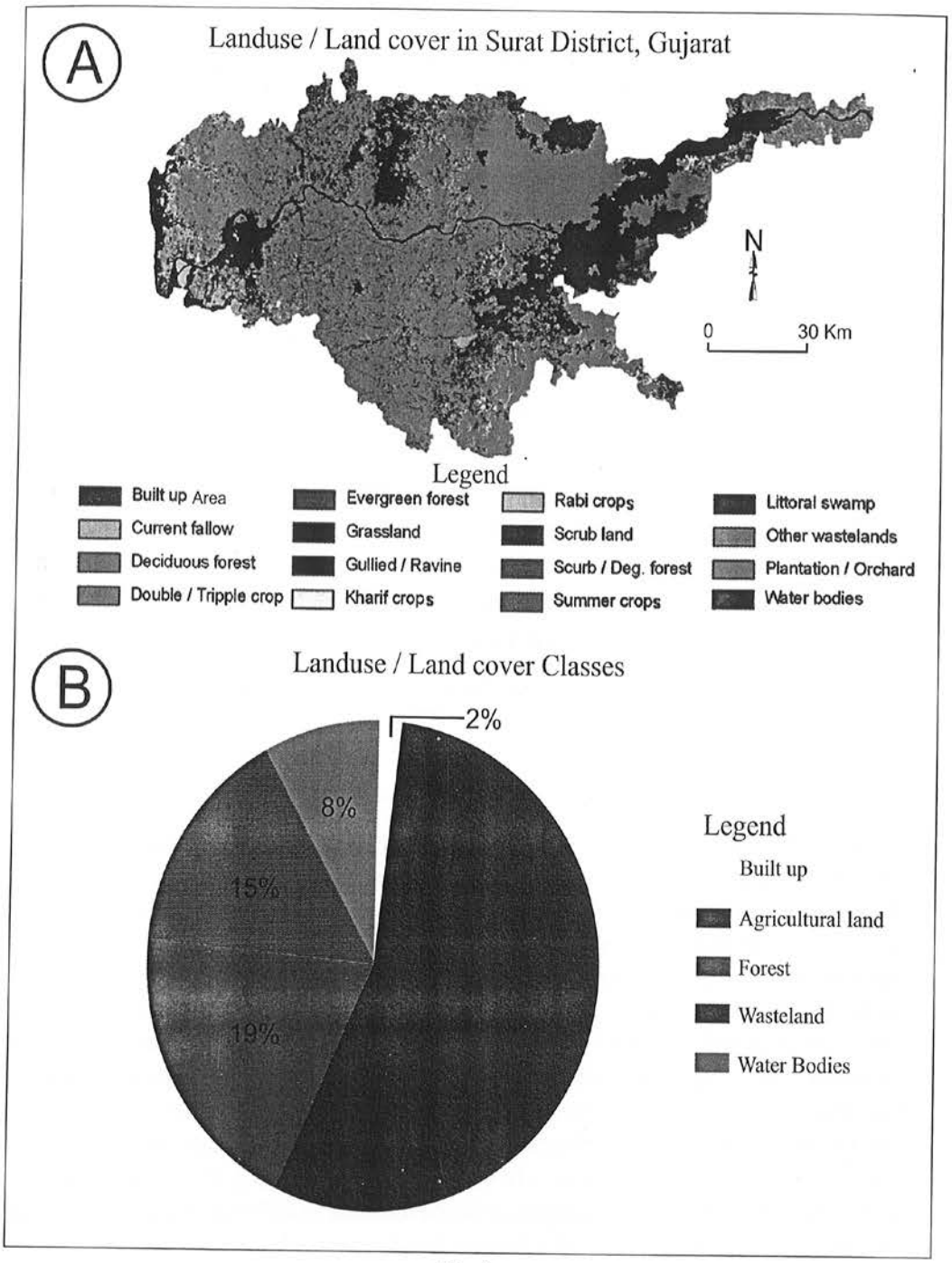
A
Landuse / Land cover in Surat District, Gujarat
N
0
30 Km
Legend
Built up Area
Current fallow
Deciduous forest
Double / Tripple crop
Evergreen forest
Grassland
Gullied / Ravine
Kharif crops
Rabi crops
Scrub land
Scurb / Deg. forest
Summer crops
Littoral swamp
Other wastelands
Plantation / Orchard
Water bodies
B
Landuse / Land cover Classes
2%
8%
15%
19%
Legend
Built up
Agricultural land
Forest
Wasteland
Water Bodies

Fig. 1

Table–1 : Landuse/Landcover Estimates for Surat District, 2007

| Sr. No. | Landuse/landcover Level – I | Landuse/Landcover Level – II | Area (Sq.Km) | Area (%) |
|---|---|---|---|---|
| 1 | Built-Up | Built-Up | 122.57 | 1.69 |
| 2 | Agricultural Land | Kharif Crop | 417.93 | 5.78 |
| | | Rabi Crop | 158.19 | 2.19 |
| | | Summer Crop | 42.33 | 0.59 |
| | | Double / Triple Crop | 2873.37 | 39.73 |
| | | Current Fallow | 485.69 | 6.72 |
| | | Sub Total | 3977.51 | 56.01 |
| 3 | Forest | Deciduous Forest | 1178.12 | 16.29 |
| | | Scrub / Degraded Forest | 192.78 | 2.67 |
| | | Littoral / Swamp Forest | 38.03 | 0.53 |
| | | Sub Total | 1408.93 | 19.49 |
| 4 | Wasteland | Scrubland | 1089.78 | 15.07 |
| | | Other Wasteland | 24.19 | 0.33 |
| | | Sub Total | 1113.97 | 15.40 |
| 5 | Water Bodies | Water Bodies | 608.90 | 8.42 |
| | Total | | 7231.88 | 100 |

*Source* : Computed by Authors.

products. Total forests occupy 1370.90 sq.km (18.96 percent) areas, concentrated in the north eastern part of the study area and eastern part of Surat district. Deciduous Forests are the forest types that are predominantly composed of species, which shed their leaves once a year, especially during summer. They appear dark red to red in tone of varying sizes in satellite image. This category also includes Acacia thorn forests in semi-arid areas. Area under this category is about 1178.12 square kilomitre (16.29 percent). Scrub / Degraded forest category includes all the forest areas where the canopy cover/ density range less than 40 persent. They appear in light red to dark brown depending on the canopy cover and soil background. Such land cover occupies about 192.78 sq.km (2.67 percent) of the area in the Surat district. Littoral/ Swamp Forest also called as Mangrove or Water Swamp. These are evergreen, halophytic, dense or woody in nature, occurring along Gulf of Khambhat, tidal water and estuary of Tapi. They appear in bright red color, small to medium in size, irregular and discontinuous shape. Littoral / Swamp forest occupy about 38.03 sq.km areas in the study area.

Wastelands are one of the important land cover in the study area. Wastelands are described as degraded land which can be brought under vegetation cover with reasonable effort and which is currently under utilized for lack of appropriate water and soil management or on account of natural causes (NWDB,1991). The Wastelands types identified in the study area are scrubland and other wastelands. Other wastelands include different types like salt affected, gullied or stony waste. Total area under wasteland category estimated is 1113.97 sq.km (15.40 percent) of the total study area. In this other waste-lands having 24.19 sq.km area. This category is shown in the Fig. 1. Scrubland could be land with scrub or land without scrub. This category appears on satellite imagery as light yellow to brown to greenish blue patches of varying size with irregular shapes. They are usually associated with upland and hills. Hence, area with scrub has been separated from those, which are devoid of any such vegetation cover, which enabled to classify them separately. In the study area scrubland area estimated is 1089.78 sq.km (15.07 percent). Water bodies comprises area with surface water, either impounded in the form of ponds, lakes and reservoirs or flowing as stream, river, canals etc. these are seen clearly on satellite image in blue to dark blue or cyan color depending on the depth of water. In the present study Tapi is the major river flows from east to west. In eastern part there is a reservoir on Tapi River. Total area under water bodies estimated is 608.9 sq.km (8.42 percent).

## Conclusion

The landuse/landcover assessment using satellite imagery provides reliable and accurate information, which is cost and time effective. It also offers a holistic view of large areas for better monitoring of landuse/cover occurrence and distribution. Hence, satellite remote sensing and GIS techniques are useful tools for assessing the landuse/landcover. The satellite imagery due to its repetitive advantage is also useful for undertaking monitoring of changes in land use patterns.

## Acknowledgment

We are gratefully thankful to the Data and Computer Lab support of the RRSSC, ISRO, Department of Space, Jodhpur, India.

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