AGRICULTURAL CROP CONDITION ASSESSMENT USING SATELLITE BASED VEGETATION CONDITION INDEX AND RAINFALL ANOMALY INDEX OVER SELECTED TEHSIL IN CHHATTISGARH, INDIA

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ABSTRACT

Indian agriculture is heavily dependent on the monsoon and a favorable southwest summer monsoon is critical in ensuring food availability to people of India. Crop condition is environmental phenomenon which can be depending upon its stage – rainfall deficit and/or level of impacts on hydrological cycle and agro-ecosystems.

Agricultural crop condition is one of the most prominent affecting economies in Chhattisgarh. Agricultural crop condition has been a recurrent phenomenon in many part of India. Remote sensing plays an important role for near-real time monitoring of the agricultural crop condition over large area. In the present study LANDSAT-8 data from 2013 to 2016 were used for monitoring agricultural crop condition through NDVI based Vegetation condition index. VCI was calculated for whole Durg, Rajnandgaon Bemetara, and Balod district in selected Tehsil using the NDVI variation. Rainfall Anomaly Index was computed from CPC NOAA South Asia observed rainfall data from2013 to 2016 for monitoring of meteorological condition of study area. VCI were compared with meteorological based Rainfall Anomaly index for monitoring Agricultural crop condition Durg, Rajnandgaon Bemetara, and Balod district in Chhattisgarh.

Results revealed that VCI and RAI could capture spatial pattern of vegetation condition and dryness within seasons and across different years. A comparative study on kharif crop conditions captured using VCI and RAI was made for different of year's viz., 2013 to 2016 as agricultural crop condition year, respectively. Crop condition severely affected which clearly discernable with both VCI and RAI of particular year.

Keyword : *Agricultural crop condition, LANDSAT - 8, NDVI, VCI, RAI.*

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1. Introduction

Agricultural crop conditions play a major role in the economic condition of India. Where more than 68% people are dependent in agriculture. About 16% of India total area is drought prone and about 50 million people are annually affected by drought (Dutta et. al. 2015).
Chhattisgarh state in central part of India. Chhattisgarh plains and Northern hills are the prime geographical landmarks that have been marked as the productive areas of Chhattisgarh agriculture. Paddy, maize, jowar, groundnut, gram, and wheat are major crops grown in Chhattisgarh. Chhattisgarh known for rice cultivation and called “rice bowl” of India. Favorable soil and climatic conditions helped the state to be a leading producer of rice, paddy, jwar, groundnut, gram, oilseeds and wheat in the country. (Source: Sharma Hari Om et. al. 2014).

Meteorological indices estimation in meteorological condition monitoring is based kharif season rainfall data. There are many indices which incorporate historic rainfall data for a given time period commonly used indices are, Rainfall Anomaly Index (RAI), (N.R.Patel et. al., 2015), Crop Moisture Index (CMI),(Jie WEI and Ailikun, 2009), Palmer Drought Severity Index (PDSI) (Jie WEI and Ailikun, 2009), and Standardized Precipitation Index SPI,(Nalbantis & Tsakiris, 2009). Every index has its own advantages and disadvantages.
Satellite data are effective in regional estimation and also for early warning of drought. It gives spatial information which is necessary for regular monitoring of drought. Various satellite based indices are developed like Normalized Difference Vegetation Index NDVI, Vegetation Condition Index VCI (Kogan, 1990), Temperature condition index was also suggested by (Konag 1997), (Thenkabail et. al. 2004), Vegetation Temperature condition index (Z. Wang et. al. 2004) and many more are used for drought monitoring. With the availability of LANDSAT 8 data it is easy to monitor short term Agricultural crop condition as it provides vegetation data on 30m scale.

2 Study Area

Study area is Durg, Rajnandgaon Bemetara, Balod district in selected Tehsil (Fig.1). It comprises of six Tehsil of Rajnandgaon (Chhuikhadan, Khairagarh, Dongargarh, Rajnandgaon, Chhuriya, Dongargaon), Three Tehsil of Bemetara (Saja, Thanakhamria, Berla), Kabeerdham (kawardha, Sahaspur Lohara), Balod (Gunderdehi), Durg (Durg, Dhamdha). In Chhattisgarh, India.Geographical area of 137, 90 thous and ha.

Chhattisgarh stretches across the latitudinal expanse of 17°46' to 23°15' North on one hand to the longitudinal meridian of 80°30' to 84°23' East.

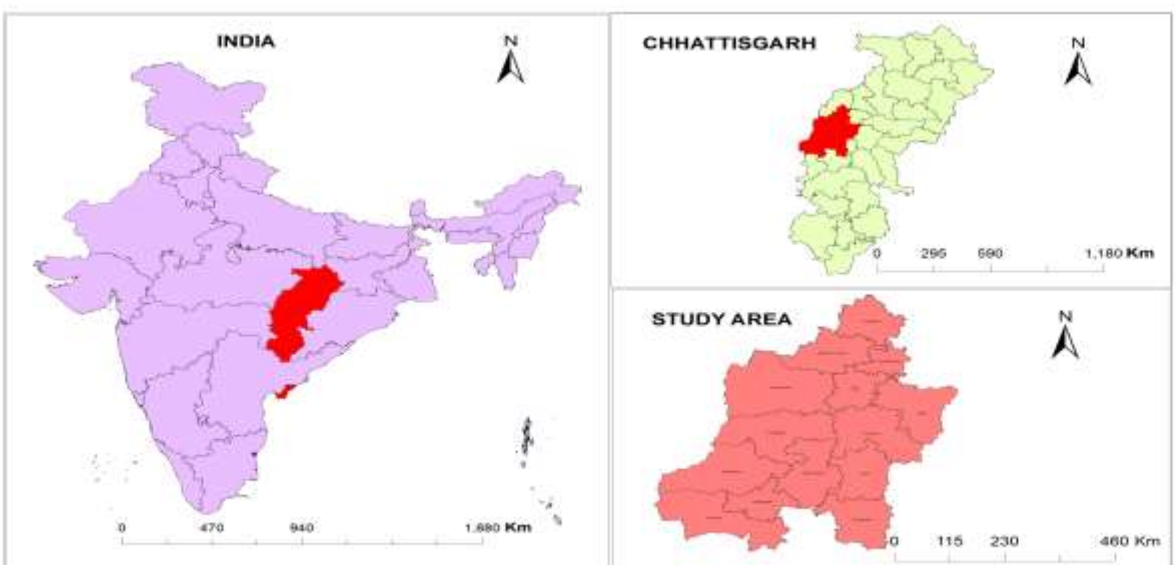


Figure 1 Location map of study area

3. Data used and Methodology

Data Acquisition

Data has been acquired from two sources: NDVI derived from satellite sources (14 years - monthly composite) and Rainfall Data from meteorological satellite data (NOAA CPC.) sources (14 years data- monthly composite).
Satellite data LANDSAT-8 satellite data was downloaded through distribution server: (USGS)Earth Explorer. The data is kharif season composite NDVI for India from which Chhattisgarh Tehsil was extracted from Jun to Nov for 2013 to 2016.

This data is used for Calculating vegetation condition index for crop condition monitoring. Its image has a constant resolution of 30 meter.

Meteorological data NOAA- CPC satellite data was downloaded freely through server: ftp://ftpprd.ncep.noaa.gov/pub/cpc/fews/S.Asia/data/ . The data is monthly composite climate prediction center in South Asia reason for India from which Chhattisgarh Tehsil was extracted from kharif season Jun 20013 to Nov 2016. This data is used for calculating Rainfall Anomaly index for meteorological condition monitoring. Its image has a constant resolution of 0.1 degree providing kharif season coverage of earth's surface.

3.1 Flowchart

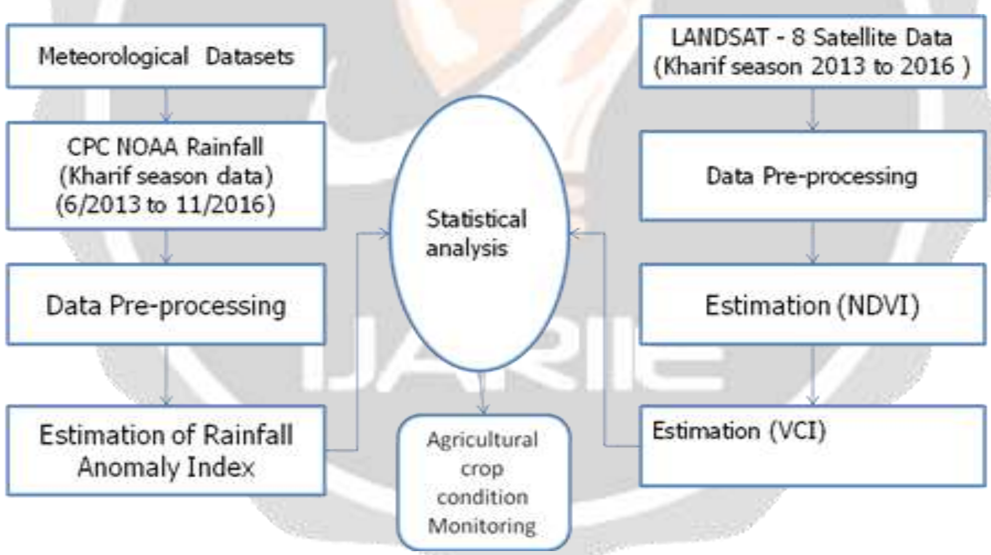


Figure 2 Flowchart

3.2 Methodology

Here is an idea of methodology used in the project. Correlation technique is used to show the relationship between RAI kharif seasons in selected Tehsil in Chhattisgarh. The flow chart mentioned below explains about the methodology adopted for this research work. VCI was calculated from NDVI image on basis from 2013 to 2016. Rainfall data was also used for the 2013 to 2016 year. Rainfall data basis calculated in Rainfall anomaly in 2013 to 2016. Then used correlation RAI and VCI. These indices were then used for some correlation.

4. Influencing Factors

4.1 Index Calculation

Under this part various indices (satellite and meteorological) are explained.

4.1.1 Normalized Differential Vegetation Index (NDVI)

The drought severity analysis was done on temporal basis for 2013 to 2016 years. The LANDSAT8 -NDVI was used to estimate the vegetation condition on basis as given in this equation.

$$NDVI = (NIR-R) / (NIR+R)$$

Where NIR is reflectance in near infrared band and R is reflectance in red band. Its value ranges between -1 to +1. Negative value indicates weak vegetation and positive indicates healthy vegetation.

4.1.2 Vegetation Condition Index (VCI)

It is a pixel wise normalization of NDVI over some time period, developed by Kogan (1990, 1995) to make a relation statement of changes in the NDVI signal by filtering out the contribution of local geographic resources to the spatial variability of NDVI. The VCI is computed as.

$$VCI = (NDVIi - NDVImin) / (NDVImax - NDVImin)$$

Where, NDVIi is the smoothed kharif season NDVI, NDVImax, and NDVImin are maximum and minimum NDVI, respectively, for that pixel and kharif season period from multiyear smoothed NDVI data and i define the kharif season interval. Its value ranges from 0 to 100.It is measured as percent. VCI with 50% value reflects fair vegetation condition, 50-100% indicates above normal. When VCI is 100%it suggests that NDVI value of that month is equal to NDVImax which indicates the optimum condition for vegetation.

4.1.3 Rainfall Anomaly index (RAI)

To indicate the meteorological drought for the growing season of kharif crop rainfall anomaly index is computed. Rainfall anomaly index give the drought years, the year with highest and lowest as well as the impact of drought and its severity in the study area. In this technique, the rainfall values for the period of study were ranked in the descending order of the magnitude with the highest rainfall being ranked first and lowest rainfall being ranked last. This technique developed by Van Rooy (1965).

$$RAI = \{(RFi - RF\ mean) / RF\ mean\} * 100$$

Where, RFi – is rainfall during month, RF mean - average rainfall at the same time during many years. Unit in mm the value ranges from -100 to ∞. Higher the RAI, higher rainfall in a decade period.

4.1.4 Analysis

VCI values of selected Tehsil are compared with RAI values for the year 2013 - 2016, to know the trend of both variables in monitoring crop condition and kharif season wise compared VCI and RAI. 2013 – 2016.

5. Result and Discussion

This chapter discusses about the total study that evaluate the agricultural crop condition using Satellite derived index (VCI), meteorological based index (RAI) and the comparison between VCI and RAI for getting the idea that which approach is best for monitoring drought using LANDSAT-8 data. The data of 2013to 2016 is considered as the time period for monitoring crop condition.

5.1 Analysis of satellite based Meteorological and Agricultural crop condition monitoring

Rainfall anomaly index and Vegetation condition index has been computed for selected Tehsil in Chhattisgarh of the study area. RAI and VCI has been computed for the Jun to Nov; kharif crop season for the year 2013 to 2016.

Satellite based meteorological condition and agricultural crop condition monitoring in study area was carried out using RAI and VCI. The results of monitoring crop condition during kharif season between Jun to Nov during 2013 & 2014 and 2015 & 2016 show the meteorological and agricultural condition, which are a series of maps indicating the stress condition in each kharif season period. The (Figures 2.) depict that the low values of RAI and VCI shows meteorological and Agricultural drought condition and high value of RAI and VCI shows the normal condition.

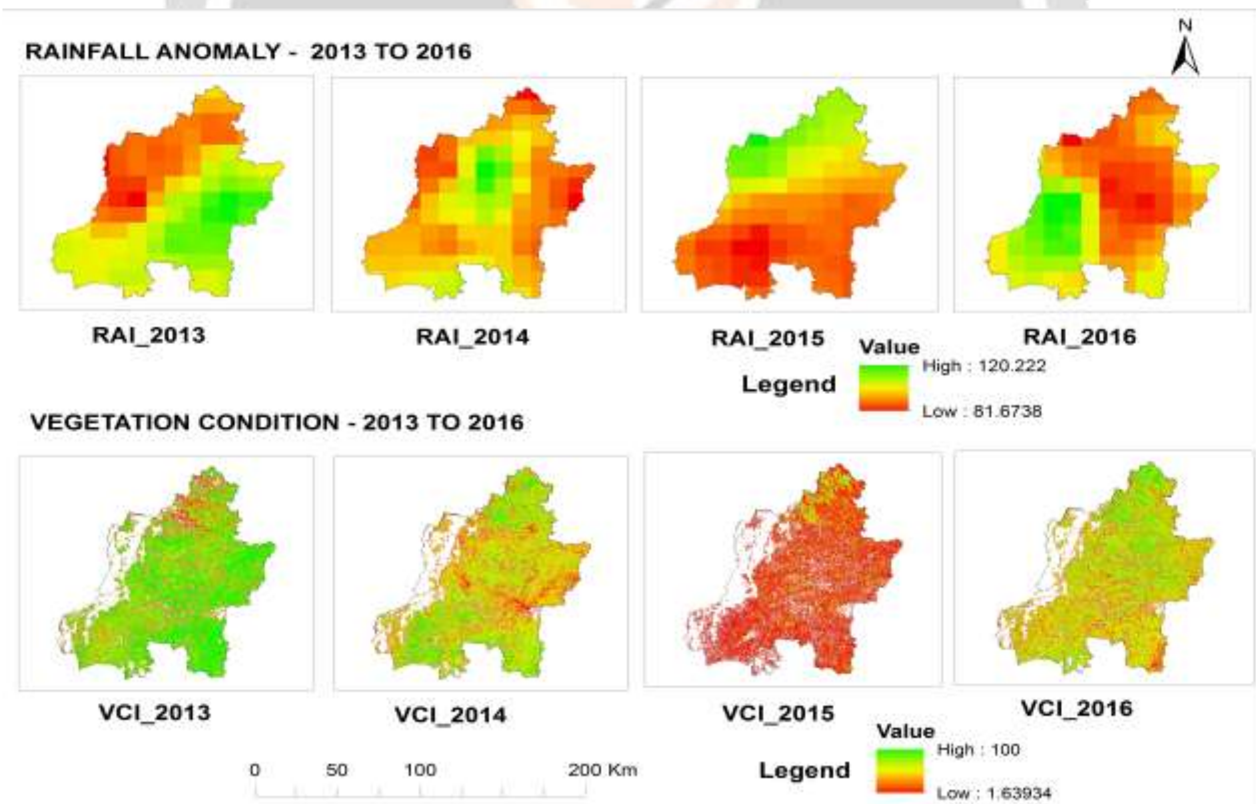


Figure 3 RAI and VCI 2013-2014, 2015-2016 year

5.2 Satellite based RAI Meteorological and VCI Agricultural crop condition monitoring in selected Tehsil

Satellite based meteorological condition and agricultural crop condition monitoring in study area was carried out using RAI and VCI. The results show the meteorological and agricultural crop condition during kharif season between Jun to Nov during 2013 & 2014 and 2015 & 2016, which are a series of maps indicating the agricultural crop condition in each kharif season period. The (Figures 3.) shows the Meteorological and Agricultural condition.

Comparison between meteorological condition in selected Tehsil Khairagarh, Chhuikhadan, Sahaspur Lohara, Kawardha in this Tehsil minimum rainfall 2013 as respectively show the weak agricultural crop condition and maximum rainfall in 2013Durg, Rajnandgaon, Dhamdha, Berla as respectively show the healthy agricultural crop condition. Meteorological condition in 2014, 2015, 2016 as respectively show in this years the Agricultural crop condition in selected tehsil.

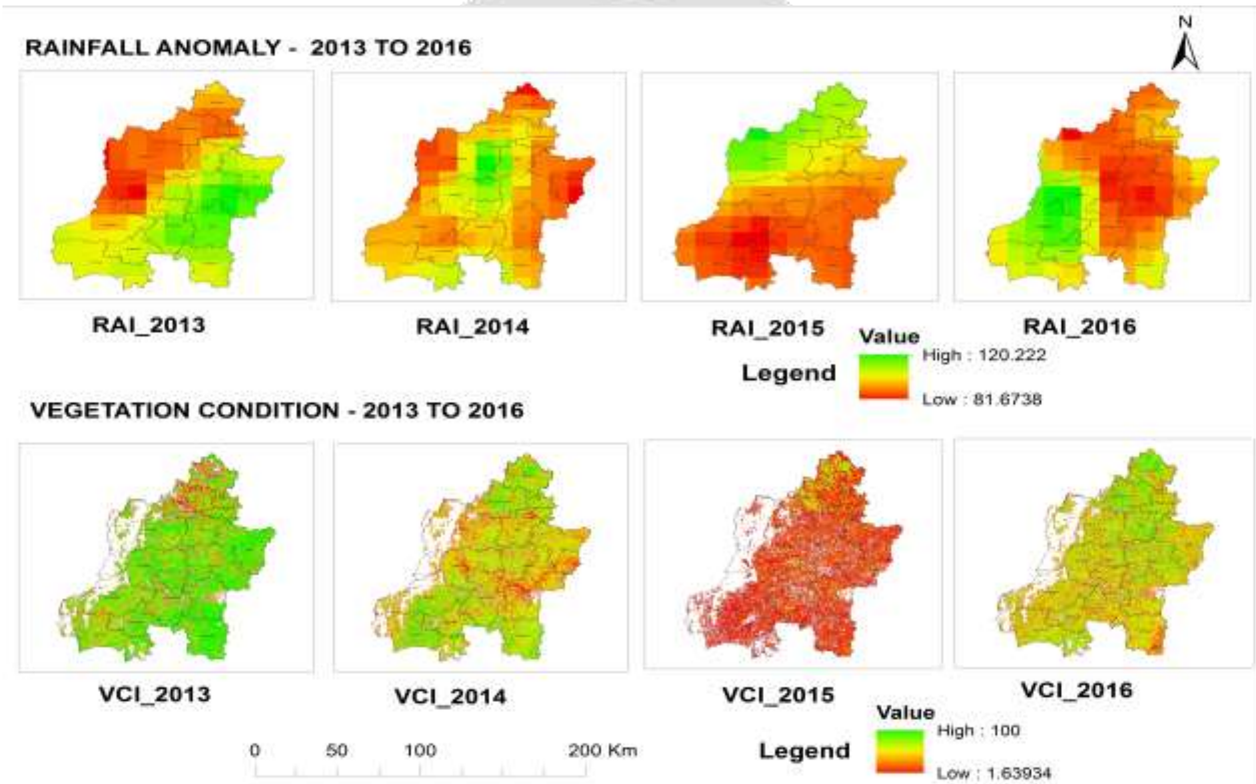


Figure 4 RAI and VCI 2013-2014, 2015-2016.year selected Tehsil in Chhattisgarh

5.3 Comparison between RAI and VCI

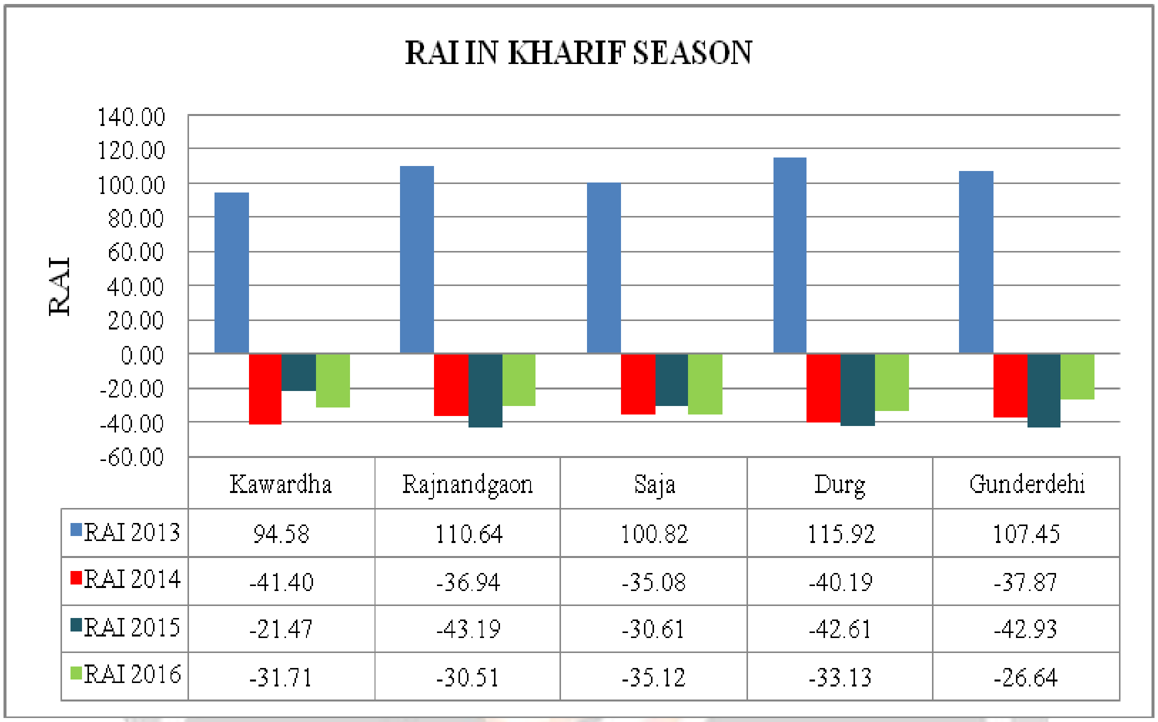
The VCI ranges from 0 to 100. Lower VCI value represents the less vegetation condition and higher value as the good season year 2013-2014 & 2015-2016, for five selected Tehsil.

5.4 Comparison between VCI and RAI selected Tehsil wise

Temporal pattern of RAI & VCI during kharif season year 2013-2014 & 2015-2016, for five selected Tehsil.

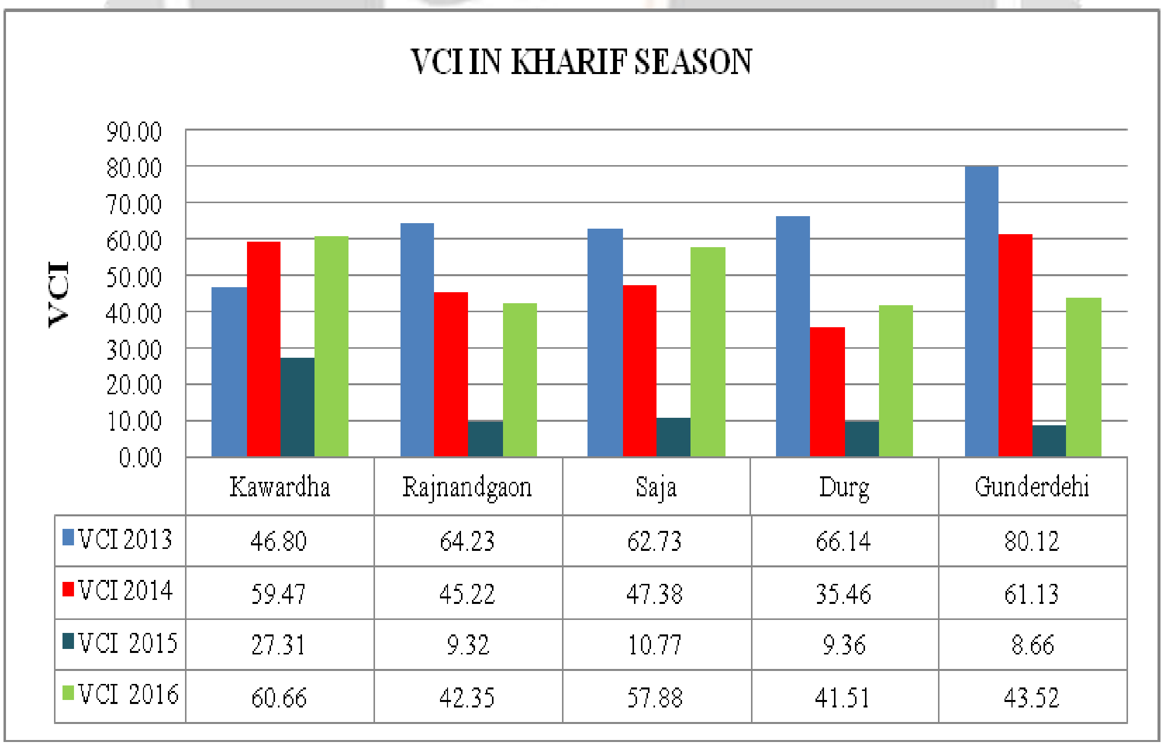
The (Figure 5) shows the selected Tehsil had maximum RAI in the year of in 2013 in Durg Tehsil and minimum RAI in the year of 2015 in Gunderdehi Tehsil.

The (Figure 6) shows the selected Tehsil had maximum VCI in the year of in 2013 in Gunderdehi Tehsil and minimum VCI in the year of 2015 in Gunderdehi Tehsil



	Kawardha	Rajnandgaon	Saja	Durg	Gunderdehi
RAI 2013	94.58	110.64	100.82	115.92	107.45
RAI 2014	-41.40	-36.94	-35.08	-40.19	-37.87
RAI 2015	-21.47	-43.19	-30.61	-42.61	-42.93
RAI 2016	-31.71	-30.51	-35.12	-33.13	-26.64

Figure 5 RAI and VCI 2013-2014, 2015-2016 year



	Kawardha	Rajnandgaon	Saja	Durg	Gunderdehi
VCI 2013	46.80	64.23	62.73	66.14	80.12
VCI 2014	59.47	45.22	47.38	35.46	61.13
VCI 2015	27.31	9.32	10.77	9.36	8.66
VCI 2016	60.66	42.35	57.88	41.51	43.52

Figure 6 RAI and VCI 2013-2014, 2015-2016 year

6. Conclusion

This section discusses about the extract derived from the results of the various different method used in this study for satellite based Agricultural crop condition monitoring.

The first conclusion which is made from this research is that integrated approaches are better than individual method for monitoring crop condition as they account for both satellite as well as meteorological data. They give better results in real time Agricultural crop condition monitoring. VCI provides good information spatially for monitoring crop condition.

The correlation between satellite indices and meteorological indices suggest that VCI gives better information about vegetation because it does not only describe the land use but also depicts the impact of weather on crop condition.

The main research area in this paper deals with VCI and RAI. The overall outcome of the work is that for monitoring Agricultural crop condition spatially RAI and VCI gives better results.

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BIOGRAPHIES

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