Analysis of Land Use/Land Cover Changes Using Remote Sensing And GIS

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Abstract- *Remote Sensing and Geographical Information System (GIS) is very helpful for time-saving and also for the efficient land use mapping. Remote sensing helps to observe land without any physical contact with surface. The world has been facing problem from all the aspect due to the increase of population which is the main reason for the urban expansion increases in township. Infrastructure caused the use of forest land which leads to deforestation. Land use/Land cover map helps to map the total area covered and used, fights with environmental causes and also to manage the natural resource. Sometime, it's important for finding the change detection without doing a physical survey.*

Keywords- Remote Sensing, GIS Approach, Change Detection, Land use Land cover

I. INTRODUCTION

The growth of a society depends on its social and economic development. This might be the specific reason why socio-economic surveys are applied. This type of survey includes each spatial and non-spatial dataset. Land Use/Land Cover maps play a big and prime role in designing, management and observation programmes at native, regional and national levels. This type of information, on one hand, provides the simplest way for better understanding of land utilization aspects and on the opposite hand, it plays a big role within the formation of policies and programmer needed for development designing. The terms land use and land cover are typically used interchangeably, however, every term has its distinctive meaning. Land cover refers to the surface cover on the underside like vegetation, urban infrastructure, water, blank soil etc. Identification of land cover establishes the baseline data for activities like thematic mapping and alter detection analysis. Land use refers to the aim the land serves once used alongside the phrase Land Use / Land cover (LULC) usually refers to the categorization or classification of human activities and natural components on the landscape at intervals a specific timeframe. supported established scientific and math strategies of research of applicable source.

II. PROBLEM DEFINITION

Due to the rapid growth in population. Gangtok has got to expertise speedy urban enlargement within the last decade that is the major reason behind land use changes. Manual survey for land use of the known location is extremely high-priced and time-consuming. No updated Land use land cover of Gangtok, Sikkim.

III. PROPOSED METHODOLOGY

We acquire the landsat-8 Remote Sensing satellite dataset of Erath explorer usgs a Remote sensing satellite Repository used Semi-Automatic Classification Plugin for QGIS as the platform for the purpose of manipulating and get different band Compositions.Our methodology involves use of Classification technique like Maximum likelihood classification, Maximum Distance classification and Spectral Angular Mapping.

IV. STUDY AREA

This study space cover Gangtok that is found between 27° 19′ 48″ N latitude and 88° 37′ 12″ E longitudes within east geographic region in the republic if India. That may be a town, municipality, the capital and therefore the largest city of Sikkim Gangtok is within the jap chain of mountains range, at an elevation of one, 650m (5,410 ft.) per the revisionary population totals, 2011 census of Republic of India, the population of Gangtok Municipal corporation has been calculable to be ninety-eight, 658. [6][7][8]

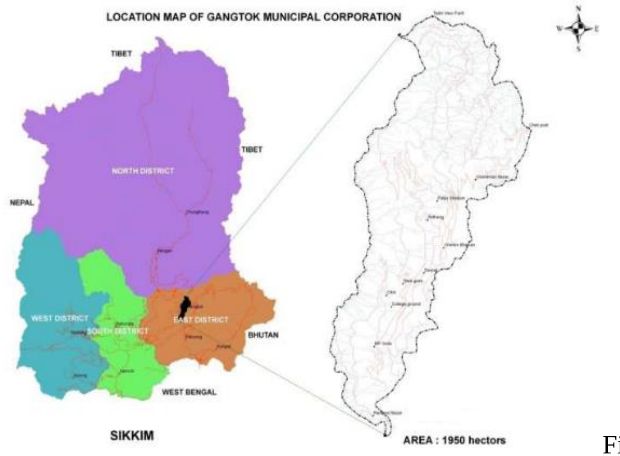

Figure 2. Location of the study area

V. DATA PROCESSING

It is a technique that is used to convert the raw data into a clean data set and also refers to the transformations applied to our data before feeding it to the algorithm. For getting better results from the Machine Learning applied model, the format of the data has to be in a proper manner and in a specified format. We use plugin such as Semi-Automatic classification

5.1 **Semi-Automatic Classification Plugin for QGIS**

The data that we have it is in Gray scaleformat and using Semi-Automatic Classification Plugin we create aband set ofdifferent bands. Using those band set we create some sample of the different Spectral signature using the regions of interests (ROIs) with a signature ID and its related values. After the classification we get our output as Gray scale images.

5.2 **Spectral Signature**

Spectral signature is the variation of reflectance or emittance of a material with respect to wavelengths (i.e., reflectance/emittance as a function of wavelength). The spectral signature of stars indicates the composition of the stellar atmosphere.

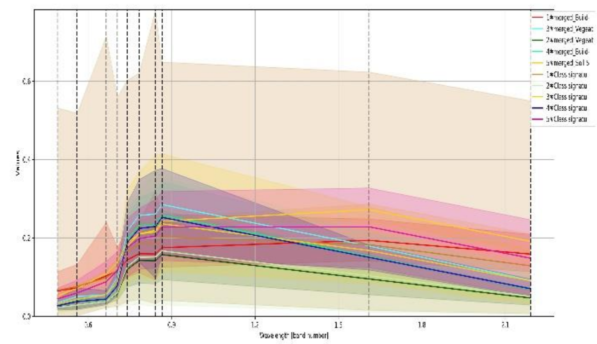

Figure 3: Signature plot

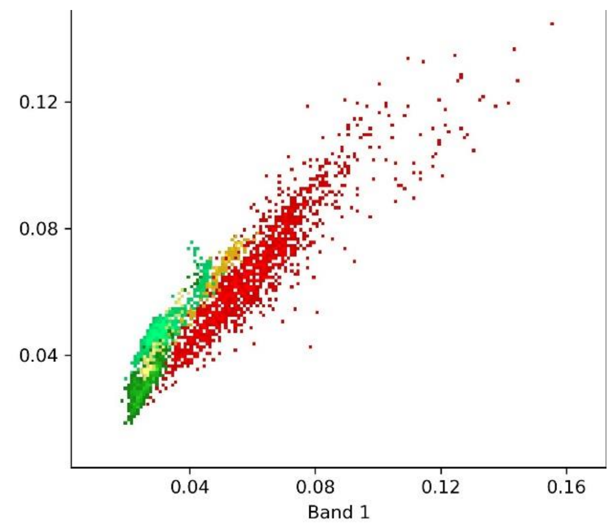

Figure 4: scatter plot

5.3 **Band Combination**

In this we combine different bands for creating colour composition there 7 band composition in landsat-8 we use 4,3,2 and 5,4,3 as two inputs to our classifier.

Natural Colour combinations:The natural colour composite uses a band combination of red (4), green (3) and blue (2). It replicates close to what our human eye sees. While healthy vegetation is green, unhealthy flora is brown. Urban features appear white and grey and water is dark blue or black.

Figure 5: Natural colour Combination

Colour Infrared Combination:

This band combination is also called the near infrared (NIR) composite. It uses near-infrared (5), red (4) and green (3). Because chlorophyll reflects near infrared light, this band composition is useful for analysing vegetation. In particular, areas in red have better vegetation health. Dark areas are water and urban areas are white.

Figure 6: Colour Infrared Combinations

VI. CLASSIFICATION METHODS FOR LAND USE

we tend to square measure about to use the food and agriculture organization classification technique to classify our Land use land cover map. LCML provides a general framework of rules supported mug and stratification of each organic phenomenon and abiotic parts that will be accustomed specify any land cover feature everywhere the planet, therefore creating accessible a typical reference for land cover classification systems.

Remote sensing may be a powerful tool for gathering such information, identify, find and map the various kind of landform units once used with GIS. Most remote sensing pattern recognition uses the closest Neighbour Technique. during this most likelihood rule.

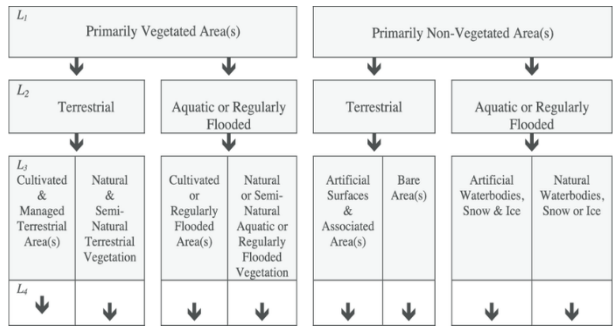

Figure 7. FAO classification Model

6.1 **Classifier**

Classifier are the building block for remote sensing it helps to identify different object efficiently by using train and test data and provides effective result. We use machine learning like supervise, unsupervised and reinforcement learning algorithm for training and testing data.

6.1.1 **Maximum likelihood classifications**

Maximum likelihood classification assumes that the statistics for each class in each band are normally distributed and calculates the probability that a given pixel belongs to a specific class. Unless you select a probability threshold, all pixels are classified. Each pixel is assigned to the class that has the highest probability (that is, the maximum likelihood). If the highest probability is smaller than a threshold you specify, the pixel remains unclassified.In this we have a accuracy rate of 53.9089 and the kappa index is 0.73

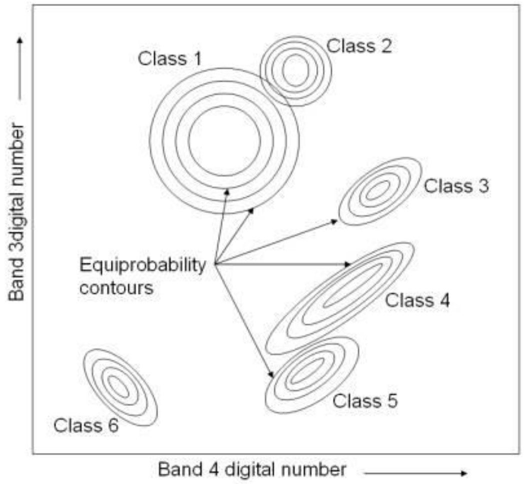

Figure 8: Equiprobability contours defined by Maximum likelihood classification

Implements maximum likelihood classification by calculating the following discriminant functions for each pixel in the image.

$$g_i(x) = \ln p(\omega_i) - \tfrac{1}{2} \ln |\Sigma_i| - \tfrac{1}{2}(x - m_i)^T \Sigma_i^{-1} (x - m_i)$$

Where:

i = class

x = n-dimensional data (where n is the number of bands)

$p(\omega_i)$ = probability that class ω_i occurs in the image and is assumed the same for all classes

$|\Sigma_i|$ = determinant of the covariance matrix of the data in class ω_i

Σ_i^{-1} = its inverse matrix

m_i = mean vector

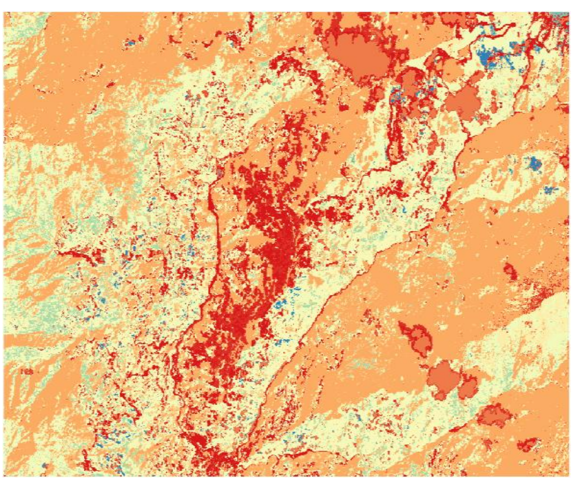

Figure 9: Maximum Likelihood Classification Result

6.1.2 **Minimum distance classifications**

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. In this we have a accuracy rate of 43.597 and the kappa index is 0.72

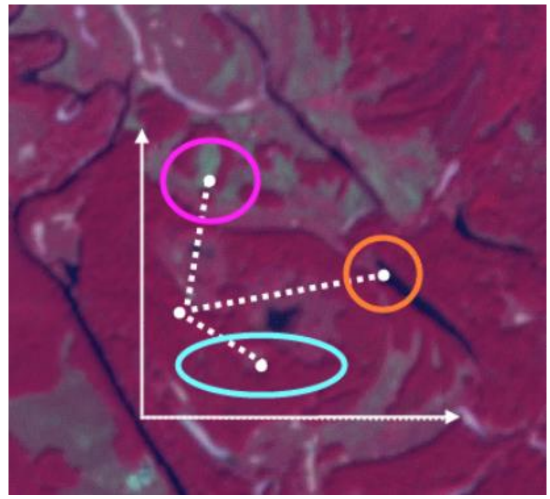

Figure 10: Minimum distance classification

The kth class ω_k is represented by its mean vector $\mathbf{m}_k$ and covariance matrix which can be estimated from the training samples:

$$\mathbf{m}_k = \frac{1}{K_k} \sum_{i=1}^{K_k} \mathbf{x}_i^{(k)} \quad (k = 1, \cdots, C)$$

and

$$\mathbf{\Sigma}_k = \frac{1}{K_k} \sum_{i=1}^{K_k} (\mathbf{x}_i^{(k)} - \mathbf{m}_k)(\mathbf{x}_i^{(k)} - \mathbf{m}_k)^T$$

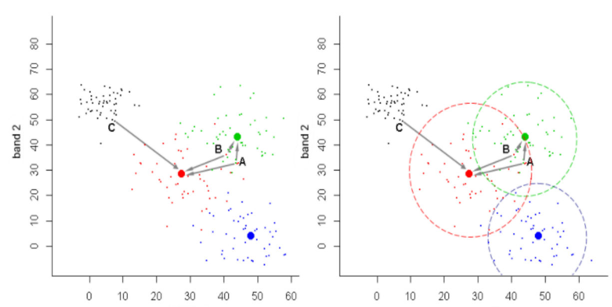

Figure11: Example of a minimum distance algorithm used in distinguish classes

The distance between any two points can be measured with a ruler.) distance to ω_k is smaller than those to all other classes:

$$\mathbf{x} \in \omega_k \quad \text{iff} \quad d_M(\mathbf{x}, \omega_k) = min\{d_M(\mathbf{x}, \omega_i) \quad i = 1, \cdots, C\}$$

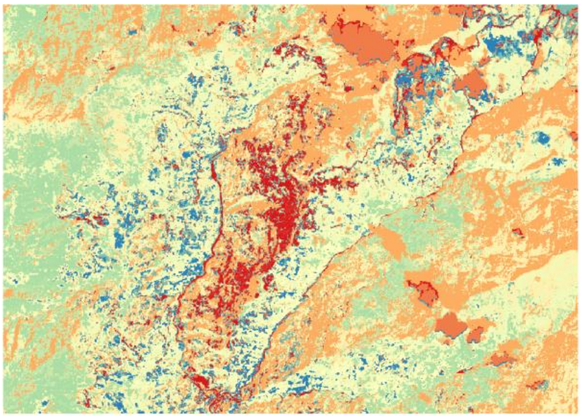

Figure 12: Minimum distance classification Result

6.1.3**Spectral Angle Mapper**

The Spectral Angle Mapping calculates the spectral angle between spectral signatures of image pixels and training spectral signatures. The spectral angle θθ.In this we have an accuracy rate of 43.597 and the kappa index is 0.7205

$$\theta(x, y) = cos^{-1}\left(\sum_{i=1}^{n} x_i y_i \,/\, (\sum_{i=1}^{n} x_i^2)^{1/2} * (\sum_{i=1}^{n} y_i^2)^{1/2}\right)$$

Where:
xx = spectral signature vector of an image pixel;
yy = spectral signature vector of a training area;
nn = number of image bands.
Therefore, a pixel belongs to the class having the lowest angle, that is:

$$x \in C_k \Leftrightarrow \theta(x, y_k) < \theta(x, y_j) \forall k \neq j x \in Ck \Leftrightarrow \theta(x, yk) < \theta(x, yj) \forall k \neq j$$

where:
CkCk = land cover class kk;1
ykyk = spectral signature of class kk;
yjyj = spectral signature of class jj.

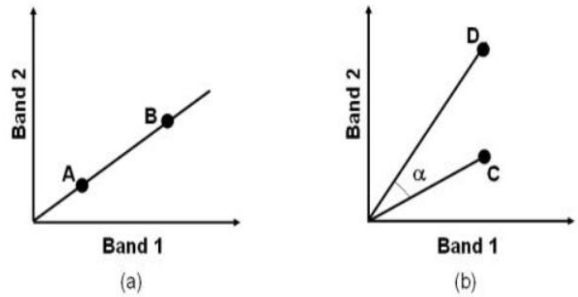

Figure 13: Representation of Reference Angle

In *N* dimensional multi- (or hyper-) spectral space a pixel vector *x* has both magnitude (length) and an angle measured with respect to the axes that defines the coordinate system of the space In the Spectral Angle Mapper (SAM) technique for identifying pixel spectra only the angular information is used. SAM is based on the idea that an observed reflectance spectrum can be considered as a vector in a multidimensional space, where the number of dimensions equals the number of spectral bands.

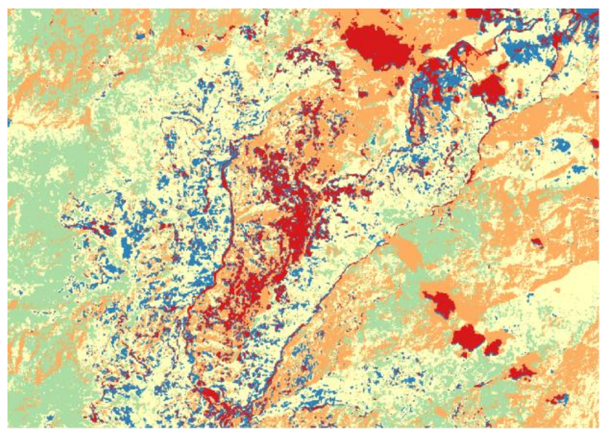

Figure 14: Spectral Angle Mapper Result

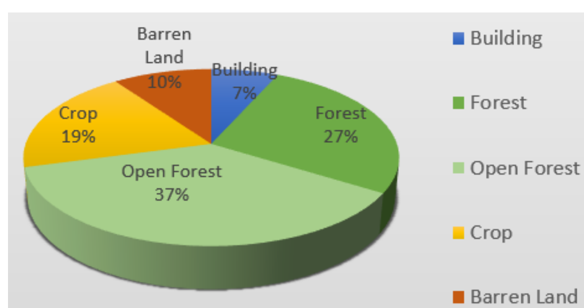

Figure 15: Graphical represenatation of land cover observesd

Table 1: Total area overserved

Class	PixelSum	Percentage%	Area [Metre^2]
1.0	97421	6.7053714002532905	9742100.0
2.0	393797	27.104578492373765	39379700.0
3.0	537794	37.015720499972474	53779400.0
4.0	280418	19.300836958317273	28041800.0
5.0	143450	9.8734926490832	14345000.0

VI. CLASSIFICATION RATE/ACCURACY

Classification rate of accuracy Is given by kappa coefficient. It is a measure of how the classification results compare to values assigned by chance. It can take values from 0 to 1. $K = (P_0 - P_e) / (1 - P_e)$

In our case the overall Kappa Index: 0.83. If kappa coefficient equals to 0, there is no agreement between the classified image and the reference image. If kappa coefficient equals to 1, then the classified image and the ground truth image are totally identical. So, the higher the kappa coefficient, the more accurate the classification is.

VII. PROPOSED SYSTEM ARCHITECTURE

As shown in below diagram, we acquire the landsat-8 Remote Sensing satellite dataset of Erath explorer usgs a Remote sensing satellite Repositorytoapplying a classification models,collecting appropriate data is very essential. After collecting the data, we created some ROIs (Regions of Interest) Above mentioned Models have been comparatively studied which is used in this project and made the Land use land cover map.

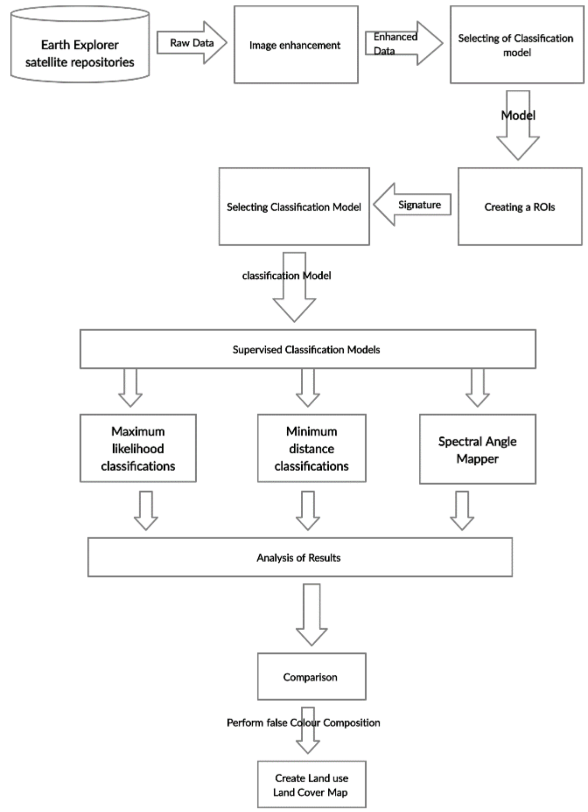

Figure 16: Work Flow

VIII. CONCLUSION AND FUTURE SCOPE

To analyse the land cover in this rapid growing age is very important it is a very important challenge to find the accuracy provide by the classifiers and also improving and updating the classifications speed and techniques are much more convenient.So in this project, we employed the machine learning classifier algorithms on the Satellite data and use 3 different algorithm are used to find efficiency and effectiveness of those algorithm s as well as the accuracy of them.

Well in Future Scope, various new deep learning algorithms are required to be implemented for the classification.

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