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Urbanization & Urban Land-Use Mapping Using Remote Sensing & GIS

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Abstract

A study on “Urbanization & Urban Land-use mapping” was carried out using IRS Satellite data of LISS III and LISS IV covering Gandhinagar city. The GIS data like the Transport Network, Urban Habitation, Bridge; Water bodies (like Rivers, canals, etc) were used along with IRS Satellite data. Satellite data was analyzed using Q-GIS as well as ENVI Image Processing Software. Q-GIS was also used to generate various thematic layers like Transport Network, Urban Habitation, Water Bodies, etc.

The urban development of Gandhinagar city over the last 10 years was mapped and monitored using multilayer IRS Satellite data. The urban sprawl during 2001, 2006 & 2012 was mapped and urban growth was monitored to understand the urbanization process. The results of this study indicate that the urban growth in Gandhinagar city has increased to a large extent. The various thematic layers generated also helped to understand the development of transport network & urban growth within the city.

Keywords: GIS, Land-use, Mapping, Remote Sensing, Satellite data, Urbanization

Introduction

REMOTE SENSING

It refers to the measurement or acquisition of information about an object or phenomena from a distance without physical contact by using devices or sensors mounted on some platform. Remote Sensing also means sensing of Earth’s surface from space by making use of the properties of the Electromagnetic wave emitted, reflected or diffracted by the sensed objects, for the purpose of improving natural resource management, land-use and the protection of the environment.

APPLICATIONS OF REMOTE SENSING

a. Urbanization & Transportation

- Updating road maps
- Asphalt conditions
- Wetland delineation

b. Agriculture

- Crop health analysis
- Precision agriculture
- Compliance mapping
- Yield estimation

c. Natural Resource Management

- Habitat analysis
- Environmental assessment
- Pest/disease outbreaks
- Impervious surface mapping
- Lake monitoring
- Hydrology
- Land use-Land cover monitoring
- Mineral province
- Geomorphology
- Geology

d. National Security

- Targeting
- Disaster mapping and monitoring
- Damage assessment
- Weapons monitoring
- Homeland security
- Navigation
- Policy

INTRODUCTION TO GIS

GIS means Geographical Information System. Geographic information system (GIS) is a system designed to capture, store, manipulate, analyze, manage, and present all types of geographical data. GEOGRAPHIC implies that locations of the data items are known, or can be calculated, in terms of Geographic coordinates (Latitude, Longitude). INFORMATION implies that the data in a GIS are organized to yield useful knowledge, often as colored maps and images, but also as statistical graphics, tables, and various on-screen responses to interactive queries. SYSTEM implies that a GIS is made up from several inter-related and linked components with different functions. Thus, GIS have functional capabilities for data capture, input, manipulation, transformation, visualization, combinations, query, analysis, modelling and output.

TYPES OF DATA

Vector Data: This data is represented in the form of co-ordinates. Data comprise series of one or more coordinate points. It is having following advantages; suitable for map preparation as lines/boundaries do not appear stepped/zigzag, suitable for information systems/attribute data management / network applications, require less storage area, vector data are accepted as input to hydrological models. *Raster Data:* It is the data where each area is divided into rows and columns, which form a regular grid structure. Each cell must be of rectangular shape, but not necessarily square. Each cell within this matrix contains location co-ordinates as well as an attribute value. It is having following advantages; suitable for overlay operations/calculations, input layers prepared from remotely sensed data can be directly accepted without any processing, usually forms an input to 'distributed hydrological models'.

APPLICATIONS OF GIS

- a. *Natural Resource Management*
 - Forest & Wildlife
 - Hydrological
 - Minerals
- b. *Urban & Regional management*
 - Land Use Planning/Environmental Impact
 - Public Works
 - Emergency Response
 - Legal Records
- c. *Commercial*
 - Market Area Analysis
 - Site Selection
 - Routing
- d. *Agricultural Management*
 - Field Records
 - Animal Management
 - Climate Change / Human Impact

Study area**LOCATION & EXTENT**

Gandhinagar: Gandhinagar, is the capital of the state of Gujarat in Western India. It lies on the west bank of the Sabarmati River. The head-quarters are at Gandhinagar. It has an area of 2163 km², and a population of 13,87,478 according to the Census of 2011. The population density is 660 inhabitants per sq.km. The district includes Gandhinagar with 3 suburbs – Chandkheda, Adalaj & Motera, 3 Tehsils – Kalol INA, Dehgam & Mansa and 216 villages. Gandhinagar district is bounded by the district of Sabarkantha to the northeast, Kheda to the southeast, Ahmedabad to the southwest and Mehsana to the northwest.

Gandhinagar presents the spacious, well organized look of architecturally integrated city. It is a well planned city like Chandigarh (Punjab) which is having 30 sectors which are of 1 Km each in length and width. Each

sector has its own shopping & community centre, primary school, secondary school, a higher secondary school, health center, a maintenance office, government & private housing.

DATA analysis

1.1 FLOWCHART OF METHODOLOGY

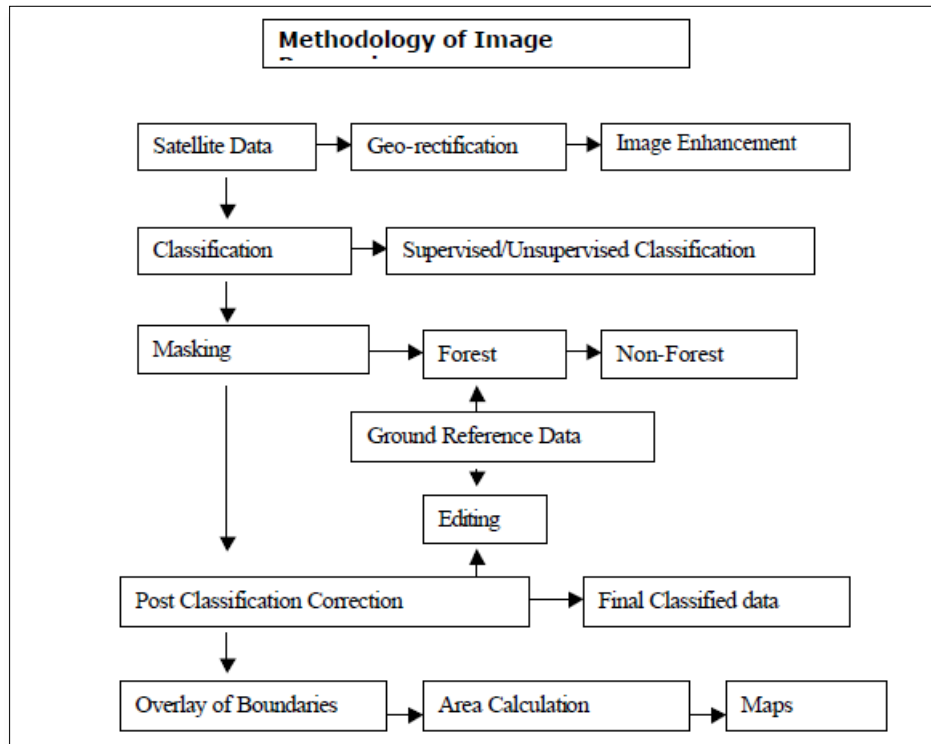


Fig 3(A): Flow chart illustrating the methodology of Image Processing

SATELLITE DATA EXTRACTION

ENVI image processing software & Q-GIS Software were used for the project. ENVI 4.4 Image Processing Software was used for digital processing of the Satellite Data. Q-GIS was used for Mapping the area required. Digital Image Processing Techniques were applied for the mapping of Land-use of the provided area of the satellite data.

The methodology applied comes under following steps:

Image Extraction: Satellite Imageries were obtained from BISAG, Gandhinagar and the area of interest was created through ENVI image processing software.

Geo-Rectification: Geo-Rectification is done to represent the ground features accurately. The satellite imagery was geometrically rectified with reference to vector data.

Image Enhancement: Image Enhancement is one of the important image processing functions primarily done to improve the appearance of the imagery to assist in visual interpretation and analysis.

Image Interpretation: Image interpretation has a step called "Field Verification" which is done to verify the actual topography with the satellite imagery.

DATA USED

Satellite data: The first phase of the project was to collect the data required for the project. Thus, the most important data, which was satellite images were collected from BISAG, institute. Satellite images of IRS LISS-III and IRS LISS-IV of three years such as year 2000, 2006, and year 2011 were obtained. This multivariate satellite data was used in the analysis for urban sprawl & land-use mapping of Gandhinagar city.

The following is the google map of Gandhinagar city, from that the highlighted area was chosen as our study area.



Fig 3(B): Selected area of study



Fig 3(C): IRS LISS-IV image study area of gandhinagar

GIS files: The GIS shape files which would be helpful for analysis and assessment of the obtained satellite images were collected. Though, we had to generate some of the shape files using software Q GIS 14.0.1 Some of the GIS layers used are as follows:-

- I. District boundary
- II. Land use map
- III. Transport network

3.4 SOFTWARES USED

The various softwares used for mapping and monitoring the RS & GIS data files are :

1. Quantum GIS (Q-GIS) version 1.4.0
2. ENVI Image Processing Software version 4.4



Fig 3(D): Functions in Q-GIS

MAPPING OF SATELLITE DATA

The mapping of the various areas of the city was done on the False Colour Composition Image of the Satellite Imagery using Q-GIS.

The mapping of different areas was done on the above Satellite Imagery shown in Fig 3(C).

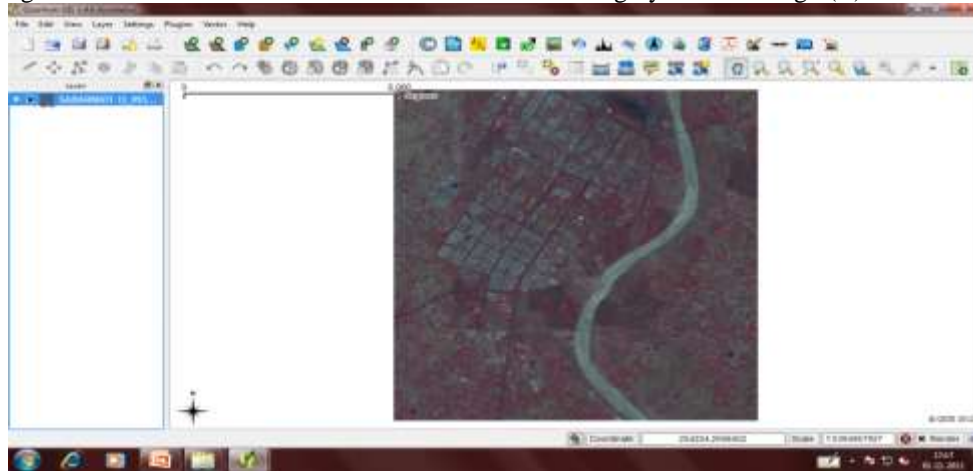


Fig 3(E): False Colour Composition of study area in Q-GIS

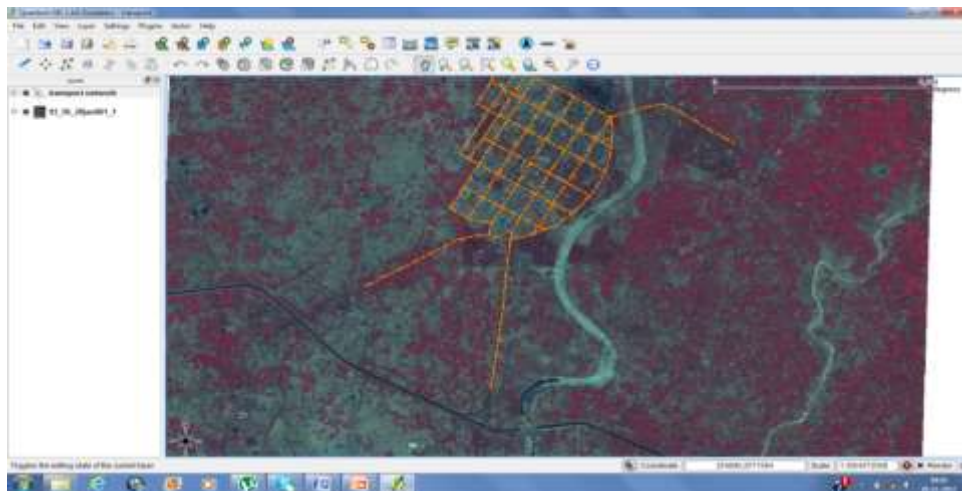


Fig 3(F): Transport Network: Gandhinagar (Generated using Q-GIS)

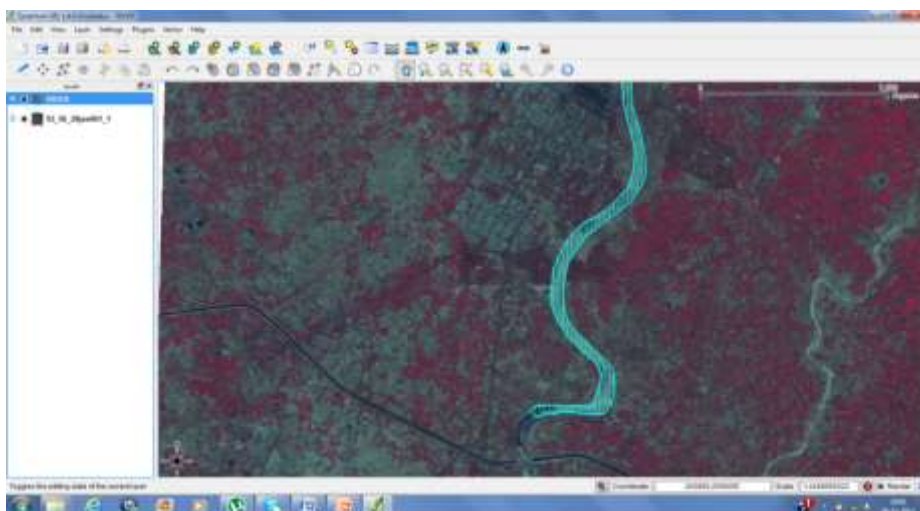


Fig 3(G): Sabarmati River: Gandhinagar (Generated using Q-GIS)

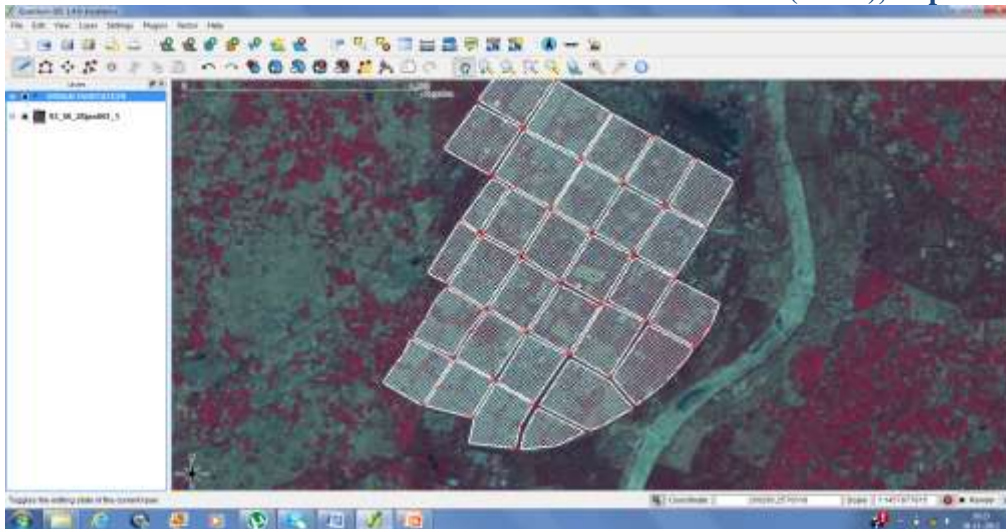


Fig 3(H): Urban Habitation: Gandhinagar (Generated using Q-GIS)

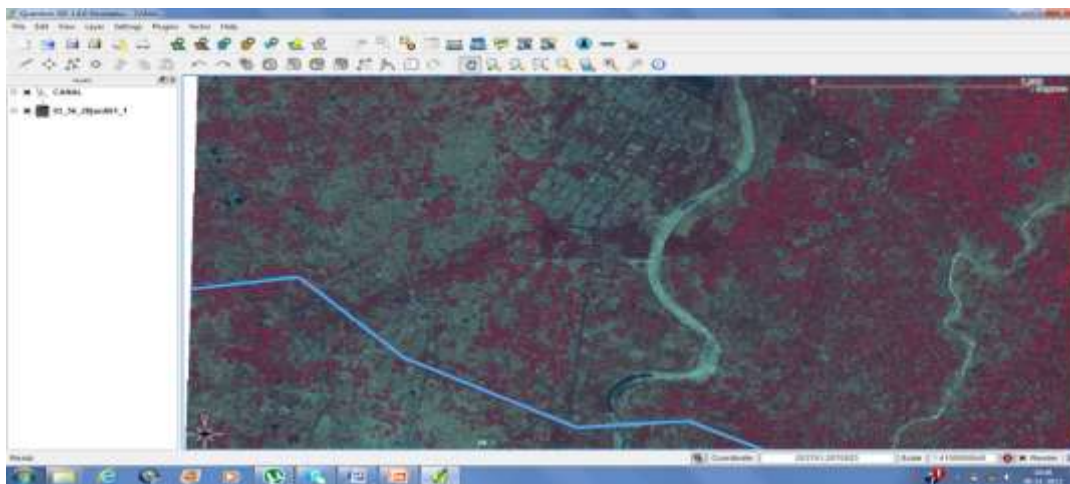


Fig 3(I): Canal around the study area (Generated using Q-GIS)

DIGITIZATION OF IMAGE

Digitization of the mapped areas of all the satellite images was done to could get the outline of mapped area. (using Q-GIS 1.4.0). This was the major process to detect the land-use of Urban Area of Gandhinagar city. For the distinction and assessment of that area this process proved to be very useful. Figures below show the digitization of the various area of Gandhinagar mapped in Q-GIS.

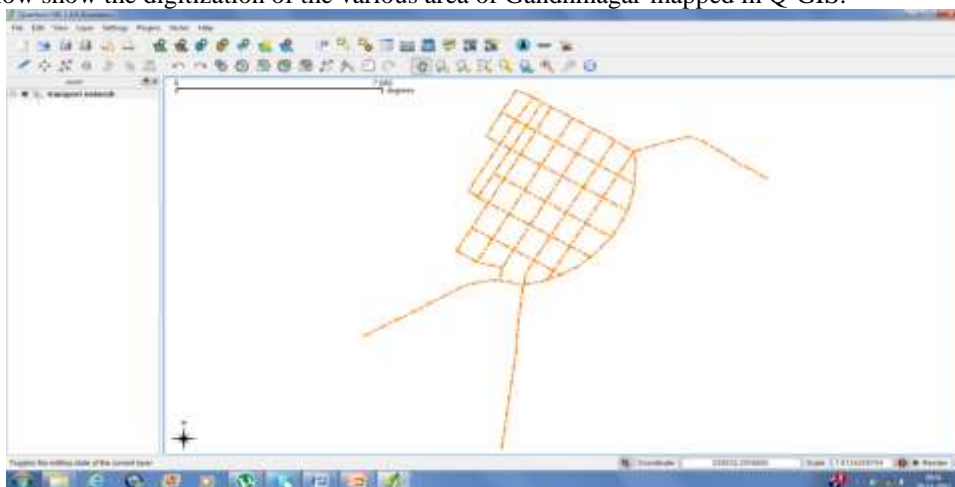


Fig 3(J): Digitization of Transport Network

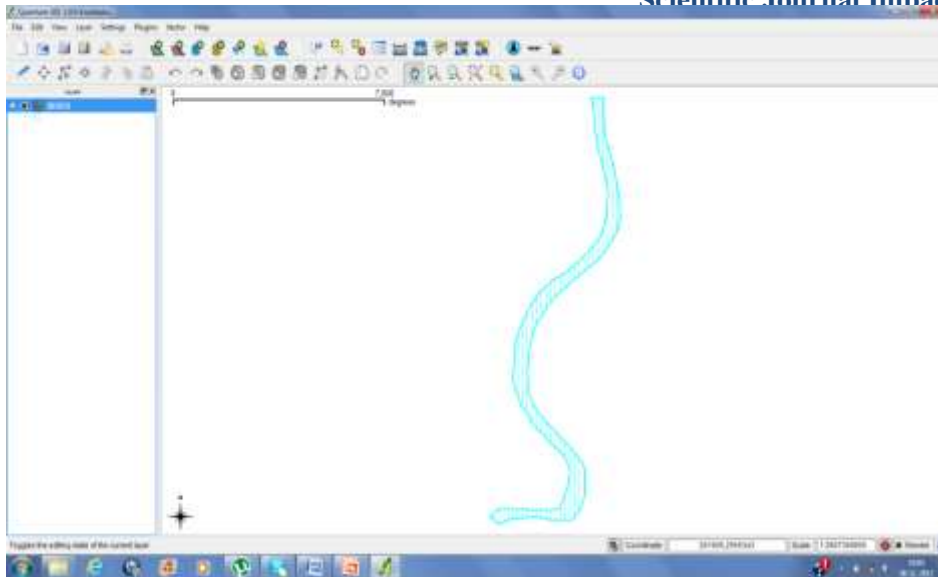


Fig 3(K): Digitization of Sabarmati River

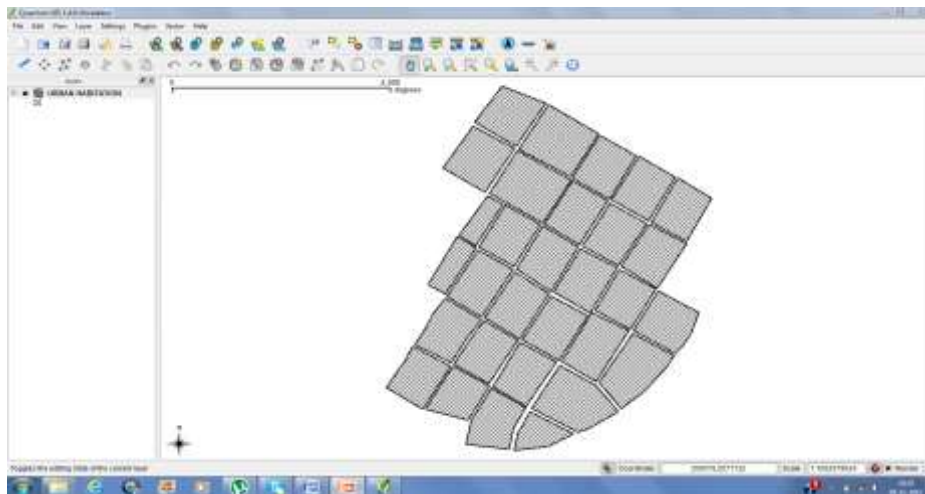


Fig 3(L): Digitization of Urban Habitation

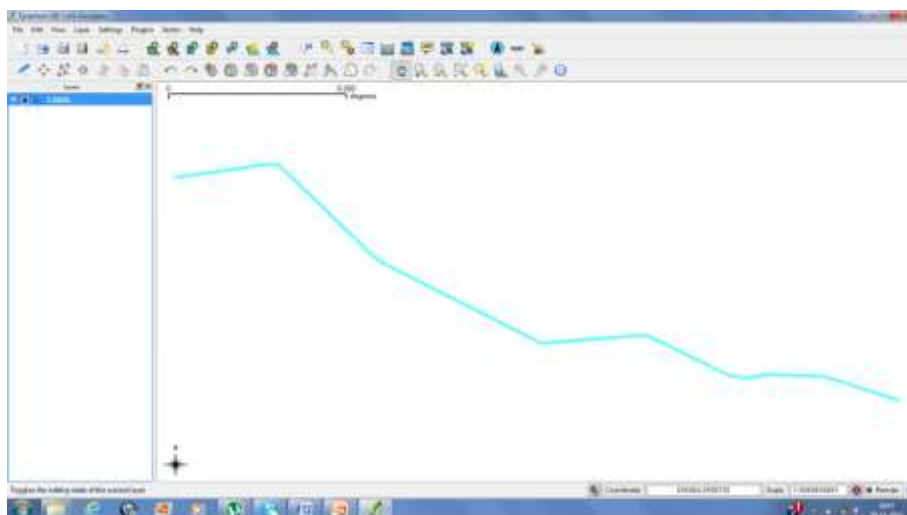


Fig 3(M): Digitization of Canal

URBANIZATION IN GANDHINAGAR

The images below show the Urban Growth of Gandhinagar city over the last 10 years.



Fig 3(N): Urban Growth of Gandhinagar city in January 2001



Fig 3(O) : Urban Growth of Gandhinagar city in January 2006



Fig 3(P) : Urban Growth of Gandhinagar city in January 2012

The above three images of Gandhinagar show that the Urbanization has taken place at a very rapid pace in Gandhinagar. The area around Gandhinagar and the small villages of Gandhinagar district have also developed well in the past 10 years.

Conclusions

IRS Satellite data of 3 different years (2001, 2006 & 2012) was analyzed using ENVI Image Processing software along with GIS data of Transport Network, Urban Habitation, Water Bodies, etc.

Major Conclusions of this study are as follows :-

- Data Analysis of various years showed that the urban growth of Gandhinagar has increased over the past 10 years.
- The Transport Network has also improved.
- Various surrounding villages and towns are getting connected because of the developed transport network to Gandhinagar.
- It was also observed that a lot of urban development is taking place outside the well defined sectors, along the various villages.
- It is observed that use of multiyear Remote Sensing data and GIS are very effective tools/ methods for mapping and monitoring urban growth during various years.

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