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Assessment of Irrigation Potential Utilization in Middle Narmada Basin of Central India using Multi-Satellite Remote Sensing Approach

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ABSTRACT: For the establishment of the Indian economy, farming and its associated segments are the very essential wellsprings of living for over 58% of the population in India. For this purpose, remote sensing and GIS (Geographic Information System) techniques are effective tools for monitoring irrigation projects regularly. In the present research work, an attempt has been made to assess the irrigation potential utilization for the Barna irrigation project of the middle Narmada basin in central India for the Rabi season crops with the help of multi-satellite imagery. Two different objectives such as net sown area and satellite assessed irrigation potential were considered for the assessment of irrigation potential utilization for the study area. Landsat 7 ETM+ and Landsat 8 OLI satellite imagery has been used to prepare NDVI maps. Digitization of the command area canal network has been done using LISS IV satellite data. With the help of image classification and vectorization of NDVI images, the net sown area (687 sq km) for the study area has been calculated from 2014 to 2018. The accuracy of around 98% is obtained by the potential created by the Barna irrigation department and irrigation potential calculated using geospatial techniques.

Keywords: GIS, Irrigation, Landsat ETM+, LISS IV, NDVI, Remote Sensing.

Abbreviations: GIS; Geographic Information System, ETM; Enhanced Thematic Mapper, NDVI; Normalised differenced Vegetation Index, LISS; Linear Imaging Self-Scanning Sensors, OLI; Operational Land Imager, USGS; The United State Geological Survey, CCA; Cultivable Command Area, ha; Hectare, GPS; Global Positioning System.

I. INTRODUCTION

India is rich in irrigation structure (irrigation projects) and steps towards irrigated agriculture over rainfed agriculture are increasing to sustain food production and for the benefits of farmers [1, 2]. Irrigation projects require proper observation for irrigation potential utilization on a regular basis. Implementing suitable technology acts as an effective tool for estimating crop areas rather than conventional approaches [3].

Remote sensing is one such technique that can be used for monitoring the irrigation projects. With the help of public domain satellite data and quick processing methods, irrigation potential utilization scenarios for larger/smaller projects can be analysed, managed and demonstrating, such methods are the main focus of this study [4].

Public domain satellite data-based analysis is the cost and time effective mode which will also ease the government for attempting those studies [5]. It is necessary to do spatial and temporal monitoring irrigation potential utilization during Kharif, rabi, and summer crop season so that necessary steps can be taken for improvements [6]. Spatio-temporal information is required to fulfil the objective of the project i.e. to know about the progress and problems of the irrigated agricultural land. A number of satellites are available for providing such datasets like Indian and global satellites provides data at fortnight/monthly interval in medium/high resolution that helps in continuous data acquisition [7].

Landsat and Indian Remote Sensing (IRS) Resourcesat are more popular and useful in this category. Satellite data offer tremendous advantages for irrigated area mapping problems at various temporal and spatial scales [8]. There are various advantages of satellite data but has limitations too for one must be careful of, so that better irrigation mapping option can be chosen from available options accordingly.

Techniques for improving the identification of irrigated areas using remote sensing data include the use of multi-temporal imagery and ancillary data and these methods hold true across all spatial scales considered. Multi-temporal imagery gives better results while delineating irrigation land cover from other types [9].

II. STUDY AREA AND DATA

For the present research work, the Barna irrigation project has been selected as a study area. Barna irrigation project located in the Narmada basin and serves parts of Raisen and Sehore districts of Madhya Pradesh (India). The headwork of the project is located across Barna river near Bari village of Bareli Tehsil of Raisen district at 230 02'N and 780 03'E approximately 105 km from Bhopal on NH-12.

The reservoir has a catchment area of 1,176 sq km at the dam site. The project is designed to irrigate 88000 ha annually on cultivable command area of 70000 ha (Rabi 70000 ha and Kharif 47000 ha). The command area covers 198 villages–140 in Bareli Tehsil of Raisen District and 58 in Budni tehsil of Sehore District.

Different Satellite data for four different years and for different purpose i.e. for preparing NDVI maps, Canal digitization and image classification has been used for the present study. Landsat-8, Landsat-7 satellite images for the Barna Irrigation project (23 02'N and 78 03'E) were downloaded from USGS Earth-explorer with 30m resolution for Landsat images are given in the table below. LISS IV satellite image of 5.8m resolution has been provided by MAPIT Bhopal. These datasets were processed for geometric and atmospheric corrections and application-ready data sets.

Table 1: Satellite images used in the present work.

Image	Satellite/ Sensor	Date of acquisition	Resolution (m)
1	Landsat 8 OLI	17-11-2014	30 m
2		19-12-2014	
3		20-01-2015	
4		21-02-2015	
5		09-03-2015	
6		20-11-2015	
7		22-12-2015	
8		23-01-2016	
9		24-02-2016	
10		11-03-2016	
11		06-11-2016	
12		08-12-2016	
13		25-01-2017	
14		10-02-2017	
15		14-03-2017	
16		09-11-2017	
17		11-12-2017	
18		12-01-2018	
19		01-03-2018	
20	Landsat 7 ETM+	21-02-2018	30 m
22	LISS IV	26-01-2018	5.8 m

III. METHODOLOGY

Obtained command area map for the Barna irrigation project (available from Bhuvan site, USGS, etc.). After obtaining the command area map, the canal network has been identified and digitized using the LISS IV image of 5.8m resolution.

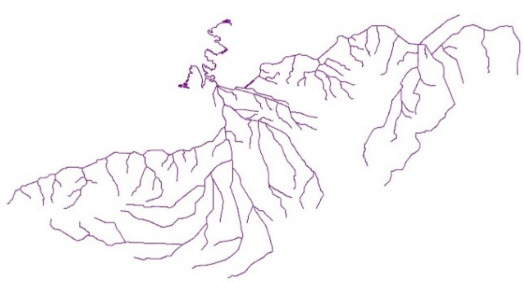

Fig. 1. Digitized canal network using LISS IV satellite imagery.

Satellite images with 30m spatial resolution have been used to prepare the NDVI map. Ground verification of satellite-derived canal length and actual constructed length on the field has been done. Superimposed the command area on satellite imagery and made necessary geodetic corrections.

Computing irrigation potential (IP) actually created was obtained using following equation:

$$\text{Satellite Assessed IP (ha)} = \frac{\text{IP proposed} \times \text{Satellite derived length}}{\text{Field reported length of canals}}$$

The gap between the potential created calculated using the above equation and field reported data of potential created has been estimated. NDVI map of the command area has been created for different years and the actual area of the crop grown (Rabi season) was calculated. Validation of the estimated crop area was done from actual ground verification. The general flowchart of the above methodology has been presented below.

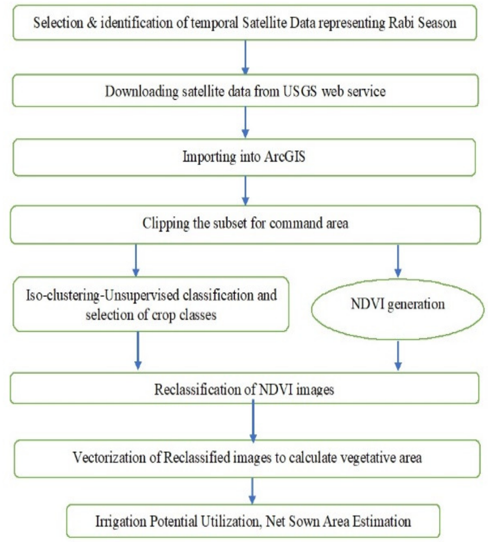

Fig. 2.

A. Vegetation Map

Difference between near-infrared (which vegetation strongly reflects) and red light (which vegetation absorbs), assists in evaluating vegetation using Normalized Difference Vegetation Index (NDVI). NDVI always ranges from -1 to +1. But there is no definite boundary of each type of land cover.

NDVI can be calculated by using following formula-

$$\text{NDVI} = \frac{\text{NIR} - \text{Red}}{\text{NIR} + \text{Red}}$$

If NDVI value close to +1, there's a high possibility that it's dense green leaves. NDVI map shown in the below figure has been prepared using Landsat images for 4 rabi season viz 2014, 2015, 2016 and 2017. Vectorization of Reclassified images to calculate the vegetative area.

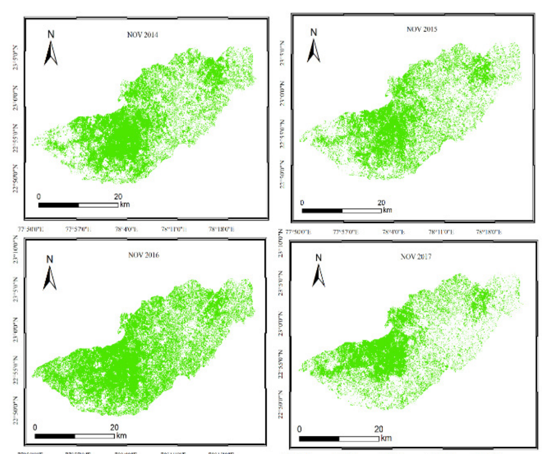

Fig. 3. NDVI images for November (2014-2017).

IV. RESULTS AND DISCUSSION

The present study mainly focused on the net sown area for Rabi season and irrigation potential utilization of the Barna irrigation project. 20 Landsat satellite images for different Rabi season (2014 to 2017) have been selected for the preparation of NDVI maps and reclassification of the NDVI image has been done to calculate the actual crop sown area.

Table 2: Calculated agricultural area through satellite imagery

Date of Landsat images acquired	Agricultural Area (sq. km)	Total CCA (sq km)
17-11-2014	319.648873	700
19-12-2014	150.376825	
20-01-2015	380.190811	
21-02-2015	687.338846	
09-03-2015	677.365124	
20-11-2015	264.457127	
22-12-2015	177.587591	
23-01-2016	396.892576	
24-02-2016	629.005102	
11-03-2016	511.714487	
06-11-2016	227.434144	
08-12-2016	179.754199	
25-01-2017	517.335153	
10-02-2017	597.619013	
14-03-2017	436.007626	
09-11-2017	238.688812	
11-12-2017	141.455425	
12-01-2018	417.147054	
21-02-2018	664.765786	
01-03-2018	619.488537	

The existing CCA of the Barna Canal System was assessed based on the actual Rabi Irrigation of 70000 ha. The table below shows the comparison between irrigation potential utilization through GIS technique and irrigation potential created by the water resources department.

Table 3: Comparison between Potential created vs Satellite assessed IP.

Canal	Digitized Length	Actual Length	Actual CCA (sq km)	Assessed IP (sq km)
Right Bank Main Canal	12.6 km	12.5 km	350.48	348.34
Left Bank Main Canal	25.2 km	25.3 km	349.52	343.19
Minor distributary 1	5.4 km	5.3 km	80.52	80.06
Minor distributary 2	6.6 km	6.3 km	77.77	77.24
Minor distributary 3	8.4 km	8.4km	113.28	109.64

LISS IV satellite image of 5.8 m resolution provides good accuracy while digitizing the canal length is found to be very good. In future work, high accuracy may be achieved by using high-resolution satellite data for the digitization of the canal networks. Land use land cover map has also been generated using the Sentinel-2B image (10 m resolution) and is used for determining the threshold limit for NDVI images. NDVI images have been prepared using Landsat scenes for the Rabi season for each year from 2014-2017 and the net crop sown area has been calculated using reclassify tool and vectorization has been performed to extract the exact crop area.

V. CONCLUSION

The present study deals with the applicability of remote sensing approaches towards the assessment of irrigation potential utilization of a major irrigation project. Results clearly indicate that assessment done using satellite imagery is quite close when we compared it with the actual ground data, digitized canal network has been compared with the actual existing canal network and its found to be very close with low errors and moreover crop area calculated with the help of NDVI images has also been compared with the actual cultivable command area. Actual CCA of Barna irrigation system is 700 sq-km whereas satellite assessed cultivable area which has been calculated using Landsat-8 ETM+ is 687 sq-km. Remote sensing technique is cheaper as well as time-saving than the other conventional approach. GIS and GPS are very beneficial for agriculture and watershed monitoring. Moreover, high-resolution satellite data are more accurate for canal digitization and for preparing land-use land-cover map as compared to freely available data of 30m resolution, but freely available satellite data also gives good results in preparing NDVI maps and for comparison of the agricultural area with the actual ground data. The government should assess the utilization of irrigation potential from time to time with the help of remote sensing and GIS.

REFERENCES

[1]. Ahmad, I., Ghafoor, A., Bhatti, M. I., & Akhtar, I.-u. H. (2014). Satellite remote sensing and GIS-based crops forecasting & estimation system in Pakistan. *Crop monitoring for improved food security*.
[2]. Bhalage, P., Jadia, B. B., & Sangale, S. T. (2015). Case Studies of Innovative Irrigation Management Techniques. *Aquatic Procedia, 4*, 1197-1202.
[3]. Chintapalli, S. M., Raju, P. V., Abdul Hakeem, K., & Jonna, S. (2000). Satellite Remote Sensing and GIS Technologies to aid Sustainable Management of Indian Irrigation Systems. *International Archives of Photogrammetry and Remote Sensing, 33*, 264-271.
[4]. Chowdary, V. M., Rao, N. H., & Sarma, P. B. (2003). GIS-based decision support system for groundwater assessment in large irrigation project areas. *Agricultural water management, 62*, 229-252.
[5]. Deshmukh, S. C. (n.d.). Performance Evaluation of Irrigation System an Overview.
[6]. Gorantiwar, S. D., & Smout, I. K. (2005). Performance assessment of irrigation water management of heterogeneous irrigation schemes: 1. A framework for evaluation. Irrig*ation and Drainage Systems, 19,* 1-36.

[7]. Inamdar, P., Singh, T. P., Metha, K., & Kumbhar, V. (2016). Assessment of Irrigation and Agriculture Potential of the Krishna River Basin using Geospatial Techniques. *Indian Journal of Science and Technology, 9.*
[8]. Kumbhar, V., Choudhury, S., Sen, A., & Singh, T. P. (2014). Assessment of Irrigation and Agriculture Potential Using Geospatial Techniques: A Case Study of “Bhima-Ujjani” Project. *Procedia-Social and Behavioral Sciences, 157*, 277-284.
[9]. Ozdogan, M., Yang, Y., Allez, G., & Cervantes, C. (2010). Remote sensing of irrigated agriculture: Opportunities and challenges. *Remote sensing, 2,* 2274-2304.

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