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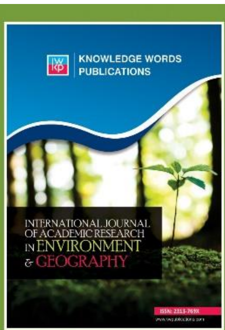

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Identification of Vegetation with Supervised, Unsupervised, Normalized Difference Vegetation Index Methods and Comparison with Standard Google Earth Image using Remote Sensing and Geographic Information System Techniques.

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Abstract
This study aims at identify vegetation using three approaches; Supervised, Unsupervised and Normalized Difference Vegetation Index methods of classification and also to examine and compare the final results to an image of higher resolution in other to determine which of the approaches best identifies vegetation. This study used Akinyele Local Government as a case study. These three methods were examined using one Landsat scene for Akinyele Local Government area Ibadan, Oyo state, Nigeria. The Landsat scene was acquired on 30th January, 2019. All operations involved in the three approaches were carried out using the ArcGIS 10.5 software and the results were also produced on the ArcGIS software. The results obtained shows that there are variations in the total vegetation areas covered when using the three approaches. The results from the three approaches were analyzed and compared to a standard image of higher resolution (Google Earth Image) in other to determine which method is best for identifying vegetation. Finally, from these observations, the Normalized Difference Vegetation Index result represents a compromise between the supervised and unsupervised results.
Keywords: Vegetation, Classification, Remote sensing and GIS, Landsat scene, Variation

Introduction

Nowadays, the application of remote sensing and Geographic information system (GIS) play an important role in solving human activities, future prediction occurrence, and environmental phenomenon. These methods have numerous benefits leading to the understanding of these subject matter; their causes and how they can be overcome (Al Awadhi et al., 2011). The science and art of obtaining information about the surface of the earth, without having any physical contact with it is known as remote sensing. Remote sensing has been demonstrated to be a very useful mechanism for Land Use and Land Cover (LULC) change detection (Matinfar et al., 2007). This is done by detecting and recording the reflected/emitted energy, then processed, analyzed, and applies that information. GIS on the other hand, is a computer system that, manages, analyzes, and displays all forms of geographically referenced information. Therefore, whatever information is captured through remote sensing can be managed displayed in form of maps and charts or any other form that can represented in the real world.

The old methods of assembling population-based data, census data, and environmental samples analysis are not appropriate for numerous complicated environmental studies, then, modern technologies such as satellite remote sensing and Geographical Information Systems (GISs) are required in solving many problems presented in environmental issues and much more difficulty of addressing the multidisciplinary data set (Mallupattu et al., 2013). These modern application techniques provide information about the changes of natural resources which can be useful for better environmental management. Moreover, these two application techniques remote sensing and GIS' provide new tools for an advanced management in ecosystem. This study aims to identify vegetation using three approaches; Supervised, Unsupervised and Normalized Difference Vegetation Index **(**NDVI) methods of classification and to examine and compare the final results to an image of higher resolution in other to determine which of the approaches best identifies vegetation. Remote sensing provides an effective way to measure vegetation properties over wide geographic areas by providing multispectral satellite images like Landsat which contains information about the earth surface and the utilization of ArcGIS software to extract this information for further analysis and management.

Change detection method is one of the main applications of Remote Sensing (RS) and Geographical Information Systems (GIS) techniques. It can be applied to several applications such as urban growth, land use change, vegetation change and also change in image classification techniques which is the focus of this study. Four aspects of change detection when detecting and monitoring natural changes as listed by (MacLeod and Congalton, 1998) are: detecting that changes have occurred, pointing out the nature of the change, quantifying the magnitude of the change and assessing the spatial pattern of the change. Several studies have addressed the use of GIS and remote sensing in the management and control of different land uses, including vegetation worldwide.

In many applications to show the changes in land cover detection, image differencing method are used and thereby shows that not only images of two different date be used but to compare the information derived from the multiple dates of the image and this can be done by subtracting the pixel by pixel of two different time to produce image that can be differentiated (Yacouba et al., 2009). For instance, Shi (2008) investigated the changes and feedbacks of Land-use and Land-cover under Global Change. Mallupattu et al (2013) carried out the analysis of Land Use/Land Cover Changes Using Remote Sensing Data and GIS at an Urban Area, Tirupati, India. Olaleye et al (2012) carried a study on changes in Land-use and Land-cover pattern in Ilorin emirate in Nigeria. All these studies and more have been instrumental in the progress of this research. There have been issues in using spatial analysis in revealing true vegetation cover among the supervised, unsupervised and Normalized Difference Vegetation Index (NDVI) methods and which one best reveals the true picture of vegetation of an area. Therefore, this necessitates using the three methods to show which one reveals the true image of vegetation of Akinyele Local Government Area, Ibadan Oyo State, Nigeria.

Objectives of the Study

- To use three (3) different methods (Supervised, Unsupervised and NDVI) to identify and extract vegetation cover of the study area.
- To use the application of Remote Sensing satellite image and Geographical Information System to identify vegetation of the study area.
- To identify which of the three (3) methods best represent vegetation most and compare with standard Google earth image.

Materials and Methods

The Study Area

Akinyele Local Government is one of the local governments among the eleven local government areas that make up the Ibadan Metropolis, having its headquarters in Moniya. It is created from the Ibadan municipal division in 1976 and located at the outer parts of the Ibadan metropolis. It covers landed area of about 464.892 km^2. As at 2006 population census, the local government has 211.359 populations and by 3.2% Nigeria growth rate in 2020, the population will increase to 306.048. The local government hosts some notable institutions/institute like Federal School Statistics, part of University of Ibadan, International Institute of Tropical Agriculture (IITA), Nigeria Institute of Social and Economic Research (NISER).

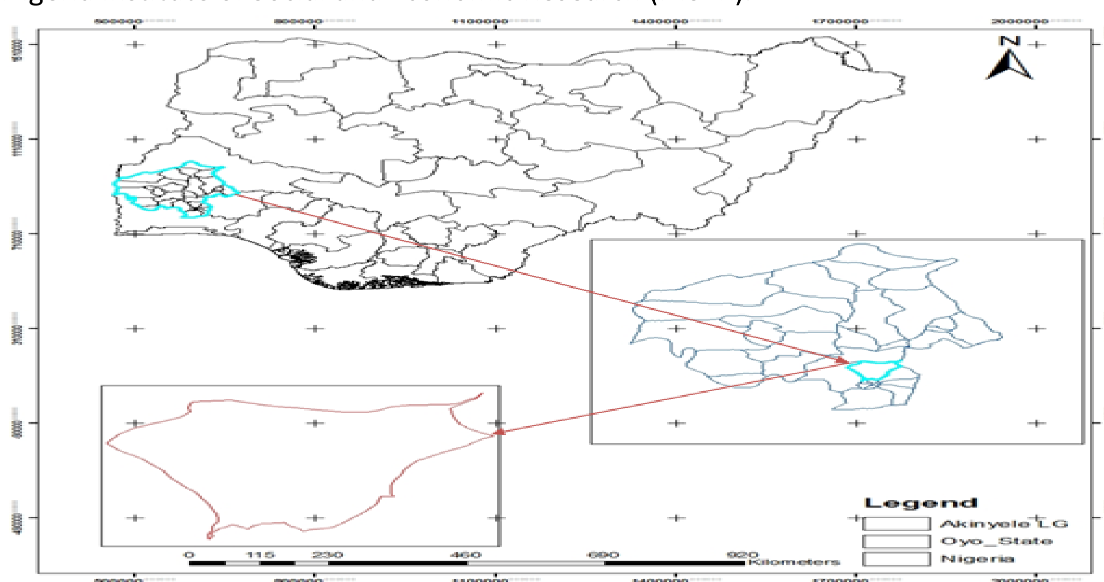

Figure 1: Map of the Study Area.

Methods

Different remote sensing and GIS data from different sources have been used in different studies according to literatures. For the purpose of this study, three (3) different remote sensing and GIS applications were used for identification and extraction of vegetation of Akinyele Local Government Area, Oyo State. The techniques include the supervised, unsupervised and the NDVI methods of image classification. Landsat image with only one scene of path 191 and row 55 was used to extract the study area. The Landsat image was downloaded from the earth explorer website for 30th January 2019, geo-referenced and projected in WGS-84 zone 31. Image processing methods such as sub-setting, pansharpening and combination of bands were applied on the image to prepare it for better classification. ArcGIS 10.5 were used for all pre-processing, processing and post processing operations.

Image processing and Analysis

The study area boundary which was exported as a shapefile was clipped out from the scene so as to focus on the area of importance and to allow for faster processing. The image was also enhanced by combining bands for better identification and interpretation of the image. The first approach which is the supervised classification was done on the ArcGIS software. This method involves selecting representative samples for a land cover class based on prior knowledge of the user about the area or using a higher resolution image as reference. With GIS application, ArcGIS 10.5 software then uses the "training sites" and applies them to the entire image based on what it looks like the most in the training set. The band 7, 5, 3 was combined for this process and training samples were selected for vegetation and other land cover classes present in the image (Figure 2a & b). Since the focus of this study is on vegetation, a class was chosen for vegetation and another class for other features. The system was able to produce a classified image in both raster and vector formats.

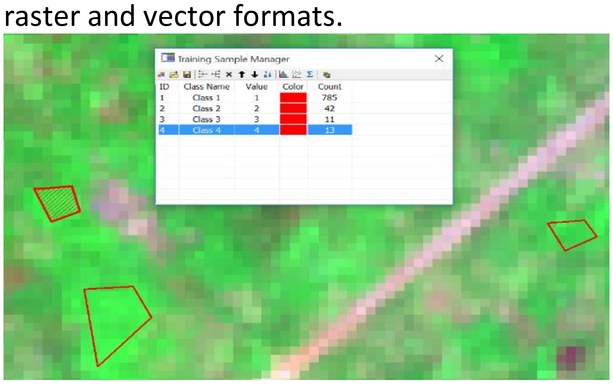

Figure 2: Supervised classification operation

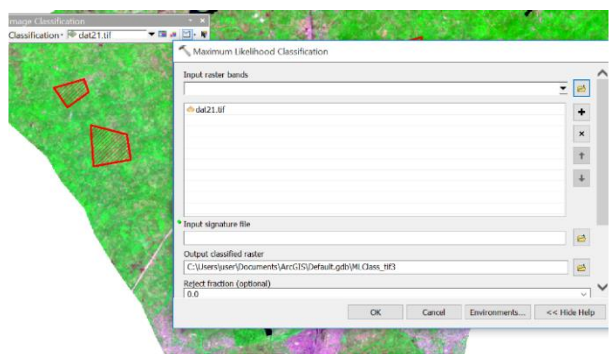

Figure 2b: Supervised classification operation

The second approach which is the unsupervised classification was also carried out on the ArcGIS software. Various techniques such as Maximum Likelihood (Gromyko and Shevlakov, 2004), Self Organizing Map (Yuan et al., 2009), and K-means (Thomas and Cathcart, 2008) has been presented by the literatures in the past years to achieve a true unsupervised classification for vegetation detection. The difference between this method and that of supervised method is that this method does not require the training samples. It allows the system to classify images based on their spectral signature that is, the color they represent and the required number of classes needed is set for the system to produce a classified image. Based on a reconnaissance and knowledge about the area, and also with the help of a Google earth image, it was discovered that the area contained three land cover classes which were vegetation, bareland and built-up area (Figure 3). Due to this observation, the number of classes for the unsupervised classification was set to three and the system calculated and produced a classified image in both raster and vector formats. Then the vegetation class was identified and separated from the other features.

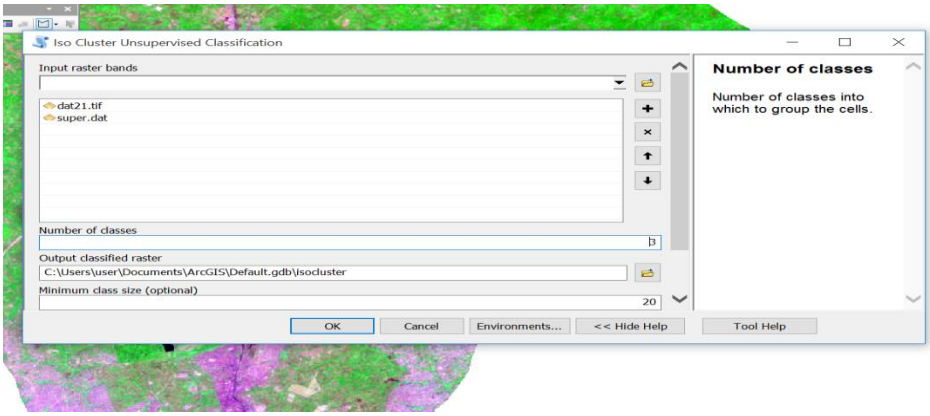

Figure 3: Unsupervised classification operation

The third approach which is the Normalized difference vegetation index (NDVI) was created on ArcGIS software. Generally, Normalized Difference Vegetation Index maps are used to assess vegetation health by using two quantities which are the near-infrared (NIR) and the red light. In the near infrared (NIR), the reflection is much higher in the visible band because of the cellular structure of the leaves. Therefore, vegetation can be determined by the high NIR. Also, pixels with high positive NDVI values are in very green color and indicate high vegetation while low NDVI values indicate low or no vegetation and negative NDVI values is a good indicator that it is water. The bands 5, 4 and 3 were combined for the NDVI classification. This was done because the band 5 is near infrared and band 4 is red (Figure 4a). After this combination, vegetation appears in red color after infrared and near-infrared waves were used, which represents the fifth band of Landsat image. On the ArcGIS software, the image analysis tool was used to create the NDVI map using just the red and NIR bands (Figure 4a) and the image was exported as raster to a .tiff image format. After this, the image was classified further to determine a range of values for areas of high vegetation and low or no vegetation. After this, the raster calculator tool was used to set areas of no vegetation to 0 and areas with vegetation to 1. This made it easy to extract the area of vegetation from the NDVI map.

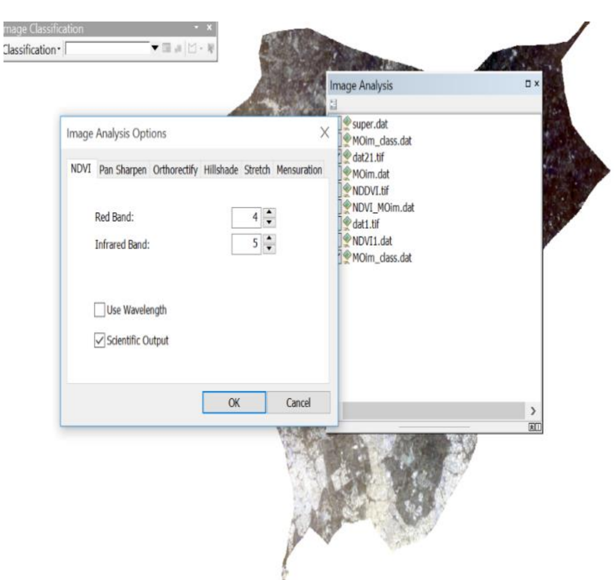

Figure 4a: NDVI classification on the ArcGIS software **Figure 4b:** The NDVI result in grayscale

Also, a Google earth image of the study area was downloaded (Figure 5) and the result from the Google earth image was used as a standard for the three techniques since it is of a higher resolution and the result from the image can be trust enough to compare to the result from the other techniques and determine which one best identify vegetation. Vegetation was vectorized from the image with respect to the boundary of the area. This approach was taken because the area of interest which had an area of 478.156km² was not too large and it made it possible to quickly and easily vectorize vegetation from it and also, to compare the area of vegetation from the three techniques to the area of vegetation from the vectorized image. When dealing with a much larger area, vectorizing the Google earth image might be more challenging and time consuming and in that case, it might have to result to only using the visual interpretation comparison which is very much good enough to identify which method is best.

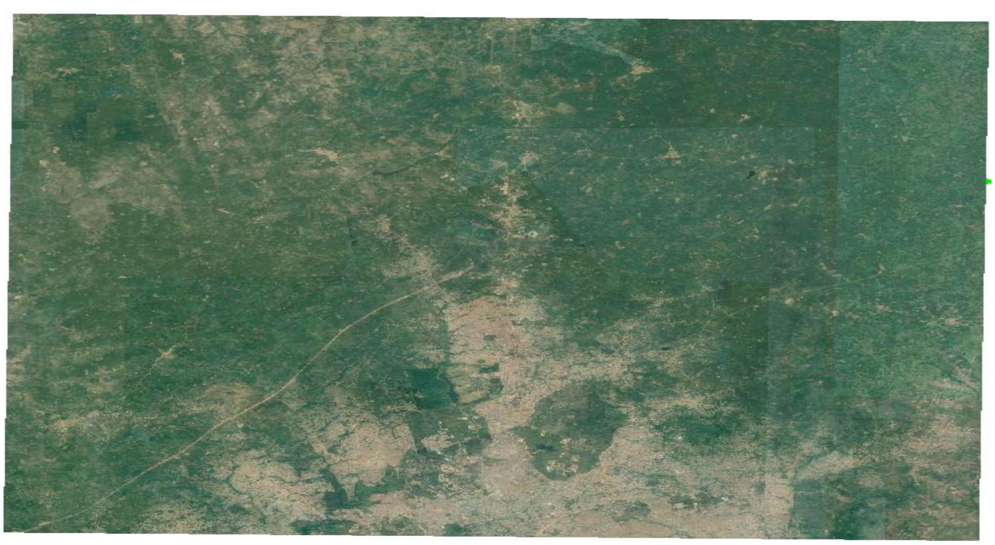

Figure 5: Google earth image downloaded from the Google earth Pro Software

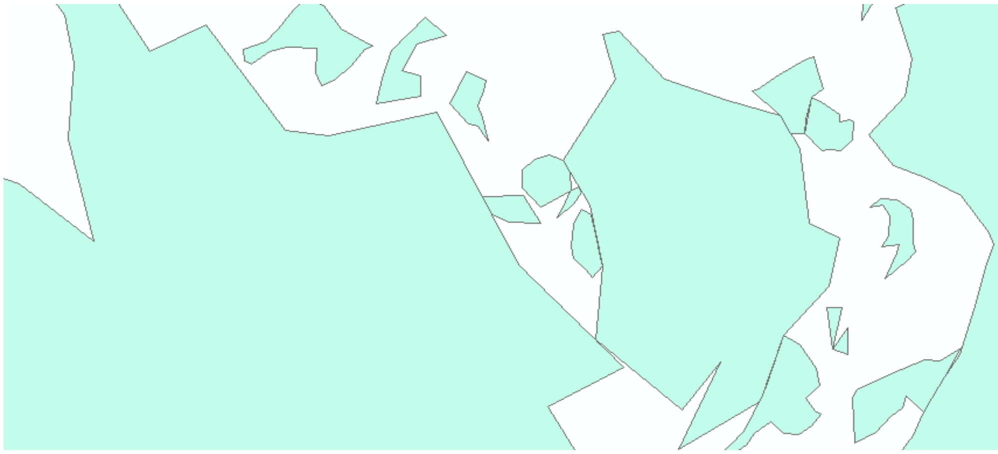

Figure 6: Vectorization of Google Earth Image on ArcGIS 10.5 Software

Finally, the major approach that was used to compare the results was the visual interpretation method. It is normal to believe what is seen with eyes the most. Therefore, the three processed images were then compared to the Google earth image by looking at it and checking which one takes the form of vegetation better as it is in the Google earth image. This was done by taking a critical look and determining which one of the three methods conformed the most. The supervised and unsupervised classification maps were opened on ArcGIS for further analysis like the extraction of area and production of maps. The area of vegetation was also extracted from the NDVI map and the vectorized Google earth image (Figure 6). The area in km² of the three techniques employed were compared to one another and also to that of the Google earth image result to determine which method is best for identifying vegetation.

Results and Discussion

Results

After completion of the image processing and analysis, then the final results were produced and presented in form of maps and tables are shown below. Figure 7(a-c) presents the NDVI, supervised and unsupervised vegetation cover map for the study. Figure 8 describes vegetation area covered in square kilometers and their percentages. Figure 9 presents the comparison between the NDVI, supervised and unsupervised vegetation cover. Figure 10 shows the comparison of the three Approaches with the standard Google Earth image. Figure 11 reveals the visual interpretation comparison of the three methods with standard Google earth image.

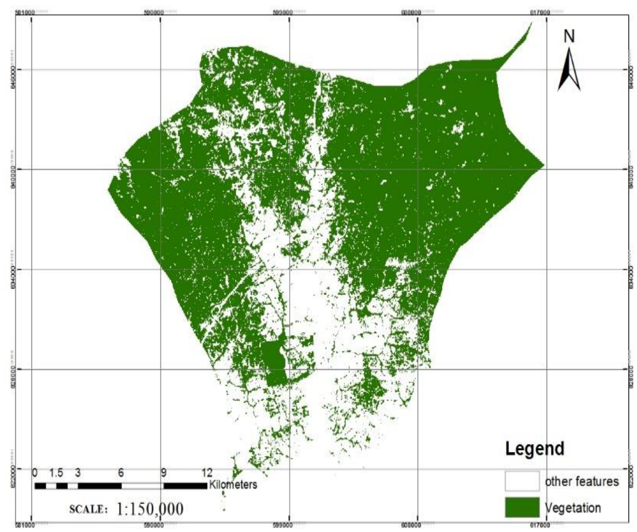

Figure 7a: Normalized Difference Vegetation Index Map

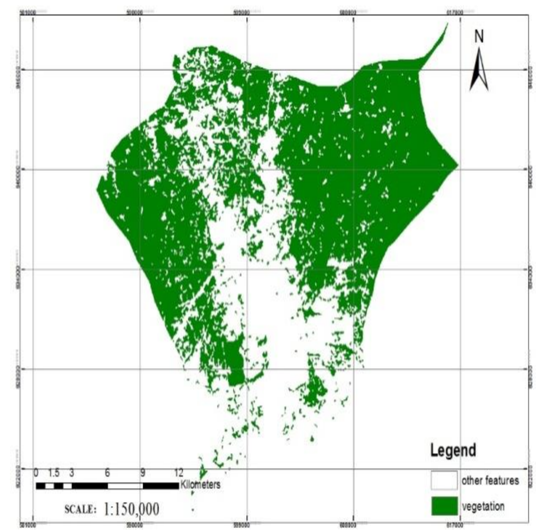

Figure 7b: Supervised classification Map

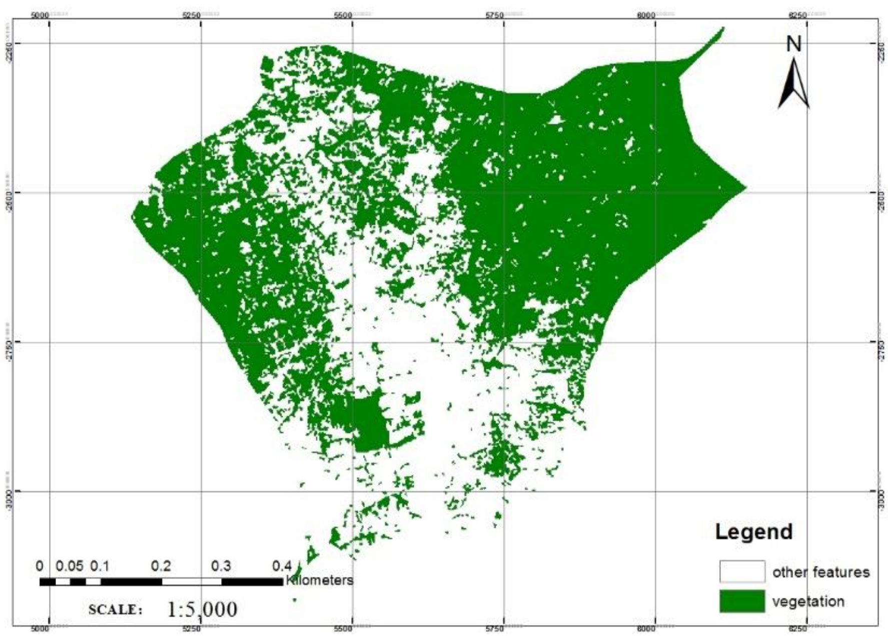

Figure 7c: Unsupervised classification Map

Table 1: Area covered by vegetation in each approach

Approaches	Area (Km²)	Percentage (%)
NDVI	280.979	58.76
Supervised classification	272.669	57.03
Unsupervised classification	275.940	57.71
GOOGLE EARTH	282.706	59.12
Study area	478.156	100

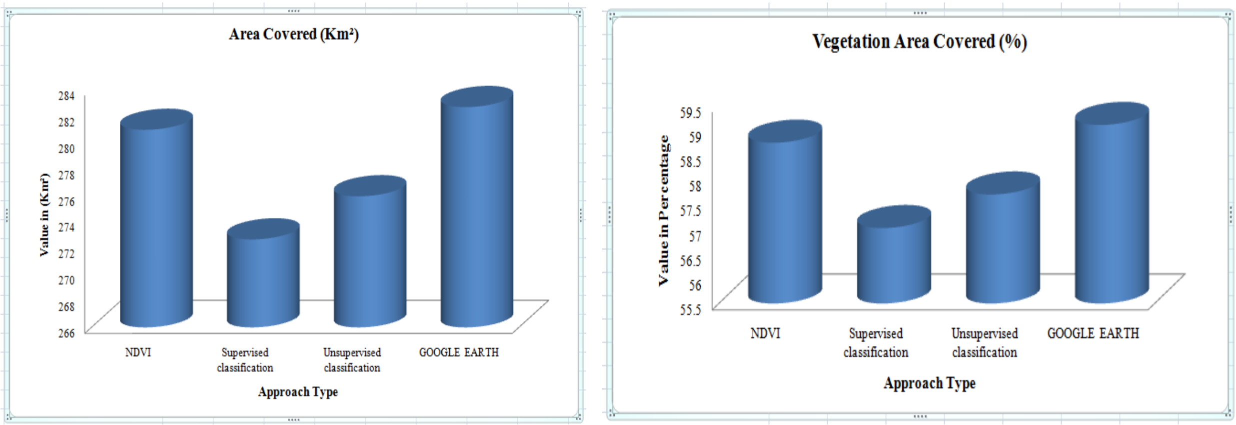

Figure 8: Vegetation Area Covered in Square Kilometers and Percentages

Table 2: Comparison of results between the three approaches

NDVI-Supervised classification (Km²)	NDVI-Unsupervised classification (Km²)	Supervised-Unsupervised classification (Km²)
8.31	5.04	3.27

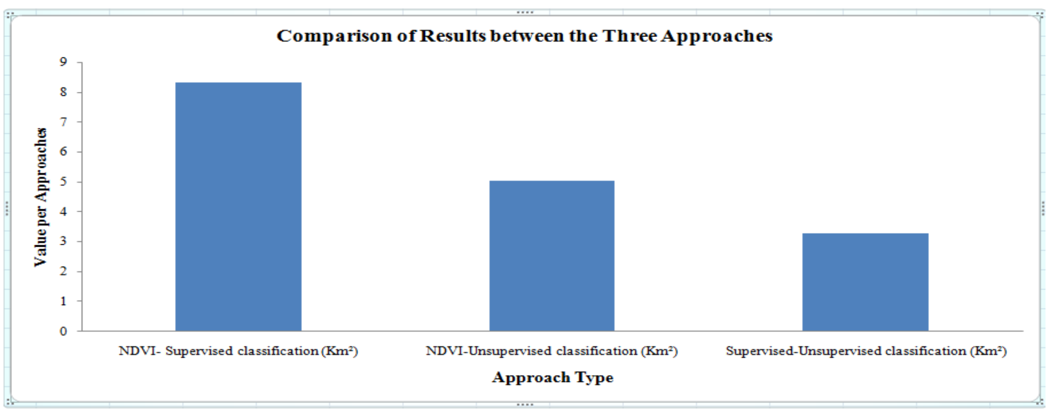

Figure 9: Result Comparison between the Three Approaches

Table 3: Comparison of the results in the three approaches to the standard (Google Earth image)

Google Earth – NDVI (Km²)	Google Earth-Supervised Classification (Km²)	Google Earth - Unsupervised Classification (Km²)
1.73	10.04	6.77

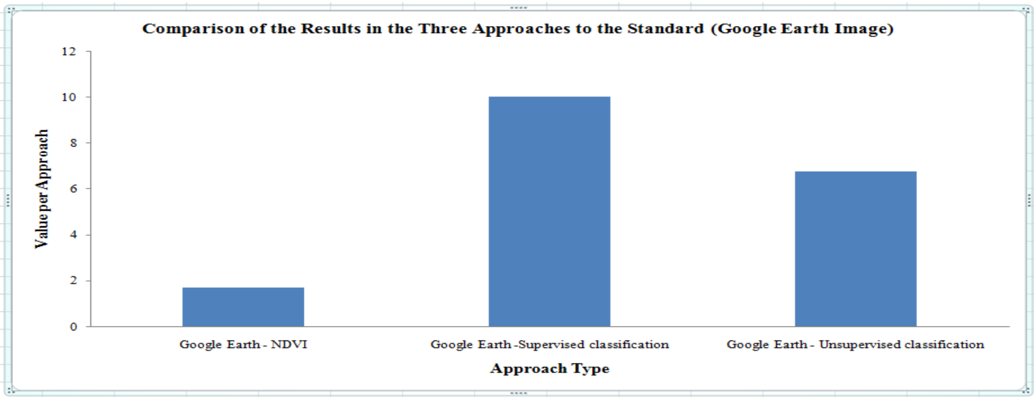

Figure 10: Comparison of the Three Approaches with Standard Google Earth Image

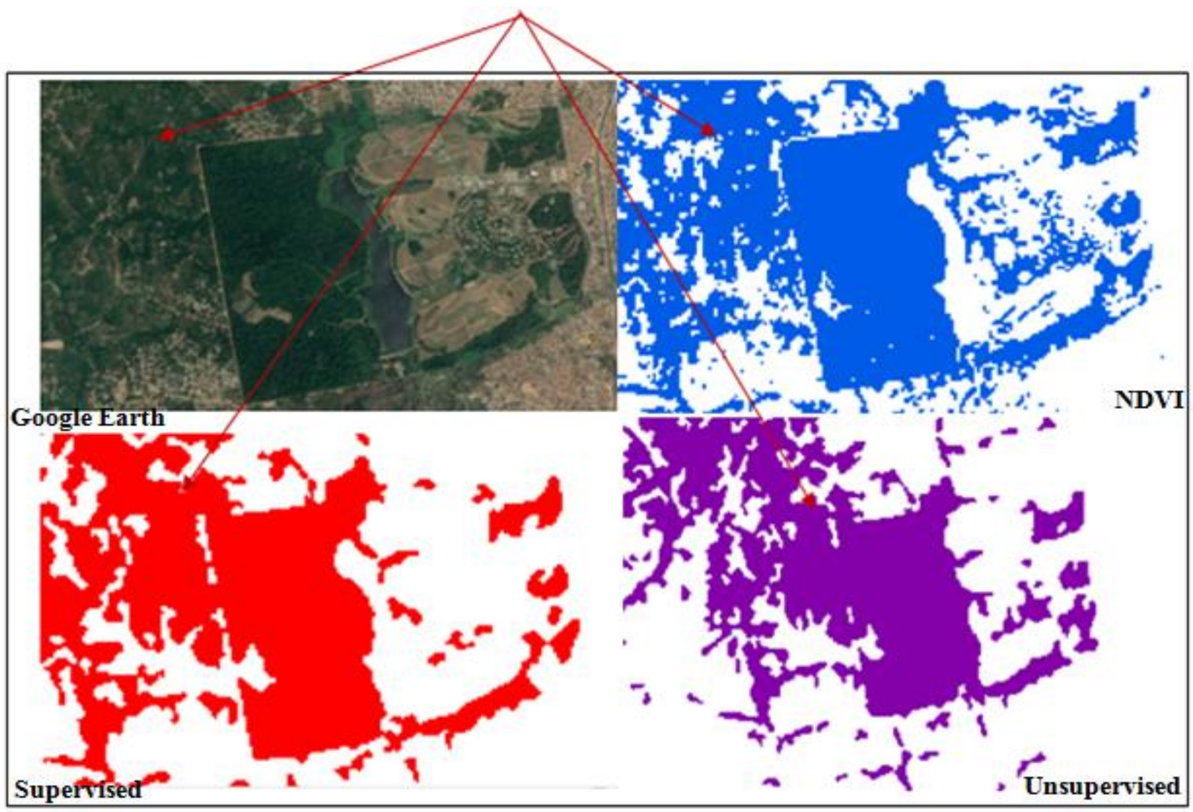

Figure 11: The visual interpretation comparison

Discussion of Results

The results obtained as shown from (table 1, Figure 8 and table 2, Figure 9) above during the extraction of vegetation when using the three different techniques reveals that there is a variation but not a huge one. The NDVI produces the highest vegetation extraction followed by the unsupervised classification, and then the supervised classification. However, from the table 1, it shows that the vegetation areas in the supervised and unsupervised are very close with difference of 3.27km² between them. Also, the area of vegetation in the NDVI is higher than that of both the supervised and the unsupervised method but not huge as well. This is most likely due to the fact that the features that exist within the study area are well distributed and easily identified which therefore, made it easier to perform both the supervised and unsupervised classification, and also made it possible to arrive at a close result between the three methods. The NDVI which has the highest vegetation extraction from the three approaches has the closest value in area to the area of vegetation extracted from the standard Google earth image as seen from table 3 and Figure 11 above. It shows that the difference between the result in the NDVI and that of the Google earth is lesser compared to the two other techniques. Lyon et al., (1998) used Landsat MSS image data of three different dates of seven vegetation indices and their results were compared for land cover change detection and was concluded that normalized difference vegetation index (NDVI) differencing method showed the best vegetation change detection and their results is similar to the result obtained in this study.

Moreover, since the Google earth image is of a higher resolution which thereby leads to a more accurate result, it can as well be concluded that going by the area of vegetation, the NDVI method is a better option for the identifying vegetation among the three methods used since the identification of vegetation by the NDVI method proved to be better from the visual interpretation of the images. The most common procedures to detect and monitor land use land cover changes was the normalized difference vegetation index (NDVI) since it is easy to implement and interpret but only that change directions matrices cannot be completely created (Lu et al., 2004). From Figure 11 above, the Google earth image serve as base map and a standard and it can be see that the NDVI image (blue) represents vegetation better than the two other methods because it takes better the shape and form of vegetation as shown in the Google earth image. Followed by the NDVI, is the supervised classification image (red) which also appears to slightly match that of the Google earth image but not as much as the NDVI image. With supervised classification method, training samples to represent the classes needed can easily be created and extracted and signature file can also easily be created from the training samples, which is then used by the multivariate classification tools to classify the image (Gbola, *et al*., 2017).

The unsupervised method (purple image), does not present vegetation well which makes it a wrong choice for representation of vegetation (Figure 11). Other way to classification by an unsupervised method for detecting vegetation automatically is by calculating the conventional spectral vegetation index and the most common index used is Normalized Difference Vegetation Index (NDVI) (Saha et al., 2005, Xie et al., 2008). The supervised classification, proved to be better than unsupervised classification following the visual interpretation and but had a lesser area of vegetation than that of unsupervised method which made the supervised result closer in area to that of the Google earth image. But as it can be seen that the result of the area between the two methods is not so different, and the supervised method appear to represent vegetation better in the visual interpretation, then the supervised method can be chosen over the unsupervised method. Finally, from all the above observations, it can be concluded that an NDVI result represents a compromise between the supervised and unsupervised results. That is for the study area, it proves to be a better technique for identifying vegetation compared to the other two methods as it shows closers picture of vegetation like that of standard Google earth image.

Conclusions

Three approaches were employed to identify and extract vegetation in this study using Remote sensing and GIS techniques. Remote sensing and GIS environment provides a wide range differences and quantity of data about the earth surface for a comprehensive analysis and change detection with the aid of different space borne and airborne sensors. It shows how powerful and capable in understanding and managing the earth resources. From the results obtained, it was obvious that there was variation in the results of the area of vegetation extracted using the three approaches. Even though the differences were not too much, it still showed that the three methods produced different results. The features present in the area of interest stood out and were easily identified which made it easier to perform the supervised and unsupervised classification which in turn gave a close value in the area of vegetation extracted. The results were compared against a standard which is the Google earth image and a conclusion was arrived at that the NDVI approach best identifies vegetation from satellite images because it had the closest value of extracted vegetation area when compared to the standard Google earth image as shown as it represents vegetation better using the visual interpretation method, that is, with visual comparisons, it shows NDVI closest reality. The result obtained from the study contributes to how powerful the application of remote sensing and GIS using landsat satellite image for image classification with supervised, unsupervised and NDVI methods and how the combination of the application will continue to further give answers to numerous geographical questions and proffer solution. The supervised and NDVI from the study showed more closely but NDVI reveal the satisfactory result. The result could further be improved by other identification process such as the object-oriented method and the result could further be done to create a more accurate vegetation cover than what NDVI produced.

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