Analysis and modeling of agricultural land use using remote sensing and geographic information system: a review

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Analysis and Modeling of Agricultural Land use using Remote Sensing and Geographic Information System: a Review

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ABSTRACT

GIS, remote sensing and Global positioning System are the most widely useful tools 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 carry only affected areas of a field. Problems within the field may be identified before they create 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 land use/land cover change detection, crop identification and classification, crop condition monitoring, crop growth, crop area and yield estimation, mapping of soil characteristics and precision farming. Thus implementating GIS and RS for better production of the crops as well as land use/land cover change detection can be achieved.

Keywords – Classification, Crop acreage and yield estimation, Precision farming, RS and GIS, Soil mapping

1. INTRODUCTION

Due to rapid growth of population, urbanization, industrization, the agricultural land is decreasing day by day. In twenty first century, land use and land cover plays an important role in global environmental change. The use of information technology to support decision making in detecting land use and cover is essential and recent. For local, regional and macro level planning and management Land cover/land use play an important role [1] by using RS & GIS it is possible to make planning and decision process more realistic, effective [2]. Land cover is nothing but the physical material on the Earth surface which is covered by different parts of the nature or also the man made parts on the Earth surface i.e. soil, rocks, water bodies, vegetation, built-up areas, trees, etc. Land use means those areas which are used by humans for their need. Peoples agreed to produce, maintain the change on land cover through the adjustments, movements and inputs [3].

Both developed and undeveloped countries are dependent on agriculture for the economic as well as food security. Agriculture is the primary source of many countries to maintain the food for everyone and it plays a dominant 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 will useful for farmer to monitor their crops before they got damage, yield estimation, soil condition as well as precision farming. Commodity brokers are also very interested in how well farms are producing, as yield (both quantity and quality) estimates for all products control price and worldwide trading [4], [5]. So there is need to secure the food in an effective way. Because good crop health is a part of every person’s diet. In every country food production through sufficient quantity and quality is essential for the well-being of the people. To growth of crop in the field of agricultural, as living organisms, it requires water and nutrients and is sensitive to extreme weather phenomena, diseases and pests. So to overcome these problems and identify as well as monitor crops, remote sensing data is very much useful. Geographical Information System along with Remote Sensing and other types of data will helpful in decision support system about crops and agricultural strategies [6]. 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 [7]. In the study of Land use/ Land cover pattern analysis different sources are important for effective planning and management like soil survey manuals, topographic maps, aerial photographs, vegetation surveys, flood maps, hydrology maps, and property surveys etc., [8]. Due to the population and urbanization land use and land cover rapidly change, to acquire the exact

land pattern remote sensing & GIS technique is most essential [9], [10].
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 [11].

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. These measurements are often linked to features on a digital map. The features can be of three types: points, lines, or areas (polygons). The analysis of collected measurements to produce more data and to discover new relationships by numerically manipulating and modeling different pieces of data. The depiction of the measured or analyzed data in some type of display - maps, graphs, lists, or summary statistics [12].

2. WORK DONE SO FAR

There is lot of techniques used to identify land use/land cover change detection, and land use/land cover monitoring from satellite imagery. Fuzzy C-mean supervised classification algorithm has been used in land use/land cover change detection through Landsat TM5 satellite images with overall 90% and 89% accuracy [13]. To classify the land use/land cover from remotely sensed multispectral imagery and to detect the change on LULC from multitemporal imagery researchers has been used supervised maximum Likelihood Classification [1], [7], [14], [15], [16], [17], [18], [19], [20], [21], minimum distance [16], [21], [22],[23], parallepiped [16], [21], fishers classification [16], unsupervised classification for ISODATA [14],[23],[24], Hybrid classification [14], Box classifier[25] mostly.

Many researchers identified and classified crops by using multispectral and multitemporal data and supervised and unsupervised classification techniques.

Fuzzy classifier, SR (Simple Ratio), NDVI (Normalized Difference Vegetation index), TNDVI (Transformed Normalized Difference Vegetation Index), SAVI (Soil-Adjusted Vegetation Index) and TVI (Triangular Vegetation Index) are used to identify cotton crop using temporal multi-spectral remote sensing imagery. The overall fuzzy highest classification accuracy 93.12% was achieved from SAVI temporal data base of data set 2 [26]. Maximum Likelihood and Artificial Neural Network algorithms are used with SPOT HRV and Land sat TM data for classifying agricultural crops combining multi-temporal, multi-spectral and multi-source remotely-sensed data to identifying general agricultural crop classes over an area in East Anglia (UK) [27]. Sugarcane, cassava and maize crops are identified through Radarsat-2 multipolarization data in Thailand, because high cloud cover availability in nature and these sensors cannot give the whole information about the objects. Therefore, the radar sensor is the alternative option to obtain satellite data especially RADARSAT-2 which provides full polarizations (HH, VV, HV, VH) [28]. Unsupervised ISODATA and NDVI (normalized difference vegetation index), these two methods was used to classify crop. Method first based on unsupervised classification of Landsat visible and Near-infrared satellite images obtained at multiple dates in the growing season, followed by traditional, manual class identification. And second method based on unsupervised classification as well as NDVI maps performed MODIS images. Tree analysis was applied for grouping similar classes into clusters using NDVI mask data and for crop type of each cluster was identified from ground truth. They got 3% more overall classification accuracy using unsupervised classification and NDVI masks which is the second method than first method [29]. Multispectral images obtained from the SPOT 5 satellite acquired two different date images has been used to identify crop area using pixel based i.e. unsupervised and maximum supervised classification and object based classification techniques [30]. Hyperspectral remote sensing has also helped enhance more detailed analysis of crop classification [31]. Maximum Likelihood classifier was performed on hyperspectral data of the Hymap sensor for different crop classification. This method was used to extract a subset of individual bands from hyperspectral data and the classification results are compared to those achieved by using principal components transformation as a well established feature extraction technique to optimize the performance of the maximum likelihood classifier [32]. Rice Crop Identification and Classification using Hyper-Spectral Image Processing System, was reviewed through the comparison of multispectral and hyper spectral image processing techniques [33]. Support vector machine method is better than neural networks classifiers as multilayer perceptrons (MLP), Radial Basis Functions (RBF) and Co-Active Neural Fuzzy Inference Systems (CANFIS) for crop classification [34]. A number of studies have been carried out on different crop acreage estimation using remote sensing and GIS technology.

Supervised classification i.e. maximum likelihood classification algorithm was used to estimate the wheat crop acreage of Indore district, M.P. using single date, and cloud free Resourcesat-1 (IRS P6) LISS-III data. This work has been carried out using the ground truth through GPS(Global Positioning System) and georeferenced by image-to-image registration existing master images then the important steps were used, like, extraction of district mask of the image, generation of training signatures, test of statistical class separability and maximum likelihood supervised classification [5]. Maximum Likelihood Classification and unsupervised classification techniques were used for Crop Area Estimation on IRS-P6 LISS-III(Resourcesat-1) data of different seasons kharif, Rabbi And Zaid in year in Bundi Tahsil of Rajsthan. The visual interpretation also performed for this particular study and classified different land use and land cover objects for extracting exactly crop area from agricultural land Finally conclude that 688.92 sq.km area was occupied in agriculture while 73.12sq.km. Area is fallow land [7]. NDVI algorithm and unsupervised classification technique were used to identify the sugarcane area as well as its condition assessment by using toposheet and IRS LISS II remote sensing data were used. NDVI image is very much useful in sugarcane crop area identification because of its canopy cover, crop biomass and vigor. For this particular study two bands were used i.e. NIR and RED of LISS-II data then georeferenced through ground control points, NDVI image has been generated and sugarcane area were extracted from NDVI image. For crop area estimation NDVI value of Band 4(NIR) and Band 3(RED) of IRS LISS-II data have been used and for classification the NDVI image cluster using ground truth have been used. And for assessing the sugarcane crop condition, sugarcane area map has been used as a 'mask' over the NDVI value map to generate respective NDVI mask for sugarcane. NDVI value is very much sensitive to crop canopy, biomass and vigour i.e. health condition of the crop. So, NDVI mask map was then classified and given the class names as 'very good', 'good', 'moderate' and 'poor' for sugarcane health condition according to verified crop condition by field observation and farmers knowledge. In referring healthy crops, reflectance in the blue and red parts of the spectrum is low since chlorophyll absorbs this energy. In contrast, reflectance in the green and near-infrared spectral regions is high. Stressed or damage crop experience a decrease in chlorophyll content and changes in the internal leaf structure. So examining the ratio of reflected infrared to red wavelengths is an excellent measure of vegetation health. Healthy plants have a high NDVI value because of their high reflectance of infrared light, and relatively low reflectance of red light. [35]. MODIS (TERRA) time series (multitemporal) data of three years using NDVI values and supervised, unsupervised as well as Hybrid classification techniques has been used for estimation of soya bin acreage and crop yield estimation in districts of M.P. They performed NDVI on all time series images and compared the scene average NDVI values for individual district over the years, to get the predicted yield of soyabin. Crop yield was calculated by comparison of the NDVI values of soyabin for these years [36]. Optical and microwave remote sensing data has been used for corn monitoring and Crop yield estimation and production efficiency model (PEM) has been used to estimate crop yield on QuickBird imagery and getting higher accuracy of predicted results than Landsat TM imagery [37]. Precision farming is a best technique to establish the agricultural management and variable rate application (VRA) is also plays a significant role in precision farming [38].

Due to the lower absorption of light comparing other objects on earth surface agricultural crops have higher spectral reflectance of signature. Vegetation frequently decreases absorption and increase reflectance and transmittance in the visible wavelength due to the dietetic scarcity in the vegetation. Hence, agricultural crops have higher reflectance of the spectral signature. In this Situation, hyperspectral remote sensing plays an important role as tool for monitoring and estimating agricultural land use and cover because it can provide earlier information than conventional land use mapping methods. So, using hyperspectral remote sensing imagery development should be increased in the field of agricultural land use and land cover for future planning and management [39].

For managing the natural resources on the earth surface mapping of vegetation and land cover is essential. For planning, management and development the information on the land use and land cover in the form of maps and data is very important [40].

3. AGRICULTURAL APPLICATIONS

3.1. Crop Inventory

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 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 [41]. Remotely sensed images are used as mapping tools to classify crops, monitor the crop health and capability and monitor farming practices. These are the some main agricultural applications in remote sensing: 1) Crop type classification and Crop identification, 2) crop condition (monitoring) assessment, 3) crop area and yield estimation, 4) mapping of soil characteristics, 5) Precision farming practices, etc.

3.1.1. Crop type classification and Crop identification

There are number of reasons to identify and classify the crops. National/multinational agricultural agencies and other agriculture related agencies are responsible to produce different crop type maps to prepare an inventory of what was grown in certain areas and when [4]. Properly identification of crops is very much beneficial for crop acreage and crop production estimation [42]. Remote sensing technique plays a vital role in identifying and classifies 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 they use the multispectral and multitemporal data and mainly supervised and unsupervised classification techniques. In Supervised technique machine require to give training signature which class is in the pixel, then identify examples of 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 natural groupings present in the image values. Unsupervised classification does not require analyst-specified training data [7], [43].

3.1.2. 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 [42]. 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 be affect to crop condition [41]. Crop condition is primarily focused on individual physical parameters as well as different indices of the crop [31].

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 due to for example, moisture deficiencies, insects, fungal and weed infestations. To early detection of diseases remote sensing imagery provides frequently images at minimum 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 [4].

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]. What is the crop condition means, there is no clear definition for crop condition and researchers in the field of this area don’t have any idea about this definition. If we don’t have any exact information about crop condition, then how could we monitor the crop condition? Therefore it is urgent requirement to know the crop condition means [44]. 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:

3.1.2.1. 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 is depends on vegetation indices which are easy to use and promised but if large area or complex area will be big then it should be failed [44]. Following table 1 shows the main important indices useful in crop condition monitoring.

TABLE 1. Useful Vegetation Indices for Crop Condition Monitoring

Vegetation Index	Formula	Usable Bands
RVI(Ratio Vegetation Index)	$RVI = \frac{NIR}{RED}$	NIR, RED [26]
NDVI(Normalized Difference Vegetation Index)	$NDVI = \frac{NIR - RED}{NIR + RED}$	NIR, RED [26]
NDWI(Normalized Difference Water Index)	$NDWI = \frac{NIR - SWIR}{NIR + SWIR}$	NIR, SWIR
SAVI(Soil Adjusted Vegetation Index)	$SAVI = \frac{(1+L)(NIR - RED)}{NIR + RED + L}$	NIR, RED [26]
TVI (Triangular Vegetation Index)	$TVI = 0.5(120(NIR - GREEN)) - 200(RED - GREEN)$	NIR, RED, GREEN [26]
TNDVI(Transformed Normalized Difference Vegetation Index)	$TNDVI = \left[\left(\frac{NIR - RED}{NIR + RED}\right) + 0.5\right]^{1/2}$	NIR, RED [26]

3.1.2.2. Image classification method

To monitor the crop growth status generally having two methods which are very important i.e. supervised and unsupervised classification methods using multitemporal satellite imagery [44].

3.1.2.3. Same-period comparing method

While we are comparing previous year remote sensing data (NDVI, LAI for instance) with new one then we come to know the crop growing state. Some vegetation indices such as differences, ratios are mostly useful in this method [44].

3.1.2.4. 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 [44].

3.1.2.5. Crop growing models 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 [44].

3.1.2.6. Diagnosis model

The Diagnosis model assesses the crop condition using the characteristics of condition and environment that influence crop growth [44].

3.1.3. 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 [5]. 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 [41]. There are three main methods of remote sensing to estimate the crop areas are followings [45].

3.1.3.1. 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 [45].

3.1.3.2. Regression, calibration and small area estimates

These methods are the combining catholic of regression, calibration and small area estimator's but inaccurate information from remote sensing imagery with accurate information on a sample through ground surveys. Combination of fine or medium resolution images provides findings of area estimation when ground surveys are not possible due high cost [45].

3.1.3.3. Supporting area frame surveys

The different ways by which remote sensing imagery can support area frame surveys may be stated as: to define sampling units, for layer; as graphic documents for the ground survey or for quality control [45]. Farmer have information on crop yield at an early stage then it will be profitable for farmer as well as countries development which is dependent on agricultural production, to propitiate the national requirements for the crops and also for income through exports [46]. The vegetation indices (VIs) generated from remotely sensed images are usable for crop yield estimation after analyzing the vegetation indices and these indices correspond to the maximum vegetation stage of the crop. The average area weighted vegetation indices calculated for each district is regressed with final yield at district. Direct weather variables such as rainfall, temperature and derived variables such as ET are used either independently or in combination in multiple regressions. Sometimes, in the· absence of weather data, purely statistical models such as Auto Regressive Integrated Moving Average (ARIMA) is fitted with time series data using standard techniques. Crop wise production estimates are thus made based on the remote sensing based acreage and yield estimates using a combination of models [42].

3.1.4. 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 [47], [48]. In this condition Microwave (active and passive) 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 [48].

Research has been carried out using microwave (active and passive) remote sensing for mapping of soil characteristics. Some soil property parameters using microwave remote sensing data for soil quality assessment are explained below.

3.1.4.1. Soil Salinity

Crop growth and productivity that could be affected by soil degradation; soil salinity is a main problem of soil degradation. For melioration of the salt affected soil it is essential to identify of soil type and intensity of soil with their exact location and areal extent. Due to unwanted spectral mixing with sand and little spectral reflectance in black soils areas it is difficult to the illustration of salt affected soil in littoral areas, infertile areas as well as black clay rich soils regions, hence using optical remote sensing imagery it is feasible to illustration of salt affected soils [48].

3.1.4.2. Ravine Erosion Inventory

For utilization of depiction and mapping of ravine affected areas we commonly use optical multispectral as well as panchromatic fine resolution imagery and its classification is mainly based on manual interpretation of the image features as well as its depth categories, because these methods are qualitative in nature. Terrain ruggedness and vegetation penetration capability are highly sensitive to microwave SAR, by taking advantage of microwave remote sensing such as SAR and InSAR (Interferrometric SAR) for illustration and characterization of ravines quantitative terms such as ravine density, ravine depth, and ravine surface cover [48].

3.1.4.3. Sand Dune Characterization

Huge infertile areas are covered by sand dune and these fixed, semi fixed sand dunes are distributed around the desert periphery with mobile dunes in the inner part of the deserts. Normally desert areas are difficult to access; hence to understand the environmental changes in dry areas information about the dune properties is very much helpful. So, remote sensing imagery are helpful for monitoring desert environments [48].

3.1.4.4. Soil texture and Hydraulic Properties

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 [48].

3.1.4.5. Soil Drainage

Although the various characteristics, soil drainage which directly affect of crop growth, water flow and solute transport in soils. Drainage is 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 [48].

3.1.4.6. Soil Surface Roughness

Soil surface roughness (SSR) has influenced soil thermal properties, infiltration rate, surface run-off and susceptibility of soil to erosion [48].

3.1.5. 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 [49]. 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 [31].

4. USEFUL TECHNIQUES FOR LULC ANALYSIS

To analyze any particular area we need a GIS or remote sensing data. Those data are in the form of toposheet, maps and satellite or airborne images. For remote sensing data there is lot of techniques used by researchers to analysis the LULC in any area. The main techniques are supervised and unsupervised classification, and others are hybrid classification, box classifier, fuzzy classifier, Support vector machine, Normalized data vegetation index (NDVI), etc. These techniques are used for identification and change detection in land cover and land use, classification of land use/land cover, agricultural areas, patches, water bodies, as well as classification of different crops and crop monitoring etc.

4.1. Supervised classification

With supervised classification, we identify examples of the Information classes (i.e., land cover type) of interest in the image. These are called "training sites or different signatures" for each class. For this method we require a priori knowledge of the interested region [30]. There are number of supervised classifiers based on the statistics, but the maximum likelihood classifier, minimum distance classifier, parellopiped classifier, mahalanobis classifier are most useful classifiers [7].

4.1.1. Maximum likelihood classifier

The maximum likelihood classifier is one of the most popular methods of classification in remote sensing, in which a pixel with the maximum likelihood is classified into the corresponding class. It is a statistical decision criterion to assist in the classification of overlapping signatures; pixels are assigned to the class of highest probability. Gaussian maximum likelihood classifier classifies an unknown pixel based on the variance and covariance of the category spectral response patterns. This classification is based on probability density function associated with a particular signature (training site). Pixels are assigned to most likely class based on a comparison of the posterior probability that it belongs to each of the signatures being considered. Under this assumption, the distribution of a category response pattern can be completely described by the mean vector and the covariance matrix [7], [52], [53].

4.1.2. Minimum distance classifier

The minimum distance classifier is used to classify unknown image data to classes which minimize the distance between the image data and the class in multi-feature space. The distance is defined as an index of similarity so that the minimum distance is identical to the maximum similarity. It uses mean vector in each class signature, while standard deviation and covariance matrix are ignored [53].

4.1.3. Parellopiped classifier

A parallelepiped is a geometrical shape whose opposite sides are straight and parallel. The parallelepiped classifier uses the class limits and stored in each class signature to determine if a given pixel falls within the class or not. The class limits specify the dimensions (in standard deviation units) of each side of a parallelepiped surrounding the mean of the class in feature space. The parallelepiped classifier is typically used when speed is required. The drawback is (in many cases) poor accuracy and a large number of pixels classified as ties (or overlap, class 255) [53].

4.1.4. Mahalanobis classifier

It is based on correlations between variables by which different patterns can be identified and analyzed. It gauges similarity of an unknown sample set to a known one. It differs from Euclidean distance. It takes into account the correlations of the data set and is scale-invariant [54].

4.2. Unsupervised classification

Unsupervised classification is a method which examines a large number of unknown pixels and divides into a number of classed based on natural groupings present in the image values. Unsupervised classification does not require analyst-specified training data [7], [53]. The two common types of these classifiers are K-means clustering and ISODATA (Iterative Self-Organizing Data Analysis) [7], [30].

4.3. Hybrid classifier

The combination of supervised and unsupervised classifier is a hybrid classifier. This classification produced more accurate classifications than the supervised classification; however, it did not improve the accuracy significantly in com-parison to the unsupervised classification [14].

4.4. Fuzzy classifier

Fuzzy logic is a soft computing technique. These soft computing techniques are better than hard computing techniques, because these soft computing techniques like as fuzzy logic, neural network, machine learning, can gives better facility to handle mixed pixels [26]. Fuzzy classification is the process of grouping elements into a fuzzy set whose membership function is defined by the truth value of a fuzzy propositional function and uses degree of membership functions in between 1.0 and 0.0 for full membership and nonmember ship respectively [55].

4.5. Normalized data vegetation index (NDVI)

NDVI is based on the principle of spectral difference based on strong vegetation absorbance in the red and strong reflectance in the near-infrared part of the spectrum. NDVI (Normalized Difference Vegetation Index) is mostly useful method to classify the land cover vegetations [56], using this formula NDVI= NIR-RED/NIR+RED [57], [58], [59] and calculated using the RED (0.6 to 0.7 µm) NIR (0.7 to 1.1 µm) wavelengths [29], [35], [59]. NDVI is a single band image having the values between -1 to +1, the value closer to +1 will tells about presence of healthy green vegetation [57], [35], [59].

5. 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 but Maximum likelihood classification technique is most useful technique in supervised classification, because it gives greater accuracy than other techniques. Unsupervised technique is the second important method for classification as well as identification. Fuzzy classification (also known as fuzzy clustering) algorithm is the best useful classifier for same elements. And Hybrid classifier is the lowest useful technique for classification. Normalized data vegetation technique (NDVI) technique is the most useful technique for land cover analysis as well as crop condition monitoring. Soil characteristics are very much useful for crop growth and crop yield. 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.

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