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An Assessment of the threats to Global Warming in Akwa Ibom State, Nigeria

By

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Research Article

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ABSTRACT

The Intergovernmental Panel on Climate Change (IPCC) asserts that most of the observed temperature increase since the middle of the 20th century was caused by increasing concentrations of greenhouse gases resulting from human activities such as fossil fuel burning and deforestation. This study assessed the situation in Akwa Ibom State, Nigeria as far as deforestation and fossil fuel burning was concerned. The study revealed that, within a period of 21 years [1986-2007], more than 50% of forest covers in the area was lost due to deforestation. Based on a handful of biome-average estimates this forest cover stored 53,003,200 tons of carbon which was released as CO_2 into the atmosphere as a result of deforestation. Moreover, the same forest cover would have sequestered 300,305.5 tons of carbon dioxide if it was not cut down. Also, the area is witnessing urban growth patterns that are compact and without green belts that can serve as sinks for carbon emissions from anthropogenic activities within area. The study concluded that an integrated information system that includes a GIS with Remote Sensing image processing capabilities is a powerful tool that can help us monitor and manage our contributions to global warming among other things.

Keywords: Global warming, Deforestation, Carbon stock, Carbon sequestration, Urbanization, Urban growth and air quality.

INTRODUCTION

Presently the scientific consensus on climate change is that human activity is the cause of the rapid increase in global average temperatures over the past several decades (IPCC, 2007). Furthermore, the list of countries that have been called upon to cut down on carbon emission does not include many developing countries. This is in spite of the fact that they are involved in some of the human activities that led to the present predicament.

This underscores the need to assess the contributions of different countries of the world to global warming. This is to enable relevant international agencies on climate change to identify countries of the world both developed and developing that should be held accountable and/or be involved in the sell of carbon credit as well as for different nations of the world to be able to, among other things, identify and deal with those activities that are contributing to global warming in their area. The aim of this paper is to use Geographic Information System [GIS] and Remote Sensing based techniques to assess the situation in Akwa Ibom State, Nigeria.

Location of the Study Area

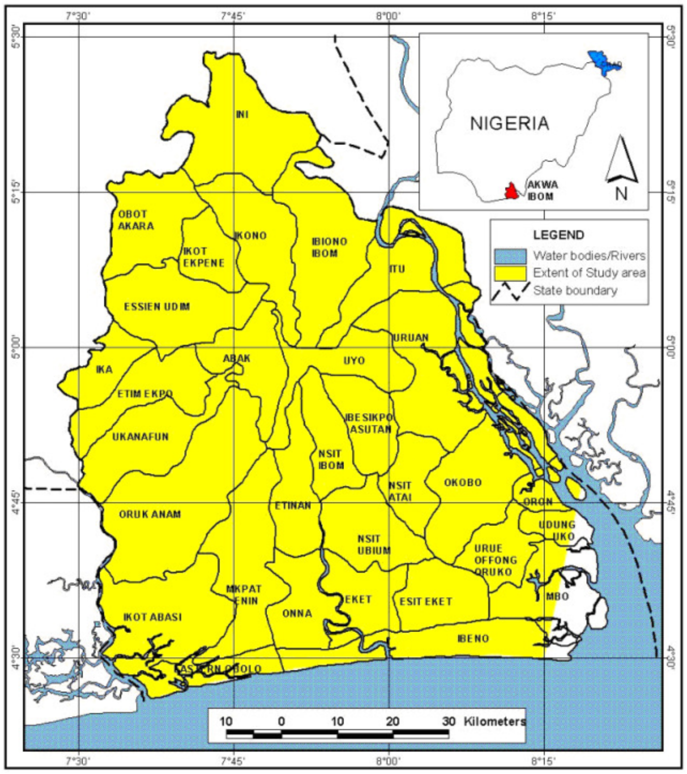

Fig 1: Location of Akwa Ibom State, Nigeria
Source: Akwa Ibom State Surveys, 1997.

Akwa Ibom State is situated in South Eastern Nigeria. It lies between latitude $4^{0}30''$ and $5^{0}30''$N and longitudes $7^{0}30''$ and 8^{0} 30"E (Figure1). The area covered in this study is shown in yellow. This is the limit of existing cloud free landsat TM imagery for 1986 when the area was not constituted into a state/administrative area. This location is within the tropical rainforest belt where deforestation destroys globally important carbon sinks that currently sequester carbon dioxide [CO_2] from the atmosphere and are critical to future climate stabilization (Stephens et al., 2007; Ayoade, 2003). Mean annual rainfall over the area decreases gradually from about 4050mm near the coastal area (the southern part) to about 2100mm in the north. Temperatures are uniformly high throughout the year. The mean annual temperature is 26.9°C. Relative humidity remains at an average of 70 to 80% throughout the year except for the short period of dry season.

Conceptual Framework

This study was based on the principles of three concepts namely: global warming, deforestation and urban growth.

Global warming

Global Warming is defined as a natural or human induced increase in the average global temperature of the atmosphere near earth's surface (Botkin et al., 1998). The Intergovernmental Panel on Climate Change (IPCC) concludes that most of the observed temperature increase since the middle of the 20th century was caused by increasing concentrations of greenhouse gases resulting from human activities such as fossil fuel burning and deforestation. There are several greenhouse gases responsible for global warming, and humans emit them in a variety of ways (IPCC, 2007). This explains why in this study, the focus is on measuring air quality to determine the impact of fossil fuel burning and analysis/mapping of land cover change to assess the effect of deforestation and urban growth.

Deforestation

Studies have shown that trees are very important in the global carbon cycle. They remove carbon dioxide [CO_2] from the air more than any other thing. Trees absorb CO_2 through the process of photosynthesis. According to Dittmar et al. (2006) and Ong (1993), one acre [ie 0.4047ha] of forest absorbs about 2.8 tons of CO_2 a year. Furthermore, Deforestation increases the severity of global warming. When the plants die and decay, carbon dioxide is released back into the atmosphere. As forests and grasslands are cleared for use, enormous amounts of stored carbon enter the atmosphere. The amount of carbon dioxide that is released into the atmosphere as a result of deforestation has been estimated using standardized methodologies (Gibbs et al., 2007). According to IPCC (2006), the biome-average tropical forest biomass carbon stock estimate is 200 tons of carbon per hectare. This biome average was used as standard to determine the impact of deforestation on carbon emission in the study area.

Urban growth

The world over, urban areas have grown in size and number because of urbanization. According to Batty et al. (2005), urban system usually grows in two ways: expansion and compaction. The first process leads to more space being occupied while the second leads to the mass increasing as measured in terms of its density or intensity. Furthermore, generally urban areas are made up of buildings, pavements, concrete, asphalt and roofs which act as solar collectors and quickly emit heat into the air. Consequently, Cities tend to have higher temperatures than the surrounding suburbs. The temperature increase result from the increase production of heat energy-the heat emitted from the burning of fossil fuels and other industrial, commercial and residential sources-and the decreased rate of heat loss because the dust in the urban air traps and reflect back into the city long wave [infrared] radiation emitted from city surfaces.

Moreover, studies reveal that, the expansion of cities results in higher energy use in transportation, housing, heating and cooling. Higher energy use means higher emissions of carbon dioxide. This leads to accumulation of global warming gases which eventually results in global temperature being higher.

An estimated 1.38 billion metric tons of carbon could be released as forest transforms to roads, buildings and homes. As it stands, the world's cities bear responsibility for at least 70 percent of global carbon dioxide emissions (Ayoade, 2003; Miller and Thompson, 1970; Ojo, 1977). In this study therefore, the changes that urban areas have undergone in size and shape is analyzed with a view to assessing the implications for global warming.

MATERIALS AND METHODS

Estimation of emissions

To estimate emissions, we need to know the area of cleared forest and the amount of carbon that was stored in those forests. Methods to assess area of cleared forest are described elsewhere (DeFries *et al*., 2007; Achard *et al.,* 2007; Jensen, 2005; Lillesand et al., 2004).

Emissions from tropical deforestation are based on a handful of biome-average datasets where a single representative value of forest carbon per unit area (e.g.tonnes of C per hectare) is applied to broad forest categories or biomes (e.g. Fearnside, 2000; Houghton and *Hackler,* 2001; DeFries *et al.,* 2002; Achard *et al.,* 2004; Ramankutty *et al.,* 2007). The estimate by IPCC in 2006 was adopted in this study. This is because the earliest compilations of biome averages were made decades ago and have been subsequently updated and modified by the research community (IPCC, 2006).

Land Cover Mapping and change analysis

To determine the area of cleared forest (deforestation) and the nature of urban growth in the study area, supervised classification was carried out using Landsat TM satellite image to produce land cover maps for 1986 and 2007 [i.e. periods before the area was constituted into a state and 20 years after]. The maps were then compared by pixel using the land-change modeler in IDRISI Taiga in order to detect and map changes that had taken place (DeFries *et al*., 2007; Achard *et al.,* 2007; Jensen, 2005; Lillesand et al., 2004). The FAO Land Cover Classification System was adopted. This system is a comprehensive standardized a-priori classification system designed to be able to meet specific user requirements, and created for mapping exercises, independent of the scale or means used to map. Any identified land cover anywhere in the world can readily be accommodated.

Fossil fuel burning

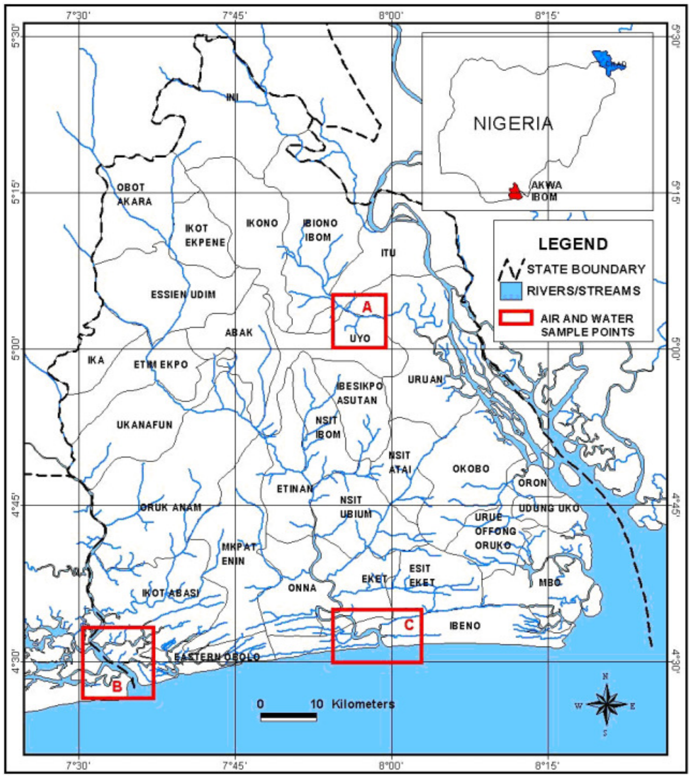

Fig 2: Locations of Environmental Impact Assessment [EIA] Project sites where air quality samples were taken

Air Quality Analysis was carried out to assess the impact of fossil fuel burning in the area. Three locations were chosen for this aspect of the study. Figure 2 shows the locations of the areas. These are areas where Environmental impact assessment (EIA) had been carried out for major industries. Location A is the state capital and the focus of many socio-economic and industrial activities. Location B is where an industry-Aluminum Smelter Company [ALSCON] is located and location C is where EXXON Mobil is located**.** Locations B and C are surrounded by two carbon sinks-swamp forest and the Atlantic Ocean. Location A is a city that is largely built-up. EIA is an important procedure for ensuring that the likely effects of new development on the environment are fully understood and taken into account before the development is allowed to take place. It usually contains among other things, a lot of detailed information and data on the condition of the project area prior to the project's implementation. In the EIA reports, details of soil characteristics, air quality, and water quality to mention just a few at various sample points are given. Since EIA studies are usually based on standardized procedures/methodologies carried out by experts in relevant fields and paid for by owners of projects, it is a cheaper and very reliable source of spatial data for environmental monitoring/management. In view of the foregoing, the data used for air quality analysis was simply extracted from available EIA reports.

RESULTS AND DISCUSSION

Analyses of land cover change

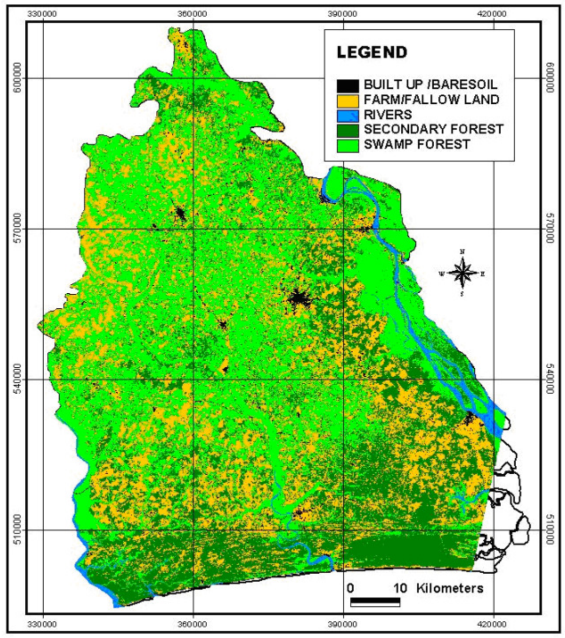

Fig 3: Akwa Ibom State: Land Cover - 1986

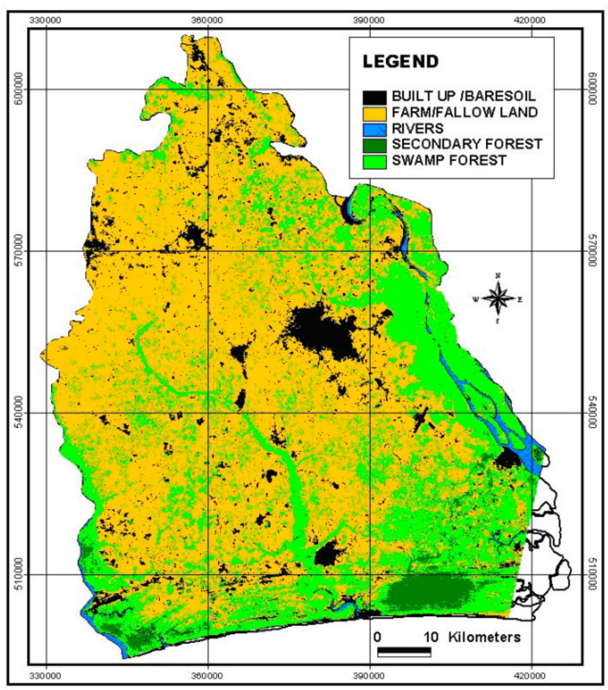

Fig 4: Akwa Ibom State: Land Cover - 2007

The types of land cover identified in the study area are shown in the land cover maps [Fig 3 and Fig 4]. The land cover types included built up area/baresoil, farm/fallow land, swamp forest, secondary forest and rivers.

Table 1: Land cover change detection statistics report 1986-2007

	Builtup/ Baresoil _86	Farm/ Fallow Land_86	Swamp Forest _86	Secondary Forest_86	Rivers _86	Class Total
Builtup/ Baresoil_07	**6948 [65.23%] Not changed**	26169 [14.06%]	7302 [2.52%]	7220 [3.90%]	871 [5.93%]	**48510**
Farm/ Fallow Land_07	3339 [31.35%]	**138511 [74.42%] Not changed**	181829 [62.58%]	94283 [50.93%]	242 [1.64%]	**418204**
Swamp Forest_07	248 [2.33%]	20686 [11.12%]	**98114 [33.77%] Not changed**	68520 [37.01%]	4239 [28.83%]	**191807**
Secondary Forest_07	1 [0.01%]	721 [0.39%]	3021 [1.04%]	**15062 [8.13%] Not changed**	50 [0.34%]	**18855**
Rivers_07	115 [1.08%]	23 [0.01%]	274 [0.09%]	53 [0.03%]	**9302 [63.21%] Not changed**	**9767**
Class Total	**10651**	**186110**	**290540**	**185138**	**14704**	
Class Changes	3703 [34.77%]	47599 [25.58%]	192426 [66.23%]	170076 [91.87%]	5402 [36.80%]	
Image Difference	37859	232094	-98733	-166283	-4937	

The result of change analysis is presented in the land cover change matrix [table 1]. It is obvious from the change matrix that, between 1986 and 2007, the land cover classes with the highest change were swamp forest [66.23%] and secondary forest [91.87%]. All others recorded below 50% change to other land cover types.

During the period, swamp and secondary forest decreased from 42% and 27% in 1986 to 28% and 3% respectively in 2007. This decrease was at the rate of 9163ha and 8099ha per year respectively. These changes are indications of high rate of deforestation in the area. This rate of deforestation is contrary to the principles of sustainable development. An unsustainable situation occurs when the sum total of nature's resources is used up faster than it can be replenished. Sustainability requires that human activity only uses nature's resources at a rate at which they can be replenished naturally. This is not the case with secondary forest in the study area. At the present rates, it means that by 2017 much of our forest cover would disappear leaving our future generation with almost nothing.

Impact of Deforestation

By loosing 166283ha of secondary forest and 98,733ha of swamp forest between 1986 and 2007, the area lost the forest cover that would have sequestered 188,425.2 tons and 111,880.3 tons of carbon respectively. This estimate was based on the value given by Ong (1993). Furthermore, based on the IPCC estimate in 2006, by loosing 166283ha of secondary forest and 98,733ha of swamp forest between 1986 and 2007, approximately 53,003,200 tons of carbon was released as CO_2 into the atmosphere**.** It is obvious from the foregoing analysis that deforestation is a serious threat to global warming in the area.

Urban growth

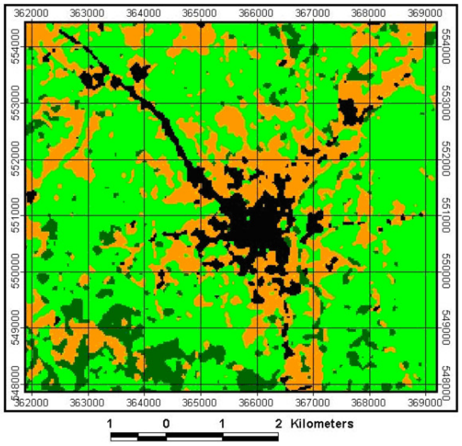

Fig 5b: Abak:Built up/baresoil in 1986

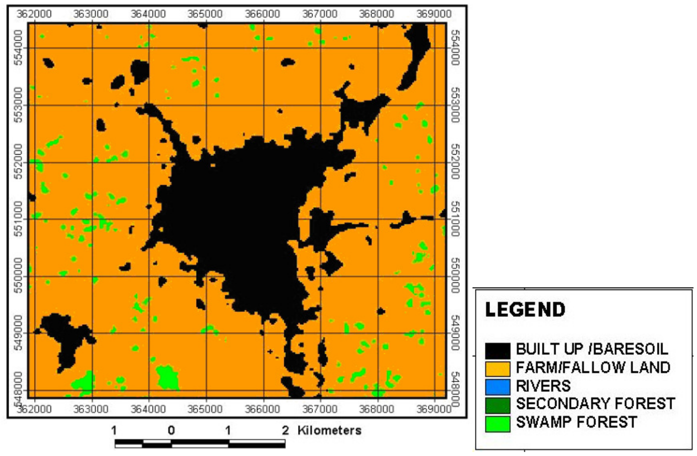

Fig 5a: Abak:Built up/baresoil in 2007

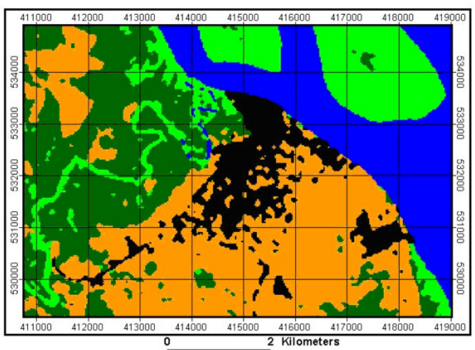

Fig 6b: Oron:Built up/baresoil in 2007

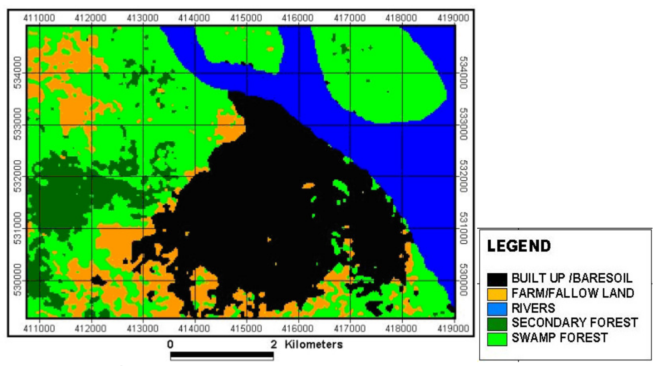

Fig 6a: Oron:Built up/baresoil in 1986

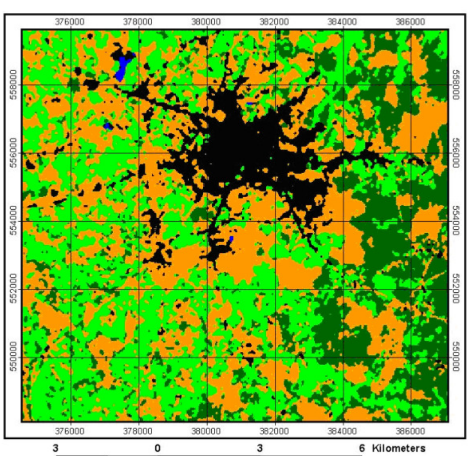

Fig 7b: Uyo:Built up/baresoil in 2007

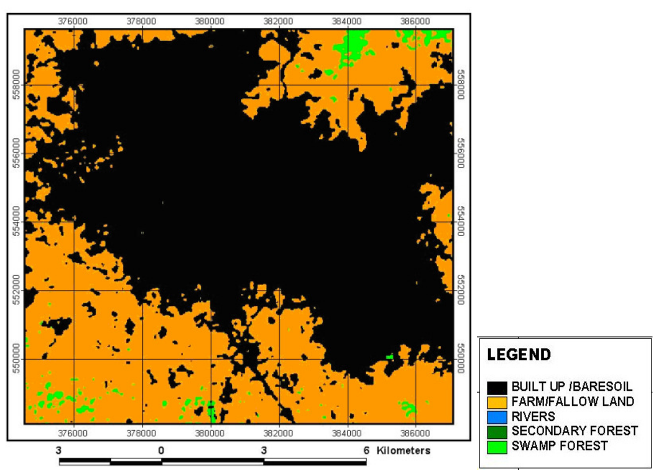

Fig 7a: Uyo:Built up/baresoil in 1986

In Nigeria, the creation of new states and local government areas brought about the growth in the number of urban centres and urbanization. In Akwa Ibom state, there were only ten urban centres which served as administrative headquarters as at 1987 when the State was created. With the creation of new local government areas, the number of administrative headquarters in the State increased to 31. The population of people attracted to these administrative headquarters has continued to increase due to the important industries and socio economic activity centres located within and or close to them. As a result, most of the urban areas have grown in size and changed in shape. For example, Uyo is a capital city and the sit of Government of Akwa Ibom State. It grew in size as a consequence of urbanization from 1567.8ha in 1986 to 9748.6ha in 2007. Table 2 gives details of what the situation was at other randomly chosen settlements. Fig 5a to 7b revealed that, not only did the built up areas change in size and shape but had become more compact/dense. This was an indication of the absence of large areas of forest cover [green belts that could serve as carbon sink] within and around the urban centers. This compact growth pattern has the tendency of increasing the built-up surface area thereby increasing thermal conductivity/heat capacity/temperature.

Table 2: Changes in the size of built up/bare areas within some urban centers in Akwa Ibom State

Urban Centers	**Area in 1986[Ha]**	**Area in 2007[Ha]**
Abak	349	999.6
Oron	458.5	1334.7
Uyo	1567.8	9748.6

Impact of Burning Fossil Fuel

Study location A: Uyo Urban area

Parameters considered in the air quality study were nitrogen dioxide [N], sulphur dioxide [SO_2], hydrogen sulphide [H_2S], carbon dioxide [CO_2], carbon monoxide [CO], amonia [NH_3] and hydrogen cyanide [HCN]. Of all the gases, CO concentration was quite high and range between 26.40ppm – 27.60ppm in the dry season and 23.80ppm – 24.40 ppm during the wet season compared with the Federal Ministry of Environment [FMENV] limit of 10.00ppm. The high levels of CO came mainly from fires, automobiles and other sources of incomplete burning of organic compounds (Botkin et al., 1998; UNIUYO Consult LTD, 2010).

Study location B: Imo River Area

The Imo River drains through some important urban centres within and outside the state. Air quality was taken within the environment where ALSCON is located. The results of the air quality measurements revealed that while some parameters were within Federal Ministry of Environmental permissible limits others like NO_2, SO_2 and CO_2 were above the permissible limits indicating that the air had been perturbed by anthropogenic sources (UNIUYO Consult LTD, 2007).

Study location C: Qua Iboe River Area

The levels of SO_2, NO_2, H_2S and CO in the Qua Iboe river area were quite low. However, they were higher than the values of control stations. Also, the level of hydrogen cyanide (5.00-12.00ppm) within the study area when compared with a range of 2.90-3.15ppm for the control stations were quite high and deserves attention, because of its toxicity potential and absence of acceptable limit (NETWORK E & P Nig. LTD, 2005).

DISCUSSION

This study has revealed that, at its current stage of development, Akwa Ibom contributes to global warming more through deforestation than fossil fuel burning. Reducing emissions from deforestation and forest degradation (REDD) is an initiative that have now moved from global to nation and local levels. The core idea behind REDD is to pay forest owners and users to reduce emissions by managing forest better and clearing less forest land. One of the key challenges to REDD implementation is information. Countries need to set up reliable system to collect information on changes in forest carbon stocks. This study has demonstrated the fact that the technology for providing this information is available and adequate. For instance, with the FAO land cover classification system (LCCS) any identified land cover anywhere in the world can be readily accommodated. This is as at now, the only comprehensive standardized a-priori classification system (FAO, 2005). Furthermore, with the change modeler in IDRISI software package, changes in forest cover and other cover types can be modeled for the purpose of carbon stock estimation. Also, for mitigation purposes, the locations of changes in land cover can be mapped using the modeler tool so that areas for reforestation can easily be identified. Lastly, global estimates of forest carbon stocks have been carried out for different forest type/region using standardized approaches (DeFries et al., 2002; Achard et al., 2004; Gibbs and Brown 2007a, b; IPCC, 2006). With this information, we can estimate carbon stock and CO_2 emission for forest covers in different parts of the world once we know the area of an existing or cleared forest cover respectively.

CONCLUSION

Like most developing countries of the world, the major threats to global warming in Akwa Ibom State and indeed Nigeria are deforestation, fossil fuel burning and urban growth patterns that are compact and without green belts that can serve as sinks for carbon emissions from anthropogenic activities. This study shows that with an integrated Land Cover Change information system that includes a GIS with Remote Sensing image processing capabilities and modeling technique, it is possible for different countries of the world to periodically assess and/or monitor and manage their contributions to global warming among other things.

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