A Study on Land Use and Land Cover Classification in Mandalay Area by Using Remote Sensing & GIS Techniques

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Abstract

Land Use & Land Cover classification have been identified by using supervised classification (MLCM) and band ratioing method from reflectance bands of Landsat7 image. Firstly, supervised classification was done by using field data and questionnaires which were asked during field survey. Field data was used for image classification and verifying the result. Finally, seven band ratios have been created and each ratio reveals two or three LULC features. Ratio of visible spectrum bands (b2/b3 and b3/b2) can help to clear the images of forests, crop lands, barren lands; ratios of red and near IR bands (b3/b4 and b4/b3) reveal urban area, vegetation, waterbody and croplands. This study has been on the basis of visual interpretation on different classification techniques. This study shows that images of large area can be obtained rapidly and low cost by using different classification methods.

Keywords: Supervised, Band Ratioing & Classification

Introduction

Land Use often associated with people take place on the land and represent the current use property. Land Cover refers to what is actually present on the ground and may also contain an ecological description. To understand how LULC change affects and interacts with global earth systems, information is needed on what changes occur, where and when they occur, the rates at which they occur, and the social and physical forces that drive those changes.

Aim and objectives

The main purpose of this research is to carry out an analysis and interpretation of satellite data, in order to produce basic maps such as structural and land use map in digital form. The main objectives are as follow:

- To analyse Land Use and Land Cover classification map by using Remote sensing & GIS Techniques and
- To identify different band ratios for different Land Use and Land Cover features.

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Study Area

Mandalay area is located between latitudes of 21° 51' 47'' and 22° 01' 27'' N and between longitudes of 96° 03'17'' and 96° 08' 47''E. It lies not only in the central part of Myanmar but also on the eastern bank of the Ayeyarwady River in Mandalay Plain.

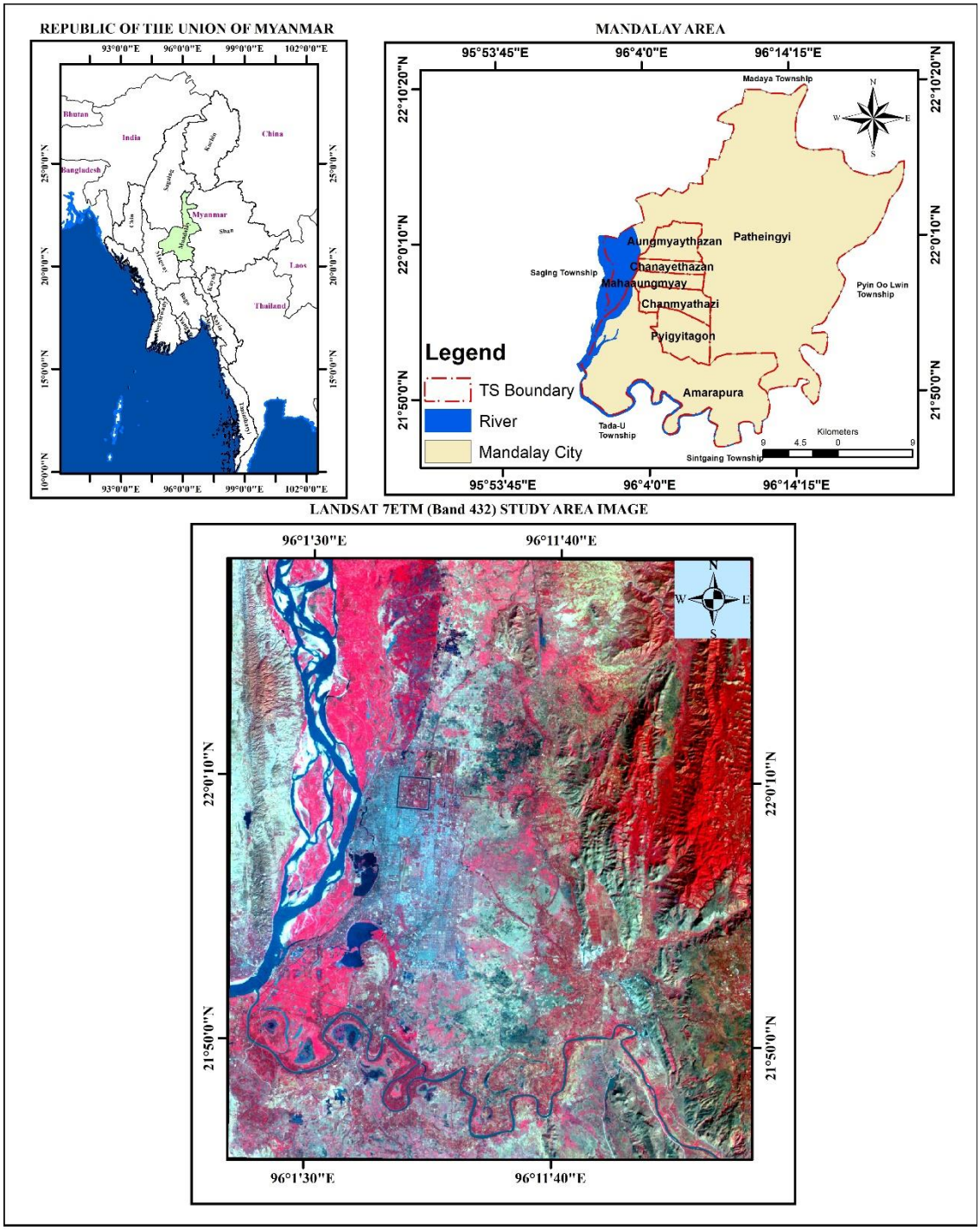


Figure (1) Location Map of Mandalay Area

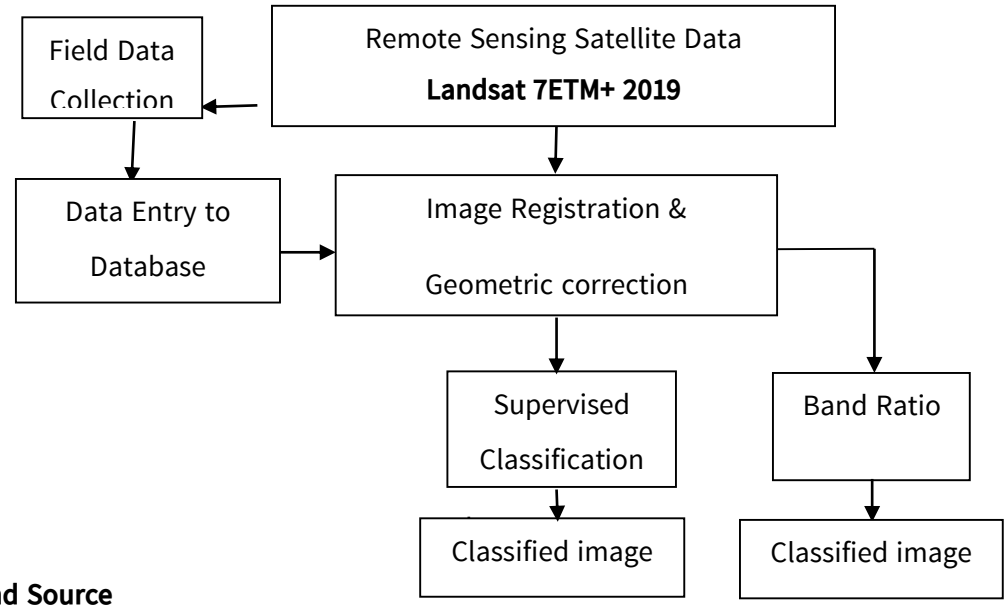
Source: Landsat 7ETM+ & UTM Map

Data collection and Methodology

The first stage of the study, the primary and secondary data were collected by field trip. It is the initial GIS spatial database development from existing analog maps and collecting of satellite image data. Remote sensing data are essentially used for the identification of the features. The Landsat ETM data is used to extract criterion thematic maps. The methodology adopted in the study can be generally described in the following stages:

- Data collection
- Pre-processing
- Field investigation
- Data analysis and interpretation

Methodology



Data and Source

Table (1) Data Uses

Data	Source	Supplement information
Landsat 7ETM+	http://www.earth explorer.usgs.gov	(path133-row45) acquired February 8, 2019
UTM maps	Remote Sensing Dept: Mandalay Technological University	84N-16, 93B-4 & 8, C-1

Equipment and Software

Global Positioning System and camera were very useful for data collection and it helped to record all field snapshot views of the study area.

The image preprocessing and classification processing were done by using RS techniques such as ENVI 5.3 and ERDAS IMAGINE 2019 software. Data analysis was performed by using ArcGIS 10.8.

Classification Process

LU classes are assigned based on existing UTM maps.

Table (2) Land Use Land Cover Classes

No.	Land cover name	Description
1.	Built-up Area	Residential, infrastructure
2.	Agriculture	Paddy field, crop, garden
3.	Forest	Deciduous, dense forest
4.	Water body	River, Stream, Creek and Lake
5.	Sand	Dune

Source: Calculated by the Researcher

Classified Techniques

Ground Data Collection

The data collection and field checking in the study area are conducted during this investigation mainly including field checking of geology, soil, landform interpretation keys to compare with actual ground situation and theme data. The existing topographic map of 1:500,000 scaled sheets can be available in the field, and it is mainly used as the base map together with GPS localization and checking the different ground features and surface material conditions in the study area. Real LULC is checked and taken photos with location assign of GPS measurement to verify LU classification map extracted from satellite image.

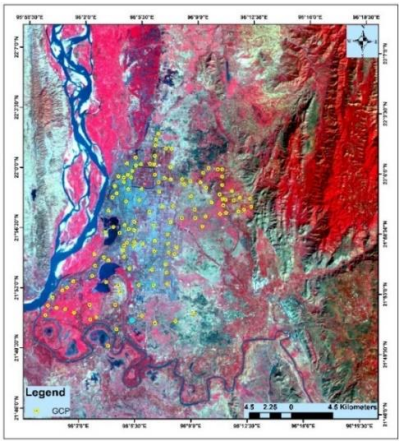


Figure (2) Ground Control Points Collected During Field Trip

Source: GPS Mark of Field Survey

Supervised Classification

There are many standard supervised classification methods. Among them, Maximum Likelihood Method is applied in making LU map of the present study. This classification method is assumed that statistics for each class in each band are normally distributed and calculated the

probability that a given pixel belongs to a specific class. Unless the user selects a probability threshold, all pixels are classified. Each pixel is assigned to the class that has the highest probability. The study area consists of categories of urban area, vegetation, forest, water body and sand.

Band Ratioing Method

Ratioing is considered to be a relatively rapid means of identifying (LULC) features. Sometimes differences in brightness values from identical surface materials are caused by topographic slope and aspect, shadows or seasonal changes in sunlight illumination angle and intensity. These conditions may hamper the ability of an interpreter algorithm to identify correctly surface materials in a remotely sensed image. Ratio transformations of the remotely sensed data can be applied to reduce the effects of such environmental conditions. To minimize the effects of environmental factors, ratio may also provide unique information not available in any single band that is useful for discriminating soils and vegetation. Ratio technique is accomplished by dividing the data base brightness values (BVs) in one spectral band by the data base (BVs) in second spectral band for each spatially registered pixel pair. The mathematical expression of the ratio function is

$$BVi,j,r = BVi,j,k / BVi,j,l$$

Ratioing two spectral bands negates the effect of any extraneous multiplicative factors in remote sensor data that act equally in all wave bands of analysis (Lillesand and Kiefer, 1987). The ratio images have two important properties. First, strong differences in the intensities of the spectral response curves of different features may be emphasized in ratioed images. Second, ratios can suppress the topographic effects and normalized differences in irradiance when using multidate images. Seven band ratio images were produced by using different bands in this study.

Results and Discussions

Image Classification Based on Maximum Likelihood Method

ETM class 1 represents urban areas (28%) (high & low-density residential and commercial) and other impervious surfaces such as roads and highways. ETM class 2 and class 3 indicate forest and vegetation cover, just (64%). The water body (6%) is defined as class 4 in this classified image. Some ETM class 4 appears in the riparian zones within the high gradient subclass due to the presence of water or moist soil conditions. The pattern of Land Use within the low gradient subclass is the extensive irrigated agriculture occurring to the east and northeast of downtown Mandalay. Sand included in this land use class, although it represents a very small proportion (<2%) of the Class 5 land use within reference domain.

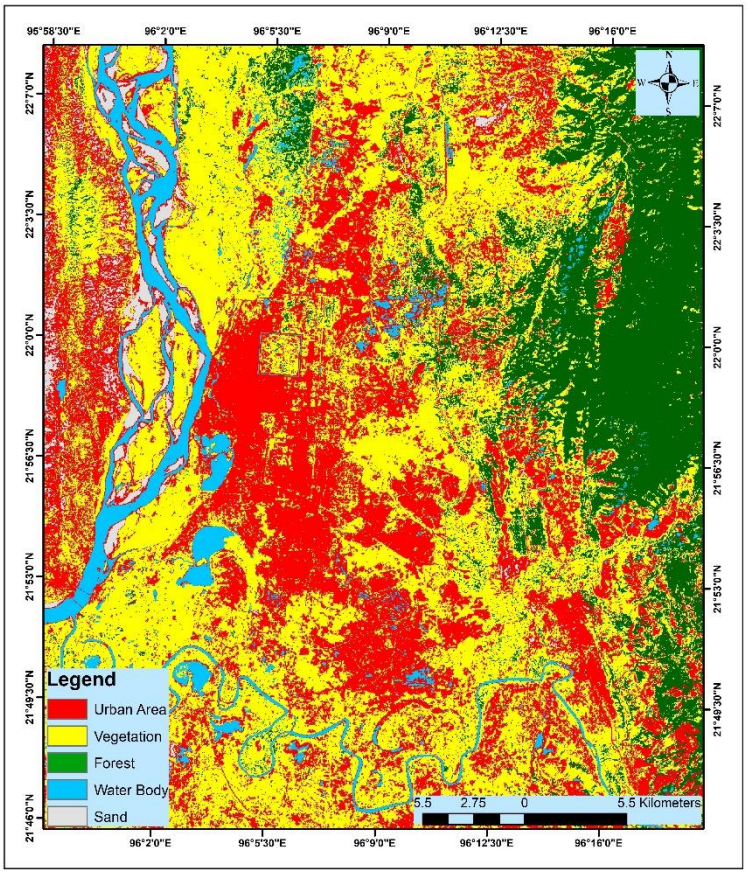


Figure (3) LULC Map Based on Maximum Likelihood Method

Source: Calculated by the Researcher

Image Classification Based on Band Ratio Method

B2/B3 : this ratio distinguishes croplands and barren lands sharply. But it could not separate croplands, forests and water body. Both forests and water body have appeared as lighter tone and barren land has appeared as dark tone. It did not enhance urban area. Chlorophyll has strong reflectance in the band 2 (0.52 -0.60 um) region and strong absorption in the band 3 (0.63 - 0.69 um) region, vegetation has appeared as higher tone.

B3/B2 : This ratio separates forests and croplands. Because band 3 (0.63-0.69 um) is the red chlorophyll absorption band of healthy green vegetation and band 2 (0.52-0.60 um) is the reflectance band from leaf surfaces. This ratio can be useful to discriminate broad classes of vegetation. Croplands have appeared as brighter tone and forests appeared as dark tone.

B3/B4 : This ratio defines barren lands and urban area uniquely. But it could not define water body, forests and croplands.

B3/B5 : This ratio enhances barren lands, highways, street patterns within the urban areas and urban built-up or cemented areas. It could not enhance the clear water but it enhanced turbid water. This ratio is useful for observing differences in water turbidity. Barren lands, highways, urban

and built-up areas have appeared as lighter tone and forests, water body and croplands have appeared as dark tone.

B4/B3 : This ratio distinguishes vegetation, water and croplands. It enhances forests and barren lands. Because forests or vegetation exhibits higher reflectance in near IR region (0.76 -0.90 um) and strong absorption in red region (0.63-0.69 um). This ratio uniquely defines the distribution of vegetation.

B4/B5 : It enhances the water body, vegetation and presence of moisture content in the croplands. Water body has appeared as dark tone and vegetation as lighter tone. Because water is a strong absorber in near IR region (band 4) and higher reflectance in (band 5) region. It can be useful for discriminating water bodies from land.

B7/B2 : This ratio separates forests and crop lands. But it could not separate forests from water body, both features have appeared as dark tone. It enhances highways, urban and built-up areas and croplands and all of them have appeared as lighter tone.

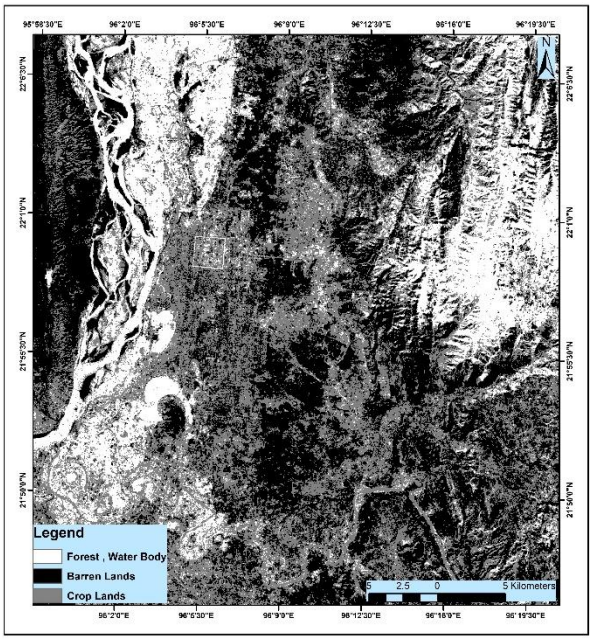
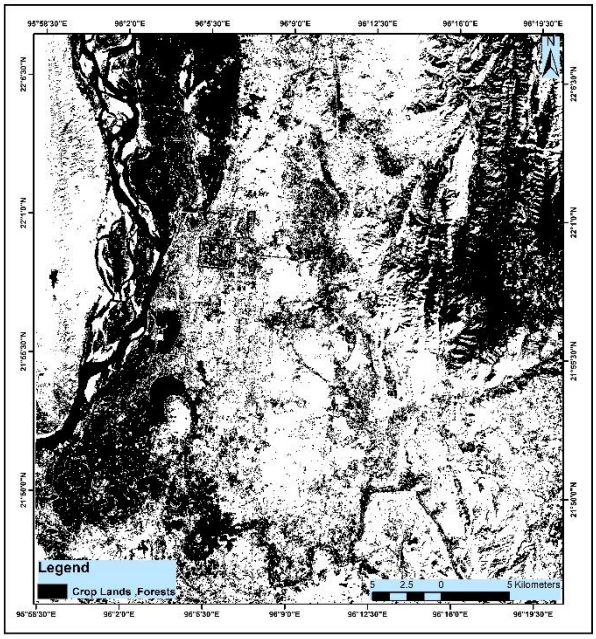


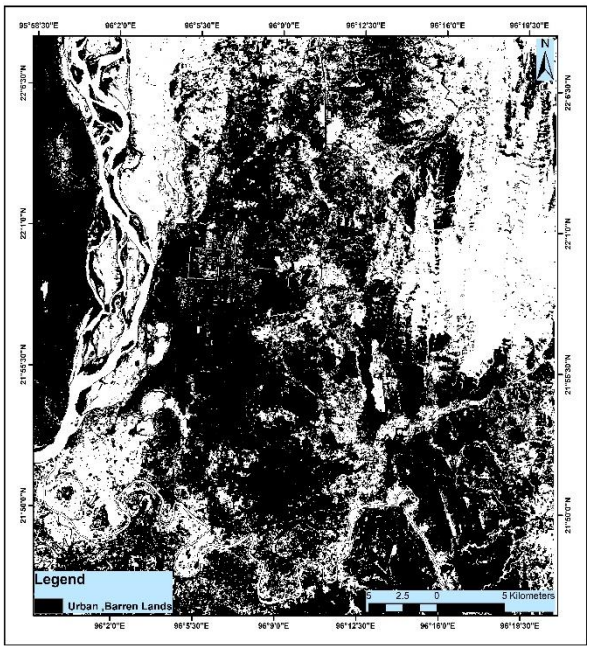
Figure (4) B2:B3(Ratio Image)

Source: Calculated by the Researcher



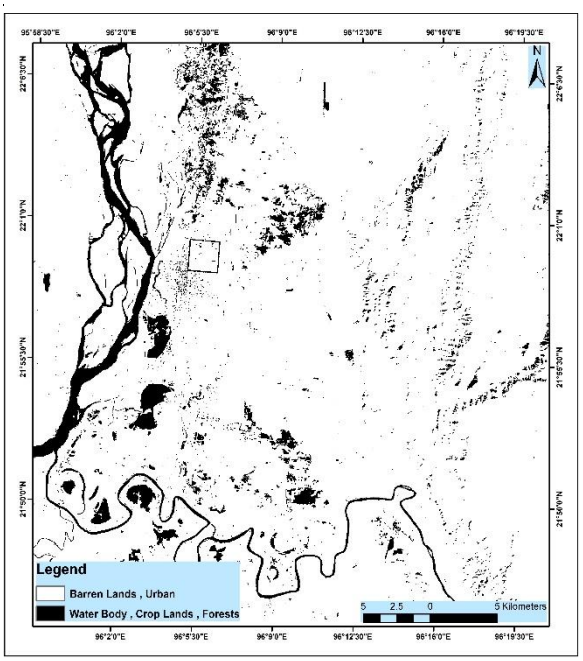
Figure(5) B3:B2(Ratio Image)

Source: Calculated by the Researcher



Figure(6) B3:B4(Ratio Image)

Source: Calculated by the Researcher

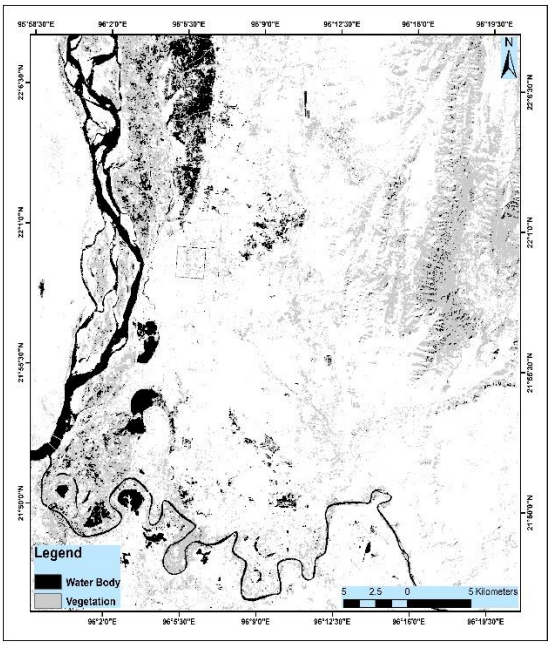


Figure(7) B3:B5(Ratio Image)

Source: Calculated by the Researcher

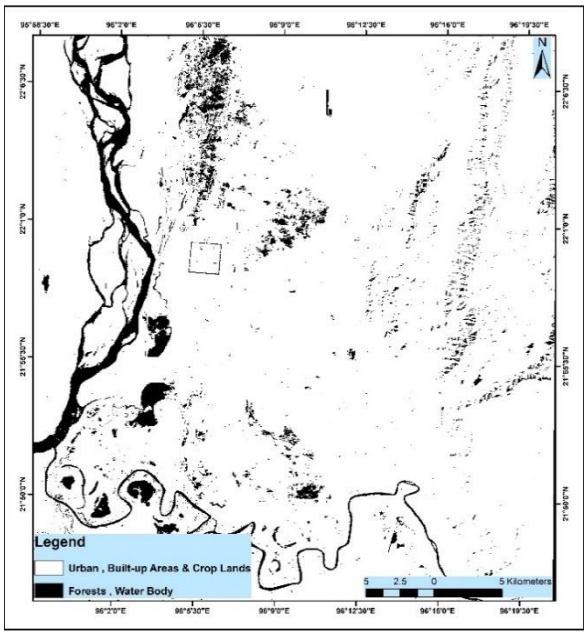
Figure(8) B4:B3(Ratio Image)

Source: Calculated by the Researcher



Figure(9) B4:B5(Ratio Image)

Source: Calculated by the Researcher



Figure(10) B7:B2(Ratio Image)

Source: Calculated by the Researcher

Statements of the problem

Land Use affects LC and changes in Land Cover affect LU. Changes in Land Cover by LU do not necessarily imply degradation of the land. Degradation is also caused by cultivation of steep slopes and riverbanks especially in the highlands. Water courses and water balances are changed along the slope due to LU by irrigation. Land Use represents a critical intersection of human activities and the environment.

Conclusion

LULC features can be fairly detected and mapped by using color combination of ratioed images. In this study, seven band ratios were created. Each ratio image enhanced two or three LULC features, but it could not enhance all the features. Several possible sources of error exist in using this technique, but they did not appear to cause serious problems in the Landsat TM scene tested. For example, the problem of pixels containing mixtures of vegetation, rock and soil in various proportions has not been addressed. Also, water bodies containing suspended sediment or abundant vegetation will probably be misclassified. Although band ratioing is relatively rapid means of identifying LULC classes, but it is not efficient.

It can enhance the brightness values (BVs) of pixels of different LULC classes, but it can not assign all the pixels into classes. Band ratioing is a suitable and efficient technique.

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