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# LAND COVER INDEX CLASSIFICATION USING SATELLITE IMAGES WITH DIFFERENT ENHANCEMENT METHODS

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***Abstract*** - *Land use/cover data is important for diverse disciplines (e.g., ecology, geography, and climatology) because it serves as a basis for various real world applications. For detection and classification of land cover, remote sensing has long been used as an excellent source of data for finding different types of data attribute present in the land cover. This paper presents land cover index classification results for Ayeyarwaddy Delta using Google Earth satellite images. The satellite images are classified into three general classes: 1) Building 2) Vegetation and 3) Road. For index classification, K-means clustering algorithm is used with different enhancement methods: V-channel enhancement, histogram equalization and adaptive histogram equalization. Then the index classification result for each enhancement method is compared using MSE (Mean Squared Error) and PSNR (Peak Signal to Noise Ratio). According to the results, V-channel enhancement method provides good result in land cover index classification compared to the other two. These land cover index classification results can be used for finding changes in land areas that undergone changes over period of time.*

***Key Words*: Histogram Equalization, Adaptive Histogram Equalization, V-channel Enhancement, Land Cover Index classification**

## 1. INTRODUCTION

Cyclone Nargis strike Myanmar during early May 2008. It caused the worst natural disaster in the recorded history of Myanmar. The cyclone made landfall in Myanmar on Friday, May 2, 2008, sending a storm surge 40 kilometers up the densely populated Ayeyarwaddy Delta, causing catastrophic destruction and at least 138,000 fatalities. Thousands of buildings were destroyed in the Ayeyarwaddy Delta, state television reported that 75 percent of buildings had collapsed and 20 percent had their roofs ripped off. One report indicated that 95 percent of buildings in the Ayeyarwaddy delta area were destroyed. For this reason, it is needed to know land cover changes before and after Nargis Cyclone for regional planning, policy planning and understanding the impacts of disaster. Information about destruction during Nargis Cyclone and reconstruction after Nargis and land cover changes due to disaster will also be needed.

The main focus of this proposed work is to classify land cover and land use area of the Ayeyarwaddy delta using remote sensing satellite images. Remotely sensed data is among the significant data types used in classifying land cover and land-use distribution. Most of the applications and researches are in need of information and data on the types and distribution of land cover. Many researchers conducted studies on the use of land cover in especially urban areas and on obtaining information regarding land cover that would further lead to both qualitative and quantitative analysis of the findings [1].

The physical material on the surface of the earth such as water, vegetation building can be regarded as land cover. Therefore, for describing the data on the Earth surface, land cover is a fundamental parameter. When land cover area is utilized by people whether for development, conservation or mixed uses, it can be defined as land use. Accurate information of land cover is required for both scientific research (e.g. climate change modeling, flood prediction) and management (e.g. city planning, disaster mitigation). Satellite images consist of various images of the same object taken at different wavelengths in the visible, infrared or thermal range. Such images have been used for urban land cover classification [5] [7], urban planning [6], soil test, and to study forest dynamics [8].

In this paper, three land cover indices: vegetation, road and building are classified from Google earth images using K-means clustering with L*a*b* color space. The paper is organized as follow: section 2 and 3 present related works and proposed scheme. In section 4, 5, 6 and 7, system methodology, data resources and software, experimental esults and discussion are described. Finally, the conclusion is given in section 8.

## 2. RELATED WORKS

The variety of land use and land cover classification techniques has been researched extensively from a theoretical and practical aspect during the last decades. Sathya and Malathi [2] presented classification and segmentation in Satellite Imagery using back propagation algorithm of ANN and K-Means Algorithm. In that paper, these two algorithms are used as the tool for segmentation and classification of remote sensing images. This classified image is given to K-Means Algorithm and Back Propagation Algorithm of ANN to calculate the density count. The density count is stored in database for future reference and for other applications. This tool also has the capability to show the comparison of the results of both the algorithms.

The analysis of the presentation of unsupervised classification algorithms ISODATA (Iterative Self-Organizing Data Analysis Technique Algorithm) and K-Means in remote sensing, to evaluate statistically by iterative techniques is proposed in [3]. This investigation used SUPARCO (Space and Upper Atmosphere Research Commission (Pakistan)) obtained remotely sensed patch of Abbottabad Pakistan. The test patch of Abbottabad is divided into Five bands i.e. NDVI (Normalized Difference Vegetation Index), green, near infrared, far infrared, and green. The ROIs (regions of interest) selected for classification of Land Cover data comprises five different types of classes i.e. water bodies, agriculture, settled area, forest and barren land. In this research of remote sensing the first step was to preprocess Abbottabad test patch by filtering, to improve performance of classification and neighboring pixels homogeneity. The next step was to assess the accuracy of two pixel based unsupervised classifiers i.e. ISODATA and k-means on the said test patch. Finally, the mentioned classifiers performance is evaluated by varying their different parameters to categorize the effect of the clustering algorithms and their class statistics on whole classification outcomes.

In [9], the authors proposed rainfall estimation over rooftop using land-cover classification of Google Earth Images of India. The idea behind in that paper is to design the development of rain water harvesting system based on rainfall runoff estimation over rooftop. K-means clustering algorithm and textural parameters based on Gray Level Co-Occurrence Matrices are used for classification of the Google Earth images into land cover and land use sector. In land use and land cover classification, the satellite image is classified into different region such as Grass area, Water area, Roof-top area, Soil area etc. Then, the area under the different regions is computed because area measurement is required for computing rainfall runoff using estimation model. The computation of the roof top and road surfaces is nearly accurate and runoff calculation can be estimated very near to accuracy, which in turn is used for design and development of rainwater harvesting system. From the author's experiments, it will help to improve the water scarcity problem without much efforts of the survey.

## 3. PROPOSED SYSTEM

The block diagram of the proposed system is shown in Figure 1. Firstly, the input image is enhanced using three enhancement techniques: V-channel Enhancement, Histogram Equalization and Adaptive Histogram Equalization. Then the enhanced image is transformed into CIE L*a*b* color space for index classification. After that, three land cover indices are classified using K-means clustering algorithm. Finally, the index classification results for three enhancement results are compared using MSE and PSNR.

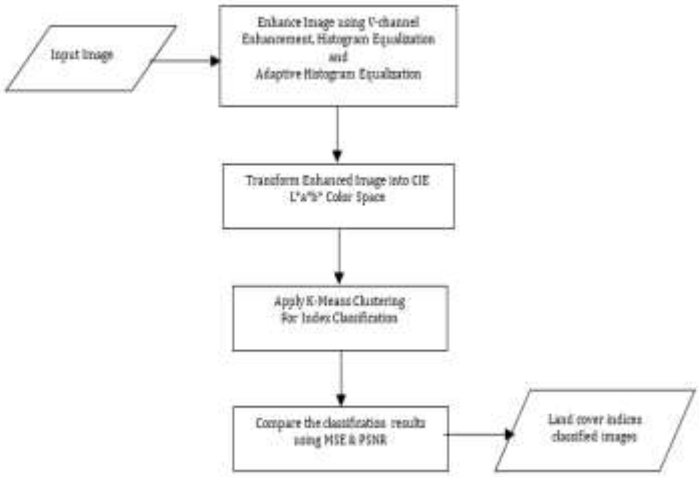


**Fig -1**: Block Diagram of the proposed scheme

## 4. SYSTEM METHODOLOGY

### 4.1 Image Enhancement

Firstly, the input Google Earth satellite image is enhanced with three different image enhancement methods. The principal objective of image enhancement is to process a given image, and then the result is more suitable than the original image for a specific application. V-channel enhancement, histogram equalization and adaptive histogram equalization methods are used for enhancement in order to decide which enhancement method is suitable for index classification.

#### 4.1.1 V-channel Enhancement

For V-channel enhancement, the original input RGB image is first transformed into HSV color space. From HSV transformed image, V-channel is enhanced because it contains the detailed information of the original image and it is a measurement of the brightness level in an image. Therefore, the V-Channel is extracted and enhanced from HSV image using both histogram equalization and adaptive histogram equalization. Then the enhanced V-channel is added again to HSV image and then transformed again to RGB color space for further process.

#### 4.1.2 Histogram equalization

In this process, the original input RGB image is directly enhanced using histogram equalization without another color space transformation. The benefit of using histogram equalization is that it is a technique that can enhance both the contrast and contrast adjustment of a given image.

#### 4.1.3 Adaptive Histogram equalization

Adaptive Histogram equalization is another image enhancement technique that is used to enhance the contrast in images. Histogram equalization is a technique that emphasize only the local contrast of the image. Adaptive histogram equalization overcomes from this issue, this technique is applicable for overall contrast. For this reason, the proposed system uses the adaptive histogram equalization as another enhancement method and compared the results with the other two enhancement techniques.

### 4.2 Color Transformation

For segmentation of satellite images for land use and land cover classification, the enhanced image is converted into CIE L*a*b* (LAB) color space from RGB color space using RGB to LAB color conversion method. In CIE L*a*b* color space, L* represents the lightness of color between 0 (dark) to 100 (white), while the a* and b* channels are the two chromatic components. It is based on the CIE*XYZ color space. So, firstly the input RGB image is transformed into CIE *XYZ color space using equation 1.

$$\begin{bmatrix} X \\ Y \\ Z \end{bmatrix} = \begin{bmatrix} 0.4125 & 0.3576 & 0.1804 \\ 0.2127 & 0.7152 & 0.0722 \\ 0.0193 & 0.1192 & 0.9502 \end{bmatrix} \begin{bmatrix} R \\ G \\ B \end{bmatrix} \quad (1)$$

After then, the CIE*XYZ component is transformed into CIE L*a*b* color space using the following equation 2, 3 and 4.

$$L = \begin{cases} 116 * \left(\frac{Y}{Y_n}\right)^{\frac{1}{3}} - 16 & if \ \frac{Y}{Y_n} > 0.008856 \\ 903.3 & otherwise \end{cases} \quad (2)$$

$$a = 500\left[\frac{X^{\frac{1}{3}}}{X_n} - \frac{Y^{\frac{1}{3}}}{Y_n}\right] \quad (3)$$

$$b = 200\left[\frac{Y^{\frac{1}{3}}}{Y_n} - \frac{Z^{\frac{1}{3}}}{Z_n}\right] \quad (4)$$

### 4.3 Index Classification

After the enhanced image is transformed into L*a*b* color space, then the image is classified into three land cover indices: 1) Building Index 2) Vegetation Index and 3) Road Index. There are many methods of clustering developed for a wide variety of purposes. K-means algorithm has lot of advantages over other algorithms. For instance, K-mean improves accuracy of classification which is drawback of algorithms such as region growing algorithm [10] [11] and nearest neighbor algorithm. In addition to that, it can be performed on any type of satellite images including Google Earth images, which are free of cost; which eliminates disadvantage of normalized difference index (NDVI) algorithm of being expensive. There is no manual intervention as in case of region growing algorithm (requires seed point allocation); which makes it easier and faster to implement. Therefore, after the image is transformed into L*a*b* color space, K-Means clustering is used to classify the image into three land cover indices. In L*a*b* color space, Luminance (Lightness) and other two color channels a and b are known as chromaticity layers. In a* layer, the color falls along the red green axis, and in b*, the color falls along the blue-yellow axis. So, for land cover index classification, only a* and b* layers are used for land cover classification using K-Means clustering with Euclidean distance metric.

After index classification, then the cluster variance for each index is calculated and compared the results for three enhancement methods.

## 5. DATA RESOURCES AND SOFTWARE

The study area used is the Google Earth satellite images of Ayeyarwaddy Delta, Myanmar, in the period from 2004 to 2014 etc., which is to be classified as land-cover. It lies between north latitude 15° 40' and 18° 30' approximately and between east longitude 94° 15' and 96° 15'. It covers about an area of 35,140 square kilometers. It is the main rice produced area in the country. It is a typical urban landscape of Myanmar. The entire proposed work is carried out using MATLAB v7.12.0 and MS-Office. While taking images from Google Earth, it is needed to define the elevation parameter 150 feet and eye altitude about 1945 feet for saving each satellite image of Ayeyarwaddy delta.

## 6. EXPERIMENTAL RESULTS

In this system, initially preprocessing is done in which the input image gets transformed suitably for segmentation. In preprocessing, firstly the satellite images are enhanced using V-channel enhancement, histogram equalization and adaptive histogram equalization. For V-channel enhancement, firstly the input RGB image is transformed into HSV and V-channel is extracted and enhanced using both histogram equalization and adaptive histogram equalization. Then, the enhanced V-channel is added into original HSV image and then transformed again to RGB image for further processing. Figure 2(a) shows the original satellite image taken as an input for experimentation. Figure 2(b) and 2(c) are V-channel enhancement images using histogram equalization and adaptive histogram equalization.

Figure 3 (a), (b) and (c) show the original image and three RGB enhancement images using histogram equalization and adaptive histogram equalization.

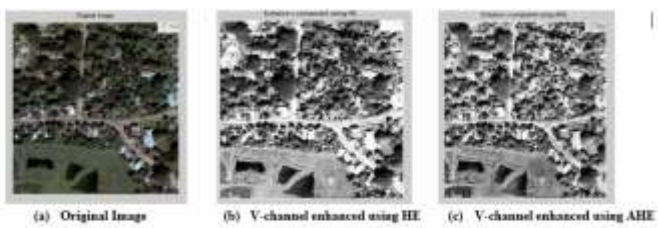


**Fig -2**: Original Image and V-Channel Enhancement Result


**Fig -3**: Original Image and Enhancement using HE & AHE

After image enhancement, then the enhanced image is transformed into L*a*b* color space for index classification using K-Means clustering algorithm. The classification results for each index are shown in the following figures. Road index classification results for each enhancement techniques are shown in figure 4. The classification results for building index are shown in figure 5. The vegetation index classification results are shown in figure 6.

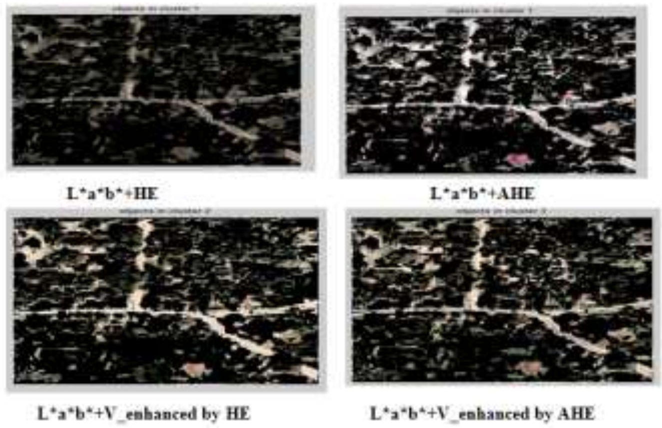


**Fig -4**: Road Classification Results with each enhancement techniques

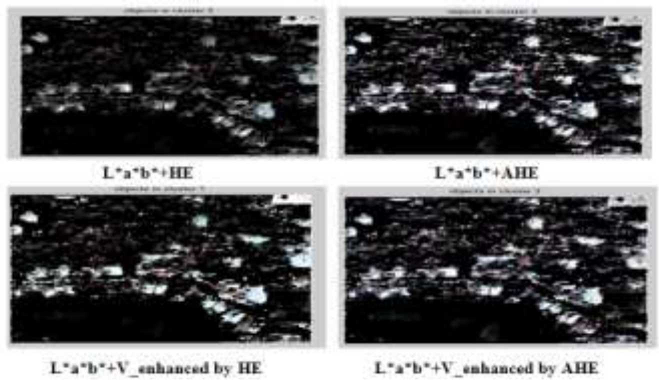


**Fig -5**: Building Classification Results with each enhancement techniques

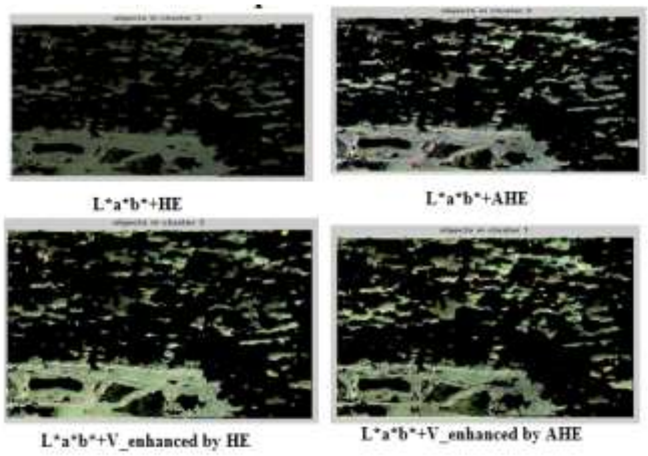


**Fig -6**: Vegetation Classification Results with each enhancement techniques

The evaluation of unsupervised learning is both quantitative and objective. The performance of a clustering algorithm within a given color space is evaluated using MSE (Mean Squared Error) and PSNR (Peak Signal to Noise Ratio).

### 6.1 Mean Squared Error

Mean Squared Error is an average of the squares of the difference between the predicated observations and actual [4]. A lower value of MSE implies lesser error. For an M*N image, the MSE can be calculated as in equation 5:

$$MSE = \frac{1}{M * N}\sum_{y=0}^{M-1}\sum_{x=0}^{N-1}[I(x,y) - I'(x,y)]^2 \quad (5)$$

### 6.2 Peak Signal to Noise Ratio

PSNR is commonly used as measure of quality reconstruction of image. High value of PSNR indicates the high quality of image. PSNR is usually expressed in terms of the logarithmic scale [4]. The formula of PSNR is as follows:

$$PSNR = 10\log\left(\frac{255^2}{MSE}\right) \quad (6)$$

The calculation of MSE and PSNR for land cover index using L*a*b* color space with different enhancement methods is shown in Table 1. The lowest MSE and highest PSNR value of each index are highlighted in Table 1.

**Table -1:** Calculation of MSE and PSNR

| Color Space + Image Enhancement Method | Road Index | | Building Index | | Vegetation Index | |
|---|---|---|---|---|---|---|
| | MSE | PSNR | MSE | PSNR | MSE | PSNR |
| L*a*b*+ | 165834 | - | 78351 | - | 16409 | - |

| | | | | | | |
|---|---|---|---|---|---|---|
| HE | 03.49 | 24.0659 | 89.6 | 20.8096 | 753 | 24.0202 |
| L*a*b*+ AHE | 14147330.46 | -23.3759 | 6408437.8 | -19.9367 | 14235926 | -23.4031 |
| L*a*b*+ V-enhanced by HE | 173.1868748 | 25.7457 | 87.778486 | 28.6969 | 340.73817 | 22.8066 |
| L*a*b*+ V-enhanced by AHE | 147.832256 | 26.4331 | 77.909306 | 29.2149 | 309.80717 | 29.2149 |

By comparing the PSNR and MSE for each index, it can be seen that L*a*b*+V_channel enhanced with adaptive histogram equalization achieved lowest MSE value and highest PSNR value.

## 7. DISCUSSION

From the experimental results, it is observed that L*a*b* color space with V_channel enhancement gives the lower MSE and higher PSNR value in comparison to other enhancement methods. Lower MSE gives lesser error and higher PSNR means better the classification results, so it can say that V_channel enhancement is better than the other enhancement methods for land cover index classification with Google Earth satellite images.

## 8. CONCLUSION

This proposed system presents a technique for the land use and land cover classification for Ayeyarwaddy Delta using Google Earth satellite images. From the experimental results, it can be seen that K-means clustering algorithm gives better results for land cover classification using Google earth satellite images. For land cover index classification, CIE L*a*b* color space can provide better classification results for satellite images. The land cover classification information of this proposed system can be used to calculate land cover change detection for Ayeyarwaddy Delta before and after Nargis Cyclone. This land cover changes information aims to form valuable resources for urban planner and decision makers to decide the amount of land cover changes before and after the disaster and the impact of disaster.

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