



FEDERAL UNIVERSITY OF TECHNOLOGY MINNA

CLIMATE CHANGE, PARADOXES AND MAPPING THE TRAGEDY OF THE COMMONS

By

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CLIMATE CHANGE, PARADOXES AND MAPPING THE TRAGEDY OF THE COMMONS

1.0 Courtesies, Protocols and the Preamble

To God Almighty, the creator of the world be all Honour and Glory, in Jesus Name. Amen

The Vice Chancellor, Deputy Vice Chancellors, the Registrar, other Principal officers, Deans and Directors, Distinguished Fellow Professor and other members of Senate, members of the Administrative and Technical Staff, my Lords, both Spiritual and Temporal, members of my family, invited guests, gentlemen and ladies of the Press, Distinguished Ladies and Gentlemen, Greatest Nigerian students.

As I welcome all of you to this great and special day in my Life, I give my God all the Glory for making this Day possible. Today we want to discuss a topic that is concerned with a looming tragedy and yet people do not seem to be worried either due to lack of understanding or lack of care or even due to the same selfishness and greed that characterize most human environmental behaviour. The topic of this inaugural lecture is **Climate Change, Paradoxes, and Mapping of the Tragedy of the Commons**.

2.0 The introduction: It is generally agreed that the environment remains the ultimate resource, resource of last hope for man's survival (Nsofor, 2014). This environment is infinite and is publicly owned with freedom of access. This makes it a common property. This freedom of access to this common

property inevitably brings ruins to all of us. Tragedy of the commons occurs because any commonly held resource invariably is degraded or destroyed because the natural self-interest of individuals tends to outweigh community values. When any resource is shared in this way, an individual's share of the profit from its exploitation is usually greater than the individual's share of the resulting loss. This is why profit motives of individuals, by itself, will not always lead a person to act in the best interest of this common-the environment. This is the so-called free-rider or open access system. This inexorable tragedy of the commons means that environmental problems can never be solved through cooperation. Some have argued that only the privatization of access to the environment or a ruthless exercise of coercive government powers can overcome our tendency for selfishness and greed. We have no idea how this can be done given the urgency that is needed. The more we wait, the more climate is changing.

Climate changes, its nature, causes and consequences and remedial solutions have been a matter of serious discourse, not just in Nigeria, Africa, but all over the world. This inaugural lecture is intended to further enliven the debate and discourse on this important matter of climate change. This lecture may not be very interesting because it will, in part, raise several questions that are crucial to the debate without providing the necessary answers to the questions. At the end, some of our contributions to the understanding of the causes and consequences of this problem of climate change are highlighted.

3.0 Climate Change: To begin with, we may wish to note the following that have been attributed to climate change:

- The running battle between our quest for economic development and its consequences on the environment

and climate change has just started. It will deepen in the near future.

- It has been widely stated that mankind as we know it today may no longer exist by 2050 if we continue current rate of abuse to the environment. Who to blame-climate change
- The window of opportunity to tackle Climate Change is fast closing. The level of Green House Gases particularly carbon dioxide in the atmosphere has increased by 40 percent. An important question is how do we clean up the tons of CO_2 to the atmosphere?
- Rising temperatures have become the norm culminating in yearly fire outbreaks around the world. In November 2018 fire disaster turned Paradise, California into Hell with more than 100 lives lost and almost destroyed everything in the town. Climate change was blamed.

BUSH FIRES



Fig 1: Wildfire in a stream at Penela, Ciembra, central Portugal

Source: *globalnews.com*



Fig 2: Wildfires raging fiercely recently in Paradise California

Source: Content.time.com

- Flood disasters have now become common yearly occurrence happening even in many places in Nigeria that 50 years ago barely gets enough rainfall and water for human purposes. We also blame climate change.

FLOODING



Fig 3: Flooded vegetation in Niger State

Source: international center for investigative reporting (photo channels TV)



Fig 4: Flooded road from Kontagora to Makera in Niger State

Source: National helm



Fig 5: Effects of flood menace in Pierretouché

Source: UN news

- Lake Chad which used to be a natural source of livelihood benefitting several adjoining countries has now shrunk to one-quarter of its original size and still going down making more than 40 million persons to lose the source of their livelihood. Climate change is blamed.

LAKE CHAD

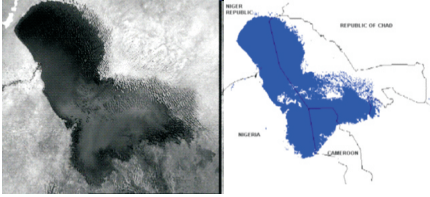


Fig. 1: Lake Chad in October 1963 from Corona from Space Photograph

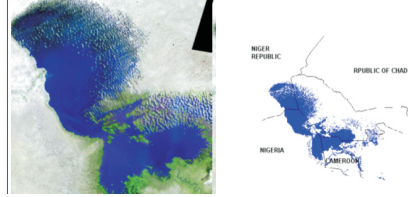


Fig. 2: Lake Chad in October 1972 from Landsat MSS

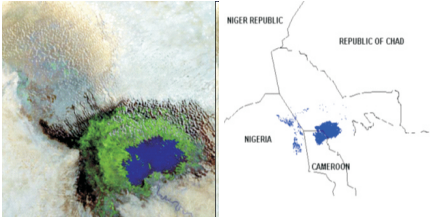


Fig. 3: Lake Chad in October 1987 from Landsat TM

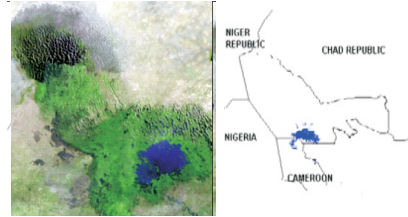


Fig. 4: Lake Chad in October 2000 from Landsat

Assessment of changes in Aerial Extent of Lake Chad using Satellite Remote Sensing Data

Fig 6: Decreasing quantity of the Lake Chad over time functioned by climate change

Source: SSA, Dept. NASRDA HQ

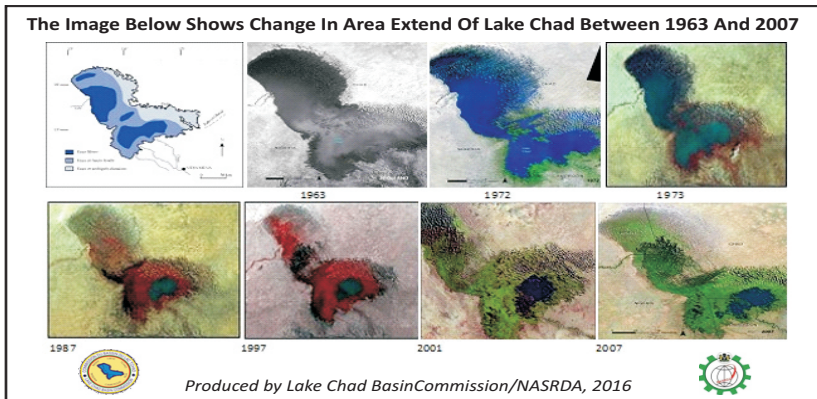


Fig 7: Decreasing quantity of the Lake Chad over time functioned by climate change, assessed using satellite remote sensing.

Source: SSA, Dept. NASRDA HQ

- Our roads have become death traps and impassable virtually all year round despite very high quoted costs of construction and maintenance. Climate change is also blamed.

BAD ROADS



Fig 8: Deplorable state of east west road in south south Nigeria

Source: Thenigerianvoice.com

- Gullies and gully erosion which 50 years ago were unheard of, have now become common sites and occurrences from Lagos to Sokoto and from Maiduguri to Port Harcourt. Who do we blame - Climate Change.

GULLY EROSION



Fig 9: Gully Erosion Site in Delta State

Source: Thenigerianvoice.com



Fig 10: Gully Erosion Site in Nanka, Anambra State

Source: *newsexpressngr.com*

LANDSLIDES



Fig 11: Landslides in Ubaha Nanka in Orumba North LGA of Anambra State

Source: *newsexpressngr.com*

- Farmers and Herdsmen that have co-existed in Nigeria for more than a century now run constant battle to determine who will survive and who will go into extinction. No matter who eventually wins the battle all of us will be losers. There is evidence of desertification all over the NE and NW States.

Again, Several Places in Nigeria that used to be covered by thick forest and vegetation have now turned to bare ground or burnt out vegetation. Climate change is blamed.

DESERTIFICATION

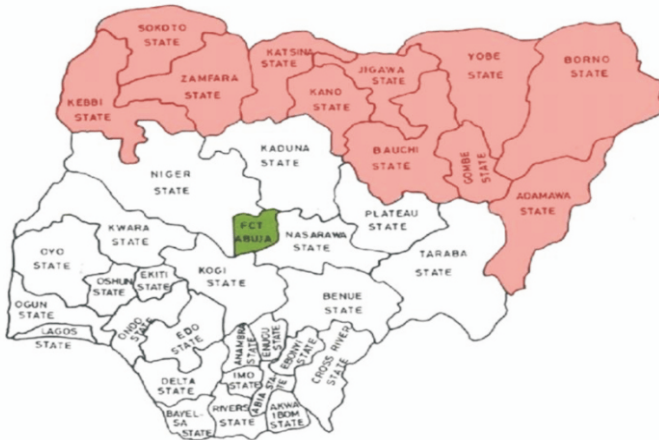


Fig 12: Map of Nigeria showing the desert prone states in Nigeria

Source: researchgate.com



Fig 13: Evidence of Desertification in the Lake Chad region/Chad Desert

Source: UN news

BURNT OUT VEGETATION



Fig 14: Burnt out vegetation in Maiduguri

Source: CNN 160423152242-nigeria-abandoned-village



Fig 15: Burnt out vegetation in Madagascar

Source: Lemor Conservation Network

- When we were small we enjoyed going to the stream to swim. The streams were sparkling clean. You see the white sand and white pebbles at the bottom of the stream. We fetch and drink the same water and typhoid fever was unheard off. Indeed the streams, oceans and rivers were blue. This is why Cartographers use blue colour to represent water bodies on maps. Today all the water bodies are brown in colour (even though we still use blue to represent them on maps). Most of those rivers and streams have either disappeared or are

DRY RIVER CHANNELS



Fig 16: Dry river channels functioned by climate change

Source: *Parismatch.com*

perennial or have shrunk to less than 10 % of their original size. Who do we blame: climate change?

3.1 What do we mean by Climate Change?

Ladies and Gentlemen, all of us are confused about what we mean by Climate Change. To many people around the world, it is not quite clear or unanimously agreeable what we mean by climate change or put differently, what we want from climate anyway. This is because of the following and perhaps more issues that are not clear

- If change is inevitable and everything in the world is changing, do we mean that climate should be the only thing that should not change?

- If we accept that climate should also change, do we mean that it is changing faster or slower than what we expect? In other words, how exactly (what rate) do we want climate to change?
- From our various complaints we imply that climate is either changing negatively (into bad climate) or perhaps positively (into Good Climate). Obviously, since we are complaining, what we really mean is that it is changing into bad climate.
- We may have to answer another question: what is a good climate and what is a bad climate? Is the status quo climate or the climate that existed some years back (for example, the climate of Garden of Eden) the good climate that we shall prefer? In essence, if we have to struggle to stop climate change, we must decide the type of climate we want to retain or return to.
- Whose perspective do we use to define the good or the bad climate? The Eskimo in Greenland (Temperate Climate) or the Fulani in Nigeria (Tropical Climate). Should both of them define good Climate similarly?
- We can also add the questions, which climate is changing? Temperate, Tropical, Subtropical, Humid etc. or are they all changing in the same unacceptable rate and manner?

Answers to the above questions and others may help us to better define and understand what we mean by climate change and perhaps enable us to agree, we hope, unanimously on the type of climate we will settle for that will never have to change or perhaps change only at the rate and manner suitable to all of us. It is only when

unanimously agreeable answers to these questions are provided that we can gauge whether we are on the right tract to tackling the problem of climate change in terms of the objectives and methods of solving the problems.

3.2 What makes a good climate to go bad anyway?

Here we wish to ruminate of what makes a good climate to go bad by looking briefly at the causes and consequences of climate change. Literature is replete with several socioeconomic and biophysical factors that can cause climate to change. Our intention here is not to discuss them extensively since they are all familiar to us. For now, we can recall that our quest for economic development and other human activities that lead to changes on the land surface can have profound influence on the Earth's climate. For example, land use and land cover changes influence carbon fluxes and Greenhouse Gas (GHG) emissions which directly alter atmospheric compositions and radioactive forcing properties. They also change land surface characteristics and indirectly, climate processes (particularly changes in Temperature and precipitation). The change in climate processes in turn causes further changes in Land use/Land cover. For example, changes in precipitation and temperature will determine the potential distribution of Terrestrial Vegetation which may constitute the principal factors in the genesis and evolution of soil (WMO, 2005). This interaction between the land surface and the atmosphere continues in a cycle of multiple processes, feedbacks and cause and effect relationships that have featured well in the climate change discourse. Therefore, given the above:

- Should we address first the causes of climate change or first the consequences of climate change or should they be addressed simultaneously and in what order of priority?

- We have established that the rush for economic development by the countries of the world is one of the major causes of change on the land surfaces and hence, climate change. Therefore, how much economic development shall be permitted and how much climate change shall be tolerated within the accepted quantum of Economic Development?
- Since the effect of Economic Development and industrialization on climate change is global, rather than local or regional, how do we allocate the quantum of economic development and the concomitant industrialisation and technological development as agreed between countries and regions, particularly between developing and the developed countries? We in Nigeria, in Africa, shall we be prepared to wait, halt or decelerate our economic development for the sake of climate change?
- We have had several international agreements on climate change to try to cover similar matters. But these agreements are based on trusts that countries will voluntarily implement international agreements on climate change. If all the countries or some fail to implement, do we or should we have appropriate sanctions as deterrents and who should be responsible to police and enforce the sanctions? Certainly the United Nations does not have such powers. So, shall we ever have internationally agreeable and implementable methodologies on how to achieve our objectives for solving the problem of climate change?
- Rising population as well as what people do to the land, to a large extent, also determine the extent of Land

Degradation and hence climate change. Therefore, there may be apparent relationship between rising population, poverty and illiteracy with climate change. Can we successfully curb rising population? How many people will be ready to reduce the number of their wives or give up marrying for sake of Climate Change. A poor illiterate farmer who practices subsistence agriculture will likely clear the vegetation and cut down the trees to provide himself or herself with energy as he or she may not have alternative, thereby exacerbating climate change. Which shall we tackle and in what order: Poverty, Illiteracy, Population growth or climate change? Should they be tackled simultaneously? How do we allocate the lean resources available to the problem Vis a Vis the other competing developmental challenges?

3.3 Where do we go from here?

In the midst of all these confusing scenarios and paradoxes one may ask at this stage, where do we go from here?

- Do we have a clear understanding on how to tackle Climate Change Problem?
- So far are we going about the issue of tackling the problem of climate change the right way or do we need to apply some brakes, have a rethink, clarify some issues and look for answers to some of these questions before we can see clearly to chart a better route to follow?
- Are we ready and willing and do we have the where-with-all to tackle climate change in Nigeria, in Africa and indeed in the whole world?
- In all, how much resources do we have or can be devoted to tackling the problem?

- How much time do we have in Nigeria? In Africa? In the world? Does the earth as it is have unlimited capacity to wait, to accommodate and continue to survive the onslaught of Climate Change?
- Who should be involved in this quest for sustainable environment: the government, the politicians, the youths, the old, the academia, the private sector, the general public, and how do we organize them? We should note that no political party discussed this problem during the just concluded elections.
- If we in Nigeria, in Africa decide how to proceed, how will other things happening globally determine whether we succeed or not?
- Is it possible to develop a super climate change remediation or mitigation model that will be able to answer all these questions and others and perhaps set us on a viable track to tackling the problems of climate change? With that we can all go home and sleep and live happily thereafter.
- Since there are too many unanswered questions about climate change, shall we then give up?

3.4 Some Thoughts

Is it not when we have answers to these questions that we can define clearly what we mean and what we want as sustainable environment and then decide how to move to achieve it. The environment is God's greatest gift and friend and yet mankind has been very unkind to this environment. We certainly cannot give up our quest for both economic development and sustainable environment. Instead we may need to double our efforts by sensitizing and involving all people. It is the people that

can be a major asset in halting, reversing or mitigating environmental degradation and climate change depending on what we have decided is our good climate. It may not take more than giving the people the control and securing their commitment to maintain the quality of the resources. In other words, we may simply need to give to the people what they will need and use to implement environmental friendly systems. That is, they need to be healthy, politically and economically motivated to care for their environment (Liniger, *et. al*, 2013).

Meanwhile, we may notice that the bulk of actions being taken so far are reactive actions to the vagaries of climate change such as promoting early warning systems, assessing vulnerability and analyzing hazards, providing emergency relief measures, enhancing preparedness, carrying out rescue operations, collecting and analyzing data on climate and climate change and their interactions with environmental degradation just to mention a few. May be when we resolve all these paradoxes, we may need to reorient our actions to a more proactive direction in finding out the causes of climate change with the view of tackling them either by removing or stopping them or slowing them down with the hope that these will enable us to land at what we have unanimously agreed as the climate we want.

4.0 Ruminations and Contributions of a Cartographer

I should not end this inaugural lecture without highlighting some of my contributions to the discipline of Cartography and Environmental Resources Management.

4.1 Training

To break the usual order, we wish to begin with where others usually do not start with: those that we have contributed in bringing up by training in the discipline. Recall that my last degree (Ph.D.) was in August 1982 from Southern Illinois University, U.S.A. I returned immediately and served in the NYSC at the University of JOS and thereafter joined the services of F.U.T.

Minna on December 1, 1983, that is, one month before the University officially opened on January 2, 1984. I have, therefore, served our University continuously for more than 35 years. Within the period, I have also rendered various types of teaching and training in the discipline to students in about five other Nigerian Universities (including University of Jos, NDA Kaduna, UMYU Katsina, University of Abuja, and IBBU Lapai). I cannot count my undergraduate and master's degree graduates, but I encounter them in almost all the ministries, establishments, parastatals and other organizations I step my feet into. As for PhD graduates I can count about 15. Four of them are already full Professors, another 4 are Associate Professors, 2 of them are permanent Secretaries in Federal and state ministries. One of them was a DG in one of our eminent parastatals. Many of these ones have in turn served as my Deans, Directors and Heads of Department. We have not finished. We shall continue to count them for a few more years until we are called to the Bar. To God be all the Glory.

4.2 Nigeria's Landuse and Landcover Assessment and Mapping at the scale of 1:100,000 Using Nigeria Sat-1 Data

4.2.1 Introduction

The objective here was to use the Nigeria Sat-1 images combined with field work and other sundry images to produce the landuse/landcover maps covering the whole country at the scale of 1:100,000. The study was conducted under the auspices of the National Centre for Remote Sensing JOS and the National Space Research and Development Agency, Abuja. Initial field reconnaissance survey was done and taking into consideration the resolutions of the Nigeria Sat-1 and the minimum mapping unit, seven Landuse/Landcover classes were identified as settlement, Agriculture, Savanna, Forest, Wetland, Water body and Bare Surfaces. Each of these had identified sub-classes. A total of 347 classified images (maps) was produced. The classed images revealed the areas covered by the various Landuse/Landcover types. Typical classified images (maps) of

Abuja and the environs, Bida and Environs, and Kainji and environs and shown in Figs 17, 18 and 19.

In order to make the classified images to be useful, it was necessary to superimpose additional information on them giving them the properties of a map. Thus vector based settlements with their names and roads were overlaid on the maps.

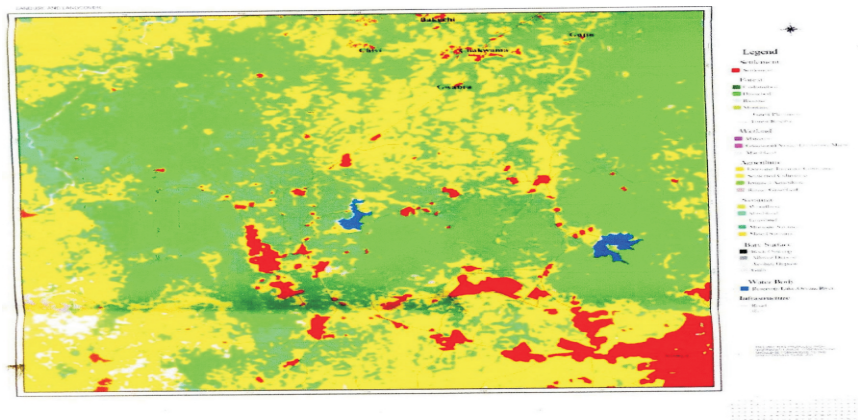


Fig. 17: Landuse/Landcover Map of Abuja and Environs at Scale 1:100,000 ABUJA

Source: NCRS Jos Laboratory Analysis

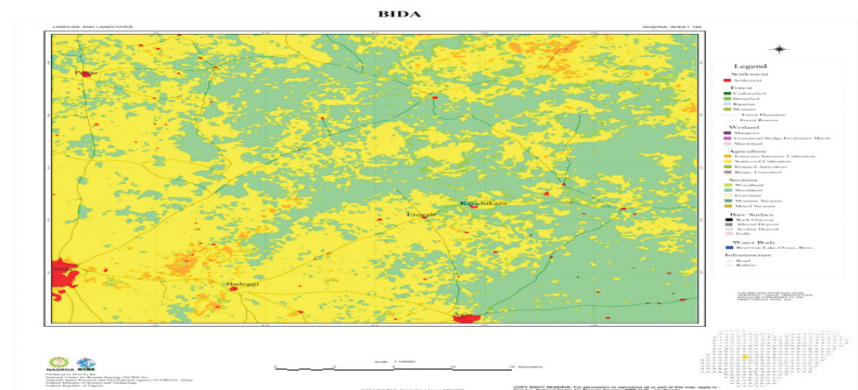


Fig 18: Landuse/Landcover Map of Bida and Environs at Scale 1:100,000

Source: NCRS Jos Laboratory Analysis

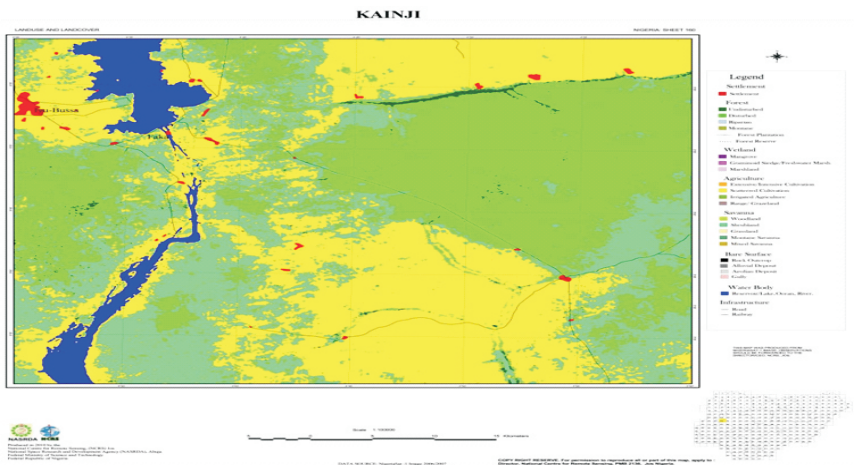


Fig 19: Landuse/Landcover Map of Kainji and Environs at Scale 1:100,000
Source: NCRS Jos Laboratory Analysis

4.2.2 Some Results

- 347 maps were produced with a general accuracy of about 81 percent. The accuracy of interpretation and classification of the different Landuse/Landcover varied with Savanna and water bodies at an accuracy level of between 85 to 96 percent. Wetland had higher accuracy while mixed forest and Agriculture had lower accuracy. The lower accuracy for agriculture was understandable because the Nigeriasat-1 images available and used were those captured in November, December and January (2006/2007) which were not the cropping season.
- There was a general decline in the areal coverage of both undisturbed and disturbed forests in the country. Undisturbed forests could only be found south of Latitude 8°N while the disturbed only in Taraba and Adamawa

states. The once large continuous unbroken forests that characterized the southern region have virtually been depleted. The undisturbed forests now appear like scattered specks in Cross River, Ogun, Osun and Ondo states. Perhaps climate change should be blamed.

- With respect to the National Park/Game Reserves, the Kainji, kamuku, the Cross River and the Oyo National Parks showed steady decline from 1995 to 2007. The decline in forest cover in the Old Oyo National Park was very dramatic losing a total of 3547 sq km of forest cover during the twelve year period representing a loss of about 296 sq. km of forest cover per annum.
- With regards to the settlements it was found that the number and size of these settlements were consistently on the increase. For example, between 2001 and 2007 the area occupied by settlement jumped from 7774 square kilometer to 14,936 square kilometer in 2007, in essence doubling within six years. This doubling of the rate at which previous lands in other uses or unoccupied lands are being brought under settlements should either concern or alert the planners and environmental managers. These increases as the findings indicate are to the detriment of agriculture, forests and vegetation and even to water bodies. These, no doubt, raise serious developmental and planning questions. In 2001 significantly large settlements existed more in the Southwest in Lagos, Oyo, Edo, and Ondo States. But by 2007 these large settlements existed in almost all parts of the country and may most certainly continue to increase as more states are created to give rise to many more state capitals and Local Government Headquarters.

- When the areal extent of the water bodies (Reservoirs) was evaluated, it was discovered that in spite of efforts by all tiers of governments in the last decade to build dams and create reservoirs the total surface area occupied by these reservoirs has plummeted significantly during the period. For instance, between 1995 and 2001 about 17053 sq. kilometers of surface area were lost when compared with 1995. This also translates to an average of 15.4 percent loss per annum. The small gains made in the surface area between 2001 and 2007 did not come as a result of rehabilitation of the existing reservoirs by dredging. They came as a result of new dams and reservoirs that were constructed during the period. The fact remains that the reservoirs existing before the year 2001 are in dire need of rehabilitation if they are to stay relevant in performing the functions for which they were designed as the answer does not lie completely in the construction of new dams and reservoirs.

4.3 Landuse and Landcover Assessment and Mapping at the scale of 1:50,000 using Nigeriasat-x Data

Since Nigeriasat-x was a more recent image sensing satellite than Nigeriasat-1, and has better resolution, the same Landuse/Landcover assessment and mapping was repeated but at a more larger scale of 1:50,000. The objective was directed towards the detection and monitoring of ecologically important Landuse and Landcover types. This activity highlighted the areas where there are major changes of Landcover (i.e. the “hot-spots”) both in temporal and spatial dimensions. Because the mapping exercise covered the whole country at this larger scale, 1388 maps were produced. Figs 20 and 21 show examples of some of the resulting maps from this exercise. Areas covered in these maps are Minna and Environs and Kainji and Environs.

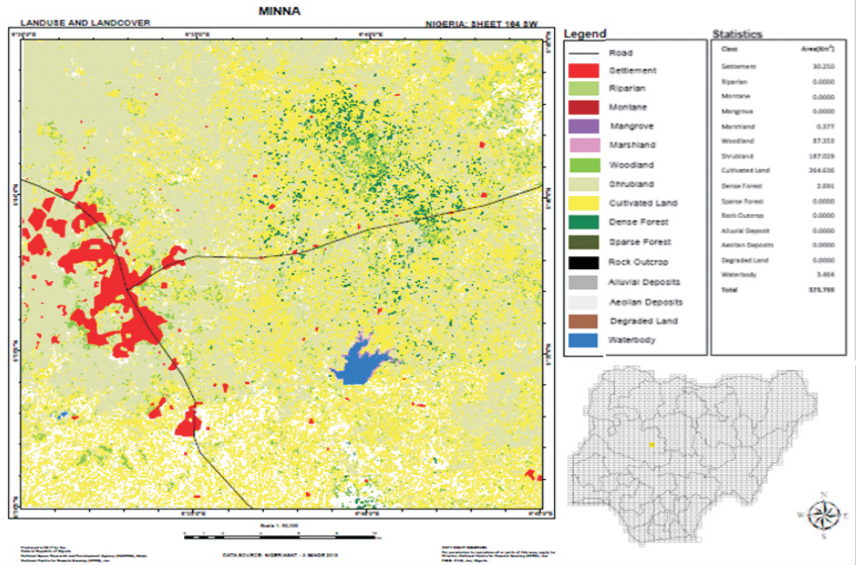


Fig 20: Landuse/Landcover Map of Minna and Environs at Scale 1:50,000
Source: NCRS Jos Laboratory Analysis

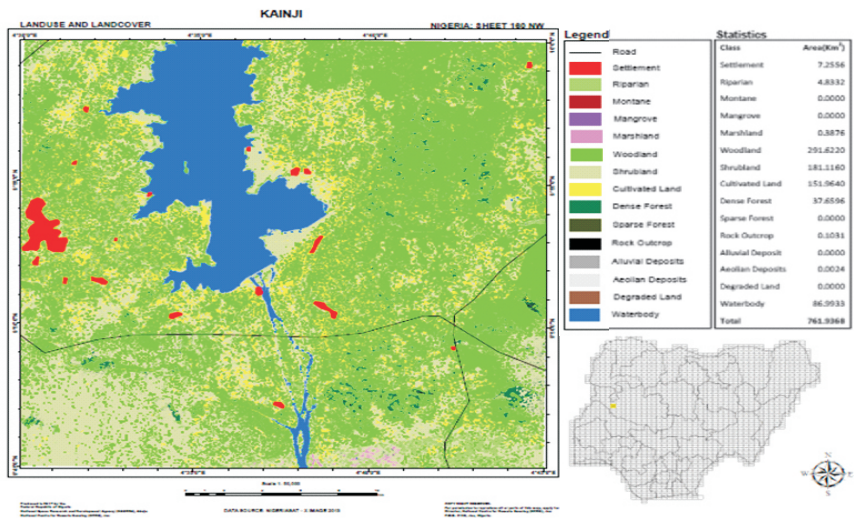


Fig 21: Landuse/Landcover Map of Kainji and Environs at Scale 1:50,000
Source: NCRS Jos Laboratory Analysis

4.4 Environmental Impact Assessment (EIA) of the Eleme Petrochemical Complex

Environmental Impact Assessment (EIA) of the Eleme Petrochemical Complex was one of the first attempts in Nigeria to provide an Environmental Impact Statement (EIS) which has long been the usual requirement in the more developed countries before a project is approved for construction. The central objective of the study was to catalogue, if any, the unreasonable environmental consequences of constructing and operating the facility and to suggest possible measures that can be put in place in order to control and ameliorate these potential negative environmental impacts. The study was sponsored by the NNPC and MOI Associated Technologies. The study covered potential sources of background Air pollution, Socioeconomics that may be impacted and possible contribution of Meteorology in the temporal distribution of air pollution within the study area.

With respect to sources of air pollution, two main sources of pollution were identified as industrial and transportation. Appropriate technical and/or historical data on the quality and quantity of these were largely unavailable because of the general low level of concern and awareness on the part of the industries, government and the other technical officers responsible.

When the study area was agglomerated into three regions, namely, Port Harcourt area, Eleme area and Onne area, it was discovered that pollution from Port Harcourt and Eleme areas may be of major concern because of the concentration of urbanization and industrial complexes in those areas. Major air pollutants include carbondioxide, carbonmonoxide, Sulphur dioxide, hydrocarbon gases, particulates and water vapour. Moreover, significant contributions were also expected from domestic sources and transportation. It was believed that the

aggregate contributions in terms of quantity and quality, duration of discharge and/or persistence of discharged materials would come from Port Harcourt and its environs.

Analysis of potential contributions of climatology to the temporal distribution of pollutants was based on years of archived data on meteorological parameters, namely, precipitation, insolation (i.e. radiation and Temperature), Relative Humidity, Wind Systems (Speed and Direction), Topography and Atmospheric Stability. The focus was on the Temporal distribution of these parameters in order to understand and describe the diurnal and seasonal patterns characteristic of the weather and climate of the region that have relevance to the temporal distribution of air pollution. Also the general climate of the region was studied and the mesoscale and microscale meteorological data analyses were performed in order to ascertain area-wide and local air movements that affect transport and dispersion of pollutants. The following findings (Summarized) may be noted:

- Temperature is high throughout the year with maximum in December to March and minimum during July to September. Highest insolation is in April while the lowest is in the summer due to presence of cloud cover and water vapour.
- Both highest mean monthly Relative Humidity and mean monthly cloudiness occur in August, the peak of the summer. The minimum RH occurs in December to February.
- Most rainfall is received May to October with peak in June. Rainfall at the beginning and end of the rainy season is associated with the disturbance lines whereas those that

occur at the middle of the rainy season (June – September) are attributable to the effects of the Southwesterlies.

- The wind patterns generally follow the movement of the sun and are northerly during the dry season and southerly during the rainy season. Wind speed is generally low while calm conditions are more prominent in the evenings to early mornings.
- As wind speed are generally calm during late night to early morning when stable conditions and low intensity inversions are predominant, air pollution episodes at these times may linger as it will not be dispersed quickly.
- There is a general B-C atmospheric stability, that is, unstable condition in the area. This situation is conducive to air pollution dispersion. However, because of the general low wind speeds prevalent in the region, toxic pollutants should not be allowed to linger for an extended period of time.
- Topography and Physiography in the area is near level. Therefore, the temporal distribution of air pollutants is not expected to be affected by Physiography, rather the distribution will be highly dependent on the natural ventilating effect of meteorology.
- Wind speed and direction are the parameters that may determine the socioeconomics that may be impacted and when the predominant wind direction at Eleme for a greater part of the year is Southerly through Southwesterly, though wind direction in January, particularly during late night to early morning is

northerly. The expected flow pattern of pollutants from the petrochemical facility will follow these general directions at the different periods. Receptors in the North, Northeast and to the west of the facility within “close distance” will be at greater threat for most of the year. The major centres include Aba, Umuahia, Ikom, Ogoja, Calabar and perhaps Onitsha, Owerri, Enugu and Awka. Receptors to the South, such as Port Harcourt and its environs may be at threat during the dry season, particularly during late night to early morning.

4.5 Environmental Impact Assessment of Kaduna Power Plant (KPP) at Kaduna Industrial Estate, Kaduna

4.5.1 Introduction

Environmental Impact Statement (EIS) which is the result of a pre-construction Environmental Impact Assessment (EIA) of a proposed Project provides knowledge on the projects potential impact, which may vary in magnitude and may be felt over short, medium and long term. With such knowledge it may be possible to avoid or mitigate serious negative impacts or to promote positive consequences by incorporating appropriate measures into the project planning.

The Kaduna Power Plant (KPP) was designed to have 8 units of the turbines each producing about 26.87 mw for a total of 215mw. KPP is to be fired by Gas and Oil. Associated with oil fired plants are air pollution, water pollution and solid waste. Although figures for KPP was not immediately available, but a buttan average oil burned in a 1000mw plant will emit each year about 74,000 tons of Sulphur dioxide, 21,000 tons of nitrogen oxide and 2000 tons of particulates (Lee, 1985). KPP at 215 mw may generate one-quarter of these values per year. This study combined analysis of Meteorological, Remote Sensing and other

field data to try to understand potential Health effects of the project and the possible Socioeconomics that may be impacted.

4.5.2 Results

The availability of sufficient supplies of affordable electric energy is important for economic development, and development is necessary for achieving the standard of living of the people of Kaduna State and beyond. In practical terms, sustainable energy development means that human health and other environmental impacts should be considered along with traditional economic and technical issues in the planning and use of the energy options.

There are obvious economic advantages of the electricity power plants. There are also a number of disadvantages due to the detrimental effects of the electricity generation on the environment. Some of these impacts (such as smog) may be highly visible, while others are not, but many of them are damaging to humans, materials, flora and fauna.

At the beginning of the project, the existing health and sanitary facilities in and around the immediate environment of the KPP may be reasonably adequate to meet the needs of the people in the absence of the power plant. However, there is bound to be arrival of many people from other areas with a consequent increase in population density. This will precipitate some health problems.

First, new arrivals (workmen who are needed to construct the project and perhaps new shelters and their dependents) may introduce new diseases or new strain of the causative organisms of locally endemic diseases, to which both residents and the newcomers may be susceptible. Second, existing housing and sanitary facilities in the area will become quickly overburdened,

especially when other non-project people (applicants, new employees and others who hope to benefit from the project) begin to arrive. This influx is likely to produce conditions that are particularly conducive to the spread of communicable diseases.

It has been pointed out earlier that River Kaduna which is the main source of water supply to the Kaduna metropolis is near the KPP and may likely receive some waste and contaminated water used for cooling purpose from the plant. Apart from adverse effects on the aquatic life in the river, communities near the project site such as Kudenda and Nassarawa, and those downstream may risk having their traditional water source affected by the discharge of the project wastes. In addition, excrement from the enlarged population, runoff from their laundries, plant workshops and laboratories may also be source for water contamination and can portend risk of communicable diseases such as viral hepatitis and cholera. Therefore, sewage collection and treatment and additional safe drinking water supply are essential. These facilities should be scheduled for installation at the earliest stage of construction of the project.

Nitrogen Oxide (NO_x) expected to be emitted from the power plant is a mixture of gases ranging from colorless to reddish-brown. Their principal sources are internal combustion engines, high-temperature stationary combustion (power plant) and atmospheric reactions. The principal health effects of NO_x because of its role in the creation of photochemical smog, include their toxicity to animals, produces animal diseases that human counterparts (emphysema and other lung diseases) have been shown to aggravate respiratory and cardiovascular illnesses and chronic nephritis.

The photochemical Oxidants (smog) result from chemical combination of reactive hydrocarbon vapours with NO_x in the

presence of sunlight to produce toxic compounds (Ozone, Peroxyacetyl Nitrates, Aldehydes and other chemical compounds). Smog is known to aggravate respiratory and cardiovascular diseases, irritates eyes and respiratory tract, and impairs cardiopulmonary function. There are also some health concerns about the possible mutagenic effects of ozone.

Sulphurdioxide (SO_2) is also expected to be emitted from the power plant. SO_2 is a colourless gas with pungent odour. It oxidizes to form Sulphur trioxide (SO_3) which forms Sulphur acid with water. SO_2 has been classed as a mild respiratory irritant. Most SO_2 inhaled is absorbed in upper respiratory tract and never reaches the lung. It is, however, known to aggravate respiratory diseases, including asthma, chronic bronchitis, and emphysema. SO_2 can result in reducing lung function, irritates the eyes and can act to increase mortality. Similarly, Sulphates are formed by Sulphur oxides and in moist environments appear as sulphuric acid (H_2SO_4) or acid rain. These are also known to aggravate respiratory diseases, including asthma and chronic bronchitis. They reduce lung function, irritate eyes and respiratory tract and can cause increased mortality, and can affect plant and animals as well as corroding aluminum and zinc roofing sheets.

Particulate matter (expected as emission from the power plant) is any solid or liquid particles dispersed in the atmosphere such as dust, pollen, ash, soot, metals and various chemicals, often classified according to size, as settleable particles (larger than 50 micron), aerosols (smaller than 50 microns) and fine particles (smaller than 3 microns). Particulate matter can have direct toxic effects or can act to aggravate asthma or other respiratory or cardiorespiratory symptoms. Particulate matter acts to increase cough and chest discomfort and can also cause increased mortality.

In sum, the presence of the KPP is likely to create heavy demands in the area for a variety of social services, including housing, sanitary facilities and medical care for project personnel, their dependents, and the many additional people that will be attracted by the project. It will have effect on the local communities, the plant's work force and the physical environment.

To prevent or control these potential adverse health effects of the project, there must be sound, comprehensive advanced planning.

The following at the minimum are expected to be part of such plan: provision of adequate housing, provision of adequate sanitary facilities, early completion and treatment, industrial and all other effluent treatment, adequate drainage of project area, monitoring of air, water and vegetation, organization of biological control services, continuous biological surveillance of the project area for vector introduction and instructions in general health issues with emphasis on prevention of diseases. Improper attention to the overall effects of the project on health will cause the health of project inhabitants and water to deteriorate.

Table 1: Background Emissions and Potential Emissions from the power plant

Air Emission (background)	Emissions from the power plant
Hydrocarbons, Oxides of Nitrogen and Sulphur, Urea, Fluorides, CO ₂ , NH ₃ , CH ₄ , Particulates, N ₂ , steam, CO, Inert gases, Hydrocarbon gases, H ₂ O, O ₂	SO _x , NO _x , particulates, bottom ash, steam, chromates, chlorides sulphates, phosphorus, sludge, calcium sulphates.

Source: field work, 2013

Table 1, shows background emission identified as already existing at the area from the industrial, transportation and domestic sources including agricultural activities. Quantities of such emissions are not available at this time. From the power plant which is expected to use both oil and gas as part of its raw materials, water pollution, air pollution and solid wastes will be the bye-products. It is estimated that KPP will generate 18,000 tons of Sulphur dioxide, 5000 tons of nitrogen dioxide and 5000 tons of particulates. Other pollutants such as chromates, chlorides, sulphates and phosphorus are likely to be discharged directly into the water used for cooling. From the analyses of the meteorological data and the potential pattern of air pollution dispersion in the area, the threat to sensitive receptors from the power plant is inherent any time the facility is under production. The threat is perhaps, more acute during late nights to early mornings when more stable atmospheric conditions are expected to occur. Sensitive receptors to the north, northeast and the east of the facility will most likely be at greater risk during the rainy season when the Southwesterlies are prevalent, especially when the wind speed is too low to quickly disperse any pollution. This may further be exacerbated during late night to early mornings when calm conditions and low intensity inversions are generally expected. The areas within this region at threat at this period include most of the Kaduna metropolis, that is, three out of the four Local Government areas of the metropolis - Igabi, Kaduna North and Kaduna South. Other Local Government areas within the state that may be at threat during the period include Soba, Zaria and Sabon-Gari, Markafi, Kubau, Ikara and Giwa.

Those receptors South, Southwest and west of the facility such as Chikun, the host local government, and the Local Government areas at the Northeast of Niger State such as Sarkin Pawa and Shiroro will be at risk during the dry season when the Northeast trade winds (the Harmattan) is prevalent. The threat is also

expected to be more serious during late nights to early mornings. This zone, however, has very few of the receptors because the area is presently sparsely populated.

4.6: Perception and Attitudes towards Gas flaring in the Niger Delta

4.6.1: Introduction

Crude oil and natured gas are mixed in every oil deposit. The natural gas (also called associated gas), however, needs to be separated from oil before refining (Ashton et al, 1999). Nigeria is the world's 6th largest producer of crude oil (NNPC, 2009). More than 80% of the production is extracted from the Niger Delta region. Most of the associated gas is flared and it is the second largest gas flaring operation in the world next to Russia (World Bank, 2007). The environmental cost is yet to be estimated, but anecdotal evidence suggests it is colossal. In fact the constant social and political tension in the Niger Delta is directly linked to the environmental consequences as much as the political economic problems and questions raised by oil production in the area.

Gas flaring in the Niger Delta has been on-going since oil production started in the area in the 1960s (Samson, 2008). Many of the gas flares are at the ground level and within communities and farms and they burn continuously for several years at a time. This study focused on examination of the perception and Attitude of Ubeji community towards gas flaring.

Data were collected through questionnaire administration, direct interviews and Focus Group Discussion (FGD).

4.6.2: Results

Table 2 presents results on the perception of respondents

towards gas flaring and the risks and consequences of gas flaring in the community. The perception that gas flaring is hazardous to both health and social well-being of the residents was found to be statistically significant at the 0.01 confidence level (See Table 3).

Table 2: Perceptions on Gas Flaring Activities

Scale	Harmful to human health	Harmful to plants (crops)	Causes of roof corrosion	Oil production activities more harmful than beneficial	Dislike activities of companies
Strongly agree	23	18	23	15	15
Agree	43	44	38	40	50
Strongly disagree	23	28	26	30	27
Disagree	10	10	13	15	8
Disagree	100	100	100	100	100
Total %					

Table 3: Test Result Hypothesis

Table x² test result for hypothesis

X ² VALUES (df = n - 1 = 3)	Hypotheses (Ho) Gas flaring not Harmful to humans	Stopping gas flaring not community's responsibility
Calculated critical	36.59 11.35 (P = 0.001)	56.31 11.35 (P = 0.001)

Most respondents (61%) hold gas flaring responsible for corrosion of iron roofs. However, there is a minority 19% that hesitates to extrapolate the chemistry of gas flaring to its full potentials by not agreeing to a link between gas flaring and the rapid corrosion of their roofs. The oil companies challenge the accuracy of such perception since they argue that Nigerian crude has low Sulphur content, the quantity of which is too insignificant to precipitate the corrosion of the roofs with the rapidity in which they occur. Efe(2006) reported a high turbidity value (18.3 NTU) for rain water harvest from corrugated iron roofs in Ubeji community which is 240% higher than the WHO

standard. This points to serious health implications which may render the arguments futile. Respondents (66%) also perceive gas flaring as harmful to human health and 62% as harmful to plants and crops.

Table 4: Gives a summary of the resident's attitude towards tackling the problems of gas flaring.

Table 4: Attitude towards gas flaring (% responses)

Scale	Stopping gas flaring Sole responsibility of Government and Oil Companies	Need Community to be more Proactive to stop gas flaring
Strongly agree/agree/	61	50
Strongly Disagree/Disagree	39	50
Total (%)	100	100

Concerning the attitude of the members of the community towards tackling the problems of gas flaring, it seems that the same human character of greed and selfishness that precipitate the tragedy of the commons have brought a rift among them on the way to go. There are opposing camps between those who have pitched their tents with government and the oil companies and the rest. Some discussants stated that there is a deliberate policy of divide-and-rule on the part of government and the oil companies.

They accused those who are directly benefiting from government and the oil companies, including the community leaders of corruption and selling out to the government and the oil companies.

These ones in turn countered that the community had benefitted from employment and facilities provided through oil production in the community. Meanwhile, the community exhibits the attitude of “*Siddon-look*”, helplessness and leave everything to God despite misgivings about gas flaring and its attendant

environmental, economic and health consequences. The lamentation of one community member during Focus Group Discussion aptly summarise this helplessness. “I left my town, Ugheli, because oil spills destroyed my farmland. I am now here at Ubeji and the heat and toxins from gas flaring is cooking me up.”

4.6.3: Lesson from these

Residents of Ubeji have clearly seen and are suffering the consequences and the tragedy of their environment degradation, and yet because of selfishness and greed they cannot agree on how to tackle the problem. One would expect that having seen the immediate tragedy that many become more catastrophic in the future there should be urgent proactive measures to tackle this potential doom. Instead, their attitudes are that of sidon-look and leave everything to God.

This brings us back to where we started this inaugural lecture. Climate change is here, climate change is devastating because of our constant abuse of the environment (the tragedy of the commons). Yet we have not agreed on how to proceed to tackle the problem. If a small community, because of selfishness and greed, cannot agree on how to go about tackling an obvious problem, how then can we agree in Nigeria, in Africa, in the world? That is the Tragedy of the Commons.

5.0 CONCLUDING REMARKS AND FINAL THOUGHTS

- Climate change is real. It is already very devastating and promises to be more intense in the future.
- The last five years have been the hottest on record and forecasts indicate that the trend will continue in the future.
- Presently, the world has recorded the highest amount of

carbondioxide (CO₂) concentration in the atmosphere. CO₂ is the gas that traps the heat on the ground (the greenhouse effect) preventing the heat from escaping back into space. The major challenge now is how do we remove or reduce this amount of CO₂ from the atmosphere and how do we prevent more CO₂ from moving from the earth surface into the atmosphere. This is a major challenge and research area for the scientists.

- We need urgently to provide answers to the climate change paradoxes already pointed out. This will enable us to chart a proactive course of action to solving the problems posed by climate change. This is urgent as time is no longer on our side.
- Every one of us here that has listened and educated on the looming challenges ought to ask the question; what can I do to contribute to the needed solution? This includes positive things I should immediately begin to contribute and the negative actions I should desist henceforth from.
- On the whole, we should realize that the people can be a major asset in halting, reversing or mitigating environmental degradation. We need to double our efforts at sensitizing and involving all people. This is what we have just done. It may not take more than giving the people the control and securing their commitment to maintain the quality of the resources. In other words, we may simply need to give the people what they will use to implement environmentally friendly systems. That is, they need to be healthy and politically and economically motivated to care for their environment (Liniger, *et. al*, 2013).

- International attempts to discuss, negotiate and come up with implementable and enforceable agreements have been marred by selfishness, self-centeredness and arrogance. One of those sessions was recently held in Poland in November/December 2018. These sessions have ended up being mere talking shops. This attitude must change.
- One may venture, because of the urgency needed, to call for international, United Nations Government, police and Courts for climate change. In fact, anything that will do the trick, whether it makes sense or not, is what we need now and urgently. We must recall that it is already predicted that mankind as we know it today may no longer exist by the year 2050.

My scriptures say that the end is near when God Himself will effect the final judgment. It seems, however, that mankind is bent on hastening that time to destroy the world even before God's appointed time. May God forbid that in Jesus Name: Amen.

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interview) with a resumption date much earlier than the official opening of the University. Prof. J. M. Baba made me stay. I was to run away to the University of Abuja. Lo and behold the Chairman of the interview panel at Abuja was Prof. J. M. Baba. He sent me away and told me to go back to F.U.T. Minna. Prof. D. O. Adefolalu mentored me on rudiments of Research and Research Publications. I am grateful to all of them.

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years several chairpersons of this committee tried to "push" me to give this inaugural lecture. I was waiting for the right time (God's Time). I appreciate all of you. Now is the time.

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With that, my Vice Chancellor, I will say, I am done. Thank you very much for listening.

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PROFILE OF THE INAUGURAL LECTURER

Prof. G. N. Nsofor who hails from Oraifite in Ekwusigo LGA of Anambra State, was born in Jos, Plateau State more than six decades ago. His early education were at St. Luke's Primary School, Oraifite and Oraifite Grammar School from where he obtained the West African Examination Council Certificate with distinction in 1971. His tertiary education was entirely in Europe and U.S.A. at the International Institute for Aerial Surveys, Enscheda, Holland (Diploma Cartographic Engineering), University of Wisconsin Madison (BS, First Class) and also MS (Cartography). He obtained the PhD Specializing in Environmental management from Southern Illinois University, Carbondale USA in August 1982. He returned immediately and served in the NYSC at the University of Jos, Geography Department and thereafter joined the services of F.U.T. Minna on December 1, 1983, that is, one month before the University officially opened on January 2, and 1984. He currently may be the oldest Employee of this University. He has served this University continuously for more than 35 years.

His research works encompass: outdoors recreation monitoring, Mapping and management, Desertification monitoring and Mapping, Census Preparation, Census Administration and Census Statistical Mapping, Remote Sensing and Geographic Information Systems Applications to Small, Medium and Large scale mapping, to oil related Production activities, Agricultural Activities, Environmental Monitoring, Cartographic Design and Production, Environmental Impact Assessment (EIA) such as for Imo River FDP Project (OML II) sponsored by Shell, Baseline

Assessment for 70KM Gas pipeline sponsored by Federal Ministry of Environment, EIA for Eleme Petrochemical Complex sponsored by Federal Ministry of Environment. Prof. G. N. Nsofor has been a regular consultant to the National Remote Sensing Centre Jos, and National Space Research and Development Agency (NASRDA) Abuja in the use of Nigeria Satellite Images to produce landuse/Landcover Nigeria Maps at various scales. His research results are published in more than 70 books and journals. He has also been a consultant to Niger State Agricultural Development Project, the defunct Nigerian National Agricultural and Land Development Authority and the Nigerian Population Commission. Prof. G. N. Nsofor joined the Nigerian Cartographic Association (NCA) in 1985. He rose to be NCA Journal Editor for several years and also edited several NCA book publications. He was NCA 2nd Vice President for two terms, first Vice president for two terms and president for two terms. He has been a member of NCA Council for several years as a Patron. As a Unionist, he was ASUU Vice Chairman here for two terms and later ASUU Chairman for two terms, first ASUU zonal Coordinator, Abuja Zone and first ASUU Investment Officer as a Principal Officer at the National level.

He has successfully supervised and graduated 15 PhD students and over 80 MSc students. He has served as a member of the editorial board of several journals and a reviewer for more than 10 journals. He has been called upon to assess the works of more than 15 candidates for promotion to the ranks of Associate Professors and full Professor, he has served the Federal University Technology, Minna in several capacities including Head of Department, Dean, Director, member of Senate, Council member as well as Chairman and member of several committees. He is a fellow of the Nigerian Cartographic Association.

Prof. Nsofor is happily married to one wife and blessed with four children (three boys and one girl).

