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Remote Sensing and GIS techniques Enabled Approach for Environment Impact Assessment in Sanand Area by Evaluating Land Use/Cover Monitoring

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Abstract: The study presents the significance of the Remote Sensing (RS) and Geographical Information System (GIS) in providing accurate assessment of environmental changes due to rapid pace of industrialization in Sanand. To illustrate the inherent inter-disciplinary nature of Geographical Information System (GIS), a study of Environmental Impact Assessment (EIA) using GIS and Remote Sensing is presented in this paper. The environment issues dealt with relate to archaeology, land use, transport, water bodies, and geology. The increasing in damage caused by industrialization activity is closely associated in the level of economic activity. The process of industrialization also brings menace of negative environmental impact to large extent. The study takes into account the geo-spatial information in order to make assessment matrix. Satellite data have been captured and studied in Landsat 7 and Landsat 8 versions. The study presents a new framework for analysis phase on EIA for projects, Transportation, Wasteland, agricultural land and water bodies etc. Such assessment based on integration between remote sensing and GIS. By integrating the merits of the map overlay method and matrix method the Framework analyzes comprehensively the environment vulnerability around the Industrialization and their impact on the environment The land use/ Cover classification of Sanand, were analyzed to illustrate the use of environmental spatial information for decision perspectives and the framework & demonstrate its capabilities ,with accurate timely data extracted and used from Remote Sensing using image processing and data classification technique for the assessment on the impact on environmental condition or within surrounding environment.

Keywords: Remote Sensing, Geographical Information System, Environment Impact Assessment, Land use, Land cover, Industrialization.

I. INTRODUCTION

Sanand is a taluka in Ahmedabad district with a approximately 80710 hectares .An environmental impact assessment (EIA) is an assessment of the possible impact positive or negative-that a proposed project may have on the environment, together consisting of the natural, social and economic aspects. Its purpose is to identify, examine, assess and evaluate the likely and probable impacts of a proposed project on the environment and, thereby, to work out remedial action plans to minimize adverse impact on the environment. It is an important management tool for ensuring the justified use of natural resources during developmental process (Gazette of India Notification on EIA, 2006). Given the spatial nature of many environmental impacts, Geographical Information Systems can have a wide application in all EIA stages, acting as an integrative framework for the entire process, from the generation, storage, and display of the thematic information relative to the vulnerability and/or sensitivity of the affected resources, to impact prediction and finally their evaluation for decision support (Antunes et al, 2001). EIA is a decision process, which aims to both identify and anticipate impacts on the natural environment. The interface between these two components produces several effects, which will generate specific impacts. GIS is employed within the EIA process to improve different features, mainly related to data storage and access, to the analytical capabilities and to the communicability of the results. The development of such a system will allow a more realistic approach to the environmental descriptors and a better understanding of their interrelationships. GIS brings to the EIA process a new way of analyzing and manipulating spatial objects and an improved way of communicating the results of the analysis, which can be of great importance during the public participation process where the results from the public consultation and social surveys can be imported into a GIS for spatial and non-spatial analysis, and display in a format that is easily understood by both technical and nontechnical stakeholders (Yousefi et al, 2003). Identified four methodologies associated with EIA, each with its own strengths and weaknesses. The four methodologies are: Overlay, Checklist, Matrix and Network. a.) The Overlay method of impact assessment involves overlaying of various layers of interest of the study area to reach the desired goal. Some of the data this method requires include topological data, air dispersal patterns, land use data, wildlife, surface and ground water intakes etc. this method depends heavily on graphical display of data and as such GIS becomes the ultimate tool for overlay in EIA. b.) The Checklist method can be a very simple or complex list of environmental components attributes and processes, which are categorized under different categories e.g. Geology, vegetation and air. GIS provides a computer platform for organizing, storing and analyzing these checklists (Erickson et al, 1994). c.) The Matrix method is the process of relating specific project activities to specific types of impacts. Matrices are required because they emphasize only direct impacts. They enforce the consideration of the impact of each aspect of a proposal for a range of environmental concerns and they consider both the magnitude and importance of impacts. Again, GIS provides a powerful tool for organizing, analyzing and storing matrices (Bhatt, R.P. et al, 2009). d.) The Network method defines a network of possible impacts that may be triggered by project activities. It also involves the identification of project actions along with the direct and indirect impacts. From the network methodology, direct, secondary, tertiary and other higher order impacts of action are to be identified. There is need for complex data analyses using this methodology and on a GIS platform large volumes of data can be better analyzed within a short period of time. Geographic Information Systems also have the capability for site impact prediction (SIP), wider area prediction (WAP), cumulative effect analysis (CEA), and environmental audits and for generating trend analysis within an environment [9].Furthermore, stresses some of the advantages of the use of GIS in EIA, namely for data management, overlay and analysis, trend analysis, as sources of data sets for mathematical impact models, habitat and aesthetic analysis, and public consultation.

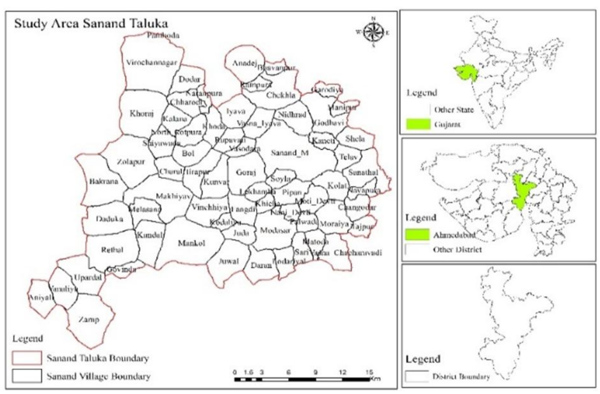
Land use/cover is two separate terminologies which are often used interchangeably. Land cover refers to the physical characteristics of earth’s surface, captured in the distribution of vegetation, water, soil and other physical features of the land, including those created solely by human activities e.g., settlements. While land-use refers to the way in which land has been used by humans and their habitat, usually with accent on the functional role of land for economic activities. The land use/cover pattern of a region is an outcome of natural and socio-economic factors and their utilization by man in time and space. Information on land use/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. Land use affects land cover and changes in land cover affect land use. Changes in land cover by land use do not necessarily imply degradation of the land. However, many shifting land use patterns driven by a variety of social causes, result in land cover changes that affects biodiversity, water and radiation budgets, trace gas emissions and other processes that come together to affect climate and biosphere (Dimyati at all, 1996).

Land use/cover change detection is very essential for better understanding of landscape dynamic during a known period of time having sustainable management. Land use/cover changes is a widespread and accelerating process, mainly driven by natural phenomena and anthropogenic activities, which in turn drive changes that would impact natural ecosystem [Ruiz-Luna et al, 2003]. Understanding landscape patterns, changes and interactions between human activities and natural phenomenon are essential for proper land management and decision improvement. Today, earth resource satellites data are very applicable and useful for land use/cover change detection studies (Yuan F et al, 2005). The land use statistics formed one type of a part of the Mainly agricultural Land statistics. The 20th century has been a century of unprecedented population increased, economic development and environmental change. Industrialization had been provided forgood economies and has sustained human development. However, this fast as fast population growth Increase and development had occurred unevenly throughout the world synchronous with expand unsustainable utilization of world‟s familiar natural resources. In India, by mid-19th, more or more than 85 percent of the cultivable area has already been brought under cultivation or cultivable land. Talking into account the total land resources contain hills or, mountain (small,big) , lakes , river and lands all description , the availability of land per person in India comes to only 0.58 hectares. The consequence of denizen grow for india span three region; change in land use , high evolution in toxic chemical free for to the environment and depletion of natural resources. As that resources are used , misuse are generated and disposed of. Thus, the extent of resource exploitation , misuses generation and environmental mutilation relies on that culture’s lifestyles and pattern of consumption. India’s bulky population base of which wide numbers are living below penury line , non-sustainable agricultural and industrial practices.

Changes in land use and environmental vitiation in the country is mainly due to urbanization is likely to be associated with increased landutilization for non-agriculture purposes and density of population with vigour cropping pattern. There is ample collection of data produced from remote sensing and vary from the very high spatial resolution images (such as CartoSat, IKONOS and Quickbird), to regional datasets produced at regular intervals (e.g., LISS III, TM/ETM, SPOT), to lower spatial resolution (>250 m) images now produced daily across the entire Earth (e.g., MODIS). The temporal dynamics of the synoptic view of the earth's surface by satellite assisted data capture has given us an important tool to study the variations in land use and land cover over a period of time. The changes in the land use and land cover manifested as a function of the changes either natural or manmade, have a bearing on the reflectance patterns of incidence radiation due to the changes in the vegetative cover, soil moisture or the various modifications of the earth's surface (Navalgund, 2001). Since the changes in land use and land cover are more or less unidirectional, without much oscillation, it is safe to extrapolate the changes in spatial extents and also calculate the rate of changes. A very important tool in this regard is the Geographical Information System (GIS). The Geographic Information System is a powerful tool in which spatial information can be stored, organized, and retrieved in a user friendly environment. The Conjunction of satellite remote sensing data and ancillary data in a GIS environment combined with the Global positioning system (GPS) data is a potential tool to environment management.

II. STUDY AREA PROFILE

Sanand is a Taluka located in Ahmedabad district of Gujarat. Sanand city is located on the south western side of Ahmedabad at a latitude of 22°58´60" N and longitude of 72°22´66" E. It is one of 11 Talukas of Ahmadabad district. There are 52 villages and 2 towns in Sanand Taluka. Sanand is part of the dedicated Viramgam Special Investment Region of Gujarat.



A. Location and Connectivity

Sanand is part of the dedicated Viramgam Special Investment Region of Gujarat. Located near the city of Ahmedabad, Sanand is about 70 kilometres (40 miles) from a recently rebuilt international airport. Sanand is linked to Ahmedabad and Kutch by state highway 17. The state highway 17 joins India's National Highway 8, part of the recently completed 4-lane Golden Quadrilateral highway linking Sanand to many of the major industrial, economic and cultural regions of India. Sanand is connected by a modern highway to Mundra Port, a fully operational and one of the fastest growing, recently expanded sea ports in southeast Asia. Sanand is about 350 kilometres (220 miles) from Mundra port. Sanand is also close to the proposed Dholera port and international airport. In addition to modern highways, Sanand-Viramgam has an operational broad gauge railway network connecting it to major industrial centres of Gujarat. Sanand has become one of the booming entrepreneurial centres in India. Like industrial hubs in the developed countries and export centres in China.

B. Natural resources and Mineral

There is no forest area or minerals found in the District. The Nalsarovar Bird Santuary well known for migratory birds is located about 41 km south west of the city.

C. Drainage

There are no major rivers that pass through Sanand. Owing to the topography and the general slope in the area from North - East to South –West the water from the city finds its way from the local ponds in the town and drains off to Nalsarovar through natural drains. The city is dotted with lakes and ponds the most distinctive ones are Bhadreti Lake, Gadhiyu Lake and Lakshmana Lake.

D. Geography and Soil

Sanand belongs to the Gujarat Plains and hence the topography of the area is plain, Sanand town is majorly, a part of Sabarmati basin. The entire area under the Jurisdiction of the Nagar Palika is comprised of plain land with no hills or any other such features in the vicinity. The altitude of Sanand town varies from 6 to 10 meters above sea level. The higher area is Darbar gadha area, where as lower area is near Gadhiya pond. The general slope of the area is from North – East to South - west direction. Geologically the area in and around Sanand Town is composed of soft soil, recent alluvium, clay kankar hard murrum and pobble etc. varies in thickness up to 6 to 10 mts. Beyond this depth, upper layer of the area consist of solid, fine sands , murrum and alluvium.The Sanand Nagar Palika has a total area of 40.4 Sq.km. which is divided into 9 administrative wards; the panchayat of Gibpura is also included in this area. Till date, the gamtal area of Gibpura is governed by the Sanand Nagar Panchayat, which is also responsible for the provision of facilities such as roads, water supply, street light, drainage, solid waste management in the gamtal area.

E. Climate

Sanand being located in the western part of India has a dry climate. Temperature varies from 43□C to 47 □C in the summers and 5.3 □C to 16 □C in the winters. The predominant wind direction in the city during morning and evenings is from the South-west direction for most of the year. The rainfall in the area is restricted to the monsoon from June to September. Average annual rainfall of Sanand city is 750 mm which is almost equal to Ahmedabad district average annual rainfall *(Census of India, 2001).* The minimum was in the year 1975 as 100 mm and the maximum rainfall was received in the year 1976 as 1510 mm.The average water level rise during pre and post-monsoon is 01.82 m. in Alluvium area. The average rainfall is 662.58 mm. The ideal temperature in sanand noted at Max 47°C; Min 5.3°C

III. METHODOLOGY

A. Data Used

In this study, Indian Remote Sensing Satellite data and field information data was used. The collected data were compiled and analyzed systematically by keeping in view of the objective of the study. GIS and Remote Sensing techniques are used for the visual analysis and interpretation of the images.

B. Data Acquisition

To do EIA and to analyze eighteen year land cover change Two Landsat 7 ETM + data of January 2000, and Landsat 8 OLI & TIRS data of February 2018 was downloaded from the earth explorer site www.earthexplorer.usgs.gov Table 1 depicts the type of satellite data used.

SL.NO	Data Type	Source	Scale/Resolution	Date of pass
1	Land Sat 7 ETM+ (Enhanced Thematic Mapping Plus)	USGS Earth Explorer	30m	16^{th} February 2000
2	Land Sat 8 (OLI/TIRS) Operational Land Imager/ Thermal Infrared Sensor	USGS Earth Explorer	30m	9^{th} February 2018

C. Software Used: QGIS

QGIS (previously known as Quantum GIS) is a cross- platform free and open source desktop geographic information system (GIS) application that provides data viewing, editing, and analysis. Similar to other software GIS systems, QGIS allows users to create maps with many layers using different map projections. Maps can be assembled in different formats and for different uses. QGIS allows map to be composed of raster to vector layers. Typical for this kind of software, the vector data is stored as either point, line, or polygon feature. Different kinds of raster images are supported and the software can georeferenced images

D. Satellite Data Classification

The Classification of Image Land Sat 7 ETM+ satellite images of the years 2000 and Land sat 8 satellite images of the year 2018 will be taken for USGS for modeling Normalized Difference Vegetation Index (NDVI), Land use and Land cover (LULC) maps and False Color Combination (FCC).For creation of Normalized Difference Vegetation Index (NDVI), use "Raster Calculator" tool in QGIS (2.18 version). Formula NDVI = NIR - RED / NIR + RED for NDVI calculation and for Land use and Land cover use "Dzetsaka Classification" tool for the year 2000 and 2018. The area of each category have been calculated and compared to study the temporal changes over a period of time.

E. Normalized Difference Vegetation Index (NDVI)

NDVI employs the Multi-Spectral Remote Sensing data technique to find Vegetation Index, land cover classification, vegetation, water bodies, open area, scrub area, hilly areas, agricultural area, thick forest, thin forest with few band combinations of the remote sensed data. NDVI is calculated as a ratio difference between measured canopy reflectance in the red and near infrared bands respectively.

NDVI calculated as

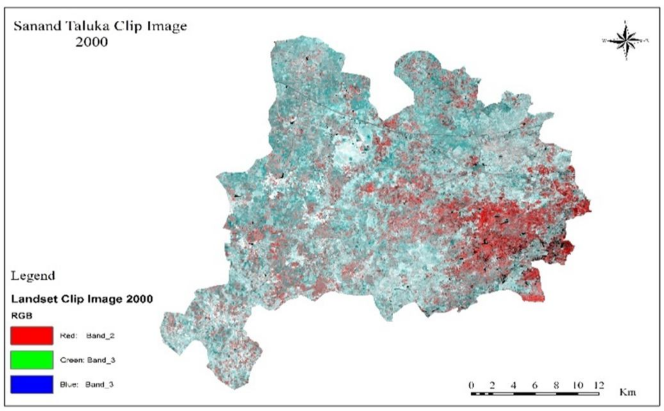
$$NDVI = NIR\text{-}RED / NIR + RED$$

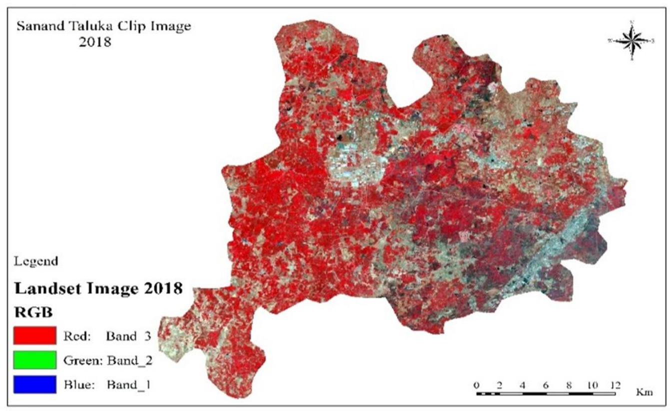
Where RED is visible red reflectance, and NIR is near infrared reflectance. The wavelength range of NIR band is (750-1300 nm), Red band is (600-700 nm), and Green band is (550 nm). Bare soil is represented with NDVI values, which are closest to 0 and water bodies are represented with negative NDVI values.

IV. RESULT AND DISSCUSION

The study to land/cover change from 2000 to 2018. It also aimed to find out the areas of rapid change, magnitude of change and assess the past and present condition of Land Cover to understand the dynamics and trend of change

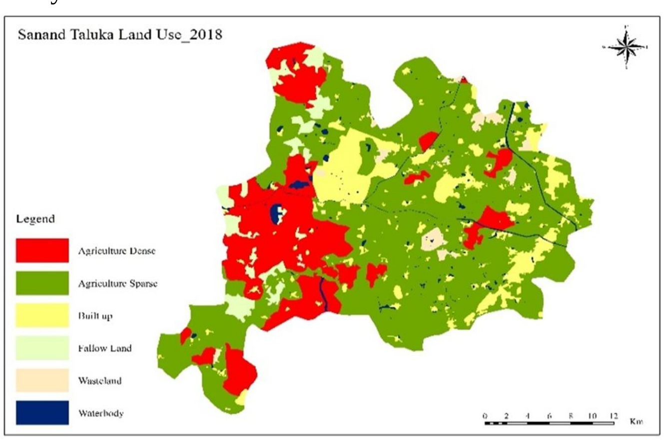
The major objective of the study to do monitoring of land use & land cover change in Sanand area using multiyear remote satellite data and GIS techniques. Mapping of density in Land use & land cover using remote sensing data of 18 years. To do study and assessment of environmental factors and analysis of Land use/cover change conversion using remote sensing and Geographical Information System.

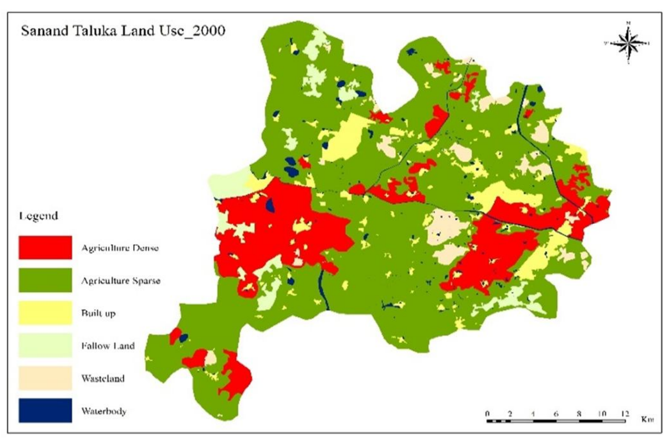




FCC Image of Sanand Taluka 2000 (based on Landsat 7 THM+) . FCC image of Sanand Taluka 2018 (based on Landsat 8 OLI & TIRS)

Similarly, monitoring of year 2018 is carried out the result represents were the agriculture dense covered area by 20 %, Agriculture sparse occupies 59%, Waste Land area occupies 2% and Water bodies occupy 1%, Fallow land grasps 4% and built up is 12% of the study area.





Land Use/Cover status of the Sanand Taluka 2000 Land Use/Cover status of the Sanand Taluka 2018

Category	Area (ha)		Difference in area (ha)	Difference (%)
	2000	2018		
Agriculture Dense	15574.73	16312.45	737.72	4.74%
Agriculture Sparse	50836.03	47955.70	-2880.33	-5.67%
Built up	6001.57	9784.91	3783.33	63.04%
Fallow Land	3478.14	3471.59	-6.55	-0.19%
Wasteland	3181.33	1681.61	-1499.73	-47.14%
Water bodies	1639.03	1504.59	-134.44	-8.20%
Total Area In Ha	80710.84	80710.84	0.00	0.00

Table: Landuse pattern in 2000 & 2018 in Sanand

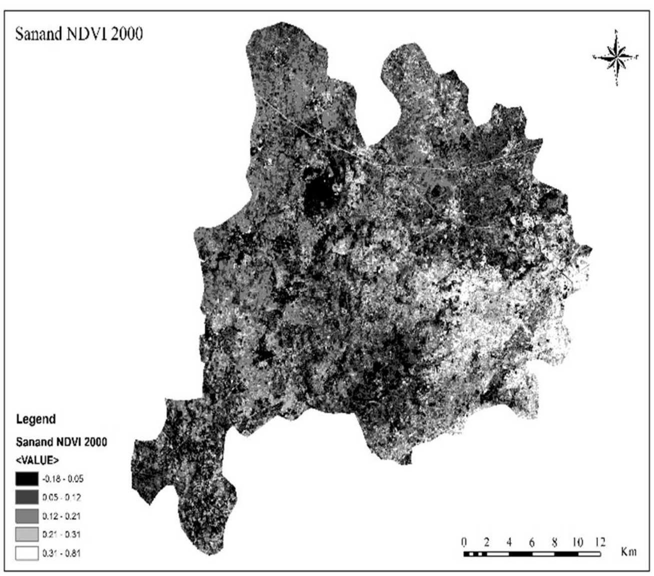
A. Major Results Of The Study Are As Follow

In the present study historical Google earth images, time series LISS III and LISS IV Images have been analyzed for the period 2000 to 2018 the land use/cover change analysis Using remote sensing and GIS technology.

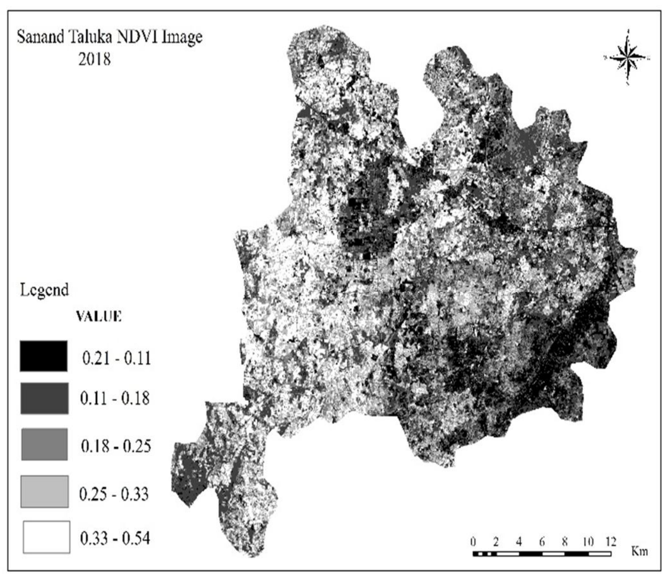
Category	FCC		NDVI	
	2000	2018	2000	2018
Agriculture Dense	0.432	0.288	0.397	0.285
Built up	-0.274	0.320	-0.096	0.051
Agriculture Sparse /Fallow Land	0.163	0.476	0.169	0.459
Wasteland	0.089	0.145	0.096	0.143
Water bodies	0.062	0.142	0.063	0.151
Total Values	0.472	1.371	0.629	1.089

Table: FCC & NDVI value of 2000 & 2018

The result of this study indicate that the total area of agriculture dense in the year 2000 was 19% and in the year 2018 it remained 20%, Similarly in year 2000, the Agriculture Sparse, Built up, Fallow Land, Wasteland, Water bodies followed by 62%, 7%, 4%, 3%, and 2% and In year 2018, the changes analysis followed by 59%, 12%, 4%, 2%, 1% respectively.

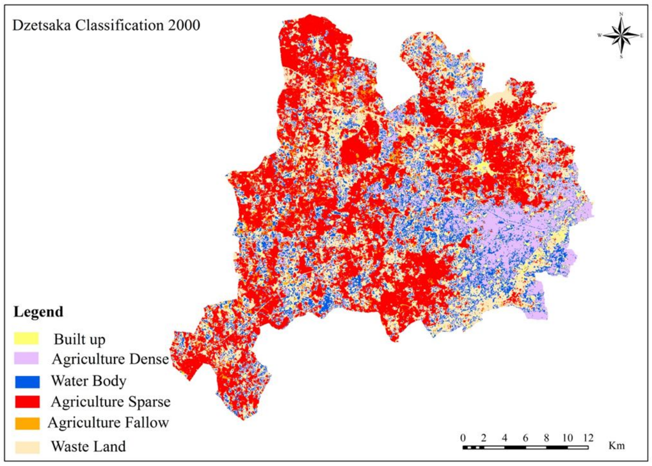


NDVI Image of Sanand Taluka 2000

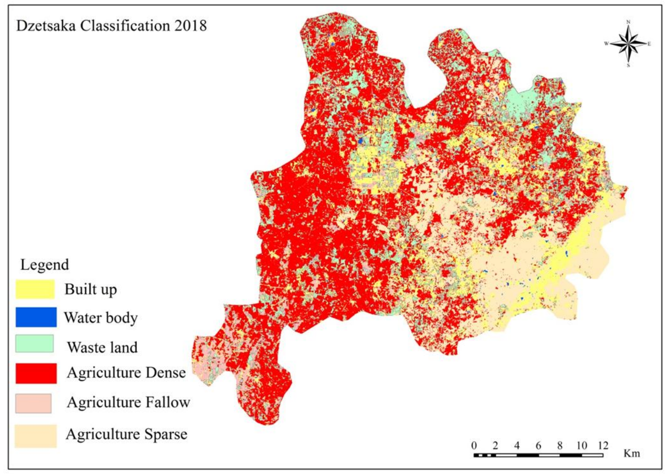


NDVI Image of Sanand Taluka 2018

The present study indicate that agriculture sparse area, water body is reduced and built up area, agriculture dense is increased and fallow land almost remained same.



Dzetsaka Classification Image of Sanand Taluka 2000



Dzetsaka Classification Image of Sanand Taluka 2018

The Dzetsaka Classification tool is a free open source plugin for QGIS that allows for the automatic Classification (also supervised classification) of remote sensing images.

V. CONCLUSION

The project Monitoring of Sanand area using geo-informatics technology was carried out using Landsat 7 TM+ & Landsat 8 OLI & TIRS Data of LISS –III of Feb 2000 and Feb 2018. The GIS Data was used to generate various base maps like study area map, transport network, river and water body to do assessment of environmental conditions in Sanand. Landsat 7 TM+ and Landsat 8 OLI & TIRS Data was analyzed for monitoring different land use classes along with different density classes of agricultural land. The online digitization technique was used for monitoring various land use/cover area. The area under different land use classes was also calculated using GIS and changes in various land use classes during last 18 years was also computed. NDVI Image of Landsat 7 TM+ & Landsat 8 OLI & TIRS LISS- III Data of Feb 2000 and Feb 2018 were generated. The NDVI Thresholding technique was carried out to classify forest into dense, Moderate and sparse categories, based upon the NDVI values and dzetsaka classification tool allows to make classification from a vector and a raster using Random Forest, Gaussian Mixture Model. This study has found that GIS are currently being used for all EIA stages, and that for most of these stages they are being used for data preparation, analysis/modeling, and results presentation. The reported advantages in using GIS for EIA justify this use, which are contributing to improving EIA effectiveness. There are three key reasons why GIS is improving environmental assessment effectiveness: better analysis, efficient storage and access to spatial digital data, and good visual display capabilities. Despite these advantages of GIS, this paper has identified a few remaining problems that need to be overcome in Sanand area in order for GIS to be a more widely accepted tool for EIA. The study area determines the key developments that must take place in the GIS field in order to help solve some of these problems in the near future of Sanand. The paper is based particularly on objective to show different land use/cover classes with their changing pattern. The study shows a change of land use/ land cover pattern over the years resulting in corresponding changes in climatic parameters like rainfall temperature etc. classification shows major 5 parameters to be considered for monitoring like agriculture dense, agriculture sparse, wasteland, fallow land and water bodies. Analysis of the changes in climatic parameters shows that the area of main agriculture sparse, water bodies and wasteland is decreasing continuously. It is vital that the existing status of environmental parameters in an around Sanand city must be assess in rationally manner by the stakeholders for them to get inspires towards sustainable development of the area. The major lakes in Sanand are Bhadreti lake, Gadhiyu lake, and Lakshmana lake. The total area of lakes and other water bodies was around 1639 hectares in 2008 and in the year 2018 it has decreased to1504 hectares. Unfortunately, it has decreased by 8% in eighteen years and is still decreasing. The lakes are now the place of disposal of storm water as well as untreated wastewater from nearby industries. The lakes and other water bodies play an important role in ecological balance of the area. The study revels decrease in blue cover that is water bodies which is detrimental to flora and fauna of the area. Therefore concerted effort are required to conserve lakes and other water bodies. Water quality in the lakes has also deteriorated because of waste water effluent released by the industries. According to the study if necessary measures are not taken in time then the scenario will be much more severe and a time may come when the water bodies will become dry in next 10 to 15 years. Due to release of untreated waste water adverse effect are being rampantly witness in Nalsarovar Bird Sanctuary which is around by 39 Km from Sanand. Furthermore as per GPCB it has been found quantity of Total dissolved solids where exceptionally high in the samples. Permissible limit is below 500 mg/l, however exhibited TDS is more than 2000 mg/l. There has been considerable increase in quantum of builtup area cover during the span of eighteen years from 2000 to 2018. In the year 2000, the builtup area cover was 6001 hectares which increase by 63 % over the years amounting to 9784 hectares in 2018, this enormous increase in builtup area is primarily due to rapid phase of industrialization. The quality of ambient air in the study area is compared with prescribed standards for ambient air quality. While the concentration of Sulphur oxides (SOx) is 16.8 ug/m3 and Nitrogen Oxides (NOx) is 18.8 ug/m3 was observed to be within the specified norms, the higher concentration of Suspended Particulate matter (SPM) and Respirable Suspended Particulate matter (RSPM) can be attributed to industries and vehicle traffic in the Sanand area. The higher concentration of suspended solid has direct impact on the respiratory system of the human beings. The increase in air pollution has considerably affected biodiversity in the study area.

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