LOW CARBON ECOLOGICAL AGRICULTURE IN THE DEVELOPING WORLD - A PANACEA FOR ENVIRONMENTAL REMEDIATION

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ABSTRACT

The realities of the threats of climate change and the effects has driven a number of international and national bodies to call for re-direction of urban management pathway, such that there is a move towards reduced Green house gas (GHG) emissions and resource efficacy. Recent experiences on ground have now eloquently confirm the phenomenon as a complex global threat, and no country is immune to this.

This paper looks at the climate change adaptation imperatives, highlighting the various climate change signposts and the implications, as well as geo informatics as reliable source of data for system wide planning purposes. Deriving from a detailed study of Akure and elaborate literature review, it presents carbon footprint implications in a third world city, and proposes panacea for mopping up green house gases in the environment. Recognizing the reliance of man for food resources, and the need to salvage cities from this onslaught, the paper makes a strong case for ‘climate smart’ world. Food is seen as a resource that is obtained by the consumption of environmental resources. In the process, effluents are released into the atmosphere, which where care is not taken, may be deleterious to the environmental resilience, thus enhancing Greenhouse gas build up. This can however be achieved without compromising the environment. The dynamics and advantages of the ecological agriculture is hereby espoused as a means of achieving this. This marries agricultural developmental needs, environmental remediation and mitigation/adaptation strategies, requisite for climate change management.

The paper concludes by presenting a way of universally responding to prevailing environmental risks in our daily cultural practices by enhancing local capacity building in farming practices. It presents ways of feeding ourselves yet preserving natural systems; thus enhancing environmental sustainability. It has capacity for local adoption initially and subsequent up scaling.

Keywords: environment, remediation, ecology, adaptation, carbon footprint, green house gas

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INTRODUCTION

We live in an age where climate change as an environmental threat is no more in the academic but now in the reality domain. In spite of the situation, poverty reduction and sustainable development especially in the developing world remain as core priorities. This is especially true and a needful fact, given that about 25% of the populace in the less developed world still live on less than $1.25 per day in spite of the campaigns and efforts on the Millennium Development Goals (World Bank Report, 2010). Along with this fact, global population attained the 7th billion mark sometime in October, 2011. A closer look at its dynamics show that the last billion was attained within a span of twelve short years, whereas the first global population was never attained until about 1850 AD. Furthermore, the population increases annually by almost 80 million (PRB, 2010). Of this, 1 billion people still lack clean drinking water, 1.6 billion lack energy (electricity) and 3 billion lack adequate sanitation (World Bank Report, 2010). These bare facts reveal the enormous populace to be adequately fed and housed, in spite of global reality of climate change. Therefore the call for food security is apposite in a world so composed.

A flip of the coin reveal that humanity and her diverse activities gradually warm up the planet Earth. For example, literature reveals that between 1800 to 1900 or thereabout, the global temperature oscillated within a range of less than 0.7^{0}C. This however spiked at the turn of the century owing to a buildup of greenhouse gas (GHG) emissions arising from anthropogenic sources. Given that sustainability is a watchword, there is the need to ensure that whatever humanity does in whatever guise – our search for adequate food resources, industrialization, and all other activities - do not further harm an already precarious environmental situation. In actual fact, efforts need be garnered from all fronts to reverse environmental damages of the past few decades, with the view of avoiding an imposition of added costs or risks on future generations. A major responsibility that the world needs to embrace, is to confront the challenges of climate change wisely by learning what science has discovered about it. This is more so the case given the fact that changes we see today in global temperature characteristics and over the past few years can only be due to man made changes in the green house gases, not necessarily because of changes arising from the Earth's orbit or the rotation around the sun (Kelling et. al, 2009). This fact is now eloquently evidenced by air and ocean temperature changes, melting ice fields, rising sea levels, among many other incontrovertible evidences. Informed environmental management strategies, derived from quality data bases are needed for disaster modeling, prediction, preparedness and management for the protection of her citizens, treasured ecosystems and valued resource base. We need quality data characteristics to model extent and the dynamics of given disaster phenomenon for effective management.

The research thrust of this paper therefore stands on this tripod:

- how do we acquire sufficient data that will reflect spatio-temporal dynamics that are needed for informed interventions in a rapidly urbanizing world?
- given the potentials of natural disasters, what is the situation in a typical urban setting in Nigeria – Akure for instance in this study?
- what are the potentials in agricultural development strands that can be exploited for environmental remediation gains?

The paper now discusses these challenges. It attempts to propound the way out of the quagmire, making a case for geo-informatics as tool for environmental monitoring. It highlights the implications for sustainable environmental management and food security while at the same time features the low carbon, ecological agriculture management system as a multi-track approach to meeting environmental remediation needs in African nations.

CLIMATE CHANGE, DATA NEEDS AND RISK MANAGEMENT

Climate change is now a much talked about phenomenon in Nigeria, particularly given the unprecedented flooding experienced in many parts of the country in the peak of the tropical rains last year (September, 2012). This has eloquently registered the issue of environmental management as that which needs every informed attention if only to build defense strategies that will alert on probabilities and the consequences of occurrence of such disasters in the country. The climate change phenomenon as a global threat will affect all, but have disproportionate impact on millions of the poor, aged and rural dwellers who are more vulnerable. It puts more people at the risk of hunger thus making it more difficult to reduce the proportion of those in abject poverty. This is critical as we approach the wind-up year of the Millennium Development Goals (year 2015).
In Africa, climate change has the following impacts:

- The historical climate record for Africa shows warming of approximately 0.7°C gain over most of the continent during the twentieth century;
- a decrease in rainfall over large portions of the Sahel (the semi-arid region south of the Sahara);
- an increase in rainfall in East and Central Africa.

Over the next century, this warming trends and changes in precipitation patterns, are expected to continue and be accompanied by a rise in sea level and increased frequency of extreme weather events. While the exact nature of the changes in temperature, precipitation, and extreme events is not known, there is agreement on:

- Global mean surface temperature that is projected to rise between 1.5 °C (2.7°F) and 6 °C (10.8°F) by 2100.
- Sea levels that will rise by 15 to 95 centimeters (6 to 37 inches) by 2100.
- Climate change scenarios for Africa that indicate that future warming across the continent will range from 0.2°C (0.36°F) per decade (low scenario) to greater than 0.5°C (0.9°F) per decade (worst case scenario) (Ali, 2010; Desanker 2010).

This warming will be greatest over the interior of semiarid margins of the Sahara and central southern Africa. This change will create a less predictable continent as crop failure and crop losses will come more often. It will bring with it biodiversity loss, decrease agricultural productivity, escalating human and animal migration, and deteriorating water supply. Whatever our disposition, it is a costly issue. We either spend on its mitigation, or spend on adaptation and repair of damages.

On a general note, the average earth temperature is held to have warmed up by close to 1^{o}C since the industrial revolution. The Fourth Assessment Report (4AR) of the Intergovernmental Panel on Climate Change (IPCC) equally reveals that the warming of the climate system is unequivocal. In a further detailed analysis, Luthi et.al (2008) reveals that the global atmospheric CO_2 which ranged between 200 – 300ppm for 800,000 years now rose up to 387ppm in the last 150 years. This is mainly from anthropogenic contributions such as consumption of fossil fuels and other contributors such as agriculture and changing land use. In spite of the Kyoto Protocol, the volume of GHGs in the atmosphere keeps increasing with all consequences on the increase. These include: higher average temperatures for air and oceans; widespread melting of snow and ice; rising sea levels; more frequent and intense droughts; more common heat waves; heavy and unpredictable rainfalls leading to floods, storms and cyclones. Climate change risk behaviours if not reversed, will leave humanity on a track of about 3^{o}C warming or even cause as high as 5^{o}C warming per century. This change will lead to :

1. ecosystem dislocations forcing many species (50%) of the biotic world to go into extinction;
2. a sea level rise of one metre this century;
3. more than 60 million people endangered; and
4. global agriculture productivity decline, occasioning more deaths per year from malnutrition.

We therefore need effective data-based frontal attack to rescue our generation and the generations to come from its clutches; hence the place of satellite based data and geo-information technology.

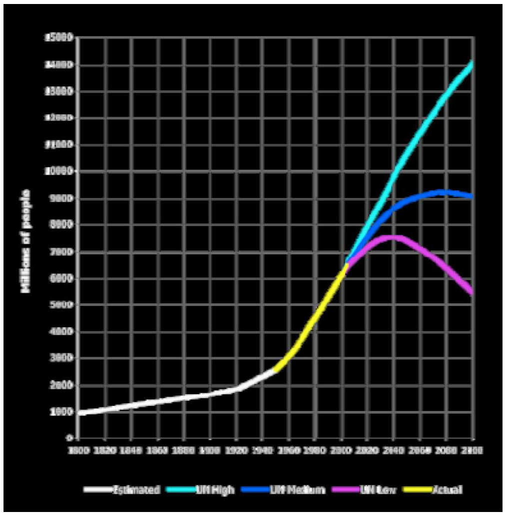
Geo-information is about intensive data acquisition for research. Through this, changing moisture and other weather parameters can be measured and monitored such that storm characteristics, changing greenhouse gas build ups and other indicators can be tracked. Early warning signals can then be issued for disaster preparedness and management through systematic risk management. As a tool, the GIS streamlines data management, ensures quality information is available as at when needed and provides a cost effective and rapid tool to build up knowledge base for policy and decision making to buffer vulnerable areas. It is in this and other regards that the field of geo-informatics and data curation become relevant as they meet the emerging global challenges of the 21st century.

URBANIZATION AND POPULATION GROWTH STRANDS

The phenomenon of urbanization as a process is a natural part of development as a country's economy shifts from the labour intensive economy to a more industrial economy (Hurdson, 2002). It is described in studies on population dynamics as 'that which engenders the relative increase in the urban population as a proportion of the total' (Teller, 1981; Akinbamijo, 2007). Being essentially a process, its consequences are well documented in literature (Henderson, 2002).

Fig 1 – The Population Growth Patterns over time

(PRB, 2010)



Given prevailing population dynamics, more population will live in urban areas; and in Africa, some cities are already displaying mega-city attributes status – Kinshasa, Cairo and Lagos. This is largely a product of natural increase with about 40% contribution from rural – urban migration. Using the J and S curves – as shown above, the Population Reference Bureau (2010) demonstrates how fast the global population has grown, and where it might be headed.

This is critical in the food security dynamics globally and for Africa. The rapidly increasing population is such that rising food demand in developing countries will need to double by 2050 to meet domestic demand (Ali, 2010). This is more so the case given that with current birth rates, Africa will double her population to 2 billion by 2050; given a total fertility rate estimated to be 4.7 children per woman (PRB, 2010). In this same vein, Nigeria will climb up to 326 million (in 2050) from a 2010 158 million mark (PRB, 2010). Consequent upon this is the need and implicit demand for food especially for the urban poor in the face of climate change challenges. Given the above, civilization is tied to an unprecedented use of fossil fuels. Petro-chemical derivatives are now critical as off-farm inputs to aid food production – all with untold costs to the host environment (Brown and Jacobson, 1987). Besides this, sewage sludge has been demonstrated as a source of phosphorus, nitrogen and potassium. Estimates of EFMA (2000) show that about 2.6% of nitrogen, 3.5% of P_2O_5 and 1.1% of K_2O used in European Union (EU) agriculture derive from non-livestock urban waste. Where not utilized as farm additives, it constitutes a drain on the 'urban food loop'. Municipal solid wastes which is dominantly organic in nature is also a viable source of inputs. In the form of compost as farm additives, they constitute a good source of potassium in particular and of humus.

Given all of the above, the growing city will always require food resources for her populace, and in return, generate solid waste and waste water. For most cities, municipal waste management has become one of the most serious challenges facing city sustainability. Here the management system is typified by inefficient as well as improper disposal. These contribute to declining environmental health conditions in cities. Ecological low carbon agriculture can help to solve such problems by providing an avenue for turning urban wastes into a productive resource. In many of

Nigerian cities, the wastes are largely (60%) organic and only 8% of these for now are recovered for reuse (Ogwueleka, 2009). Local or municipal initiatives exist however, to collect household waste and organic refuse from residences, vegetable markets and agro-industries in order to produce compost or animal feed. Quality compost is an important input that can fetch a good price, as well as allow the farmer to use less chemical fertilizers on the farm. By doing this, it prevents problems related to the contamination of groundwater and the environment. This is the kernel of this paper.

Given the huge global human population, we need to harness the strengths therein for the benefit of all, when our societies are built on mutual respect and understanding for the environment. However in developing countries like Nigeria, urban growth parameters lack articulated policy to stem its tide. The dynamics of the scenario is typified by the fact that while less than 15% of the total population lived in cities of 20,000 or more population by 1950, 25 years later - in 1975, this proportion increased to 23.4% and by 2000, the proportion had risen to 43.3%. The prognosis is that by 2015, more than half of the nation's population will live in urban centres (Mabogunje, 2007). This will result from the interaction of demographic forces (external and internal) acting on given settlements, in response to the socio-economic, psychological and physical development demands. This pace has been implicated in the dynamics presented across some developing countries, for its untold implications. The societal learning required to adapt rural institutions to urban ones in the developing world becomes a crash course, leaving little or no room for adjustments (Henderson, 2002). Therefore, and in agreement with Owusu (2010), one can say that in many of these cities, pace of urban growth readily outpaces the capacity of metropolitan and municipal authorities to provide basic services that include adequate sanitation, water and even food resources. These growths have spatial implications that reflect on availability of food resources in the adequate varieties, quantities, qualities and costs for the dwellers. Given the above nexus, food resources now become a hard to find but essential resource. In this regard, the physical and spatial changes in urban areas with rural base can be a considerable challenge in metropolitan areas and a monumental one on continental scale. Along with this challenge are the climate change and food security nexus, especially given the anthropogenic contributions by man to the climate change phenomenon. These are potent problems in the African development saga which ecological and organic agriculture has the potential to mitigate – if well articulated and harnessed, with the view to attaining a balance in the living environment.

SUSTAINABLE DEVELOPMENT / ENVIRONMENT STRAND

In every facet of the development agenda, the issue of achieving 'sustainability' is now shifting from the rhetoric to action. Whatever the sector of development, opportunities are being harnessed to marry the forces of economic growth with the foundation issues of sustainable development i.e. prudent husbandry of environmental resources, equitable distribution of benefits and reduction of negative effects on the people and the environment from the processes of economic growth. Hitherto, economic development and improved environmental quality were thought off as mutually exclusive goals. Given informed combination of sound environmental policies, proactive planning and judicious investments, the goals of rapid economic growth and improved quality of the environment can be achieved (Serageldin, 1996).

Wherever development issues are needful, the issue of sustainability becomes a front burner issue, particularly where the issues of environmental remediation are needful. This is more the case with agricultural development. Here the conventional farming systems has been implicated for the build-up of green house gases from petro-chemical based fertilizers. There is therefore the need to appraise the potentials of ecological organic agriculture with a view to mitigating the effects of Greenhouse gas emissions in our environment. Besides the sustainability issue, organic agriculture affords us the opportunity of meeting up with the Millennium Development Goals (MDGs). Mainstreaming the organic agriculture paradigm is an action line in Nigeria and indeed all African nations, if the issues of sustainable development and environmental remediation is to be embraced.

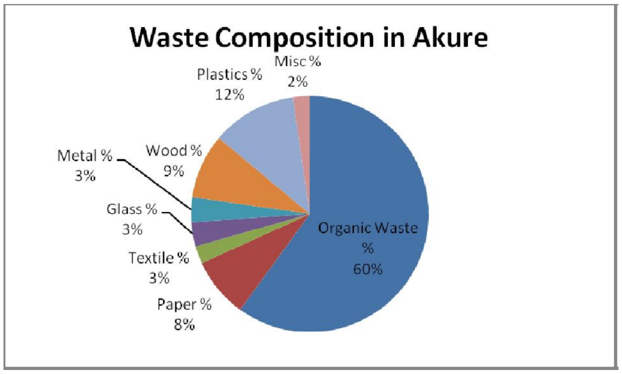
THE AKURE URBAN GROWTH IMPLICATIONS

Akure like most urban centres in Nigeria is rapidly expanding her frontiers leading mainly to land use and land cover changes. The rapid expansion comes with myriads of other implications such as loss of agricultural land, vegetal surfaces and food security. Like other cities, urbanization induced changes affect the urban micro climate in the least. Anthropogenic heating in terms of waste heat from automobiles fuel consumption, industrial energy needs and human metabolism; macadamisation and vertical surfaces in buildings all add up to the heat buildup.

These changes have been well captured by Balogun (2012). Using both multi-spectral and multi temporal analysis on a rural-urban tract across Akure, Balogun (2012) reveals glaring urban growth and anthropogenic implications on the climate change phenomenon. With the aid of remotely sensed Landsat TM imageries of the town between 1986, 2002 and 2007, the study was able to document the spatial growth implications on the Akure urban terrain. From these imageries, dense city centre development was recorded for Akure, along with haphazard expansion to the fringes, depleting vegetal and arable land composition as it does. The dynamics of growth reveal that Akure grew from 16505.58m^2 in 1986, to 52703.65m^2 in 2002 and 62487,71m^2 in 2007. With the aid of the change detection analysis, the change in the built and arable land is seen to be more than 30% and the vegetated areas – carbon sinks were greatly depleted. From the classification of imageries for the bench years, nature of the change was done and was discovered that this will continue for some time to come except drastic re-engineering is done to arrest this tendency. The growth pattern also went towards water bodies, and other flood prone areas.

With the aid of sensors, including the Lascar EL-USB CO portable loggers over a one year study period, a traverse tract analysis was done from the rural fringe of the Federal University of Technology, Akure through the city centre to the rural fringe of Eleyowo village, off the Akure Airport. The sensors reveal buildup of carbon monoxide emissions, changing air temperature and relative humidity characteristics as the city centre is approached. They reveal diurnal as well as day of the week variations. It is necessary to add that the city centre data were 2 – 3 times higher than rural data (Balogun, 2012). The carbon monoxide status is critical as it is very potent in ozone layer depletion and major pollutant harmful to man and plants.

The Municipal Waste Scenario in Akure



The trend of solid waste generation in Akure and other Nigerian cities has been rising in the last couple of decades due to sheer population dynamics and socio economic enhancement in the country. It has also been a challenge to the sustainability of the city. As the country progresses, waste recycling, reduction and full utilization as resources will be more relevant as issues for sustainable development in the country. Akinbamijo (2004) and Aluko (2008) reveal preponderance of improperly managed wastes in cities. From studies on Akure, Nigeria; municipal wastes are largely organic (60%), thus it constitutes a viable source of closing 'nutrient loops' in cities as it is a potential source of on-farm additives to boost farm production. In doing this, it will save on green house gas build up that would have resulted had the conventional fertilizer been used. Akure generates between 0.44 to 0.66kg/ca/day. This amounts to about 280 tons of waste per day. This waste generated therefore is to a large extent, bio-decomposable wastes. The composition constitutes a basis for promoting the low carbon ecological organic agriculture (EOA) paradigm as a remediation measure to contain the monstrous Climate Change phenomenon, and in one fell swipe also, to help attain the needful Millennium Development Goals. The city will also be the better for it as the reuse approach is noted for savings of close to 18.6% on waste management costs and 57.7% savings on landfill costs (Ogwueleka, 2009).

CONCLUSION

The paper established population and urban growth as phenomena that are likely to persist for some time to come. The population being largely made up of the urban poor for who adequate feeding will still remain a challenge. The Ecological Organic Agricultural (EOA) paradigm as an inner city food production management system is espoused as that which will help achieve needed environmental remediation and food security. This can be arrived at, when EOA protagonists disseminate the potencies of the system at local levels, with the view of upgrading to higher tiers of participation over time and across national boundaries.

The paper is also of the view that greening on a large scale need be done as this will help simulate needed carbon sinks which were lost to the urban incursion of the peripheral and vulnerable districts.

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