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Crop Separation with Sentinel-2 Temporal Satellite Imagery in Hingoli District, Maharashtra

Poonam Jayhind Pardeshi[1], Dr. Indal Ramteke[2], Dr. Sudhakar Shukla[3]

[1]M.Tech Scholar, School of Geo-Informatics, Remote Sensing Applications Centre, Uttar Pradesh, India
[2]Scientific Associate, Agriculture Resource Division, Maharashtra Remote Sensing Applications Centre, Maharashtra, India
[3]Scientist-SE and Head of School of Geo-Informatics, Remote Sensing Applications Centre, Uttar Pradesh, India

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Abstract - *Separation of multiple crop types is difficult to classify using Optical Remote Sensing and having similar harvesting and sowing time may create complexities in classification. Sentinel-2 satellite provides free data available to use for analysis, which is the most suitable choice for crop mapping. This study aims to classify and acreage estimation of different crops taken in the Hingoli district using multi-date Sentinel-2 imagery for Kharif season. Classification is achieved using the Unsupervised classification method with this overall accuracy is tested using Crop statistics data of the Department of Agriculture, Maharashtra.*

***Key Words*: crop; separation; k-means; sentinel-2; layer stacking; unsupervised classification**

1.INTRODUCTION

Agriculture, with its allied sectors, is the largest source of livelihood in India. Around 70% of its rural household still depend primarily on agriculture for their livelihood, with 82% of farmers being small and marginal. Therefore, planning and management of agriculture are also important for the economic development of the country. In this paper time-series, satellite imagery of sentinel-2 is used to get data of 10m of spatial resolution with 5 days of revisit time for data procurement.

As Sentinel-2 is the multispectral sensor with Blue, Green, Red and Near-Infrared bands having spatial resolution of 10m are most used bands for agriculture monitoring. Optical remote sensing provides required spectral bands for crop information which may be at local to global scales. Spectral indices, which are combinations of spectral measurements at different wavelengths, have been used to extract vegetation phenology or quantify biophysical parameters, such as leaf area index, NDVI (Normalized Difference Vegetation Index) calculation for estimating biomass and drought forecasting, VCI (Vegetation Condition Index) for crop condition assessment.

Here, Time series sentinel data of Kharif season is taken for analysis of the study area. To perform unsupervised classification with good accuracy crop statistics data acquired by the Department of Agriculture is compared.

2.STUDY AREA

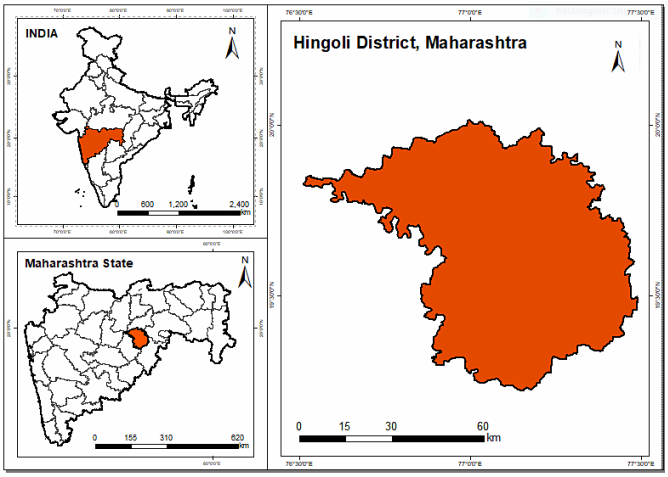

Fig -1: Location map of Hingoli district

Maharashtra is the third largest state in area and the second-largest state in the population of India. Having an area of 307,713 sq. km with 35 districts, 358 blocks and 43711 villages and a population of 112,372,972 with 45% population of the state is urban. Hingoli is the district of Maharashtra state which comes under the Central Maharashtra plateau & Central Vidarbha Agro-climatic zone. Located at 19.43”12.00” N Latitude 77.11” 00.00” E Longitude and at 547 m above sea level. For South West monsoon (June-Sept) normal rainfall is about 829.5 mm, Northeast monsoon (Oct-Dec) rainfall is 75.4mm, winter (Jan-Feb) monsoon rainfall is 10.2mm and for summer (Mar-May) monsoon rainfall is 31.5mm. Hingoli has a Net sown area of 345644.00 ha for Kharif crops only. For crop separation and acreage estimation, multi-temporal Sentinel-2 data is acquired for the Kharif season of 2021, from USGS Earth Explorer.

3.DATA AND SOFTWARE USED

Data used: Sentinel-2b, Shape files of Hingoli district, Crop Statistics data from Depart of Agriculture

Software: ArcGIS, Erdas Imagine, Google Earth Pro

4.METHODOLOGY

Crop separation is the classification of the different crops, which depends on various elements such as the growing cycle of crops and crop season. There are various crops such as Onion, Turmeric, Sugarcane, Cotton, Paddy, Wheat, Gram, Soyabean, Oilseeds, Pulses, etc. which are being used to classify them based on the multi-temporal classification. Hingoli district takes Cotton with Tur intercropping, Soyabean with Urad and Moong intercropping, Maize, Jowar and Other Kharif crops in Kharif season. Hence, in order to classify multiple crops, we used time-series data for classification.

Two major categories of crop classification techniques include Unsupervised and Supervised classification. Unsupervised classification is the classification method where output is based on the algorithms used by software without providing any training samples. And supervised classification is based on the signatures of training samples provided by the user. Where software uses training samples as references for the classification of all other pixels to classify the image.

Three different temporal images of October month were downloaded with dates as 13 October 2021, 23 October 2021 and 28 October 2021 selected for analysis with less than 20% of cloud cover. False colour composite images were obtained from band-2(Blue), band-3(Green), band-4(Red) & band-8(Visible and Near Infrared). The colour infrared band combination is meant to emphasize healthy and unhealthy vegetation. Near-infrared (B8) band is good at reflecting chlorophyll which shows healthy vegetation in bright red. Raster layer of agriculture mask and Orchard mask layer are applied on stacked NDVI image of agriculture fields for masking out only agricultural area for classification.

Unsupervised classification type is used for the present study. For spectral profile generation of Kharif crops and crop identification, unsupervised classification is performed on the masked NDVI layer. K-Means clustering method is used with the 50 classes. Where k-means is an algorithm that partitions 'n" observations into 'k' clusters in which each observation belongs to the cluster with the nearest centroid. The images are classified into clusters having similar pixels values. Class wise NDVI profile is generated, which helps to identify the crop based on their varying reflectance characteristics in the course of crop duration.

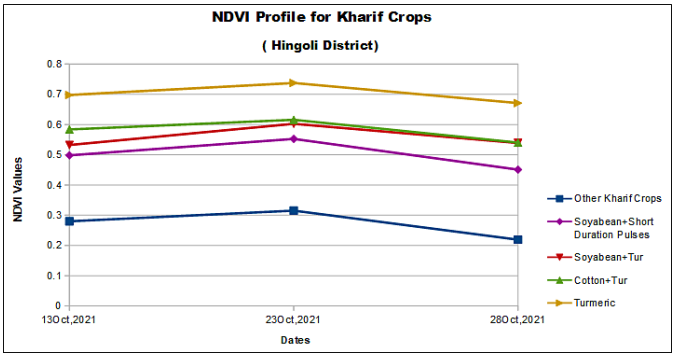

Chart -1: Graphical representation of identified Kharif crops, NDVI versus date graph (2021-2022)

Major Kharif crops taken in Hingoli are Cotton, Tur, Soyabean, Short duration Pulses and other Kharif crops. The crops taken abundantly can be identified easily but the crops taken with less production are difficult to classify. Hence, we take those crops in the other kharif crop class. As per the NDVI profile obtained through mean NDVI values, we can easily interpret that Turmeric crops are standing crops for the study area in Kharif season. Where, Soyabean crops are likely to be harvested in Oct- Nov month. Cotton and Tur crops are standing crops that will be harvested in Jan-Feb. And other Kharif crops are those crops that are taken in fewer amounts or the harvesting of crop is done or it may be late harvesting. Other standing crops are also taken in other Kharif class.

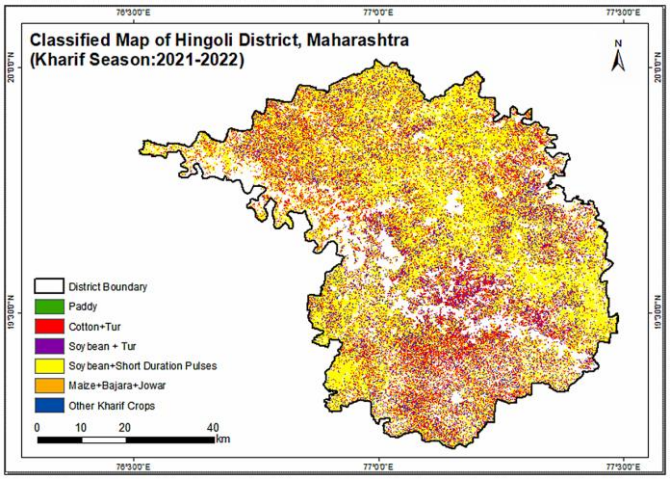

Fig -2: Classified Map of Hingoli district for different crops (Kharif Season: 2021-2022)

5.RESULTS

The results of crop classification are based on reflectance values obtained from sentinel-2 satellites. The mean reflectance value obtained from each pixel is grouped into different classes. NDVI versus month of the year (Kharif-2021) graph is created for each class for crop identification. Classification is achieved by studying the NDVI curve

obtained for each class according to the crop growth timeline. Accuracy of classification is verified by comparing the crop statistics data of total sown area in the district obtained from the Department of Agriculture, Maharashtra (2021-22) with area obtained for each crop by classification. Accuracy of classification is also achieved by Geotagged ground-truth points for the identification of crops. According to crop statistics we observed that Cotton+ Tur crops are taken with -5 relative deviations with DOA sown data for Hingoli. Soyabean+Tur crops are taken with higher relative deviation where Soyabean+Short duration pulses are taken with a relative deviation of -22.95. And other Kharif crops are taken with 49.70% relative deviation with DOA sown data for the study area.

Table -1: Crop statistics for Hingoli district, Kharif season: 2021-2022 (Source: Department of Agriculture, Maharashtra)

Crops	Total Area Sown as per DOA (Hectares)	Total area as per Classification (Hectares)	Relative Deviation as per DOA sown area (Hectares)
Paddy	0	0	0
Cotton+Tur Crops	71439	68317.49	-4.56
Soyabean+Tur Crops	296014	44359.34	-567.30
Soyabean+Short duration pulses	268821	218641.74	-22.95
Other Kharif Crops(Including maize+Jowar+ Bajara)	5273	10484.95	49.70

6. CONCLUSIONS

Using multi-date sentinel-2 images for classification NDVI is calculated from original mean reflectance data. In order to obtain the NDVI profile curve according to crop duration, NDVI images are layer stacked together.

K-Means unsupervised classification is performed with 50 classes, which is sufficient to identify different crops and to discriminate crops of Hingoli district. NDVI profile curve obtained for each class is observed according to crop duration and crop health. And accordingly, classified crop area is compared with total sown data from Department of Agriculture.

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