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SUITABILITY EVALUATION OF LAND USE LAND COVER OF IMO STATE FOR SUSTAINABLE ECOTOURISM DEVELOPMENT

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ABSTRACT

This study seeks to establish the current status of the land use/ cover of Imo State going by the level of urbanization in the state, in order to determine the proportion of land available for sustainable ecotourism development in the state. The data used for this study were mainly secondary data obtained from the United State Geological Survey (USGS) website. The satellite data covering the study area which was obtained from earth explorer site was imported in ERDAS Imagine version 9.2 satellite image processing software to create a False Color Composite (FCC). The layer stack option in image interpreter tool box was used to generate FCCs for the study area. The sub-setting of satellite images was performed for extracting the study area from both images by taking geo-referenced out polygon boundary of Imo State AOI (Area of Interest). All satellite data were studied by assigning per-pixel signatures and differentiating the area into five land use/cover classes on the bases of the specific Digital Number (DN) value of different landscape elements. The delineated classes are; Built up area, Bare land, Light forest/Agricultural land, Water body and Dense forest. Based on experts opinion and literature, the most important land use/ cover for sustainable ecotourism development is dense forest while built-up area does not support ecotourism development. For each of the predetermined land cover/use type, training samples was selected by delimiting polygons around representative sites. Spectral signatures for the respective land cover types derived from the satellite imagery was recorded by using the pixels enclosed by these polygons, after which, maximum likelihood algorithm was used for supervised classification of the images. Classification accuracy was determined using an error matrix (sometimes called a confusion matrix). This is because image classification using different classification algorithms may classify pixels or group of pixels to wrong classes. The study revealed that light forest/ farm land constitute the largest proportion of the total land area (59.5%) of the total land area, followed by built up area (21.3%) which has no value for ecotourism development, then dense forest (12.8%), the valuable ecotourism. Water body comprises 0.4% while bare land made up (6.0%) the remaining proportion. The study suggested that government should make and implement proper land use management policies for sustainable land utilization and tourism development.

Keywords: Suitability evaluation, Land use Land cover, Sustainable development, Ecotourism, Imo State.

INTRODUCTION

The land cover is taken as one major parameter that affects the suitability modeling. Land use is the way in which, and the purpose for which, human beings employ the land and its resources. Examples include farming, mining, and logging. Land cover is also the physical state of the earth's surface. The term, originating, referred to the type of vegetation that covered the land surface, but has broadened subsequently to include human structures, such as buildings or pavement, and other aspects of the physical environment, such as soils, biodiversity, surface and groundwater. Land use Land cover map is useful for resources assessment, land use planning, land evaluation, and land use/ land cover change detection, etc. Likewise (Ayele, 2006). Land use land cover evaluation is the characterization of land use land cover in a given area for specific land use (Khwanruthai, 2012). The success of land use land cover suitability evaluation is based on the information obtained during field survey as it helps in the development of land use plans and the management of environmental resources. The specific purpose of land use / cover suitability evaluation is strongly related to the conformity of the land use with other contending land uses (FAO, 1976).

That the land use/cover of place can favor or deter sustainable ecotourism development. Vegetation has been outlined as the most important land use /cover type that encourages sustainable ecotourism development (Iheaturu, 2017). Sustainable ecotourism development is that which meets the needs of present tourists and host region while promoting and enhancing opportunities for the future, it leads to the management of ecotourism resources in such a way that economic, social and aesthetic needs can be fulfilled while maintaining cultural integrity, essential ecological processes, biological diversity and life system (WTO, 1996). Therefore, to achieve sustainable development in ecotourism, the land use/cover types, especially vegetation which fosters ecotourism development need to be preserved. Unfortunately, Nigeria has the highest rate of deforestation in the world (FAO, 2005). Nigeria lost 55.7% of its primary forest between 2000 and 2005 which made the rate of forest change to have increased by 31.2% yearly (Wikipedia, 2006).

Keay (1995) ascertained that a combination of high density human settlement in the state and concomitant land use systems of farming have caused vegetation changes. Nze (2012) corroborated this assertion by attributing the natural vegetation depletion to various land use abuses, resulting in biodiversity depletion and its implication for ecotourism development. Uchegbu (2013) indicated that change in land cover affects ecotourism development, while highlighting that vegetation removal for urbanization and agricultural purposes do not favor ecotourism. He went further to state that results in biodiversity depletion which is one of the life-wires of ecotourism development.

Aigbe and Oloku (2012) blamed the high level of vegetation destruction on the uncoordinated land use policy and other forms of land use such as agriculture, urbanization and industrialization. Therefore, this study investigated into the proportion of land available for sustainable ecotourism development in Imo State.

STATEMENT OF THE PROBLEM AND OBJECTIVES

Ecotourism is a sub-sector of the tourism industry which depends for its very existence on quality natural environment, especially on forest vegetation as it equally does on the specific culture and society of the local inhabitants (Komla & Veirier, 2012). The rate of destruction of vegetation in the state, either for urbanization, farming and other purposes leaves a lot to be desired, knowing the importance of vegetation to sustainable ecotourism development. One begins to wonder if there would be enough places for sustainable ecotourism development in the state if the current rate of vegetation

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destruction continues unabated. It therefore becomes very imperative to evaluate the land use/cover of the state to ascertain the suitability for sustainable ecotourism development.

The following objectives were pursued in the course of this study:
i) Identify the major land use/cover types of Imo State.
ii) Produce land use/cover map of the study area using 2019 LandSat imagery of the state
iii) Ascertain the proportion of land use/cover available for ecotourism development in the state.

MATERIALS AND METHOD

Imo State is located between latitudes 4°45'N and 7°15'N, and longitudes 6°50'E and 7°25'E.It has a total population of 3,934,899 people (National Population Commission, 2006) with a total land area of about 5136.052km^2 and an average population density of 760 people/km^2. It is bordered by Abia State on the East, by the River Niger and Delta State on the west, by Anambra State to the north and Rivers State to the south (Figure 1).

Figure 1: Location map of Imo State

The state is rich in natural resources including crude oil, natural gas, lead, zinc. Economically exploitable flora like the iroko, mahogany, obeche, bamboo, rubber tree and oil palm predominate. However, with a high population density and over farming the soil has been degraded and much of the native vegetation has disappeared. Deforestation has triggered soil erosion and loss of ecotourism resources.

Sources and Analysis of Data

The data used in this research were mainly secondary data obtained using 2019 LandSat imagery from the United States Geological Survey (USGS) website(http://earthexplorer.usgs.gov/) from which the land use land cover map of the state was extracted. Landsat Thematic Mapper at 30m resolution was used for land use/cover classification in ArGis environment. The satellite data covering the study area was imported in ERDAS Imagine version 9.2 satellite image processing software to create a False Color Composite (FCC). The layer stack option in image interpreter tool box was used to generate FCCs for the study area. The sub-setting of satellite images was performed for extracting the study area from both images by taking geo-referenced out polygon boundary of Imo State AOI (Area of Interest). All satellite data were studied by assigning per-pixel signatures and differentiating the area into five classes on the bases of the specific Digital Number (DN) value of different landscape elements. The delineated classes are; Built up area, Bare land, Light forest/Agricultural land, Water body and Dense forest. For each of the predetermined land use/ cover type, training samples was selected by delimiting polygons around representative sites. Spectral signatures for the respective land cover types derived from the satellite imagery was recorded by using the pixels enclosed by these polygons, after which, maximum likelihood algorithm was used for supervised classification of the images. It is the type of image classification which is mainly controlled by the analyst as the analyst selects the pixels that are representative of the desired classes.

In order to determine classification accuracy, it is necessary to determine if the output map meets, exceeds, or does not meet certain predetermined classification accuracy criteria. One of the most common methods used to assess classification accuracy is the use of an error matrix (sometimes called a confusion matrix) and revalidated using Kappa coefficient. Currently, accuracy assessment is considered as an integral part of any image classification. This is because image classification using different classification algorithms may classify pixels or group of pixels to wrong classes

RESULTS AND DISCUSSION

Major Land use/ Cover Types of Imo State

The major land use/ cover types of Imo State and the rating as identified in the course of this study, according to bio-physical vegetation characteristics of ecotourism potential resources as seen in Table1 are Dense forest, Water body, Light forest/ Farmland, Open space/ Bare land, and Built up area

Table 1: major Land Use/ Cover Types of Imo State for Sustainable Ecotourism Development and Rating for Ecotourism Development

LULC	Rank	Suitability

Dense forest	5	Highly important for ecotourism,
Water body	4	Very important for ecotourism. It can serve as a recreation as boating, parks and natural zoological parks.
Light forest/Farmland	3	Very important for ecotourism, area needs to be managed and conserved properly to attract eco-tourist as well as general tourist.
Bare Land	2	Bare land can be converted to play grounds for sports and other activities
Built up area	1	Developed areas are good for eco-tourism.

Source: Author's Compilation

Dense forests are the most suitable land use/ cover for sustainable ecotourism development hence they are ranked highest (5), followed by water bodies (4), Light forest/ farm land (3), Bare land (2) and built Environment (1) which has no ecotourism development value at all.

Land Use/ Cover Map of Imo State.

Figure 2 shows the classified land use land cover of Imo State as analyzed from the 2019 Landsat imagery of Imo state.

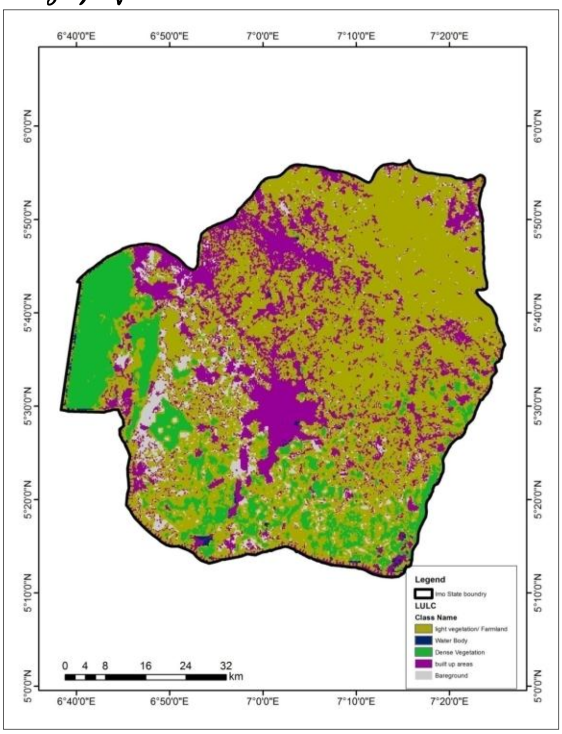

Fig 2: Imo State Land use/Cover
Source: Author's Fieldwork/GIS Analys

Accuracy Assessment

In order to determine classification accuracy, it is necessary to determine if the output map meets, exceeds, or does not meet certain predetermined classification accuracy criteria. One of the most common methods used to assess classification accuracy is the use of an error matrix (sometimes called a confusion matrix). Currently, accuracy assessment is considered as an integral part of any image classification. This is because image classification using different classification algorithms may classify pixels or group of pixels to wrong classes. The most obvious types of error that occur in image classifications are errors of omission (producer accuracy) or (user accuracy) (Alebachew, 2011).

Therefore, in this study, the overall, user's and producer's accuracies, and the Kappa coefficient were calculated (Table 4.6). The error matrix was obtained from reference data [ground control point (GCP)] with the help of Arc GIS 10.5 software accuracy assessment operations data management extensions. The researcher executed field observation and random ground truth data collection using GPS from well-known sample sites to arrive at reasonable validation statistics. The study assessed the image classification accuracy by using 71 random GCP for all land use classes (16, 12, 15, 11 and 17) for farmland/ Light Forest, water body dense forest, built environment, and bare land respectively)

Table 2: Error Matrix Table

Class category	Reference (GCP) data						Producer accuracy %	User accuracy %
	1	2	3	4	5	Total		
Farm land/light forest (1)	16	0	1	0	1	18	86.36	90.47
Water body (2)	0	12	1	0	1	14	88.25	88.23
Dense Forest(3)	1	0	15	0	1	17	86.36	90.47
Built Environment(4)	1	1	1	11	2	16	85.71	70.58
Bare land (5)	1	1	0	2	17	21	77.27	80.95
Total	19	14	18	13	22	86		

Source: Researcher's Compilation (2019)

Overall Accuracy

This was computed by dividing the total correct number of pixels i.e summation of the diagonal (16+12+15+11+17= 71) to the total number of pixels in the matrix [grand total (86)]. It can be expressed by Xii and N as:

Overall Accuracy = $\sum Xii/N$

Where, Xii = Number of correctly classified pixels, or the diagonal value and
N= entire number of pixels in the matrix.
Therefore, the overall accuracy under this classification is, 82.6 %; which is (71/86)*100

Producer's Accuracy

This refers to the probability of a reference pixel being classified correctly. It is also known as omission error because it only gives the proportion of the correctly classified pixels. It is obtained by dividing the number of correctly classified pixels in the class category by the total number of pixels of the category in the data. As clearly indicated in (Table 4.6), lower producer's accuracy exists for bare land class (77.27 %). The remaining 22.73 % percent is omission error. This is probably due to the similar spectral properties of pixels in this land use/land cover classes with some of the other features. For instance, bare land is similar to grassland and pasture land in dry season and farm land under crop harvesting season, and fallowing time may have a relative similar spectral property and might make it difficult for the researcher to identify at pixels level.

User Accuracy

This presents the probability that the pixels in the classified image of the study area represent that class on the ground. It is obtained by dividing the total number of correctly classified pixels in the category by the total number of pixels on the classified data. As in the case of this study, from the user's accuracy point of view, built environment presented low accuracy (70.58 %). This implies that, to some extent, it is misclassified. This is probably caused by the presence of built environment in other land use class in the study area.

Kappa Coefficient

The Kappa coefficient which measures classification agreement, can also be used to assess the classification accuracy. It expresses the proportionate reduction in error generated by a classification process compared with the error of a completely random classification (ENVI, 2013; Congalton, 1999). The Kappa coefficient (K) is calculated using the information in the error matrix table (Table 4.6) and using equation given by (Congalton, 1999).
Where: r = is the number of rows in the matrix; Xii = is the number of observations in rows i and column i (along the major diagonal); Xi+ = the marginal total of row i (right of the matrix); Xi+1 are the marginal totals of column i (bottom of the matrix); N is the total number of observations.
Therefore, to get the kappa coefficient of the classification process, the Congalto formula was applied.

$$K = \frac{(total * sum\ of\ correct) - sum\ of\ all\ the\ (row\ total * column\ total)}{total\ squared - sum\ of\ the\ (row\ total * column\ total)}$$

Therefore, K= 0.84 implies that the classification was relatively good. It is reasonable to employ the generated map for further analysis and studies of potential ecotourism development.

Proportion of Land Use/Cover Available for Sustainable Ecotourism Development in Imo State

Table 3 Proportion of Land use/ Cover Classification Area Coverage

LULC	Rank	Area Coverage (Hec)	%
Dense forest	5	65747.34	12.8
Water body	4	2163.84	0.4
Light forest/Farmland	3	305365.50	59.5
Bare Land	2	30656.92	6.0
Built Environment	1	109601.49	21.3
Total		**513535.09**	**100.0**

Source: Author's GIS Anaylsis (2019)

The result in Table 3 revealed that majority (59.5%) or 305365.50 Ha of the land space were covered with light forest/Farmland, followed by 21.3% or 109601.49 Ha that was covered with Built environment. Dense forest which is the best land cover for ecotourism development covered only 12.8% or 65747.34 Ha of the study area. However, water cover amounts the least with only 0.4% or 2163.84 Ha of the area coverage. Built environment covered 21.3% or 109601.49 Ha and has no value for ecotourism development.

CONCLUSION

The purpose of this study is to evaluate the land use/cover of Imo State suitability for sustainable ecotourism development. Built environment has taken over a large chunk of the land space in Imo state and this does not favor sustainable ecotourism development. Water bodies play important part in ecotourism in terms of boating, recreation and natural zoological parks etc, the proportion is not encouraging for ecotourism. While light forest/farm land can encourage ecotourism, they need to be managed and conserved properly and the opportunity weighed. Since dense forest plays a major role in ecotourism, government should come up with a clear cut policy on forest conservation as only 12.8% of the entire land area is made up of dense forest at present. If there is no adequate policy to put in check the destruction of vegetation, this percentage will continue to degenerate, going by the high level of urbanization in the state. Hence the government should come up with adequate land management and implementation policies.

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