Use of gis and remote sensing data

INTRODUCTION

Studies have shown that only few landscape on earth surface remain unaltered or in their natural state and is due to immerse demographic pressure and anthropogenic activities (Zubair, 2006). Competition between species and human beings has been the leading cause of land cover change in the world. This factor is substantially verified by the conversion of forest land to other uses like farmlands for agriculture, industry urban development, infrastructure, recreation and others. (Brown, 2004)

Forest plays an important role in the overall stability of carbon in the atmosphere mitigating or exacerbating the effects of global warming. Therefore, Forest carbon sequestration can help to minimise the raise of greenhouse gases in the atmosphere, (Juan and Louis, 2009)

It is therefore important to note that forests are counted among the world's chief carbon sinks contributors. They store more than 289 gigatonnes (Gt) of carbon in their litter, deadwoods and soil and these are more than the carbon found in the atmosphere. Globally, there was decrease in carbon stocks of forest biomes of 0.5 Gt a year between 2000 - 2010 and was mainly due to deforestation, (FAO, 2010)

“Globally, about 13 million hectares of forests were changed to other uses an some were lost through natural causes each year, that is between 2000 and 2010 as when compared to almost 16 million hectares per year during the 1990s” (FAO, 2010). The biggest losses or the highest net annual loss of forests from 2000 to 2010, are in South America and Africa with four and 3.4 million hectares respectively.

On the other hand, a recent study by the Food and Agriculture Organisation (FAO, 2010) reveal that generally, the destruction of tropical forest for agricultural activities has decreased over the last ten years, but the rate of deforestation for other activities continues to increase at an alarming high rate.

The tropical rain forests are significant component of the climate system and play an important role in the total carbon-dioxide exchange balance of the earth's plant cover. McGuffie et al. (1995) suggested that the existence of tropical rain forest has a great influence on regional climate and as such tropical deforestation has been seen to affect the climate of different parts of the world.

Tropical forests make up the most diversified ecosystems in the world with the highest biomass per square metre especially in the lowland rain forest (McGuffie et al. 1995). But much of the forest areas have been subjected to continuous depletion as a result of artificial or natural factors. The annual rate of destruction to the rain forest seems to be increasing and could double in the next few decade (Myers, 1992).

The tropical rain forest in Nigeria is also undergoing severe exploitation as a result of population growth, urban expansions, mismanagement and socio-economic development. The process of deforestation is mainly caused by clearing of forest land for agricultural activities, logging, fuel wood, mining and industrialization etc. Like most tropical regions of the world, deforestation remain a key issue on environmental, ecological and socio-economic challenge in Nigeria (Uneke and Ibeh, 2009)

Nigeria has the highest deforestation rate of primary forests from the revised deforestation figures obtained from Food and Agriculture Organisation of the United Nations (FAO). Between 2000 and 2005 the country lost 55.5% of its primary forests and contributes 3.3% in the world therefore ranked the world highest rate deforested country. Since 1990 the country has lost a total of 6.1 million hectares or 35.7% of its forest covers and this has result in the lost of its primary or old forest at a faster rate. Since 2000 report have shown that Nigeria is losing at an average of 11% of this primary forest and which has double the rate of 1990s. Moreover, the Nigeria First National Biodiversity Report-NFNBR (2001) estimates the rate of deforestation at about 5% annually compared with 0.6% globally.

The major causes of deforestation in Nigeria include corruption, overpopulation, urbanization, population growth, inequitable distribution of wealth, and poverty (Ayodele, 2010).The United Nations Framework Convention on Climate Change has stated that the overwhelming cause of deforestation is agriculture. It stated that subsistence agriculture accounts for 48% of deforestation, while 32% of deforestation results from commercial agriculture. Wood-fuel is said to account for 5%.

Forest biomass has remained the most common source of household energy in Nigeria, meeting 80% of domestic energy requirements. In 1992, alone, forest wood and charcoal products were estimated at 55 million tons, suggesting that much forest woods are been used for domestic purposes.

According to Choji (2005), more than half of 9.6 million ha of rain forests in the south of Nigeria have been used to meet the demand for fuel wood in rural and urban neighbourhoods. Compared with the costs of petroleum product, fuel wood is cheaper than any commercial fuel substitute and this has, over the years, increased forest depletion. He further noted that this appears to have propounded effect on the environment and the sustainability of the forest.

Similarly,(Uyigue and Agho,2007) also noted Logging, urbanization, oil exploitation, subsistence agriculture, and the collection of fuel-wood among all are noted as foremost causes of deforestation in Nigeria.

Therefore an attempt will be made in this study to map out the status of changes in the forest areas of Niger Delta Region of Nigeria between 1987 and 2002 using both remote sensing and GIS.

Research Question: Is there change in forest cover in Niger Delta Region of Nigeria between 1987 and 2002?

Aim: To identify and map out changes in forest cover of Niger Delta Region Nigeria and adopt suitable methods in detecting such changes using remote sensing data and GIS techniques

Objectives:

* To analyze the Spatio-Temporal change in forest cover using classification methods

* To apply different change detection techniques and identify changes in forest cover

* To map out areas of changes

* To analyze the effects of land cover change in the region and to suggest some recommendations.

THE STUDY AREA

The study area is located in the Atlantic coastline of southern Nigeria 5°30N 6°30s. Niger Delta region falls within the tropical rain forest zone of the world. It's named as the second largest delta in the world occupying about 450 kilometres spanning coastline. The region is describes as largest wetland in Africa and covers over 2000 square kilometres that mainly consists of lakes, rivers and creeks. Ecosystem is diverse and highly supportive to numerous species both aquatic and terrestrial and human life, (Uyigue and Agho, 2007).

The region is vegetation cover is mainly swamp forest which can be further divided into two classes; the Mangrove and the fresh water forest. The Mangrove spanning around 1900 square kilometres and the largest in Africa,(Uyigue and Agho,2007). The main features of its geography include extreme blocks of luxuriant high forest that occur in the region. It has the largest ply-wood and veneer plants in West Africa and has known as a centre for saw milling. The area consist of three types of forest strata of tree tall (120m high), moderate (50m - 100m) and those below 50m.Some common trees found in the area are obeche, abura, sepele and mahogany. http://www.britannica.com/EBchecked/topic/523642/Sapele

States found around the region include Niger Delta, Port Harcourt to south western states Oyo, Osun and Lagos state. The region has heavy precipitation of between 1824 millimetres and over 4000 millimetres along the coast. Rainfall falls throughout the year with a shorter break in August and longer one from December to January. Trade winds originated from Atlantic Ocean of the southern part of the country is responsible for Nigerian rainy seasons Nigeria. The region has an equatorial monsoon climate; temperature ranges between 28°C (82.4°F) and 26°C (78.8°F) (Wikipedia).

Map showing the location of the study area

LITERATURE REVIEW

Landsat is an important component in the climate system, and plays a key role in monitoring global change and is primary source of medium spatial resolution earth observation used in decision making (GyaneshChandera et al., 2009). Remote sensed imagery provides accurate understanding and comprehensive way of modelling and projecting land change (Elvidge et al., 2004)

With the introduction of landSat5 1984 and landSat7 ETM+ 2002, this has marked a significant advance in remote sensing through obtaining more sophisticated advance sensor; improve acquisition and transmission of data and more rapid processing at a highly processing facility (GyaneshChandera et al., 2009).

Change Detection is one of the main applications of remote sensed data. A considerable amount of literatures has been published by the researchers in trying to quantify and assess land cover change detection

Change detection is the process of identifying differences in the state on an object or phenomena by observing it at different times, over a certain period of time. (Singh, 1989) cited in (Lu et. al., 2004)

A quite number of change detection techniques have been summarised by many authors in an attempt to find out land cover changes over time. Lu et al., (2004) categorizes these techniques into seven classes ranging from simple algebra's to more complex and advance ones namely; Algebra which include image rationing, image differencing vegetation index differencing, Change vector analysis, others in the category includes transformations, classifications, Advance models, Biophysical parameter methods and those that involve the combination of both GIS and remote sensing data for analysis

Change detection have gained wide range of application in the field land use land cover change; Peiju et al., (2010), reported to have used multi- temporal remote sensing Landsat TM to monitored urban land cover and vegetation change in Xuzhon city between 1987 - 2007, the result of the statistical analysis show that build up areas have obviously increase while farmland have seen in a continuous loss due to urban growth and human activities. Zubair (2006) detects changes in land use land cover in Kwara state Nigeria between 1972 1nd 2001 using change detection techniques of GIS and remote sensing data, the result of the analysis show that there was rapid growth in the built up areas and was a result of population pressure. He noted that there was steady reduction in forest cover in the study area and further predicts continues loss in subsequent years. Chen, 2002, noted the use of GIS and remote sensing techniques and monitors changes along the coastline zone of Korea, the result of the study show that both human and natural factors are responsible for the change and this has on the

other hand impacted the sustainable development of the region. Janifer et al., 2010, monitors forest change in the landscapes area of Chile between 1975 and 2008, the result of the study show an average rate Deforestation was -1.7% and shrub land -0.7%, however agriculture and timber plantations increased at annual rate of 1.1% and 3.3% respectively. The study concludes there is progressive lost of forest cover in the region.

Moreover, in the field of Urban and environmental change; George et al., (2009), used Landsat imagery change detection methods in updating the 2001 national land cover database land cover classification to 2006, conservative thresholds based on Anderson level 1 classes were used to segregate the change vectors and determine areas of change and no change. An accuracy of 83.225% of the five selected areas achieved. Woodcock et al., (2001) noted Landsat in detecting environmental change over time, the study makes use of generalization method in monitoring large areas for forest change and conclude that method is state-of-the earth as other methods and consumes less time as other conventional methods

Change detection in the field of forest or vegetation change includes the work of Chengquan et al., (2009), in the assessment of Paraguay's forest cover change using Landsat observation of high resolution image showed that Atlantic forest ecosystem experienced the most loss with the 73.4% forest cover in the 1970's decreasing precipitously down to 40.4% by the 1990s and further down to 24.9% by the year 2000. Rasuly et al., 2010, noted the advantage of using GIS and remote sensing techniques to monitor the rate of forest alterations in the Arasbaran protected area using various methods, the result of the study show that about 6146.9 hectares of the area has being deforested over the past 18 years, in cooperating with the GIS also show that the lost was due to physiographic factors and they suggest to distant settlements from the protected area. Similarly Li et al., 2011, noted the advantage of Landsat Lider fusion for modelling the height of young forest. Schlerf and Atzberger (2005), estimates the structural canopy variables using hyper spectral remote sensing data INFORM “Invertible forest Reflectance Model”. Main advantage of this method is that it does not require previous calibration.

Olthot el al., (2004) map out deciduous forest of ice storm damage using Landsat and environmental data in the east of Ontario, the study show a limitation in the difficulty of both remote sensing and environmental data to discriminate many levels of the deciduous ice damage, however it can be consider as a useful technique in differentiating areas of low to medium damage from the severe damage. An overall accuracy of 69% was achieved. Mapedza et al., 2003, investigate s land cover change of the forest reserve area of Mafungautsi Zimbabwe, the study show that whilst forest cover within the reserve remain the same, but however there is steadily decline outs its boundaries as a result of agricultural expansions, the collection of fuel wood and building materials demand

3.0 METHODOLOGY

Pair of multi- temporal cloud free Landsat images was selected to classify the study area; 1987 and 2002, the image of image 1987 was Landsat 5 TM and the other Landsat 7 ETM+. The images were downloaded from GLCF websites in different layers and will be layer stack together using ERDAS Imagery 9.2. A subset will be collected and image enhancement is to apply using Histogram equalised to visualised features more clearly. The images were geo-reference to Universal transverse Mercator (WGS84 - zone 32), and a common geo-link window covering the same geographical coordinates were then extracted from each image

3.1.1IMAGE PROCESSING TECHNIQUES:

Digital image processing is classified into three classes which includes; pre-processing phase, processing phase and the post-processing phase. The pre-processing phase is the first stage in the processing technique, it involves correction of data through various means and techniques, different types of errors that are associated with any satellite images includes; geometrical error, atmospheric error and radiometric error. Geometric correction is a technique used to correct errors that are usually induced by sensor viewing, geometry and terrain variations, it involves correcting spatial distortion in an image due to earth curvature, atmosphere etc and thus giving it a real world coordinate system.

The two images to be used in this study will not undergo the pre-processing phase because the two images obtained are ortho-rectified. The processing stages involve manipulation of images through the spatial enhancement and the spectral enhancement techniques.

Image Enhancement; the procedure is applied in order to display effectively the tonal distinctions within various features display in the image. It normally involves techniques for increasing the visual distinctions between features to assists in visual interpretation and analysis. (lillesand et al., 2008 p482)

Histogram -equalised stretch is going to apply to expand the DN values and also enhance the quality of the features in the image so that radiometric detail is enhanced. (Lillesand **et al.,** 2008)

3.1.1 CLASSIFICATION ANALYSIS

Supervised classification, using maximum likelihood algorithm is going to be used, supervised classification requires selection of sufficient training sample which are subsequently used to assign image pixels to the training samples that best fits the corresponding data, it separately classifies multi-temporal images, pixel by pixel. Supervised classification requires an immense amount of time and know-how in creating classified products. Moreover, the final accuracy depends upon on the value of

the classified image of each date. Yueling and Xu (2010),reported to have used supervised classification technique in monitoring and driving force analysis of urban expansion in Guangzau City China and the result of the outcome shows an annual 19.7% growth rate.

Post-classification comparison (PCC), is another important method that is recognized as the most effective and accurate method of detecting changes in mages with different dates and registry, the algorithm is capable of comparing the classified images pixel by pixel. The use of PCC is thus reduces the environmental and atmospheric effects associated with the temporal images and thus p**rovide a complete change matrix** (Lu et al**.,** 2004).

Accuracy assessment is the overall accuracy of the work done; it shows the proportion of ground sampling points that are correctly classified. The user accuracy shows the proportion of classified pixels in according with the actual ground types as taken from the ground truth testing data. Accuracy assessment allows you to evaluate a classified image file (Thematic raster layer).

3.1.2 CHANGE DETECTION TECHNIQUES:

Change detection techniques is useful in a wide variety of applications such as; land use change analysis, monitoring shifting cultivation, assessment of deforestation etc. change detection techniques to be used for this studies will include; change vector analysis, image ratios and image differencing. These techniques have the ability to calculate area change, change rate as well as the spatial distribution changes. These techniques will involve computing the area covered by each of the two supervised classified images from the two data sources independently and compare between the two images for increase or decrease in changes that have occurred in terms of forest change cover (Lu et al., 2004).

Change vector analysis is a technique that generates two outputs, the first output produced is on spectral change from the first to the second image and the second output will produce the total change magnitude per pixel, Change vector analysis is computed by determining the Euclidean distance between end points through n-dimensional change space (Lu et al., 2004). Its main advantage in terms of analyzing change detection is its ability to process any number of spectral bands desired by the analyst and capable of producing in detailed of change detection information as it defines threshold and identify change trajectories which is a good way to calculate percentage rate of change that has occurred in a particular studies. Moreover the direction of the spectral change is often relates to that type of change that had occurred (Lillesand et al., 2008). Method was used by Allen and Kupfer (2000) in conifer forest change detection.

Image differencing is a change detection technique that will be used in this research to extract more information regarding the changes that have occurred in the study area;

image differencing subtracts the first date image from the second date image, pixel by pixel to show the changes within the two dated images, it identifies suitable image bands and thresholds. Image differencing usually yields a better results when carried out on the intensity bands generated by transforming the RGB data sets into IHS color space. Singh (1986) applied this method in tropical forest change, similarly (Jha and Unni 1994) in forest conservation change detection.

Image ratio is going to be applied because it is a simple way of trying to extract useful information from TM imagery. With image ratio technique, intensities of reflected energy recorded in one band for the pixel of a satellite images are divided by intensities in the same band for the other rectified images. Image ratios describe the color of an object, although the color only corresponds to human perception when the three visible bands of red, green and blue are considered. Image ratio is prepared by dividing the digital number in one band by the corresponding digital number in another band for each pixel, thus stretching the resulting values, and plotting the new values as an image rationing is an effective way of visualizing different types of soils because the main spectral differences in the visible and near infrared spectral regions are found in the slope of the reflectivity curves. It calculates the related quantity of registered images of different two dates pixel by pixel. Ratios for changed areas have higher values or lower ratio values whereas an area of no change tends to move towards one (1). An important advantage of this method is it tends s to normalize the impact of sun angle and shadow which has been caused as a result of external factors. (Lillesand et al., 2008 p596) Method has being used in land use mapping and change detection by Prakash and Gupta (1998)

Finally, overlay operations would be made to see the changes that occur in the region. And Data is exported to GIS data base for map production.

The above figure show a change detection procedure for the Landsat Images would undergo during the analysis.