Impact of Sanand Branch Canal on Landuse Pattern in Sanand Taluka, Gujarat, India using Geoinformatics Technology

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Abstract— The study here aims to analyze the changes that occurred in Landuse/ Landcover over a time span from 2001 to 2015 using remote sensing and GIS techniques. This paper focuses on evaluation of impact of branch canal in study region using satellite images with the help of software such as ArcMap, ERDAS.Impact of canal irrigation in the Sanand branch command area has been assessed and evaluated. About 16.399% of area has increased under cultivation during the period of study. This trend is continuing at present also.

Key words: Canal, Sanand, landuse change, supervised and unsupervised classification

I. INTRODUCTION

Surface irrigation is very important in Indian agriculture as having very less average rainfall and a few days of monsoon, artificial provision of watering the crops is absolutely essential. Evaluation of irrigation canal is done on based of cropping carry out using irrigated water. Land use is the manner in which human beings employ the land and its resources; it includes agriculture, urban development, grazing, logging, and mining. In contrast, land cover describes the physical state of the land surface, which includes cropland, forests, wetlands, pasture, roads, and urban areas (Jaisawal et al., 1999).

The detection and monitoring of change using multispectral satellite image has been a topic of interest in remote sensing. Change detection is an important application of remote sensing technology. Remote sensing is a viable means of extracting land-use and land-cover data, and hence provides effective inventory and monitoring of land-use change (Ridd and Liu, 1998; Mas, 1999). The aim of this study is to analyze the changes for Sanand taluka using IRS-P6 LISS III images that has occurred due to development of canal irrigation.

II. STUDY AREA

Sanand is a Taluka of Ahmedabad district. It is located at 22.98°N 72.38°E. It has an average elevation of 38 meters (124 feet). Annual rainfall varies from 319.44 mm to 1262.5 mm from 2000 to 2010 in study area. More than 70 per cent of the annual rainfall occurs during the monsoon season from July to September. Most of Sanand is a fertile plain having sandysoil.

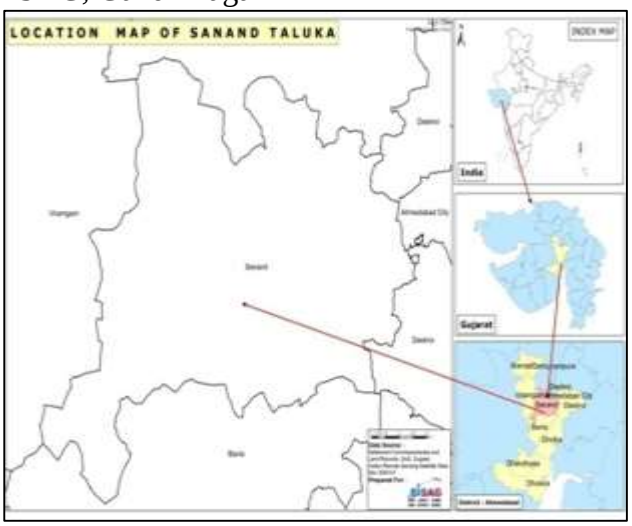

Fig. 1: Study Area Location map

The Sanand Branch Canal is 28.170 Km long, passes through Kadi Taluka of Mehsana District and Sanand Taluka of Ahmedabad District. Sanand Branch Canal crosses Irana-Indroda drain at Ch. 3.259 Km. It emanates from Narmada Main Canal at Ch. 258.632. There are Paddy, Cotton, Juvar, Pulses, Wheat, Vegetables, Gram, and Linseed Crops generally being shown in the command area of this canal. The general slope of command is flat. There are 8 No's of falls with total 17.087 m drop depth of all falls, constructed on the canal to traverse the geography.

The canal was constructed during 1998 to 2004 of a total cost of 2928.77 lacs and get fully constructed and operated since 2005. It is capable of running discharged at head 31.387 cumecs and at tail 8.074 cumecs. There are 18 no's of bridges, 5 no's of Nalah crossing and no river crossing locate at the canal for passing through the region.

III. DATA COLLECTION

A. *Satellite Data:*

Satellite images of IPS P6 of sensor LISS III for different years have been collected from government agencies such as BISAG, used for the overall study of change detection of area.

Sr.no.	Satellite	Sensor	Date of pass
1	IRS P6	LISS III	23Jan 2001
2	IRS P6	LISS III	22Nov 2004
3	IRS P6	LISS III	5Feb 2009
4	IRS P6	LISS III	22Nov 2011
5	IRS P6	LISS III	8Oct 2015

Table 1: Summary of Satellite Data

B. *Rainfall Data:*

Rain fall data has been obtained from State Water Data Center, Gujarat for the period 1999 to 2010 of Sanand Taluka. Average annual rainfall varies from 319.44 mm to 1262.5 mm.

Sr. No.	Year	Avg. annual rain (mm)
1	1999	745
2	2000	534
3	2001	530
4	2002	319.44
5	2003	739.4
6	2004	1051.6
7	2005	1073
8	2006	878.5
9	2007	913.5
10	2008	860.5
11	2009	363.5
12	2010	1262.5

Table 2: Average Annual Rainfall Data

C. Satellite Images:

The RS and GIS software used for study and analyse the data in ArcGIS/ArcMap. The satellite image of Indian Remote Sensing Satellite P6 (IRS P6) Linear Imaging Self Scanner III (LISS III) captured is used in analysis.

Fig. 2: LISS III Image of Sanand Taluka Of 2015

IV. METHODOLOGY

A. Thematic Map:

Various thematic maps such as landuse, soil, etc. have been prepared using Arc GIS as shown in Figure4 and Figure 5. The thematic maps are composed in ArcMap. In the landuse, crop land, fallow land, built up/indusial area, towns/cities, forest, waste land; water bodies, etc. have been identified in landuse pattern. The soil map defines the relative proportion of sand, silt and clay in mass of soil. This map classifies in different soil texture like coarse loamy, fine loamy, mixed, etc.

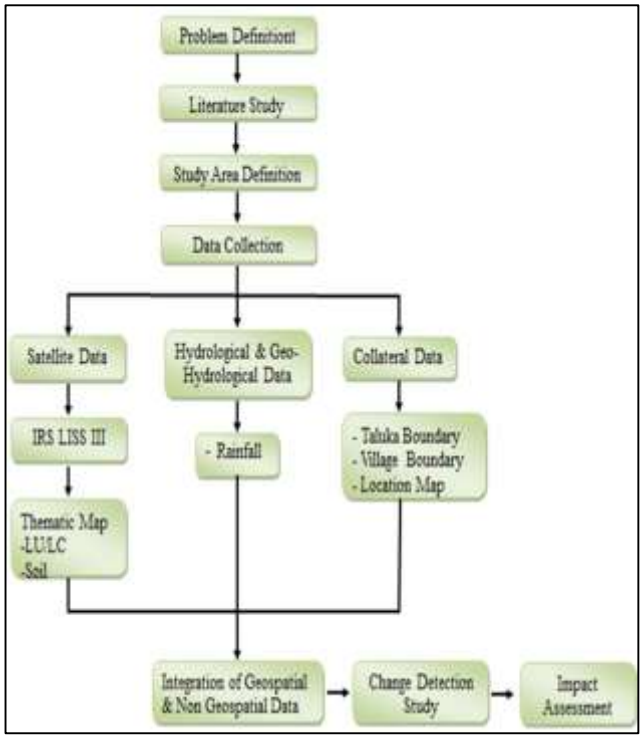

Fig. 3: Methodology

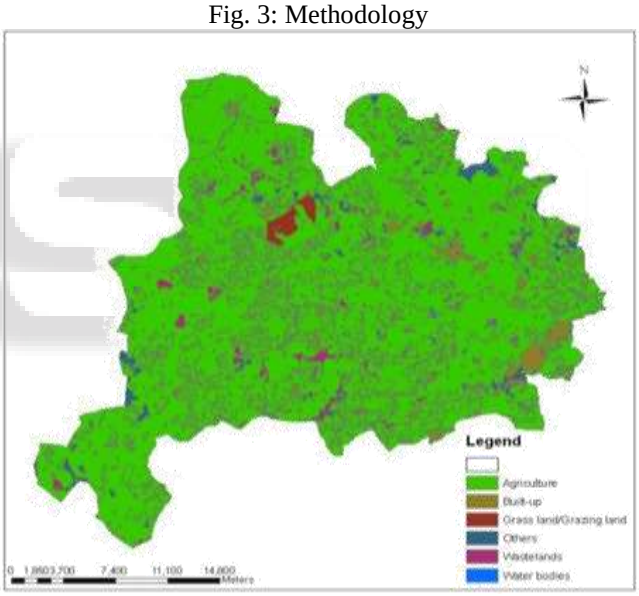

Fig. 4: Land Use Map

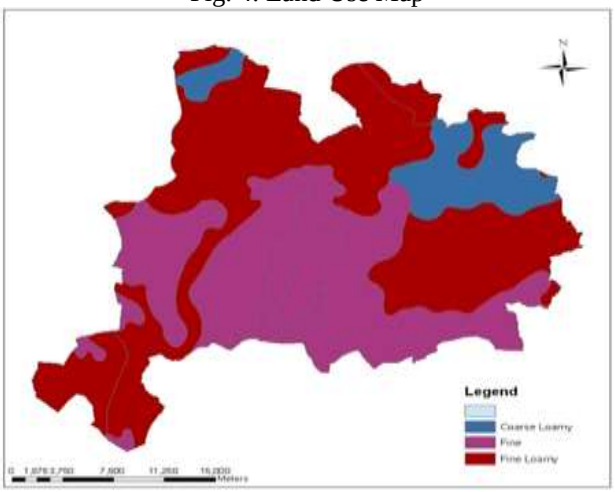

Fig. 5: Soil Map

Images were geometrically corrected and mosaicked. As the study involve detecting changes in the Land Use pattern, IRS-P6 LISS III Images were used for analyses of change detection. Classification of such Images of various dates has been done.

Supervised classification requires training sets as the reference signature. Unsupervised classification does not require such data sets. Both the classifications were performed on various images of varying years from 2001 to 2015. We have taken seven classes in unsupervised classification such are crop field, harvested land, barren land, water body, settlement and other. Getting the classes using vector format of that classified image area calculation has been carried out for different land use pattern.

While in case supervised classification reference signature have been selected based on visual image interpretation. Various sample polygons were selected to create signature. Using that signature supervised classification is carried out. Four land use classes is used i.e. crop land, Waterbody, harvested land and settlement.

B. Image Classification:

In present study, classification of LISS III image of various years has been carried out on ERDAS IMAGINE8.4 to study the change in landuse pattern. The steps for the procedure are mentioned below:

- Open raster image file by main menu, image band combination is carried out by: menu > Raster > Band combinations.
- Selcet AOI tools to carry out classification further. Use polygon to mark interested area.
- Use signature editor to add polygons to create supervised classification. Select Classifier > Signature Editor > Create new Signature form AOI. Add needed sample polygons and save as .sig
- To classify image select Classifier > Supervised classification. Add input raster file .img and input signature file .sig. Giving output path we will have the classified file .img.
- After getting the classified raster file, convert it into vector image from ERDAS > Vector > Raster to Vector. The generated output file is open in ArcMap.

C. Image Clipping And Area Calculation:

- To clip the study area boundry, we used the 'clip' tool from Arc Toolbox > Analysis Tools > Extract > Clip. By giving the Input Features and Clip Features, we got the clipped image.
- In this vector file pixels are divided by different polygons. Individual polygon must be named by a class. For that we have used 'Dissolve' tool to merge polygons by their grid. Arc Toolbox > Data Management Tools > Generalization > Dissolve.
- The dissolve file carries set of polygones for each class of image. So this set of polygons needs area. For that we have used 'Calculate Areas' tool from: Arc Toolbox > Spatial Statistics Tools > Utilities > Calculate Areas.

V. Discussion and Result

Analysis of satellite images have been carried out for the supervised classifications in ERDAS software. Spatial and non-spatial data (rain fall etc.) has been integrated to study the effects of canal irrigation on land use pattern in the study area. After completing all the necessary processes and using required tools like Clip, Dissolve and Area Calculation we have theareas of various landuse class of study area of varying years

Landuse Class	2001 (Ha)	2004 (Ha)	2009 (Ha)	2011 (Ha)	2015 (Ha)
Crop Land	37163.764	38908.373	39868.907	40803.453	41469.877
Water body	2848.828	2826.759	2831.465	2925.068	3040.464
Settlement	6116.238	6224.408	6262.725	6521.453	6530.982
Harvested Land	33878.572	32047.863	31044.305	29757.428	28966.079
Total	80007.402	80007.402	80007.402	80007.402	80007.402

Table 3: Areas Of Landuse Classes: Supervised Classification

Landuse Class	2001 (Ha)	2004 (Ha)	2009 (Ha)	2011 (Ha)	2015 (Ha)
Crop Field_1	12129.498	9173.069	14215.872	17046.250	10222.949
Crop Field_2	12320.211	15577.686	14280.951	11375.959	15929.496
Harvested Field	23053.791	24547.733	24018.716	25054.790	28173.428
Barren Land	6221.402	5840.576	5557.314	4700.431	4276.658
Water body	2933.976	2945.131	2929.918	3096.167	3218.199
Settlement	6277.591	6385.040	6450.354	6484.989	6574.723
Others	17070.934	15538.166	12554.276	12248.815	11608.949
Total	80007.402	80007.402	80007.402	80007.402	80007.402

Table 4: Areas Of Landuse Classes: Unsupervised Classification

In Supervised approach, we have four classes named cropland, water body, settlement and harvested land. Our focus is on crop land and harvested land, which has been increased by 11.587% from 2001 to 2015, while in unsupervised classification 7 classes i.e. crop field, harvested land, barren land, water body, settlement and other. In this approach crop land and harvested land increased by 16.399%. The introduction of canal irrigation has brought achange in LULC.

On the basis of classificationit was observed that there wascanal helped to maintain the condition of cropping in the area when rain is not sufficient. We have rainfall information from 1999-2010. The average rainfall of these data period is 769.58 mm.

In the year of 2001, average annual rainfall was 530 mm which is less comparatively. Also rainfall around 2001 was low. Then in the year of 2004 it was 1051.6 mm, that was good, precipitation wise and that implies crop increase. Now

in 2009 it was much less rain i.e. 363.5 mm but due to introduction of canal irrigation system crop yield in that year was stable instead of getting worst.

VI. CONCLUSIONS

With the help of remote sensing and GIS study change pattern in the command area of Sanand branch canal has been analyzed. It has been observed that area under cultivation during the year 2001 has increased by 16.399%. The use of this technology has helped in trend analysis of the change of the land use pattern. However, the results of canal irrigation has to be interpreted in conjunction of ground water use and rain fall data of the concerned period for finding the correct impact of canal irrigation. Also the monitoring of Land pattern change using remote sensing data in study region forms an essential element for creating policies of natural resources.

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