Assessment of Waterlogged Areas in Kheda District, Gujarat, India using Remote Sensing

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Abstract— The introduction of canals has made increment in food grains but at the same time it has also led to the introduction of waterlogging and subsequent salinization, rendering large portions of Agricultural land unproductive. Remote Sensing and Geographical Information System (GIS) techniques can be extremely useful in accurate mapping and quantification of waterlogged area. Thus helping in preparing a sound database required for taking up various reclamative and preventive measures. In this study visual interpretation of satellite data, authenticated by ground truth was carried out for delineation of waterlogged areas in Kheda district. Visible temporal changes of land use/ land cover have been observed in the Kheda Mahi Right Bank Command Area affected by water logging and salinity. Supervised classification and NDVI calculations based on the 2014 LISS III data show that total 1844 ha area comes under wetland mapping , in which waterlogging is 12.81% of the total wetland area.

Key words: NDVI Calculations, Satellite Data, GIS

I. INTRODUCTION

For Sustainable Agricultural Development There Is A Need To Develop New Technologies Suited To Local Hydro-Geologic Environment And Socio-Economic Conditions. There Has Been A Remarkable Increase In Food Grain Production In Kheda District, Especially After The Introduction Of Mahi-Kadana Irrigation Project. The Introduction Of Extensive And Enhanced System Of Canal Irrigation System Throughout The State Could Be Attributed To As One Of The Major Factors Contributing To This Phenomenal Increase. With Time Degradation Of Land And Soil Resources Due To Waterlogging And Salinization Have Been Noticed After Canal Irrigation

Waterlogging is one of the major problems of irrigation command area, which turn the highly productive land into unproductive lands. The major causes of waterlogging are seepage from unlined or damaged canals, poor drainage and excessive irrigation. In addition to this, natural factors such as topographic depressions, absence of natural. drainage and incessant rains have further compounded the waterlogging and salinity problems. Due to waterlogging and subsequent salinization, the fertile productive land is gradually becoming unproductive. Keeping in view the above situation, an attempt has been made to delineate, map and quantify the distribution of waterlogged area, using remotely sensed data and GIS techniques. And to find out the possible causes responsible for the problem and so that remedial measures can be taken. In this study, supervised classification was carried out using Imagine software ENVI 4.5. The Normalized Difference Vegetation Index (NDVI) was considered to estimate the surface wetness and to examine the impact of waterlogging on agricultural area

II. STUDY AREA

The district Kheda covers an area of 4,219 sq. km with total population of 22, 99,885 according to 2011 census. Geographic co-ordinates of Kheda district are Latitude 22^0-45^0 N Longitude 72^0-41^0 E with Altitude 21 m. The district has over 600 villages and Anand district was carved out of Kheda district in 1997. Kheda district covers Matar , Kheda ,Nadiad , Mehmedabad , Mahudha , Kathlal , Thasra , Kapadvanj ,Balasinor , Virpur talukas.

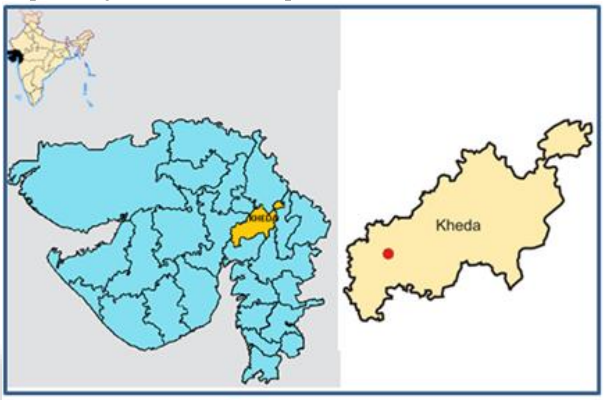


Fig. 1: Location Map of Kheda District

Previous Survey results show that total Wetland Area in Kheda district is 144.15 sq. km, which is 0.41% of total wetland area and 3.42% of District geographic area.

Major wetland category of the district are Rivers/ streams, Tanks/ponds, waterlogged and Reservoirs.

LANDUSE PATTERN OF DISTRICT	AREA(ha)
Cultivable land	298.54
Forest area	7.9
Land under non- agricultural use	1.5
Permanent Pastures	7.9
Cultivable wasteland	15.8
Barren and uncultivable land	9.8

Table 1 : Landuse Classification Of Study Area

III. METHODOLOGY

A. *Remote sensing data*

Use of satellite data enables to evaluate different land use classes like vegetation, waterbodies, salt affected area etc. by visual interpretation and other techniques. By classification methods various inventories for large regions can be done in relatively short period of time. Classification of remotely sensed data has traditionally performed by employing supervised classification or unsupervised classification. These classification is widely used to identify spectrally different groups of data.

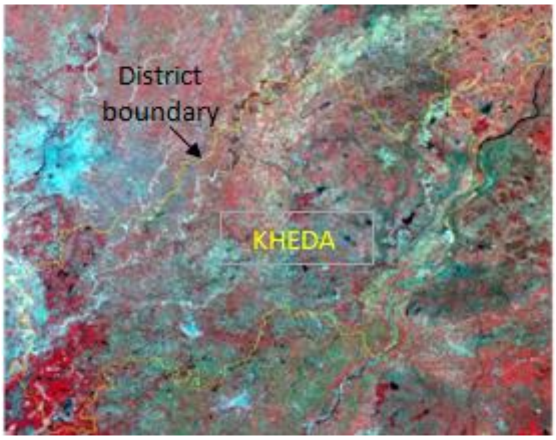


Fig. 2: IRS P6 LISS III 2006

Application of Remote Sensing for surveying and mapping of waterlogged and salt-affected soils began with the use of black and white photography. The relatively dark appearance provides the information about waterlogging whereas the bright appearance provides information about salinity due to the efflorescence of salt crust as shown in Fig3, provides the in which the pre-monsoon and post-monsoon scenario is shown

Pre-monsoon   Pre-monsoon

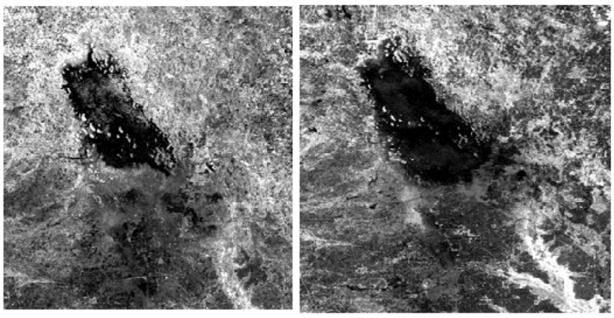


Fig. 3: PAN Panchromatic Satellite Images

B. *Soil conditions*

Major part of the Study area is covered by alluviam consist of fine sand and loamy soil. Loamy soil is considered good for agriculture. Infiltration rate in both of these sandy and loamy soil is high due to integral porosity and permeability. These types of soils allow vetrtical movement of water downward as well as upward causing in the rise of sub-soil water level and thus Rise in water table creates faourable condition for water logging.

Soil class	%
Coarse Loamy	18.19
Fine sand	15.81
Fine Loamy	64.75
Loamy	0.89
Loamy Skeletal	0.32

Table 2: Distribution of Soil Texture Categories

C. *Hydro-geology*

Hydro-Geology class	**%**
Alluvial Plain	63.70
Coastal Plain	3.08
Flood Plain	2.59
Pedi plain	23.29
Others	7.32

Table 3: Different Classes of Hydro-Geology

D. *Ground water conditions*

The following graphs show Ground water level of different villages of Balasinor, Matar, Mehmedabad, Thasra, Kapadvanj, Mahudha Talukas where waterlogging takes place due to rise in water level in post-monsoon compare to Pre-monsoon.

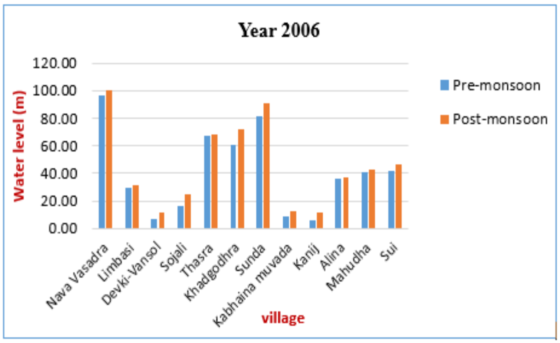


Fig. 4 : Ground Water Level In Year 2006

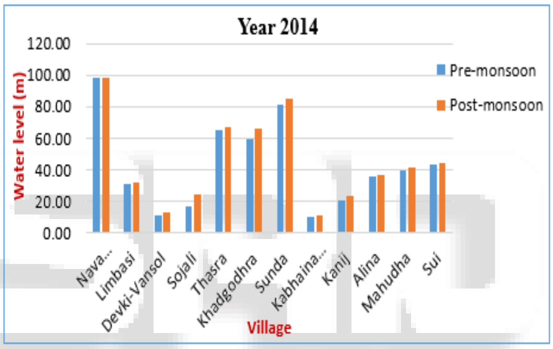
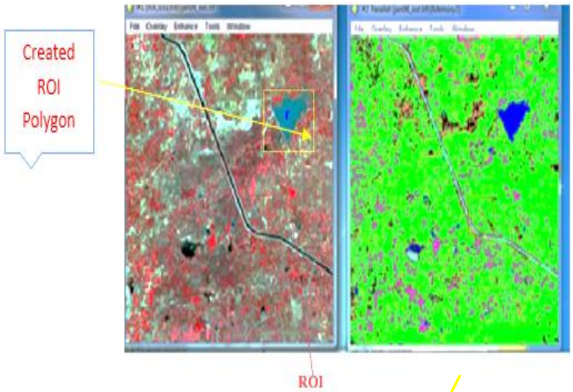


Fig. 5 : Ground Water Level In Year 2014

The above graph shows that the water level is highly rising in Sunda of Kapadvanj Taluka, Nava Vasadra of Balasinor Taluka, Khadgodhra of Thasra, and Thasra Taluka have threat to get waterlogged.

E. *Supervised classification using ENVI4.5*

Supervised classification allows the user to select training areas for use as the basis for classification. Various comparison methods are then used to determine if a specific pixel qualifies as a class member. There are different classification methods, including Parallelepiped, Maximum Likelihood, Minimum Distance, Mahalanobis Distance, Binary Encoding, and Spectral Angle Mapper. In present study Parallelepiped type of classification is used to identify the waterlogged areas. For this purpose ,Training Sets Using Regions of Interest (ROI)are selected:



The standing water areas appearing as dark blue to black depending upon the depth of water, while the wet areas appear as dark grey to light grey in colour/ tone on the imagery. Noticeable waterlogged area was identified on the image as blue to black mixed tone.

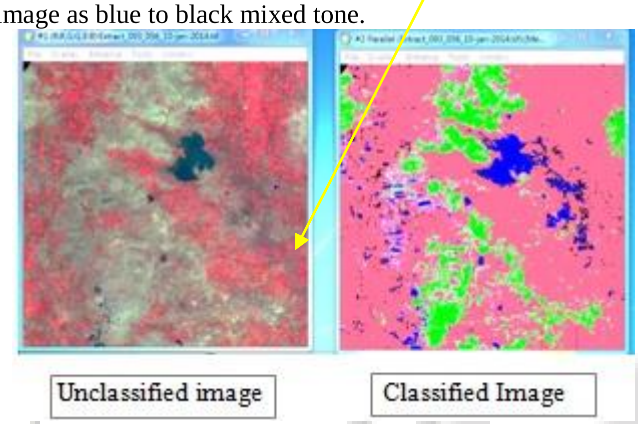


Fig. 6: Supervised Classification of LISS III Image Year 2014

The classified Raster image is then transformed to vector image to estimate the waterlogged area, the output generated is shown in Fig 7, in which the waterlogged areas are indicated in Blue colour in Map.

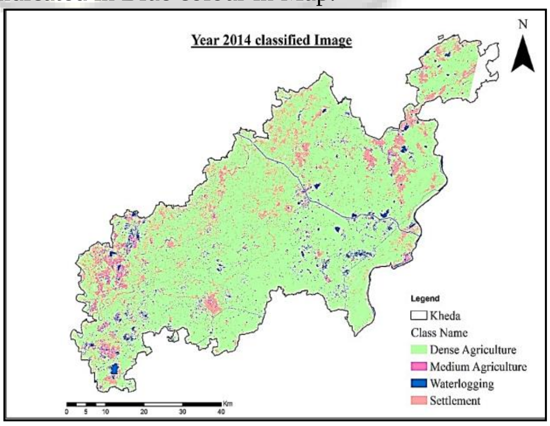


Fig. 7: Classified Vector Image File Year 2014

F. *NDVI calculation using ENVI4.5*

As water appears completely black in the Infrared remote sensing image, it is easy to delineate the water bodies in the infrared part of the image.

NDVI is calculated from the visible and near infrared light reflected by vegetation. Free standing water which have a rather low reflectance in both spectral bands and thus result in very low positive or negative NDVI values. The NDVI algorithm subtracts the red reflectance values from the near-infrared and divides it by the sum of near-infrared and red bands.

NDVI= (NIR-RED) / (NIR+RED)

–where RED and NIR stand for the spectral reflectance measurements acquired in the red and near-infrared regions, respectively. NDVI itself thus varies between -1.0 and +1.0.

False colour composite (FCC) constituted by three bands NIR, R and G bands are used for delineation of surface waterlogged areas.

Calculating NDVI for year 2014

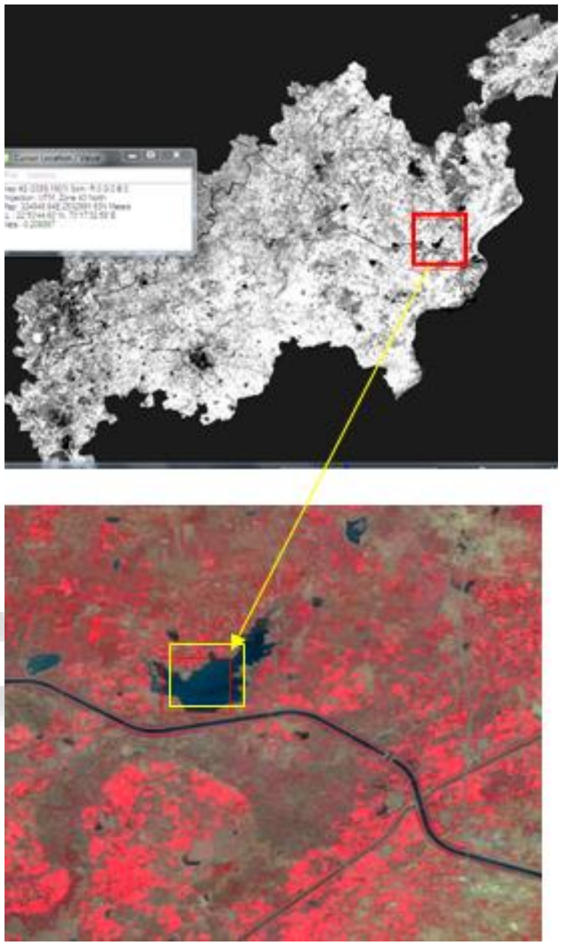


Fig. 8: Identifying waterlogged areas

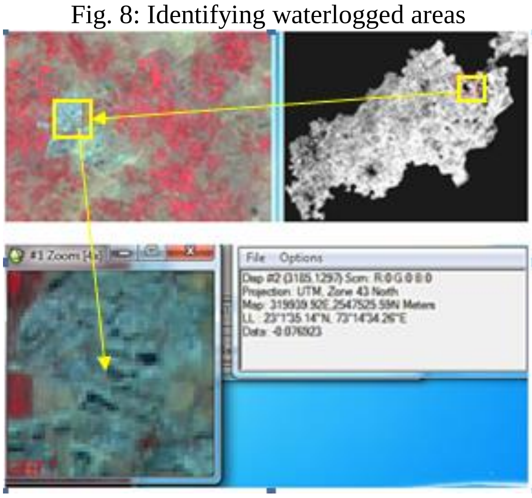


Fig. 9: Calculation of Ndvis For Different Waterlogged Areas

YEAR 2014

For pre-monsoon image:

CLASS	LAT/LONG	NDVI PIXEL VALUE
Waterlogging	22°52'N 73°21'E	-0.0769
	22°38'N 72°39'E	-0.1475
	22°48'N 73°21'E	-0.05
	22°45'N 73°8'E	-0.0827

Table 4: NDVI Values for Pre-Monsoon Year 2014

For post-monsoon image:

CLASS	LAT/LONG	NDVI PIXEL VALUE
Waterlogging	22°52'N 73°21'E	-0.2163
	22°38'N 72°39'E	-0.2710
	22°48'N 73°21'E	-0.1692
	22°45'N 73°8'E	-0.2068

Table 5: NDVI Values for Pre-Monsoon Year 2014

IV. RESULTS AND DISCUSSIONS

After studying and integrating the results of Supervised classification and NDVI calculations for the year 2014 , it has been observed that total 1844 ha area comes under wetland mapping , in which waterlogging is 12.81% of the total wetland area. The waterlogging has increased to 704 ha in post-monsoon Compared to Pre-monsoon of 502 ha.

Open water spread of the wetlands is much higher in post-monsoon (8079 ha) than pre-monsoon (3258ha).

Continuous waterlogging is observed in some portion of Matar and Mahudha Taluka. These areas may be considered as high priority for the use of ground water for irrigation. In Year 2006**, Mahudha, Thasra** and **Matar** talukas were prone to be waterlogged, whereas major Portion of these talukas shows waterlogging in Year 2014.

V. CONCLUSIONS

The analysis of remote sensing data has shown that waterlogged, salt affected area is increasing in the command area of Mahi Right Bank Canal. Study of imageries can show the areal extent of degraded lands affected by water logging and salinization and their temporal changes which would be helpful for planning of proper reclamation measures. Hence a regular monitoring of command area using satellite based remote sensing is essential for improving the performance of canal irrigation systems.

Canal seepage, Flat topography, inappropriate irrigation practices and cultivation of high water requirement crops are some of the factors which contribute to the waterlogging problem. These problems are further compounded by natural factors such as existence of topographic depressions, absence of natural drainage and heavy continuous rains. The rising groundwater levels in the study area shows that the conjunctive water use is necessary to prevent the possible water-logging conditions. Surveys show that the average annual income from agriculture has reduced due to degradation of agricultural land in the last decade. Thus there is a need for the promotion of water efficient irrigation methods like drip and sprinkler systems for the crops other than paddy. As per current situation, the better utilization of the rainfall should be done during the crop period so that it reduces the dependency on canals for crop water requirements.

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