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Application of Geospatial Techniques in Crop Inventory: A Review

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Abstract: *Geospatial techniques are the most extensively useful techniques for land use planning and decision support system. Remotely sensed imagery is beneficial for agricultural production. It gives the accurate information of agricultural activities such as different crop identification and classification, crop condition monitoring, crop growth, crop area and yield estimation, mapping of soil characteristics and precision farming. Information from remotely sensed imagery, geographic information system and global positioning system allows farmers to take information of the wide areas of a field. Problems within the field may be identified before they face a big problem in the agricultural production using remotely sensed images. This paper attempts to review different techniques for various applications of GIS and Remote sensing for crop identification and classification, crop condition monitoring, crop growth, crop area and yield estimation, mapping of soil characteristics and precision farming. So by implementing GIS and RS better production of the crops can be achieved.*

Keywords: *Crop acreage and yield estimation, Precision farming, RS and GIS, Soil mapping*.

1. INTRODUCTION

Due to rapid growth of population, urbanization, industrialization, the agricultural land is decreasing day by day. Agriculture is the primary source of many countries to maintain the food for everyone and it plays a leading role in almost every country to develop the economical condition. Food production in a cost-effective manner is the goal of every farmer as well as large scale farmer and agricultural agencies, so there is need to be informed a farmer in an efficient way to get the knowledge and inform them about food production. Remote sensing, GIS and GPS these technologies are useful for farmer to monitor their crops and their conditions of growth, yield estimation, soil condition as well as precision farming. Geographical Information System along with Remote Sensing and other types of data will helpful in decision support system about crops and agricultural strategies. Extracting land use/land cover (LU/LC) information is crucial exercise for agricultural land which is most useful for decision support system, planning and development in agriculture. Remote sensing is the technology to acquire the exact information from the earth surface patterns without making any physical contact to it. In today's date, this technology uses the satellites to detect and classify objects on the earth surface and in the atmosphere and oceans by using the signals of electromagnetic radiation emitted from aircraft or satellites. Geographic Information System (GIS) is a computer system designed for capturing, storing, integrating, analyzing and displaying data from a geographic angle. The measurement of natural and human made phenomena and processes from a spatial angle. These measurements emphasize three types of properties commonly associated with these types of systems: elements, attributes, and relationships. The storage of measurements in digital form in a computer database. The analysis of collected data to produce more information and to discover new relationships by numerically manipulating and modeling the data. The depiction of the measured or analyzed data in some type of display - maps, graphs, lists, or summary statistics.

2. AGRICULTURAL APPLICATIONS

The importance of spectral reflectance of data to identify and classify different crops is very much useful in crop area estimation, crop condition monitoring, and crop yield estimation. Remote sensing data have unique spectral signature which is useful in crop identification and crop classification.

When two crops have same spectral signature occur in a given date, then multi date data is required to identify them. Remotely sensed images are used as mapping tools to classify crops, monitor the crop health and farming practices. These are the some main agricultural applications in remote sensing: 1) Crop type classification and Crop identification, 2), crop area and yield estimation 3) crop condition (monitoring) assessment, 4) mapping of soil characteristics, 5) Precision farming practices, etc.

3. CROP TYPE CLASSIFICATION AND CROP IDENTIFICATION

There are number of reasons to identify and classify the crops. Properly identification of crops is very much beneficial for crop acreage and crop production estimation. Remote sensing technique plays a vital role in identifying and classifying different crops in acreage. It shows the vegetation health and growth based on the spectral reflectance of the vegetation and other patterns. For crop identification and classification the multispectral and multi-temporal data with mainly supervised and unsupervised classification techniques is used. In Supervised classification training sets are given to classify the pixel of particular class, and then it identifies the Information classes (i.e., crop type) of interest in the image. These are called "training signatures". But unsupervised classification is a method which examines a large number of unknown pixels and divides into a number of classed based on spectral groupings present in the image values. Unsupervised classification does not require analyst-specified training data.

4. CROP AREA ESTIMATION SUBSYSTEMS:

Crop inventory subsystem includes four main processes for identification of crops, estimation of their area and mapping their distributions. These are: stratification, area estimates through area frame sampling, area estimates through remote sensing, area estimates through combination of the two sub-processes and aggregation/ desegregation to different administration levels.

1. **Stratification of the Region:** This process makes use of a number of data sets such as current land use map, soil map topographic map and Landsat, and Spot satellite data to stratify the region into homogenous areas in term of use-type and pattern of agricultural fields.
2. **Area Frame Sampling:** Is well established techniques used in agricultural statistics based on sample parcel survey .This technique have proven itself in terms of reliability and accuracy. However, to achieve a reliable estimate it requires rather large number of samples and field measurements every year. As a result, costs are high and the procedure is error prone, and the product is an estimate of the total area of each crop per stratum without providing their distributions as a map. The application of remote sensing techniques (images) can provide a total coverage of the area and reduces the total number of segments to be surveyed while keeping the accuracy and reliability of the estimates.
3. **Area Estimate through Remote Sensing:** One of the operational methods of applying remote sensing in agricultural statistics is so called “regression estimator” that has been recommended by JRC as a results of their years experimentation in Europe. The process includes preprocessing of satellite data to remove the radiometric and geometric errors in the data-set and their classification through supervised routines which include training of the classifiers by sample segments. In this method the result from the area frame sampling and the image processing are statistically related and used to derive an improved area estimate per crop in each stratum.
4. **Aggregation/Desegregation to various administration levels:**

The area estimate derived through the above method is at the stratum level which, physically do not exist. To transform that into the required administration units, the result is overlaid with the lowest administration maps and later on aggregated to the required level.

5. CROP CONDITION (MONITORING) ASSESSMENT

Crop condition monitoring is one of the main important advantages using remote sensing. To preserve the countries food it is necessary to monitor the crops timely and accurately. Crop condition monitoring is very much useful in crop acreage and crop yield estimation. Availability of water and

nutrients, pest attack, diseases outbreak and weather conditions these are the some factors that could affect the crop condition. Crop condition is primarily focused on individual physical parameters as well as different indices of the crop. It is difficult to ensure good agricultural productivity due to crop health assessment and early detection of crop infestations. Some diseases should be detected early enough to provide an opportunity for the farmer to mitigate for example, moisture deficiencies, insects, fungal and weed infestations. To early detection of diseases remote sensing imagery provides frequent images minimum of within 2 days. The growth of the crops in the field is not even, it can vary in the field from one place to another place of the farm. The differences in growth are result of various factors such as soil nutrition or other forms of stress. The remote sensing technology can help the farmer to identify such places in the farm where the growth is decreased or slow; this will allow farmer to provide adequate amount of fertilizers, pesticides and herbicides to the crop in such areas. It will not only increase the productivity of the farm land but it will also reduce the farm input cost and the environmental impact will be minimum. The remote sensing image provides the required spatial overview of the farm land. It allows a farmer to observe image of his fields and make timely decisions about managing the crops. Remote sensing can be helpful in identifying crops affected by conditions that are too dry or wet or that can be affected by insect, weed or fungal infestations or weather related damage. Images obtained throughout the growing seasons will help to detect to problems but also to monitor the success ratio of the treatment. To monitor the crop condition we need a cloud free data, but crop signatures are not unique or the variance in the signature of a single crop is too large, so it's difficult to monitor the crop. In this condition, radar remote sensing plays a significant role to vegetation biomass and structure as well as these sensors are very much useful in crop monitoring [37]. The use of remote sensing methods in crop monitoring has been reported by many researchers. These are the some main useful methods for crop condition monitoring as following:

1. Direct Monitoring Method

Vegetation indices which are very much useful in crop condition monitoring, because if vegetation indices higher, then the crop condition is better. This direct monitoring method depends on vegetation indices which are easy to use. Table 1 shows the important indices useful in crop condition monitoring.

2. Crop Growth Profile Monitoring Method

The crop growth profiling method is the different between the year and year for the crop growth profile can it can be seen by the crop growing in the prolong time duration of the growing season. The crop growth profiles are produced by getting the statistic of NDVI at the level of province. The time series data of NDVI during the crop season is used for crop growth profile. Different crops have different characteristics in the crop growth profile using NDVI; even the same crop grown in different environment is having the different crop growth profile. The NDVI profiles are useful in the crop growing conditioning.

3. Crop Growing Model Method

In this method the crop growing model is used to simulate the various stages in the crop life cycle. The growing status and the estimated crop condition are the result of the simulation.

4. Diagnosis Model

The Diagnosis model assesses the crop condition using the characteristics of condition and environment that influence crop growth.

6. CROP AREA AND YIELD ESTIMATION

Crop area estimation is very much important for number of reasons; it is especially helpful for yield estimation. Reliable and timely crop acreage estimation could be helpful in agricultural planning and decision support system to planners and policy makers for purchasing, storing, import export of food. Crop area estimation is the backbone of agricultural activities. This crop acreage estimation procedure is basically divided into following main steps are 1) Single date data selection with maximum vegetative crop growth, 2) Identification of crop through image using ground truth, 3) Signature

generation for the training site, 4) Image classification through training statistics, 5) Crop area estimation using administrative boundary like district masks. There are three main methods of remote sensing to estimate the crop areas are followings.

7. PIXEL COUNTING AND SUB-PIXEL ANALYSIS

using remote sensing imagery pixel counting or sub-pixel analysis can be done to estimate area. But there are some limitations of this method for image classification due to same order of the commission or the omission errors.

8. MAPPING OF SOIL CHARACTERISTICS

An elevated understanding of the soil used to increasingly better scale. It is beneficial in agricultural management and development. Traditional soil sampling and laboratory analyses methods are very slow, valuable, and they could not reacquire all spatial as well as temporal changeability of the soil quality, so this methods cannot efficiently provides the required information. In this condition Microwave (active and passive) remote sensing as well as optical remote sensing plays a significant role in mapping of soil quality parameters. Mapping of soil characteristics is useful for different purposes such as soil and crop management for improving crop yield estimation, sustainable land use planning, soil erosion and runoff modeling in watershed management, land – atmosphere gaseous exchange study for climate change modeling, biogeochemical cycles study and precision agriculture etc . Research has been carried out using microwave (active and passive) remote sensing for mapping of soil characteristics. Some soil property parameters.

9. SOIL TEXTURE

An accurate estimation of spatially variable soil physical properties such as texture and hydraulic properties is necessary to develop reliable models of water flow and the efficient management of soil resources for improving crop productivity with an environmental quality. To Measure soil physical properties are time consuming, expensive but a large number of measurements are necessary to quantify their space-time variability.

10. SOIL DRAINAGE

Although the various characteristics, soil drainage which directly affect of crop growth, water flow and solute transport in soils. Drainage is a major issue at every where so soil information will help to took decision at various levels. Therefore, radar remote sensing has the effective way to map and analysis soil properties, such as soil drainage.

11. SOIL SURFACE ROUGHNESS

Soil surface roughness (SSR) has influenced soil thermal properties, infiltration rate, surface run-off and susceptibility of soil to erosion.

11.1. Precision Farming Practices

Precision farming or agriculture is nothing but the management of farm which is depends on noticing and giving response on various changes in the intra-field with the goal of increasing returns on inputs without changing the resources. Precision agriculture is helpful to locate the exact position of the farmer in the field which is totally based on remote sensing, GIS and GPS or GNSS technology. To increase yield, quality, and profit and reduce waste it is essential to control the crop production using water, seed, fertilizer, etc. In this condition, precision farming will be helpful for taking right decision, in the right situation, in the right position, in the right way, at the right time to become eco-friendly [50]. Hence precision farming opposes to conventional farming practices which include crop treatments like irrigation, use of fertilizers, pesticides and herbicides were equivalently applied to the whole area without noticing variability within the area. Remote sensing technologies are becomes advanced and the cost of sensors are reduced, so we can easily use of these facility in the farming to identify the particular area in which the specific treatment is required for that crop as well as use of chemicals in required area, to reduce the amount chemicals used. So these technologies will be helpful for protecting environment and saving the cost of the application [51]. Precision farming is an

emerging methodology which is designed to link management actions to site-specific soil and crop conditions, and place inputs of fertilizers, herbicides, and pesticides when and where they are needed most to maximize the farm efficiency and minimize the environmental contamination. The core technologies which play an important role in precision agriculture are GIS, GPS, and remote sensing. The importance of these technologies in agriculture was underscored when NASA (Stennis Space Center), in the early portion of the current century, embarked upon the Ag 2020 program in an effort to commercialize the geospatial technologies, develop practical tools for producers, and undertake projects with various types of crops to illustrate the utility of the technologies.

12. CONCLUSION

There is lot of remote sensing techniques used by many researchers for land use/land cover classification, identification, classification and analysis of any area or any region. Soil characteristics are very much useful for crop growth and crop yield. Normalized data vegetation technique (NDVI) technique is the most useful technique for land cover analysis as well as crop condition monitoring. Precision farming is useful to enhance the agricultural production, to reduce the chemical use in crop production, to use water resources, to improve quality, quantity & reduced cost of production in agricultural crops with the help of RS, GIS and GPS technology.

REFERENCES

[1] Abhishek Kumar Maurya, Janeuary (2011), Estimation of Acreage & Crop Production Through Remote Sensing & GIS Technique, Geospatial World Forum, Hyderabad, India, 18-21.

[2] Arun Mondal, Subhanil Guha, Prabhash Kumar Mishra, Sananda Kundu, (2011) Land Use/Land Cover Changes In Hugli Estuary Using Fuzzy C-Mean Algorithm, International Journal of Geomatics And Geosciences, Volume 2, No 2,.

[3] Emilio Chuvieco and Alfredo Huete, (2010) Fundamentals of Satellite Remote Sensing (CRC Press, Taylor & Francis Group).

[4] F.J. Gallego, Review of The Main Remote Sensing Methods For Crop Area Estimates, ISPRS Archives Xxxvi-8/W48 Workshop Proceedings (2006): Remote Sensing Support To Crop Yield Forecast And Area Estimates, Agriculture Unit, IPSC, JRC, 21020 Ispra (Va), Italy.

[5] Hojat Ahmadi And Kaveh Mollazade, (2005). Application of Remote Sensing In The Agricultural Land-Use Assessment, Journal of Theoretical and Applied Information Technology, Jatit

[6] Ian Heywood, Sarah Cornelius and Steve Carver, (Third edition, Pearson, 2010) An Introduction to Geographic Information Technology.

[7] J.T. Aranha, H.F. Viana And R. Rodrigues, April 6th – 9th 2008. Vegetation Classification and Quantification By Satellite Image Processing. A Case Study In North Portugal, International Conference And Exhibition On Bioenergy.

[8] Md. Rejaur Rahman and S.K. Saha, June (2008),Multi-resolution Segmentation for Object based Classifi cation and Accuracy Assessment of Land Use/Land Cover Classification using Remotely Sensed Data, J. Indian Soc. Remote Sens. 36:189-201.

[9] M. Duane Nellis, Kevin P. Price and Donald Rundquist, 14 Apr. (2010). Remote Sensing of Cropland Agriculture, Papers in Natural, Resources. Paper 217, The SAGE Handbook of Remote Sensing, (SAGE Publications.), pp.4, 5, 13, 14, 1-1-2009.

[10] Meng Ji-Hua and Wu Bing-Fang, (2008). Study On The Crop Condition Monitoring Methods With Remote Sensing, The International Archives of the Photogrammetry, Remote Sensing And Spatial Information Sciences. Vol. XXXVII, Part B8.

[11] Ramchandra T.V.,(2008). Regional land cover mapping using remote sensing data, Journal of Agricultural, food and Environmental sciences, Volume 2, Issue 1.

[12] R. Kalpana, S. Natarajan, S. Mythili, D.E. Shekinah and J. Krishnarajan, (2003). Remote Sensing For Crop Monitoring - A Review, Agric. Rev, 24(1):31-39.

[13] Sandeep Kr. Soni, 18-21-janeuary (2011) Crop Area Estimation for Bundi Tahsil of Rajasthan using Remote Sensing and GIS Technique, Geospatial World Forum, Hyderabad, India.

[14] Sebastian Mader, Michael Vohland, Thomas Jarmer and Markus Casper, 28- 30 September (2006). Crop Classification With Hyperspectral Data of The Hymap Sensor Using Different Feature Extraction Techniques, Proceedings of the 2nd Workshop of the EARSeL SIG on Land Use and Land Cover, University of Trier, Germany.

[15] Shwetank, Jain Kamal and Bhatia K. J., January-June (2010), Review of Rice Crop Identification and Classification using Hyper-Spectral Image Processing System, International Journal of Computer Science & Communication, Vol. 1, No.1, pp. 253- 258.

[16] Shesha Sai MVR, Ramana KV and Hebbar R, Remote Sensing Applications in Agriculture, (National Remote Sensing Centre, ISRO, Department of Space, Government of India, Balanagar, Hyderabad-500 625, A.P., India), 1-21.

[17] Sudeesh S and Sudhakar Reddy C, (2012). Vegetation And Land Cover Mapping Of Nagarjunasagar-Srisailam Tiger Reserve, Andhra Pradesh, India Using Remote Sensing And GIS, International Journal of Geomatics And Geosciences, Volume 2, No 4,

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