A SPATIAL TEMPORAL ANALYSIS OF WETLAND LOSSES IN THE LAGOS COASTAL REGION, SOUTHWESTERN NIGERIA, USING MULTI-DATE SATELLITE IMAGERY.

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Abstract

This paper assesses the temporal trend and the spatial patterns of wetland forest loss in the Lagos coastal region of southwestern Nigeria between 1978 and 2006 based on the comparative analysis of multi-date satellite imageries for 1978, 1987, 1995, 2000 and 2006. The initial number of wetland habitats was derived using an unsupervised classification algorithm. Freshwater and mangrove swamp forests dominated the area. Generally, the wetlands declined by 19% between 1978 and 2006 at 0.6% annual rate of loss. The freshwater and mangrove swamp forests declined by 20.9% and 13.0% with an annual rate of loss of 0.7% and 0.43% respectively. Using the Markov Chain technique, the trend in wetland loss would likely continue if the current economic, social and political systems are maintained. The lower rate of decline of mangrove forests compared with freshwater swamp forests is a reflection of the more waterlogged and difficult terrain.

Key Words: wetland habitats, wetland loss, mangrove swamp forests, freshwater swamp forests, Landsat images, unsupervised classification.

Introduction

The global pattern of wetland loss including changes in wetland extent overtime has been explored by numerous authors [1234]. But, little or no information is available on the rate of loss and the challenges confronting wetlands in the developing countries. Where the information is available, it points to the fact that these wetlands will ultimately be lost based on the current rate and pattern of exploitation of their resources [12]. However, there is very limited published information on the trend and spatial pattern of wetland conversion along the coast of Nigeria [678]. Therefore, the aim of the present study is to analyze the temporal and spatial trend in wetland conversion along the Lagos coastal belt, using remotely sensed satellite imagery. Two major types of wetlands are found in the Lagos coastal region, namely, freshwater swamps; and mangrove swamps.

Materials and Methods

The major source of data for this study is Landsat imagery. The choice of images was based on the percentage cloud cover on each image. Thus, the Landsat TM of the December 1978, Landsat MSS of December 1987 and January 1995 and Landsat ETM of January 2000 and January 2006 were used in this study. The five Landsat images were georeferenced to the UTM 31. In view of the differences in band compositions among the three Landsat types used in this study, it was decided to select bands that capture images in the same wavelength. Based on this premise, bands 3, 4 and 5 were selected from the Landsat TM and ETM, while bands 2, 3 and 5 were selected from the Landsat MSS image. In each case, these three bands were combined to develop a colour composite image of the study area. This resulted in five composite images which were subsequently used in the estimation of wetland loss in the study area. In order to achieve uniformity in spatial resolution, the Landsat MSS which has a 79-meter resolution was resampled to 30meters so that it would conform to the TM and the ETM images.

The satellite images were georeferenced to each other so that they refer to the same coordinate space. The images were then enhanced to determine the various information (signature) classes on the image. An unsupervised classification of each of these images produced the initial landuse/landcover classes within the delineated area (Figure 1). The unsupervised map for the year 2006 was verified during a field survey to ascertain the type of vegetation or uses for which each class represents. The year 2006 image was chosen because it corresponded with the year for which the verification was carried out. A 200m x 200m grid was superimposed on the 2006 satellite image and a 5% random sample of the grid cells in each habitat was selected for the field verification. The remaining images for 2000, 1995, 1987 and 1978 were retroactively classified using the 2006 image as the reference base.

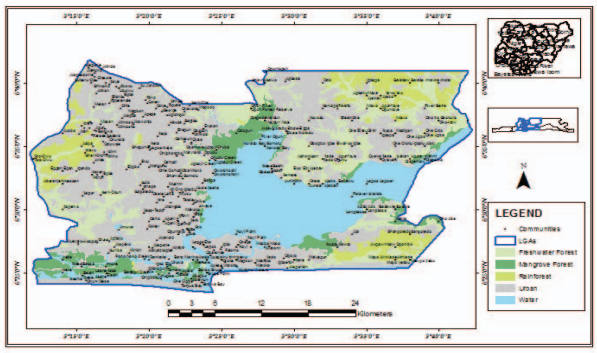

Figure 1: Classified Landsat 1987 Image of the Study Area

The spatio-temporal trend in wetland loss was arrived at by converting the classified images to their corresponding vector equivalents. The vector conversion helped to delineate wetland boundaries for each of the imageries under consideration. The derived wetlands vector boundaries were overlaid on each other to identify areas where wetlands had been converted to other uses between the time intervals. The percentage change and annual rates of change in wetland habitats were subsequently determined. In order to forecast the future trend in wetland loss in the study area, Markov-Chain analytical method was employed to explore the trend in wetland loss. For this purpose a 28-year forecast was carried out.

Temporal Variations in Wetland Forest Vegetation Loss

Temporal variations in wetland loss were examined by analyzing and quantifying variations in the area coverage of different wetland forest types between 1978 and 2006. Figure 2 shows a sample landuse/ landcover map showing the two dominant wetland types in the study area. Table 1 shows that the total area of wetlands declined by 19% from 399.54 km^2 to 323.47 km^2 between 1978 and 2006, giving an annual rate of loss of 0.6% over the 28-year period. Freshwater swamp forests declined by 20.9% from 304.49 km^2 to 240.80 km^2, while mangroves declined by 13% from 95.05 km^2 to 82.67 km^2 over the same period. The lower rate of decline of mangrove forests compared with freshwater swamp forests is probably a reflection of the more waterlogged and difficult terrain. Over the 28-year period, the annual rate of loss of freshwater swamp forests was 0.7% while the rate for mangroves was 0.43%. The slow but steady increase in the proportion of mangrove swamps relative to freshwater swamp forests does not imply that the area covered by mangrove forest is increasing; the fact is that the area of freshwater forest vegetation is declining faster than that of mangroves. Since 1995, annual rate of loss has been 1 percent and above suggesting that the loss of wetlands has increased in recent times

Table 1: Temporal Trend in Wetland Vegetation Distribution in the Study Area

Year	Fresh water	Mang-rove	% Fresh water	% Mang-rove	Total Wetland
1978	304.49	95.05	76.21	23.79	399.54
1986	290.18	92.81	75.77	24.23	382.99
1995	280.23	90.39	75.61	24.39	370.62
2000	265.94	88.98	74.93	25.07	354.92
2006	240.80	82.67	74.44	25.56	323.47

Relationship Between Wetland Loss and Eco-Geographic Factors

To understand the variables that explain the pattern of wetland loss in the study area; the administrative map of Lagos State showing local government areas (LGAs) was overlaid on the wetland loss map. The amount of wetland loss is the dependent variable, while X_1 total population of LGAs; X_2 length of roads in each LGA; X_3 average price of land; and X_4 change in built-up area extent are the independent variables.

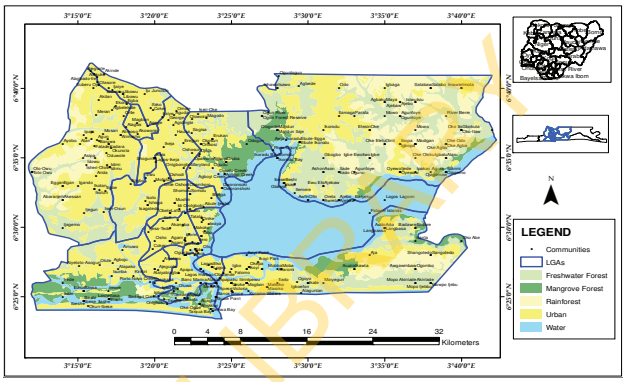

Figure 2: 1995 Landuse/Landcover Map of the Study Area

The analysis revealed that there is a positive correlation between the extent of wetland loss and the proportion of built-up area in each of the LGAs under consideration. This fact clearly reveals urban expansion as one of the principal agents of wetland conversion in the study area. The negative correlation observed between wetland loss and price of land reveals the importance of land price in influencing its consumption, as the higher the price, the lower the quantity that is consumed. This highlights indeed what has been happening of recent in the Lagos coastal region: big capital from wealthy individuals, businesses, and other organizations has played a major role in the urban encroachment on wetlands. Only such wealthy individuals and concerns can afford the high cost of land development in the wetlands. Rapid wetland loss appears to be occurring faster in LGAs that are structurally, economically, socially and characteristically rural in outlook. These are the areas currently attracting the urban spill from metropolitan Lagos as individuals and businesses are seeking more space and more ecologically and aesthetically conducive locations to expand into.

Predicted Pattern of Wetland Loss

Markov chain analysis was used in predicting wetland status in 2034 and the predicted pattern of wetland loss was derived by subtracting the areas of wetlands by type in 2006 from the predicted year 2034 wetland forest (Figure 3). It is clear that by 2034, the total area of wetland forests that will have been lost will be about 92.62 sq km comprising 72.86km^2 of the freshwater forests and 19.76km^2 of mangrove forests. The greater loss of wetland will be in erstwhile rural to suburban areas which are now being encroached upon by the spillover from metropolitan Lagos. If current trends continue the greater losses will be sustained

in the freshwater forest areas which are less waterlogged and easier to develop.

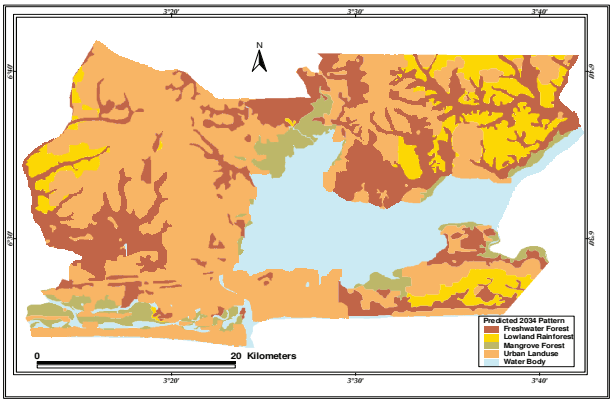

Figure 3.0: Predicted Wetland Pattern in 2034

Conclusion

The study shows that freshwater forest faces much more threat than mangroves obviously because of the more favourable terrain conditions. Loss of wetlands is increasing in the previously 'safe' rural areas as individuals, businesses and corporate organizations are all moving out of metropolitan Lagos to more spacious and aesthetically more pleasant environments. This study has also shown that remote sensing techniques can assist in filling data gaps in developing countries where there are no up-to-date maps for basic planning.

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