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A Novel Approach for Analyzing the Paddy Fields using Vegetative Indices by Remote Sensing the Data for Davangere Region

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Abstract:- With the ever increasing demand for food, the need for efficient management of agricultural practices is the need of the hour. Through the use of modern technology, every passing day has seen a surge in the amount of new techniques to improve agricultural management. One such method is through the use of Computer Vision practices which can be used to determine the optimal strategy for agricultural management like analyzing the best nutrition requirement for the soil, finding an optimal time and location to plant crops or spray fertilizers, herbicides and other such crop yield enhancers. Computer Vision practices can also be used to keep pests under control through detection and elimination of pests via a practice called Precision Agriculture. This paper discusses the image processing output from the Davangere region in detail, where the output has been developed through Remote Sensing operations. The output is then analyzed to provide optimal strategy for paddy fields.

Keywords:- *Precision Agriculture (PA), Remote Sensing, NDWI (Normalized Difference Water Index),NDVI (Normalized Difference Vegetative Indexes), NDBI (Normalized Difference Built Index) and SAVI (Soil Adjusted Vegetation Index)*

I. INTRODUCTION

One of the largest agrarian nations in the world is India, with a massive 70 percent of the population dependent on the agricultural sector for their daily income. The diverse nature of farmlands across India provides farmers with a variety of crops to choose from. But, the efficient utilization of farmlands to get top grade yield with optimal practices requires an in-depth technical analysis. One such example is where PA (Precision Agriculture) utilizes GPS and GIS to aid farmers in maximizing yield and minimizing by products. The latest trend of PA (Precision Agriculture) has leaned towards reducing the overall cost overheads in production while maintaining a focus on maximizing yield. This has been achieved majorly through the application of Satellite Imagery, a prominent Remote Sensing application [3,6]. An added advantage is through the use of GPS Technology (Global Positioning System) that would provide a geographical referencing system and will easily locate infertile or pest infected portions of the farmland that can be corrected.

A fundamental aspect of PA is Remote Sensing whose usage has grown exponentially by scientists and agriculturalists alike. In the last twenty years, a sophisticated progress in Remote Sensing Techniques has provided enhanced Data Acquiring capacity through rendition of observations made on the crop and also through satellite monitoring systems [7]. All these improvements have made it possible to implement Remote Sensing practices along with Precision Crop Management Systems.(Waheed et al., 2006).

The primary objective of this paper is to provide a brief summary of agricultural enhancing techniques like PA (Precision Agriculture), NDWI (Normalized Difference Water Index), NDVI (Normalized Difference Vegetative Indexes), NDBI (Normalized Difference Built Index) and SAVI (Soil Adjusted Vegetation Index). An outburst of world population in the 21st century has provided a challenge to the agricultural sector who have to constantly provide a sustainable production strategy to produce the maximum yield. One such emerging technology that can assist with this is PA (Precision Agriculture). The purpose of PA is to analyze the crop land prior to plantation and find out the weak spots in the land that need to be rectified in terms of nutrition, pests and other such malicious factors. PA also aims to evenly distribute soil fertility, seasonal monitoring of the crop, early detection and prevention of pests. Thus, the main incentive to apply PA techniques to farming is to enhance the overall profit, while also laying down a sustainable long term agrarian operation. It also takes preventive measures against detrimental effects to the surrounding environment.

II. BACKGROUND WORK

As a yield management context, Precision agriculture examines Within field spatial variability [1], site-specific information and variable rate application [2] with the involvement of many Machine learning techniques using remotely sensed data for the yield prediction. Advanced ML techniques such as support vector regression, boosted regression tree (BRT), Gaussian process regression (GPR), random forest regression (RFR)[7]. Further, techniques like

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Deep learning (DL) [4] and others [3,5,6] are used for image processing including remote sensing (RS) images that explores multilevel architecture to implicate coverage of land and classification of crop type from multi-temporal multisource satellite images.

III. METHODOLOGY

The major aspect of the current research work is to focus on usage of high spatial resolution data for determing the vegetative indices such as NDVI,NDWI,SAVI and NDBI which in turn leads to the marking of paddy field.

The methodology adopted for the research work is presented and described in Figure 1. required data, such as satellite images can be obtained by Landsat 8 OLI and Resourcesat-1(LISS –III) satellites. Data obtained is preprocessed using filtering, histogram equalization and band selection methods. Good analysis and interpretation of the maps leads to the development of a empirical equations for soil variables within fields and the vegetation indices such as NDVI,SAVI,NDBI and NDWI were calculated and paddy fields were marked based on the pixel values.

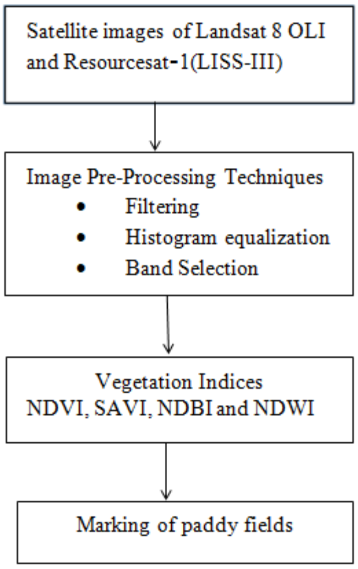

Fig 1:- Methodology of the research work

All the mentioned indices (NDVI, NDBI, SAVI and NDWI) which are calculated through the optimal usage of Images obtained from satellites have a value starting from a minimum of -1 and go to a maximum of +1.

A. *Normalized Difference Vegetation Index (NDVI)*

The NDVI or Normalized Difference Vegetation Index is the most widely used to keep track of vegetation and growth pattern of vegetation. NDVI is obtained from NIR & RED images from satellites as per the equation below.

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

B. *Normalized Difference Built-up Index (NDBI):*

NDBI or Normalized Difference Built-up Index is used to locate manmade structures like buildings, roads, bridges etc., and have indices range from -1 to 1. NDBI is obtained as per equation below:-

NDBI = (SWIR – NIR) / (SWIR + NIR)

C. *Normalized Water Index (NDWI):*

The NDWI or Normalized Water Index is used to locate water bodies. NDWI data is obtained from Green and NIR images from satellites. The formula for NDWI is as below:-

NDWI = (GREEN – NIR) / (GREEN + NIR)

D. *Soil Adjusted Vegetation Index (SAVI)*

SAVI= (1+L) (NIR-RED) / (NIR+RED+L)

L is the canopy background adjustment factor. L value of 0.5 in reflectance space will minimize soil brightness variations and remove the need for additional calibration for different soils. Vegetation indices. The resolution for SAVI is from" -1.5 to +1.5"

IV. RESULT AND DISCUSSION

BhuvanResourcesat-1 LISS-III satellite images for Davangere Geographic location were downloaded, images obtained from "Bhuvan LISS-III" images are in "TIF" format, Images are "Orthorectified". Spatial resolution of LISS-III images are 23.5Mtr, need for Reflectance Correction and Sun Angle correction are preprocessed in "Orthorectified" images obtained in "Bhuvan-LISS III". Unlike Landsat-8 images.

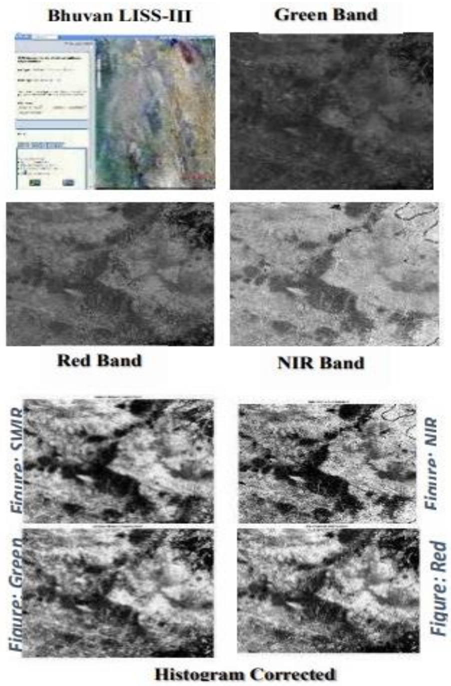

Fig 2:- Raw image and three different band images Corresponding to Red, Green and NIR Bands

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"TIF" Satellite images of Bhuvan -LISS III have pixel values of 0-255 (8bit), Histogram equalization is done for all the acquired images to improve contrast of images, Intensity range of the image are enhanced by spreading most frequent values of pixels.

Vegetation indices (NDVI, NDBI, SAVI)were calculated as explained in the equations.

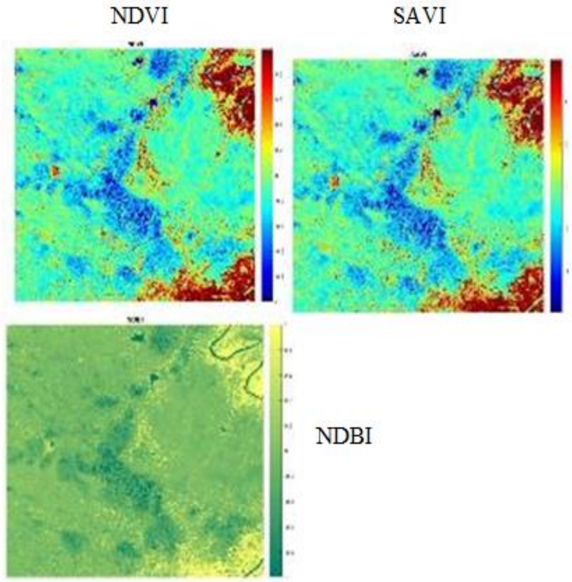

Fig 3:- Thresholding (Vegetation Separation)

For the obtained vegetation indices, "Thresholding" technique is applied to separate 'Waterbody', 'Barrenland', 'Vegetation', 'Trees' & 'Thick Vegetation' and 'Rice (Paddy)'.

	NDVI		SAVI	
	Upper Limit	Lower Limit	Upper Limit	Lower Limit
Water Body	-0.8	-1	-0.8	-1.3
Barren Land	0.2	-0.2	0.4	0.2
Other Vegetation	0.6	0.2	0.8	0.5
Trees, Thick Vegetation	1	0.8	1.1	1.3
Rice (Start of Cultivation)	-0.5	-0.8	-0.7	-1.2
Rice (Harvesting)	0.9	0.6	1.2	0.8
Rice(3 weeks to 12 th week)	0.6	0.2	0.8	0.5

Normalized Difference Built-up Index (NDBI) is used to extract built-up features and have indices range from -1 to 1. The built up area in NDBI will have maximum resolution, whereas in NDVI it will be near to "Zero"-0, the difference of NDVI and NDBI will allow us to decide between barren land and Manmade Built up areas.

	Built-up	Barren	Woodland	Farmland	Rivers	Lakes
NDVI	0	0	254	254	0	0
NDBI	254	254	254 or 0	254 or 0	0	0
NDBI-NDVI	254	254	0 or −254	0 or −254	0	0

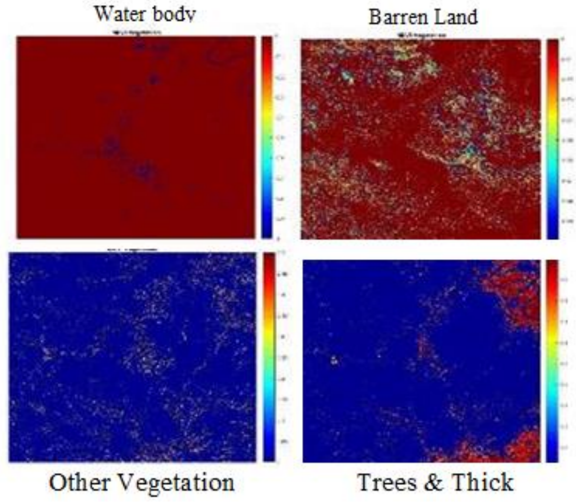

Fig 4

Diffrence of NDBI & NDVI i.e, (NDBI-NDVI) is calculated. The pixel values saturated after the difference were removed from NDVI. Manmade structures and Barren lands were removed. Only required Rice crops are marked.

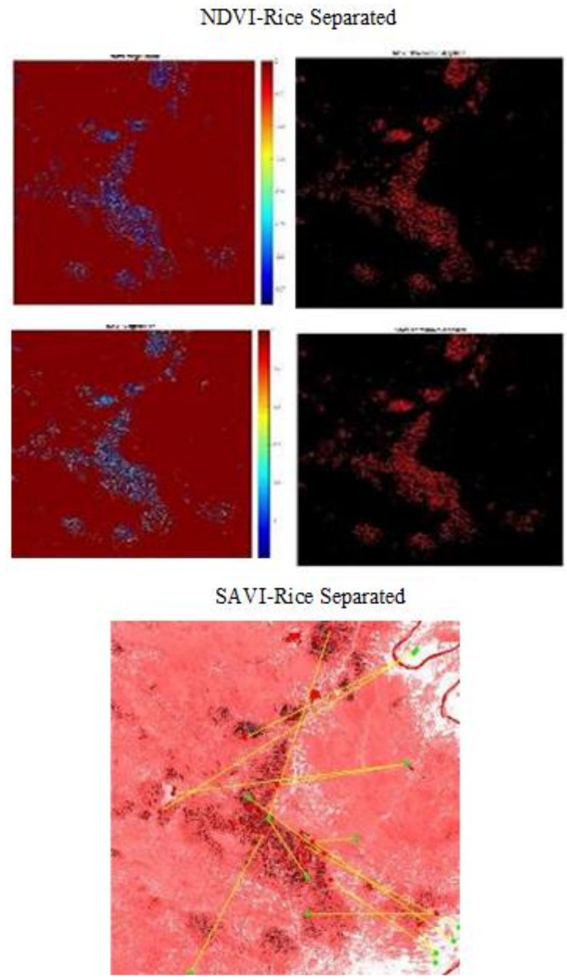

Fig 5

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Identifying the Rice crop irrigated land at the start of cultivation is important during 1st to 2nd week, this is the time where NDVI and SAVI values for rice crop will be in negative because Reflectance of light will be from more of water than the chlorophyll of rice. After third week NDVI and SAVI will start overlapping with other vegetation. The irrigated land identified at 1st to 2nd week has to be used for analysis.

The below results shows two data sets of 'Davanagere district' Karnataka- India. Jan 2018 is when Paddy cultivation starts and April 2018 is when Paddy is ready for Harvesting.

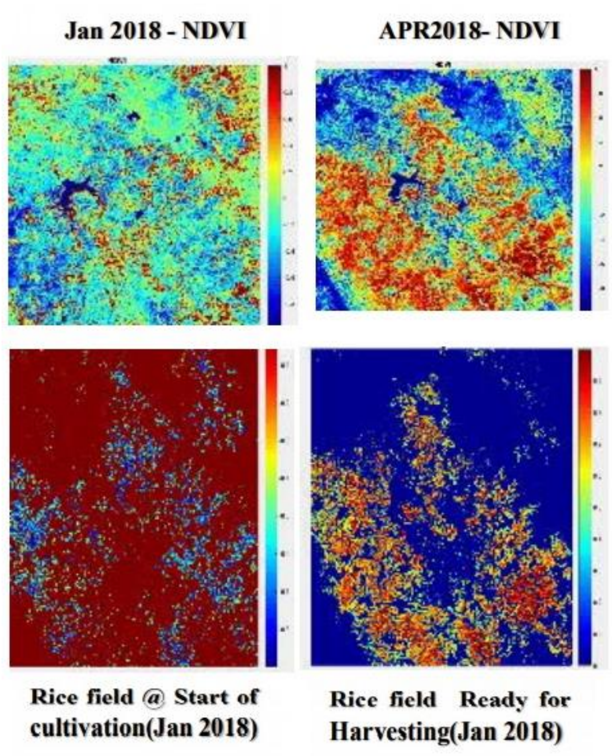

Fig 6

V. OBSERVATION

Jan 2018- Paddy cultivated in patches, Vegetation Indices in Negative values for cultivated area with indices value between -0.5 to -0.8. April 2018- Rice crop ready to Harvest have vegetation indices value of 0.85 to 1, Still not ready to Harvest Crop have 0.6 to 0.8.

VI. CONCLUSION

It is observed that Rice crop marking is possible during start of cultivation when the 'Vegetation Indices' values are in negative. With NDBI all manmade structures and barren lands can be removed from data at this stage.

Paddy fields ready to Harvest have vegetation Indices of 0.85 to 1, which is between 9th week to 12th week after cultivation. the range overlaps with Trees and Thick vegetation.

After cultivation from 3rd week to 9th week Vegetation indices are in the range of 0.6 to 0.8, the range overlaps with other vegetation.

Ortho-rectified data from "BHUVAN- LISS III' provided have high spatial resolution compared to 'Landsat or Sentinel' data. The data sets from "Bhuvan" are useful in accurately predicting Yield prediction.

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