

Crop Type Mapping by Integrating Satellite Data and Crop Calendar over Okara District, Punjab (Pakistan)

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Abstract—Remote sensing is a Powerful tool for monitoring and identification of crop types of certain area. Pakistan is an agricultural country with a large variety of crops. Hence it is very important to map different crop types in order to have accurate yield statistics. This study aimed to map crop types by integrating satellite data and crop calendar. Study area for this research is the Okara district of Punjab, Pakistan. Okara was chosen because it contains multiple crop types. Landsat TM cloud free images for the whole year of 2009 and 2010 were acquired for this study. As NDVI is a very good indicator of crop health and growth, NDVI for each image was calculated and stacked for each crop according to its complete season from sowing to harvesting (provided by crop calendar of Okara District). Unsupervised classification (ISO Data Model) was performed on stacked image. Resultant NDVI phenological profiles were compared with crop calendar in order to identify the crop type. This research provides an effective method to map crop type that was previously mapped with the help of extensive field truthing. Furthermore, it can help to map crop types in real time scenario, if time series data is available.

Index Terms—Crop Calendar, NDVI, ISO Data, Landsat, Phenological profile

I. INTRODUCTION

CROP type mapping can be used to monitor grain supply, crop production statistics, crop rotation records, crop management according to seasonal variation. Remote sensing has been proved a powerful, effective and reliable technique to identify and map crops. Remote sensing provides timely assessment of conditions and changes in growth of crops. Different national and international agencies are doing crop mapping for the above reasons. As agriculture is the major economic activity of Pakistan's peoples, approximately 67% population directly or indirectly engaged in agricultural activities, so that's why it is necessary to make decisions to make this economic sector strong and developed. Each crop grows in specific conditions and in a certain time period. For this study crop calendar of Okara district was used to identify crop plantation period. Crop calendar is the schedule of the crops of a certain area on the basis of phenological parameters. Crop calendar provides information about crops planting, sowing and harvesting period supports farmers, agricultural planners and specialist.

Phenology is the cyclical biological event of plant or animal life relative to climatic condition. Information about crop Phenology is necessary for crop management, crop yield modeling, and decisions about water supply and to estimate crop production. Phenological profile of crop changes with respect to changes in Phenology, Stage of crop plantation period, and crop health so it is possible to measure crop production and monitor crop health with multispectral sensors [2]. Ratio Images are useful for discriminating slight differences in spectral variation. Normalized Vegetation Index (NDVI) is a very good indicator of crop health and each crop has different NDVI value. This research also validates the calendar of Okara district. This is an initial investigation whether the NDVI based Phenological curve of crop over a one year growing season used to map crops of the study area. NDVI profile visually assessed and compare with crop calendar of study area. Unique phonological curve pattern assessed during its plantation period [6]. In 2010 [3] used MODIS satellite data and reference information about crop. In this research Landsat 5 TM data is used for the 2009-2010 and crop calendar was used as a reference of crop growing seasons. As in 2009 [4] derived crop calendar using Time series MODIS satellite images. This study proposed the idea to drive the crop calendar with filtering time series data using Local Maximum Fitting and Fourier Series Fitting of the time series profile.

II. STUDY AREA

Okara district of Punjab Province, was selected for this study, selection of this study area was based on the criteria of existence of multiple cropping. Okara district has very fertile soils beneficial for agriculture. Okara districts is bounded on the West by Sheikhpura district, Sahiwal and Faisalabad district, Kasur district lies on the north of Okara District and Bhawalnagar and Pakpattan make its southern boundary. On the east it's bordered by India. Some of the part of Okara lies in Bari Doab (Interflow land of Beas & Ravi Rivers). It's a part of Indus flood plain. The geographical extent of Okara is 30.258°N to 31.131°N and 73.272°E to 74.211°E. According to Punjab Development Statistics 2008, total population of Okara district is 2,699 thousands persons out of which 1,411 thousands are males and 1,288 thousands are females. Density of

population in the district is 593 persons per square Kilometer[1]. Okara District is famous due to its fertile lands, peaceful natural environment and green fields of potato, sugarcane, wheat, rice and maize crops[1]. Oranges and Mango orchards are famous. The average annual rainfall is approximately 200 mm. May and June are the hottest month with maximum temperature 44° and January is the coldest month with minimum temperature 2° Okara district administratively subdivided in three tehsil's (1) Depalpur, (2) Renala Khurd, (3) Okara[1].

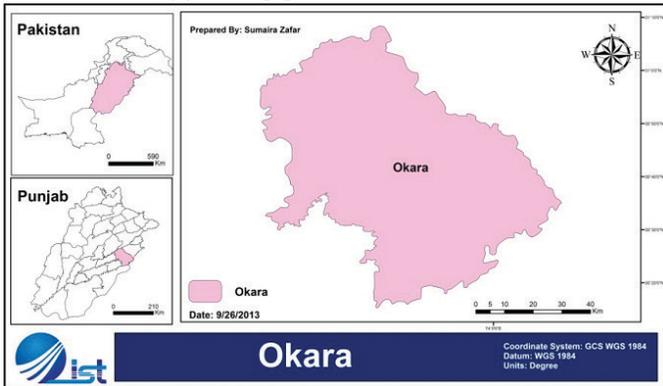


Figure 1: Study Area Map

III. METHODOLOGY

a. Data Description

As multispectral images were used to identify crop type and crop growth stages. Landsat 5 TM images for the year of 2009 and 2010 were downloaded Earth explorer's Official website (<http://earthexplorer.usgs.gov>), and crop calendar of study area was provided by SUPARCO.

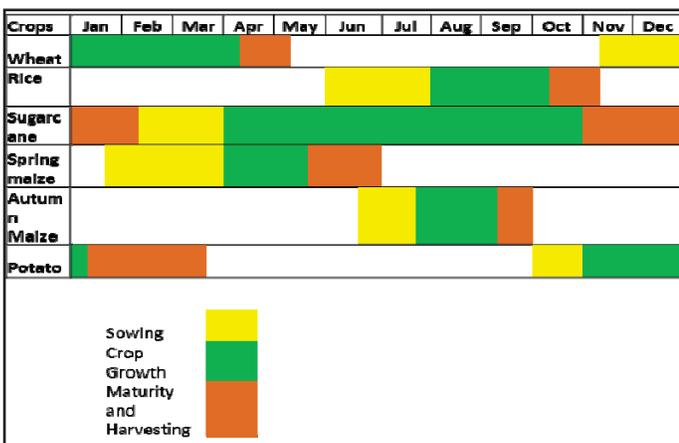


Figure 3: Crop Calendar of Okara District

b. Pre-Processing of Data

Landsat images consists of 7 discrete bands, for this study only 1-5 and 7 bands were used as band 6 is a thermal band so it was not used for further analysis. After stacking study area was extracted. Stacking is the method used to produce multiband image from discrete bands.

c. Crop type mapping using NDVI and crop calendar

Different crops can be identified on the basis of their phenological profiles and temporal profile [2]. A vegetation index allows more efficient exploration of spectral and temporal profiles. NDVI is a very good indicator of vegetation health. NDVI is a ratio between Red and NIR Spectral bands of satellite images. This index is very helpful for determining crop health through satellite imageries. Six crop types of the study area were used for extracting Phenological profile through NDVI images. NDVI images were Stacked for each crop type according to their Phenological time period, which is given in crop calendar. Unsupervised classification was done on stacked NDVI Images using ISO Data Model [5]. By changing the number of classes; number of classes vs Separability graphs were plotted to identify a suitable number of classes for unsupervised classification to capture variability of the satellite data. Finally the one showing maximum Separability was chosen for further analysis. Finally the Phenological profile of each cluster was matched with the crop calendar to find out the different crop types Phenological profile of stacked images shows NDVI value for each image, beginning and end of the plantation period identified through Phenological profiles [7]. Phenological profile shows the minimum NDVI value at the start, which indicate its sowing period as the crop reached its mature stage, at the mid of Phenological profile NDVI value reaches at peak and with the start of harvesting, NDVI value again decreases. After validating Phenological profile of each cluster with crop calendar final crop type maps was prepared as shown in figure 5, 7, 9, 11 13 and 15.

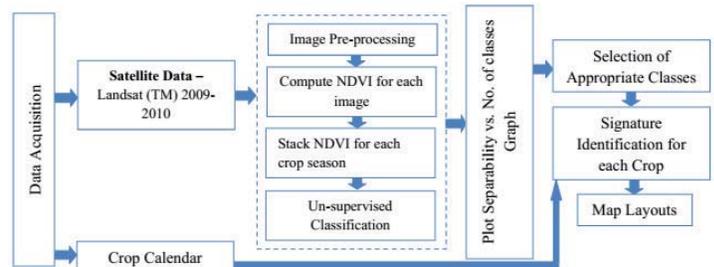


Figure 4: Methodological Framework

IV. RESULTS AND DISCUSSION

Separability curve helps to identify the number of classes with maximum variability in data. Separability curve for rice shows maximum variability in a number of classes of 80 and 85. 85 number classes were used to classify the phenologically stacked images of rice crops this step was repeated for each crop to identify the number classes with maximum variability.

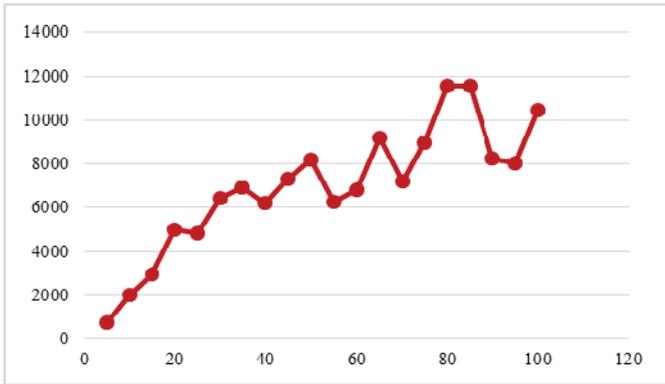


Figure 5: Separability Curve for Rice Crop

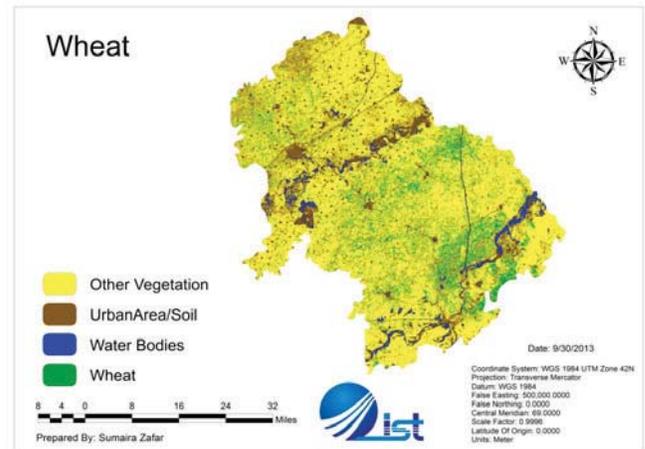


Figure 7: Map Showing Wheat Crop in Okara

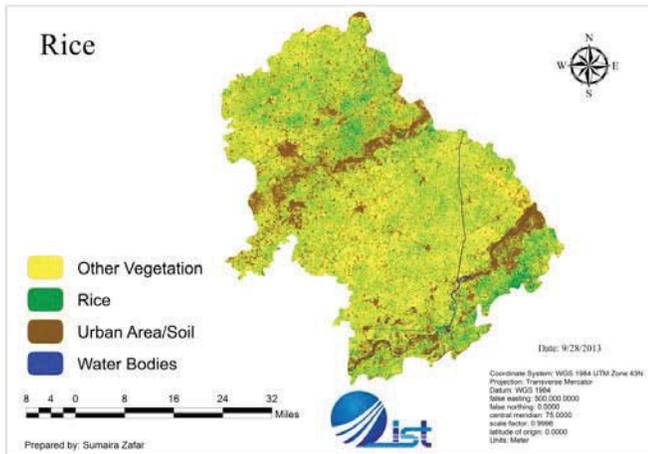


Figure 5: Map Showing Rice Crop in Okara District

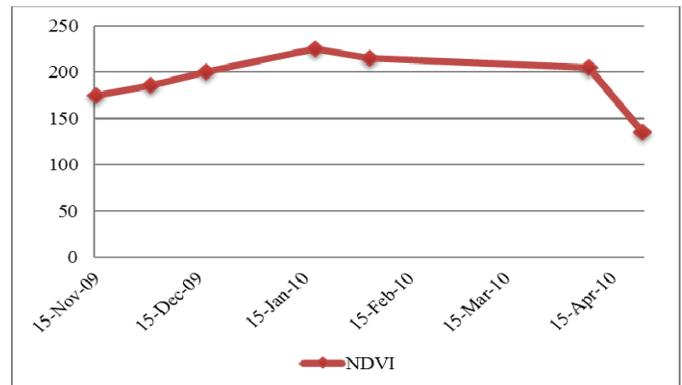


Figure 8: Phenological Profile of Wheat Crop

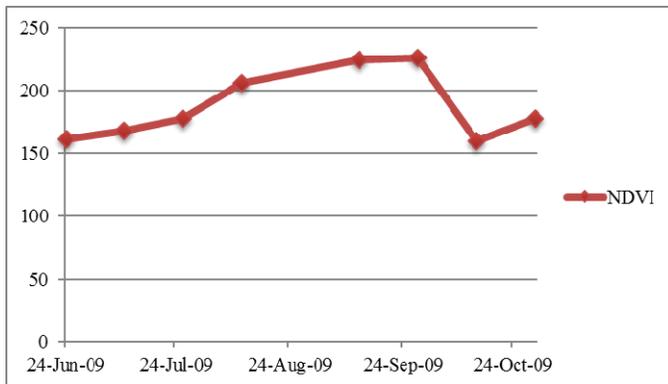


Figure 6: Phenological Profile of Rice Crop

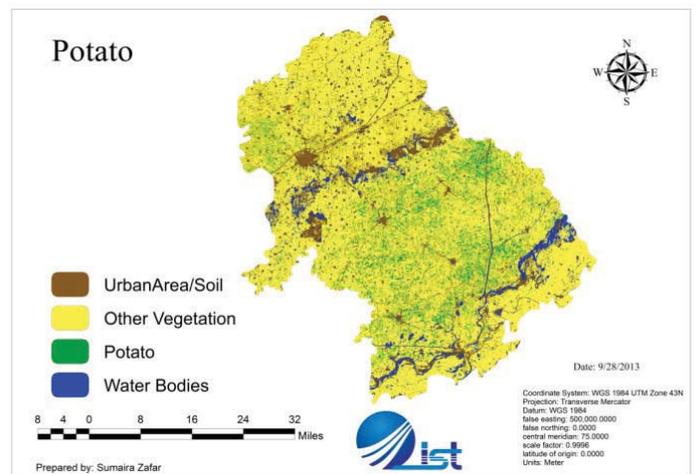


Figure 9: Map Showing Potato Crop in Okara District

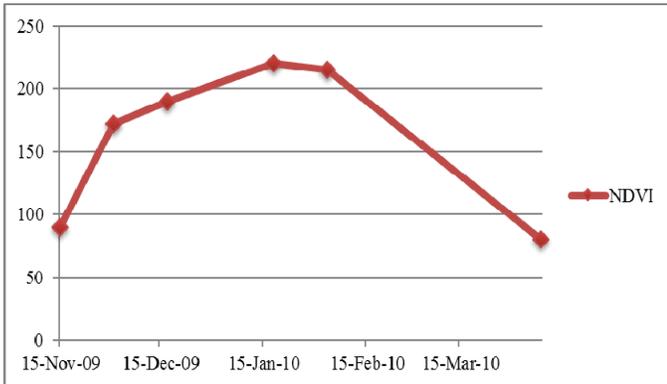


Figure 10: Phenological Profile of Potato Crop

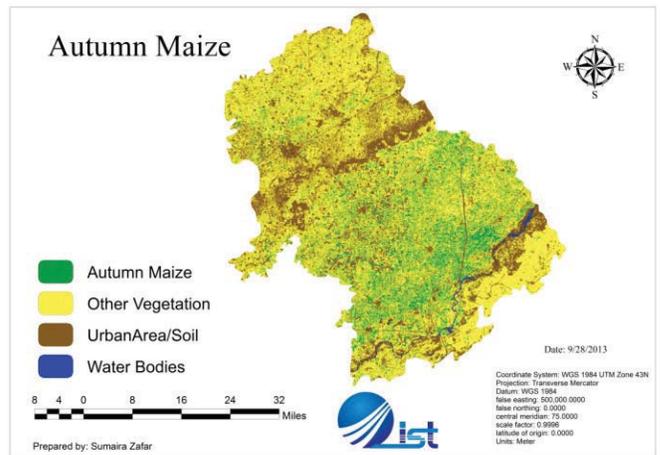


Figure 13: Map Showing Autumn Maize Crop of Okara District

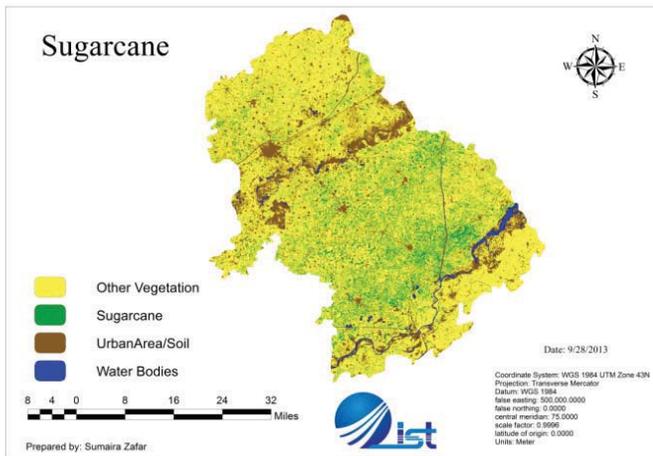


Figure 11: Map Showing Sugarcane Crop in Okara District

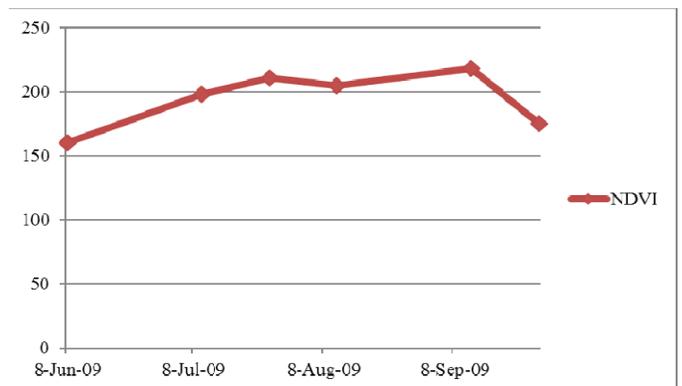


Figure 14: Phenological Profile of Autumn Maize Crop

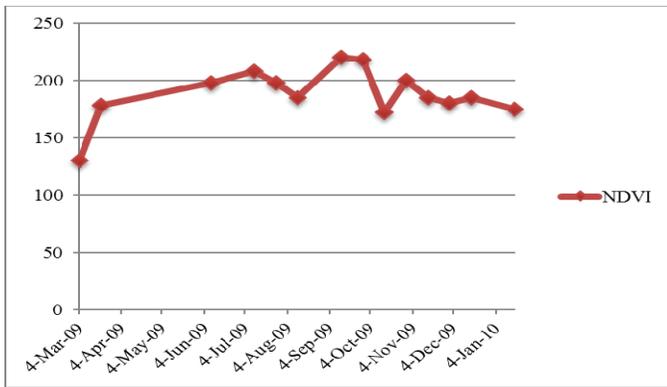


Figure 12: Phenological Profile of Sugarcane Crop

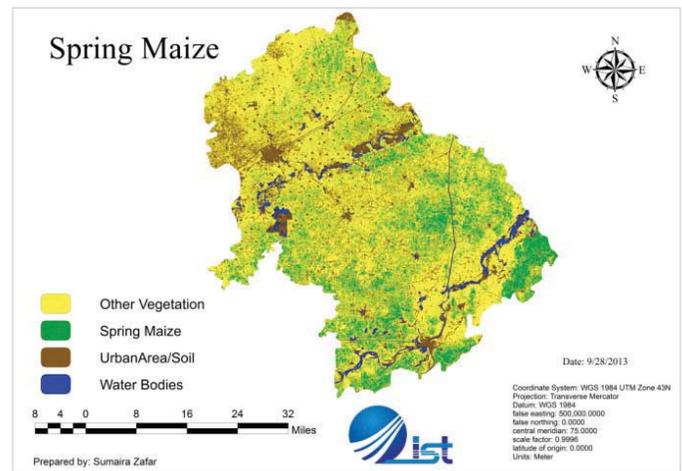


Figure 15: Map Showing Spring Maize Crop of Okara District

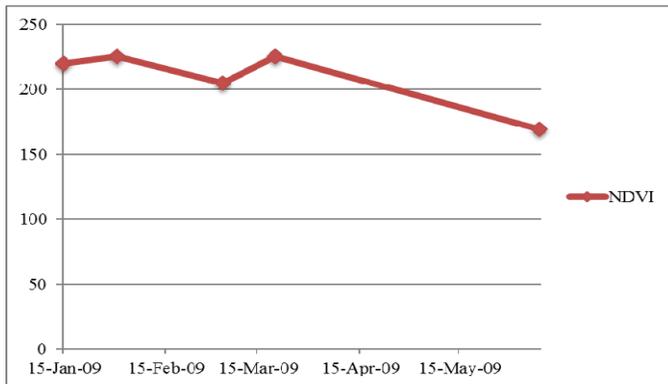


Figure 16: Phenological Profile of Spring Maize Crop

Crop type mapping can be done by using satellite images. Phenological profile of each crop can be distinguished on the basis of phenological time period. This study can also be used to validate the crop calendar of the study area

V. CONCLUSION

Remote sensing has been proved as a valuable tool for decision making. In this study it is possible to identify slight changes in crop health, and can be overcome by decision making about crop management. It can ensure the crop production of certain area and it is possible to make decision about future production and future exports

VI. LIMITATION

Crop calendar of the study area has some limitations, there are some slight changes in Phenological profile of crops e.g. spring maize profile has its maximum NDVI value at the start of profile it show that there is a shift of crop plantation period. For crop type mapping it is necessary to use cloud free data, it is understood that weather condition of an area changes with time. So it is not possible get cloud free data for the whole year. Accuracy assessment of this method can be performed from ground truthing. But due to limited time and non-availability of financial support this section of research not performed.

VII. REFERENCES

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