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Full Length Research Paper

Environmental education: A holistic approach using *Wall Chart* with *Manual*

Nwachukwu M. A, Okoro Uwaezu, Ntesat Brownson, Ijeoma M. Nwachukwu

Department of Environmental Technology, Federal University of Technology Owerri, Nigeria.

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Human activities such as inequitable and unsustainable production and consumption of earth resources cause *environmental problems*. There is need to develop research and innovative techniques towards public understanding of these environmental problems and sustainable development. This paper contains the first edition of *Environmental and Sustainability Wall Chart with manual for explanation*. This chart will be displayed at public places such as schools, libraries, hospitals, airports, rail stations and offices, as a holistic approach to environmental education. How to use this wall chart and manual for teaching environmental education at all levels (K-16 or P-16) is contained in the manual. All types of degradation threatening natural landscape, resources, existence and the ability of planet earth to serve future generations are contained in this manual. This wall chart and manual model presents environmental education as early education, accessible education, and education for all and for sustainable development.

Key words: Environmental degradation, education, ESS 200, Sustainability study, Wall chart.

INTRODUCTION

The goal of environmental education is to develop a world population that is aware of and concerned about the state of earth environments; the atmosphere, the water and the land (Figure 1), including plants, animals and all classes of organisms therein.All types of degradation threatening natural landscape, resources, existence and the ability of planet earth to serve future generations are contained in this paper. This paper is about awareness creation concerning regional and global environmental problems threatening the planet earth. A total destruction of the earth surface similar to the biblical great flood (Genesis 7) is imminent if people are leftin ignoranceof the earth continuous environmental degradation. A general knowledge of earth environmental problems, their consequences, how they relate and applicable solutions summarized in this paper is vital to all people across nations. Global awareness about conservation and preservation of earth natural resources, its biodiversity and natural landscape is needed to protect interest of future generations. It is in doubt if the earth environment will continue to be livable at the end of this 21st century if total awareness of the problems identified in this manual is not created with control measures justified. The primary target audiences of this paper are the developing countries. Stockholm Declaration of the United Nations Conference (1972) on the Human Environment described Environmental education as organized efforts to teach about how natural environments function.

E-mail: futo.essg@hotmail.com. Tel: 08163308776.

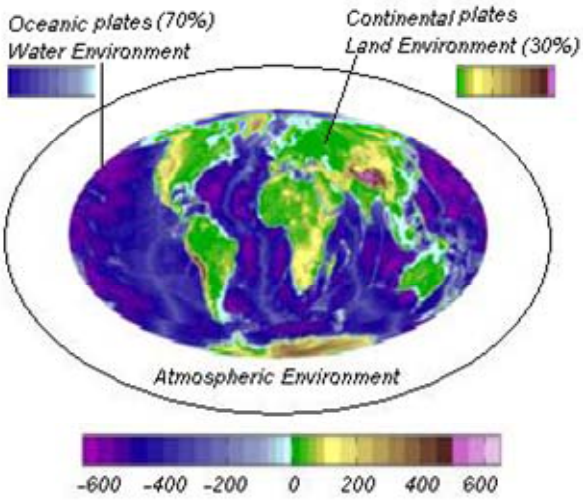

Figure 1. Present Day Earth Environment & Topography (m)

Particularly, how human beings can manage their behavior and ecosystems in order to live sustainably.

The terms "sustainability" burst into the environmental literature in the 1980s as people became aware of the global problem of overpopulation. Since then, sustainability issues are largely concerned with how to preserve the earth environments and conserve its resources for future generations. Destruction of the earth like the time of Noah and the Biblical great flood is neither a portion of present generationnor the future generations. Sustainable living and development therefore has emerged as a global watch word, and the goal of every generation. To achieve this goal in the 21st century motivated the structure of this paper. In his recent systematic studies of the environmental movement in Ghana, Osuteye (2013) revealed an apparent disconnection between environmentally focused civil society organizations and local academia. This disconnection has implications on both the study of the social dimension of environmental issues and sustainability, and the lack of academic literature on the subjects. He maintained that the bridging of this gap has potential benefits for both civil society and the development of environmental study that could bring sustainable development.

In a study conducted by Howe et al., (2013), there is an urgent need for empirical research interdisciplinary, including developing acommonly understood set of definitions, in order to begin to elucidate pathways that will significantly affect the abilities of people to appreciate and adapt to our rapidly changing climate. According to Bell (2004), major environmental problems can only be solved by radical transformation of the attitudes, preferences and lifestyles of the citizens of contemporary liberal democracies. This implies the use of a more holistic approach to educate the public on issues of global change and their responses. It is on this note that this wall chart and its manual presented in this paper havebecome very significant to the desired goal. The goal is to provide environmental education which will transform children, and through them society, in the direction of sustainability. Schinkel (2009) thus sketched a form of compulsory environmental education that realizes at least some of the objectives commonly stated in Education for Sustainability and Education for Sustainable Develop-ment.

Cough and Scott (2007) stated that environmental education and sustainable developmentexamines the possibility to monitor and evaluate products of higher institutions. It assesses the ability of universities to produce educated, innovative, and independent individuals, while achieving wider policy goals at the same time. Their lecture examines this question in the context of environmental change and sustainability issues that threaten the integrity of the biosphere and human well-being. They challenged universities to try to produce graduates who are well-informed about sustainability.

World Association of University Presidents' report and declaration at an international conference in Talloires, France, (1990)associated university leaders with sustainable future. Therefore, universities bear great responsibilities to increase the awareness, knowledge, technologies, and toolsto create an environmentally sustainable future. This is the first official statement made by university presidents, chancellors, and rectors, for a commitment to environmental sustainability in higher education. The Talloires Declaration (TD) is a ten-point action planfor incorporating sustainability and environ-mental literacy in teaching, research, operations and outreach in colleges and universities. It has been signed by over 400 university leaders in over 50 countries.

Shevgaonkar (2011) could not hesitate to respond to the decision reached by India Government that environmental science will be a mandatory subject at graduation level in all Indian universities. He stated that there was an immediate need to spread awareness about environmental conservation. He continued "There is a clear lack of awareness among students about the issues that we are facingtoday; issues like depletion of natural resources and its effects on the human life are important. According to El-Ahraf(1981) universities can contribute to environmental education by addressing theoretical considerations and by developing practical applications. The wall chart product of this study is a considerable practical model for the teaching of environmental education in line with El-Ahraf'sphilosophy. Bevins and Wilkinson (2009) reported the 1997 council of Deans atFlorida Gulf Coast University as saying "we have made a commitment as a university to make environmental education anintegral part of our identity'; to this end, all undergraduates must complete a course on sustainable development, called 'the *university colloquium:* A Sustain-able Future". From 1997 to date, all students who have received an undergraduate degree

from the university have taken this class.

Further review of environmental education surveys in Nigeria such as that conducted by Akinnuoye and AbdRahim (2011) and Akomolafe (2011) revealed that more than 70% of the schools in Nigeria do not have environmental education books, newspaper and magazines. Neither of the schools have any form of environmental education wall chart or posters particularly the government schools. Most government schools visited lacked basic environmental education display room. In Nigeria facilities and resource-persons to teach environmental education are respectively inadequate and not considerably up-to-task. Only about 12% of Nigerian schools investigated have some sort of facilities to teach environmental education. Most teachers and the state education ministries agreed thatthere are major problems in the implementation of Environmental Education program in Nigeria particularly the lack of qualified teachers. Personal environmental awareness, knowledge and attitude were identified as key factors affecting environmental knowledge and practice between the schools and the civil society. Experience and qualification of teachers affects the opinions of teachers significantly on the infusion of environmental education in the Nigerian Primary School Curriculum.

A recent survey by Wambua (2012) revealed that there are no adequate resources for teaching environmental education in the four Kenya primary teacher colleges from which the sample was drawn; that most of the tutors were not even aware of what environmental education was all about. Consequently, field studies were not being effectively used and hence it could be concluded that environmental education has not properly taken off in Primary Teachers Colleges in Kenya, since this study can be generalized to the other thirteen Teachers Colleges which were not covered. In a survey conducted by Yemisi et al. (2010), out of the 140 respondents, only 43 (31%) are aware that use of firewood and charcoal for domestic cooking are sources of environmental degradation. This suggests that most of the respondents are only aware of environmental problems that directly affect them and their immediate environment such as oil spillage and pipeline vandalization but are ignorant of global environmental problems. It is expected that the wall chart/manual summarized in this paper will bridge this gap. According to Alnewashi (2003), formal educators and awareness program leaders in developing countries require more educational resources and environmental education training programs. This wall chart and manual complies with this requirement of educating the educators, government officials, program leaders and the general public. A recent survey conducted by Turan (2014) on the views of prospective primary school teachers regarding environmental education in Turkey revealed greater need of visual teaching aids. According to Turan, these teaching aids could be computer assisted wall charts and postersprojected on the wall or printed.

In this study, a survey of the availability of wall charts as environmental education teaching aid in secondary schools in Imo, Abia, Ebony and Anambra states was conducted. Thirty schools were sampled in each state comprising urban, rural, and private and public schools. The result was singular; none of the schools have any environmental education teaching aid in the form of wall chart or poster. In some schools, wall charts on personal hygiene and sanitation were presented as their only environmental education teaching aid. Much as personal hygiene and sanitation come under environmental education, it is onlyabout 5% of environmental subject matter. This survey result and that of those conducted by other scholars mentioned above specifically motivated the making of this wall chart and its manual. Based on these findings, it is important that a holistic approach to environmental education be introduced in tertiary, secondary and primary schools. That its curriculum should not only reflect the immediate needs of the students but a broad view of global environmental issues, with emphasis on sustainability concepts (Figure 2).

METHODOLOGY AND STRUCTURE OF THE WALL CHART

In writing this manual, several publications, websites, university curricula and public opinions on the subject matter worldwide have been considered. Twenty environmental and sustainability issues are listed in the wall chart and briefly discussed in this manual. A wall chart is a type of large poster often displaying information for educational use or entertainment. This chart measuring 100 x 120 cm is the first of its type practical guide to environmental education. It will be displayed at public places such as schools, libraries, hospitals, airports, rail stations and offices. This book will be used for teaching environmental science and sustainability *(ESS, 200)* in universities and colleges. Its wall chart version is accompanied by a manual, where all the environmental and sustainability issues identified have been explained. Course outline for ESS 200 is designed based on the environmental issues presented. In writing this book, effort was made to use simple and common terms that could be easily understood by the general public. Degradation associated with each environmental issue is briefly discussed. The book explains the benefits, setting and operation of a center for sustainability study in universities.

Some of the environmental problems identified result from natural forces; some are due to man-made forces, while others are as a result of both natural and man-made forces. Out of the eighteen problems labeled in the wall chart and discussed in the book, only earthquake and volcano are of natural forces. Many of the problems identified are related, and as such share the same mode of environmental degradation. The much related environ-

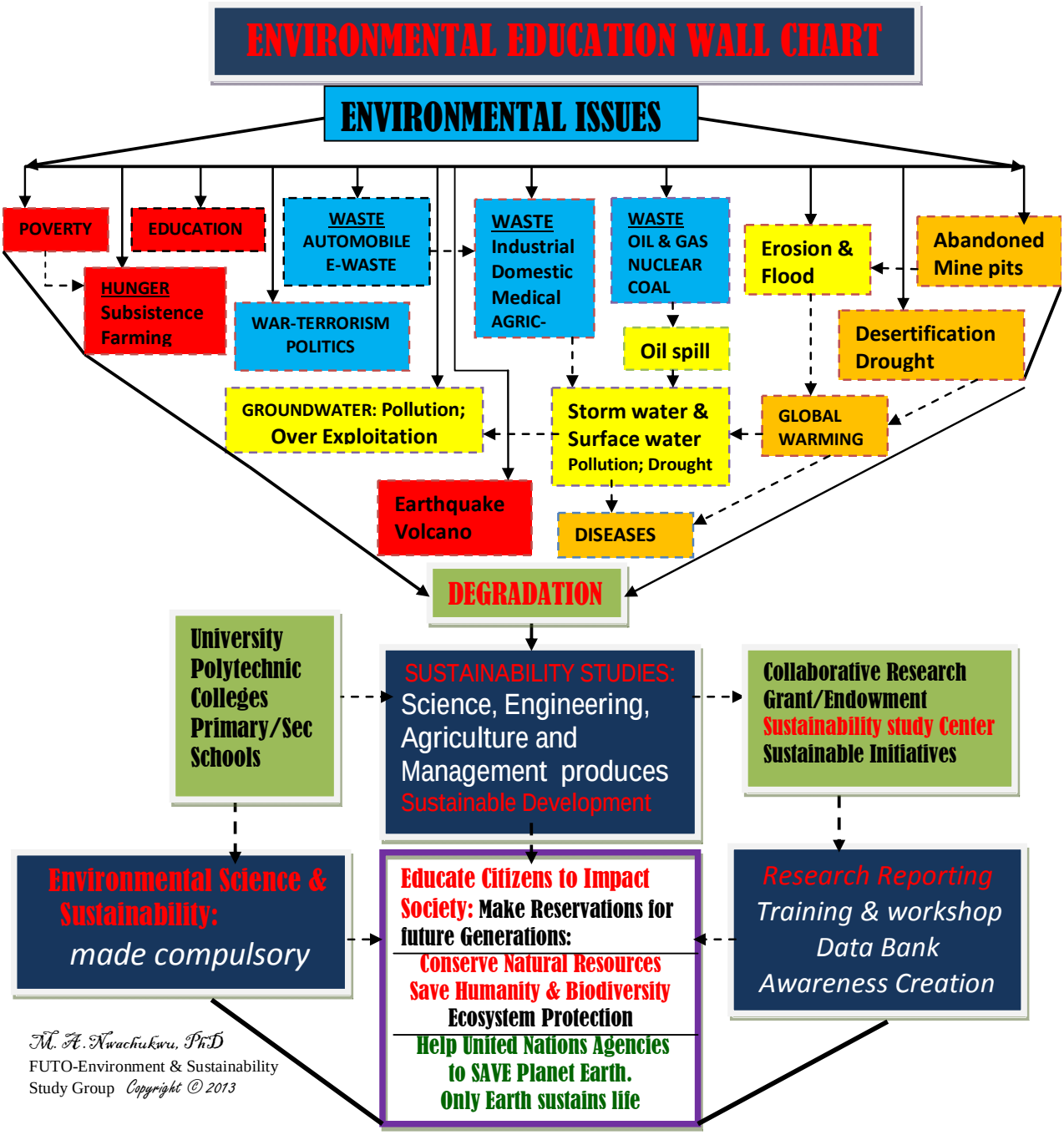

Figure 2. Environmental and sustainability wall chart first edition.

mental issues are linked in the chart with broken line. The wall chart will be printed on heavy-duty paper with a large-format high-resolution color printer. The final output will be fantastic and attractive when displayed in public places. The author has the original copyright to mass produce and distribute the chart. Quality fabric is used to produce this wall chart to allow for durability and its flexibility. Different grades of paper with or without cloth-baking are used in making wall charts used in lecture rooms and in public places. Shade cloth used in this chart is cheaper, lighter, easily folded and displayed, and more durable than paper chart. All environmental and sustainability issues captured in the wall chart are explained under discussion to represent the wall chart manual.

How to use the wall chart

In public places: Hang the wall chart on the wall where it

will be conspicuous with proper illumination. Preserve the manual in a closet as a reference material that can be provided on demand. In the case of offices and public libraries, place the manual on a stool or a table beside the wall chart.

In Primary schools: Environmental education shall be a subject for primary grade five or six. The wall chart shall be displayed at appropriate wall location in each classroom of the concerned grade. Each classroom of the concerned grade shall have a wall chart and a manual preserved by the teacher. The teacher will read the manual and become familiar with the various environmental issues identified. The teacher shall introduce two of the environmental issues each week, projecting the concept of sustainable development. References should be made to global changes such as increasing population and global warming. It is expected that the teacher will explain important keywords such as Environmental degradation, Ecosystem, Biodiversity, and Conservation of natural resources in the context of sustainability. Teachers are encouraged to create songs and poems for the pupils based on environmental issues. Teachers are encouraged to compose recitations or poems based on the environmental issues mentioned in the wall chat to improve perception of earth environmental degradation by the pupils.

In Secondary schools: Teachers of Environmental Science, Geography and other science teachers can teach this subject as Environmental studies, Environmental education or as Environmental science. This subject shall be taught in junior secondary or middle school and continued in senior secondary as a subject for the West African School Certificate and GCE examinations. At senior secondary, the teacher will endeavor to give simplified notes to the students per topic, based on the content of this manual. The teacher prepares short explanatory notes for each of the eighteen environmental issues presented. Similarly, the teacher will prepare explanatory notes with local examples on vital keywords such as *Sustainability and Sustainable Development.* Students will be given additional notes with local case examples to explain other vital keywords like *Natural Resources, Conservation of natural resources, Ecosystem and Biodiversity.* All discussions and notes will be prepared to capture the concept of sustainability and sustainable development. At junior secondary level, emphasis will be on the listed eighteen environmental issues. At senior secondary, greater emphasis will be on the vital keywords.

In Universities and Colleges: Here the wall chart stands out on its own for people to read. Students will purchase the manual for their private reading. This subject will be studied as a university or college course, compulsory to all students. This will be a two hundred level course titled Environmental Science and Sustainability (ESS 200). This course must be taught by a number of faculties who share background in environmental management or Engineering. In universities and college, this manual and its wall chart represents the first handy teaching material readily available to students and faculty. Any other text (s) on the subject matter may be added to widen student's perception of the course.

Sample poems - recitations of environmental awareness K-6 to K-12

Planet Earth-Planet Earth
The only planet of life
Now under destruction
By unending human activities

We rise against your destruction
For interest of future generations
Who wish to see your beauty and
Enjoy your abundant air of life
Enjoy your abundant water of life
Enjoy your abundant farmland
Enjoy your abundant vegetation
Enjoy your abundant minerals

We must preserve your beautiful environment
We love you Planet Earth.

Planet Earth, you are the greatest
Because you house man and all animals
You are the strongest planet
Because you withstand all human activities
You are the onlylivable and comfortable
Because of your abundant Air, Water and Land

You are the richest
Because of your abundant mineral resources
Diamond, Gold, Silver, Iron, Aluminum, Zinc,
Copper, Sand, Uranium, Chromium, Nickel
Potassium, Manganese, Magnesium, Calcite,
Fluorite; A total of about 2720 different minerals
In addition to fuel minerals; Coal, Oil and Gas

Planet Earth what consumption rate per generation
do you approve of your resources?
I approve < 1%
WOoo! We have exceeded by about 25%
We are sorry Planet Earth
Pardon us, while we amend.

Do you know about Global Change?

Yes, Planet Earth system comprising the land, oceans, climate, poles, life, natural cycles and resources, Earth processes and human society face large-scale changes,

affecting one another.

Do you know earth temperature is changing?

Yes,earth temperature is rising, known as global warming

Do you know about desert encroachments?

Yes Northern Nigeria stands to be wiped off, due to encroachmentof the Sahara desert. It is encroaching with about 20 to 30 kilometers annually.

Does it mean that Sokoto, Kebbi, Jigawa, Katsina, and Zamfara states are most affected?

Yes, these states may be wiped off in no distant time if adequate control measure is not put in place. *You don't mean it!*Watch out for the next 100 years.

Do you know about Gully Erosion?

Yes over 65% of soil on earth has displayed degradation phenomena as a result of soil erosion. Most states in Nigeria have one form of erosion or the other. The states in the southeast namely Imo, Abia and Anambra are most devastated by gully erosion. 65% of available land in these states may be wiped off in no distant time if adequate control measure is not put in place. *Don't tell me this!* Watch out for the next 100 years.

Do you know about Sea level rising?

Yes, it is the outcome of ice melt in the polar region due to global warming.
Global sea level has risen along our coastline about 7 inches during the 20th century, and recent satellite data show that the rate of sea-level rise is accelerating. If allowed, places like Victoria Island, parts of Bayelsa and River state may be submerged. *Woo oh! God forbid*

Oscar, what then do we do to save our country and the planet earth?

1. Control all vices of environmental degradation
2. Create environmental awareness to government, law makers and the public
3. Teach environmental education in primary, secondary and in tertiary institutions
4. Study environmental management; insist on sustainable development programs/initiatives

DISCUSSION

The wall chart manual

Poverty

The word poverty is not only about economy, but a major player in environmental management. The environmental condition of a nation or state could be assessed by the percentage of its annual budget voted for environmental management. Similarly, the economy of a household affects the level of environmental sanitation maintained. Generally, dirty or degraded environment stands as a symbol of poverty, and sustainability study is inevitable. While other researchers may look at poverty from economic point of view, environmentalists could address poverty from the environmental point of view. This is the new trend for poverty alleviation.

Education

Lack of education has its strongest hold on environmental education in Nigeria. Probably, not up to one percent Nigerians has some sort of environmental education. Lack of Environmental education has been identified as a major cause of poor sanitation leading to degradation of air, soil, water, and public health. Environmental education should be seen as sustainable education and education for a purpose. Universities should intensify sustainability study in environmental education to reduce environmental degradation and their impacts on human and biodiversity existence on earth. Impart the students; to impart the society, for better environment and good living. This is education for a purpose which Dewey (1859-1952) described as vital for society. According to Neiland Richard (2005), a society grows great when old men plant trees whose shade they know they shall never sit in.

Hunger

Global climate change leads to an increased number of weather-related disasters such as floods and droughts, which cause food shortages and famine. However, agriculture not only suffers from environmental problems, it also contributes to them, through pollution, overgrazing, and release of greenhouse gases. Land degradation, low and declining agricultural productivity, and poverty are severe and interrelated environmental issues. Declining soil fertility, which limits crop yields, is a particularly serious and widespread problem. Land management and land use policies and practices can plan an important role in alleviating hunger and poverty, while increasing agricultural productivity and the sustainable use of resources. Effective policies are particularly needed to tackle the land degradation problem, which is one of the greatest challenges to the modernization of agriculture in many African countries.

Population

Human impact on the environment is a function of population size, per capita consumption and the environmental

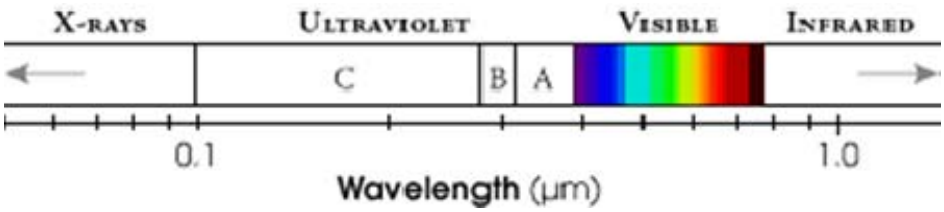

Figure 3. Solar electromagnetic spectrum.

damage caused by the technology used to produce what is consumed. Changes in population size, rate of growth and distribution have a far-reaching impact on the environment and on development prospects. The largest population increases and the most fragile environmental conditions are usually found in poor countries, which typically have limited financial means and least adequate political and managerial resources to address the challenges. This threatens sustainable development and produces further deterioration in living standards and quality of life. People in developed countries have the greatest impact on the global environment. The first two Laws of Sustainability points out that in any society, population growth cannot be sustained, and that the larger the population, the more difficult it will be for the society to achieve sustainability.

Global warming

The earth's average temperature increased by 0.7° Celsius (1.3° Fahrenheit) in the 20th century often attributed to the effects of industrial revolution. Greenhouse gases mainly carbon dioxide (72%), methane (18%), nitrous oxide (9%), and chlorofluorocarbons contribute to this global warming (Spencer, 2011). Gas flaring, burning fossil fuels and wood and human industrial and agricultural practices contribute to this global warming. Emission of CO_2 has been dramatically increased within the last 50 years and is still increasing by almost 3 percent each year. To this effect, effort must be made to reduce smoking vehicles, check automobile emission, and stop gas flaring in Nigeria to mitigate environmental degradation. Sustainability study to control global warming is inevitable.

Sun radiation often erupts in a terrible blast at surface of the sun with increasing ultraviolet B rays on the earth surface. Electromagnetic radiation exists in a range of wavelengths, which are delineated into major divisions for our convenience. Ultraviolet B radiation, harmful to living organisms, represents a small portion of the spectrum, from 290 to 320 nanometer wavelengths (Figure 3).

Increase of ultraviolet radiation and sun blast on the earth surface is most allowed following depletion of the stratospheric ozone layer in the Antarctic region largely by human emission of green house gases into the atmosphere. This has caused notable rise in the earth surface temperature and skin diseases, including cancer (WHO Geneva, 2003).

Terrorism

Recent advances on terrorism are not all about politics, war and loss of lives. It borders largely on environmental degradation. There is destruction of structures causing change in urban esthetics, and use of explosives causing emission of green house gases. Shelter displaced citizens are subjected to poor environmental health and sanitation. There is urgent need for greater investments on the control of terrorism in Nigeria and worldwide. Major terrorist groups identifiedby the U.S. are mainly Religious-Political: Aum Shinrikyo (Japanese);Klu Klux Klan (U.S.);Abu Sayyaf (Philippines); Al Qaeda (Afghanistan); Egyptian Islamic Jihad; Hamas (Palestinian); Boko Haram (Nigeria); Hezbollah (Lebanese).

Automobile waste

The unprecedented increase in transfer of old vehicles, junk engines and transmissions from industrialized to developing nations of the world like Nigeria may be reciprocated by more automobile junk markets (AJMs), and mechanic villages (MVs). There is increasing volume of automobile gas emission, discharge of spent engine and transmission oil, spent electrolyte and spills on the ground in MVs and AJMs. Topsoil within and around AJMs and MVs become heavily contaminated by toxic trace metals in many parts of Nigeria (Nwachukwu et al., 2013). This may lead to larger environmental degradation this 21stcentury, affecting land use planning, soil and water quality, and public health. Storm water from these urban infrastructures gets into the waterways untreated, and there is no protection to both surface and groundwater. The overall outcome is environmental degradation that demands intensive sustainability study.

Waste electrical and electronic equipment

Waste electrical and electronic equipment (WEEE), also

Figure 4. Plastic type containers for sorting wastes in homes and offices prior to disposal, as household efforts to support recycling.

known as *e-waste* has been defined as any electrically powered appliance that has reached the end of its life. Or that no longer satisfies the current owner for its original purpose. Importation of WEEE of all grades into Nigeria for crude recycling and reuse and consequent littering of their scrap casings and other hazardous components is not a sustainable international trade development (Nwachukwu and Feng, 2010). Subsequent to the continuous development and innovation of electronic technology, e-waste will undoubtedly represent one of the most serious environmental issues of the century in many developing countries. A comprehensive waste management strategy should be established and implemented. Sustainability study is necessary to continuously investigate and address the problems of e-waste in Nigeria.

Industrial and domestic waste dumping

Improper management of industrial, domestic, medical and agricultural wastes are often seen as indiscriminate waste discharge or dumping in different parts of the world. This is a major cause of environmental degradation leading to poor environmental health and diseases. It causes hazards through physical, micro-biological, or chemical agents of disease. Some domestic wastes that pose environmental issue in Nigeria are human and animal feces, food and market wastes, sewage, and industrial and agricultural wastes. Improper disposal of solid wastes and the absence of engineered sanitary landfill in Nigeria could cause direct health risks to people living around the waste dumped. Human beings need to be protected as much as possible from contact with waste. Specific risks are found in handling hospitals wastes and animal wastes. The most obvious environmental damage caused by municipal solid wastes is poor aesthetic, street littering, and urban degradation.

Stop indiscriminate dumping of wastes, classify wastes. Isolate recyclable waste such as paper, bottles, cans and plastics (Figure 4) from other wastes in homes and offices to make money (Waste to Wealth). Indiscriminate waste dumping pollutes surface water which in turn, pollutes groundwater. Home sorting of wastes is most appropriate to stop scavengers who go to waste dumps to pick recyclable materials thereby endangering their health. Waste littering is a serious offence; polyethylene bags including that of sachet water fall under plastics that hardly decompose. Dispose your domestic wastes weekly by taking them to collection points or bring them outside your home for waste collectors to pick them.

Incineration: This is waste destruction in a furnace by controlled burning at high temperatures. However, it is a highly contentious method because incomplete incineration can produce carbon monoxide gas, gaseous dioxins, and other harmful substances.

Incineration is a waste treatment technology, which includes the combustion of waste to produce energy. It is a high temperature waste treatment. During the process, the waste material is converted to gases, particles and heat, used for generation of electricity. The gases, flue gases are first treated for eradication of pollutants before going in to atmosphere. A major problem of incineration is in the disposal of the ash residue. This means that incineration however, does not replace the need for landfill but it reduced the amount to be thrown in it. Among waste-to-energy technologies, incineration is most effective. Other technologies are gasification, anaerobic digestion and Pyrolysis. Sometimes Incineration is conducted without energy production. In the past, incineration was conducted without separating materials thus causing harm to environment (Figure 5).

Usage of incinerators for waste management is divisive. Despite the provision of emission control systems in modern incineration plants, arguments against the use of incinerator outweigh arguments in support of the use.

Recycling: This is a process to change waste materials

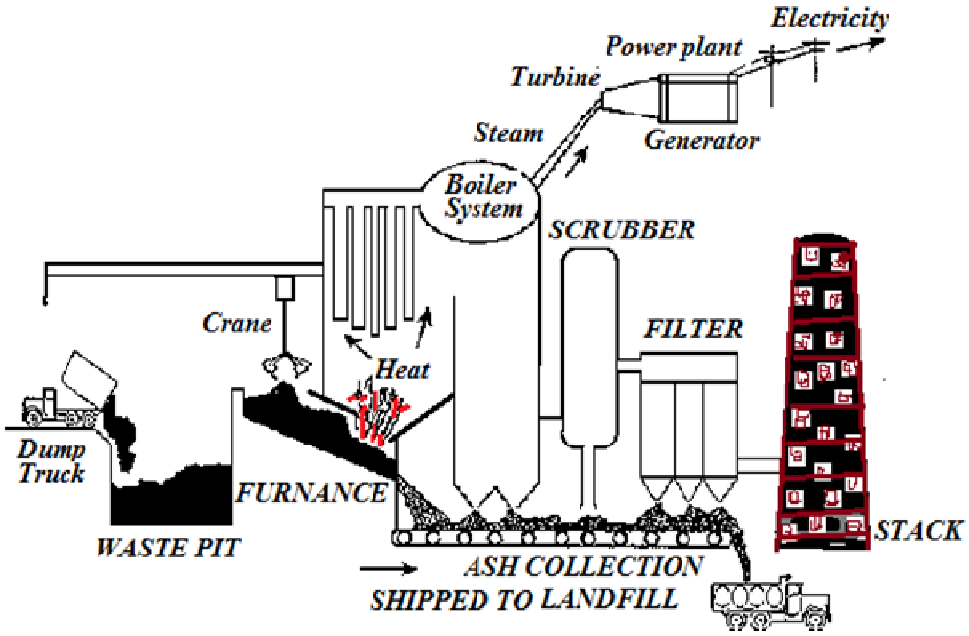

Figure 5. Simple design of an energy production incinerator.

into new products, thereby changing waste to wealth, and reducing the consumption of fresh raw materials. Recycling reduces air pollution from incinerator and water pollution from landfill. It reduces the need for "conventional" waste disposal, and lower greenhouse gas emissions.

Recycling is a key component of modern waste reduction and is the third component of the "Reduce, Reuse and Recycle" (RRR) waste hierarchy. There are some international standard organization (ISO) standards related to recycling such as ISO 15270:2008 for plastic wastes and ISO 14001:2004 for environmental management control of recycling practice. Recyclable materials include used oil, glass, paper, metal, plastic, textiles, automobile and electronics. The composting or other reuse of biodegradable waste such as food or garden waste is also considered recycling. Materials to be recycled are either brought to a collection center or picked up from homes as against picking from waste dumps. These materials are then cleaned thoroughly and reprocessed into new materials. For example, used office paper would be converted into new office paper, and plastics can easily be recycled to produce fuel oil (Figure 6).

Oil and gas, coal, nuclear wastes

Coal, oil, and gas consist largely of carbon and hydrogen. The process that we call "burning" actually is chemical reactions with oxygen in the air. For the most part, the carbon combines with oxygen to form carbon dioxide (CO_2), and the hydrogen combines with oxygen to form water vapor (H_20). In both of these chemical reactions a substantial amount of energy is released as heat. Since heat is what is needed to instigate these chemical reactions, we have a chain reaction: reactions cause heat, which causes reactions, which cause heat, and so on. Once started the process continues until nearly all of the fuel has gone through the process. The carbon dioxide that is released is the cause of the greenhouse effect causing the world largest share of environmental degradation. According to NNPC report (2010), a large proportion (about 63%) of the gas produced in Nigeria is being flared. By 2002 and 2003, gas flared remained as high as 45.4 and 42.7% while gas used was 54.6 and 57.3%, respectively. The economic costs in terms of lost incomes, air pollution, higher ambient temperature and reduction in the standard of living are expected to be excessive.

Coal:A large coal-burning plant annually burns 3 million tons of coal to produce 11 million tons of carbon dioxide. The water vapor release presents no problems, since the amount in the atmosphere is determined by evaporation. In addition to combining carbon and hydrogen from the fuel with oxygen from the air to produce carbon dioxide and water vapor, burning fossil fuels involves other processes. Coal and oil contain small amounts of sulfur, typically 0.5 to 3% by weight. In the combustion process, sulfur combines with oxygen in the air to produce sulfur dioxide, which is the most important contributor to acid rain water. The greenhouse effect causes only economic disruption and acid rain kills only fish and trees, whereas air pollution kills people and causes human suffering.

Figure 6a. Waste plastic recycled to fuel oil **(b)** The Universal Recycling Symbol

Nuclear wastes:Nuclear energy relies on the fact that some elements can be split (in a process called fission) and will release part of their energy as heat. Because it fissions easily, Uranium-235 (U-235) is one of the elements most commonly used to produce nuclear energy. It is generally used in a mixture with Uranium-238, and produces Plutonium-239 (Pu-239) as waste in the process. All the steps in the complex process of creating nuclear energy entail environmental hazards. The mining of uranium, as well as its refining and enrichment, and the production of plutonium produce radioactive isotopes that contaminate the surrounding area, including the groundwater, air, land,plants, and equipment. As a result, humans and the entire ecosystem are adversely and profoundly affected. Some of these radioactive isotopes are extraordinarily long-lived, remaining toxic for hundreds of thousands of years. Presently, we are only beginning to observe and experience the consequences of producing nuclear energy as unsustainable due to accident risks.

Oil Spill:Oil spill worldwide causes environmental degradation with chain reactions.The Niger-delta region of Nigeria has continued to attract scholarly attention in view of devastation of its environment and people due to failure to manage the negative consequences of oil exploitation and underdevelopment it has spawned in the region. The Niger Delta is one of the world's most important wetland and coastal marine ecosystems. It is home to some 10 million people by the 1991 census, estimated to over 28 million by 2006. Due to its rich natural resource base, environmental exploitation is rife and pollution affects the people in unprecedented ways. Oil has been extracted inthe Niger Delta bythe national and multinational oil companies since 1958. Oil pollution caused by oil spills and gas flaring by the oil industry devastates farmland, rivers, villages and the air. Oil pollution kills fish and theirfood sources; it damages agricultural land causing soil infertility and negatively impacts agricultural productivity (Egberongbe et al., 2006).

Groundwater pollution and Over-exploitation

There is proliferation of shallow substandard private water wells, poor distribution of public water wells, poor planning,and poor management of public wells in Nigeria. About 60% of public water wells are either abortive or not functional. The lack of public water supply notwithstanding, private wells cannot replace public wells in communities. Proliferation of shallow substandard private water wells is neither environmentally friendly nor a sustainable groundwater development practice. Suggested sustainable practices are government-private partnership for public wells, and private-private partnership for private wells. Two major practices supporting failure of public water supply in Nigeriaare:

a) Improper or partial distribution of public wells due to lack of easily retrievable information on existing wells in the region, and favoritisms. Often a community may have two or more public wells whereas the next community does not have one.
b) Poor maintenance and often sabotage in the development and operational processes of public wells. Fund budgeted for water well development and maintenance may be diverted, resulting to the use of inferior materials and no proper supervision during the well construction.

Earthquake

Earthquake is the world largest cause of environmental degradation seconded by flood. It is caused by excessive accumulation of seismic waves beyond the elastic limits of rocks in the affecting area. Regions situated between continental plate boundaries are most seismically active to experience earthquakes. Forecasting a probable timing, location, magnitude and other important features of a forthcoming seismic event is called earthquake prediction.

Various attempts have been made by environmental seismologists and others to create effective systems for precise earthquake predictions, including the VAN method. Most seismologists do not believe that a system to provide timely warnings for individual earthquakes has yet been developed, and many believe that such a system would be unlikely to give significant warning of impending seismic events.

However, sustainability study, involving more general forecasts routinely predict seismic hazard. Such sustainability study estimates the probability of an earthquake of a particular size affecting a particular location within a particular time-span. Universities are therefore obliged to intensify efforts in earthquake prediction.

Storm water and Surface water Pollution and Drought

Environmental degradation due to no storm water management in Nigeria is significant in soil and surface water degradation. Lack of storm water treatment best management practice facilities in Nigeria indicates poor environmental awareness, because infiltration and detention basins are cheap, with no complex hydrological designs. Storm water or runoff from market square, mechanic villages, industrial layouts, construction sites etc. deserve treatment before it is allowed to join the urban water way. Sustainability study in the area of storm water treatment is inevitable towards improving environmental quality in this 21st century. Safety means sustainability across our value chain worldwide to protect our environment and communities. Protecting our natural environment is critical to the health and prosperity of our communities and country.

Drought: This is an extended period when a region notes a deficiency in its water supply whether surface or underground water. This global phenomenon has a widespread impact on agriculture. Lengthy periods of drought have long been a key trigger for hunger, poverty, mass migration and other humanitarian crises within Africa and the Sahel.

Abandoned Mine Pits

The increasing number of abortive and abandoned quarry pits, and the several associated geo-environmental hazards have given cause for greater concern. Environmentalists, governments, and the general public now seek innovative ideas, and research collaborations that will reduce incidents of abortive and abandoned quarry pits. Quarry operators may be charged with the responsibility to reclaim quarry pits as soon as their operation is over. Indiscriminate roadside excavation of borrow pits for road construction and other civil Engineering works without the intention of restoring or reclaiming the pits have left much to be desired in terms of the potential hazards. Abandoned road sides borrow pits causes landslides, rock falls, gully erosion, road failure, and ground water contamination. Abandoned borrow pits show evidence of unsustainable engineering practices. Firstly, there should be no road side excavation, and operators of borrow pits should get the necessary site approval from government ministries of environment before opening a borrow pit. Secondly, geotechnical assessment must be carried out to certify adequacy of a site, in terms of its soil characteristics to avoid cases of trial pits that leads to abandon borrow pits. There is loss of human life and arable land, ecosystem disorder with poor environmental quality and safety. Stagnant water in the pits supports daily breeding of mosquito and tsetse fly, (Nwachukwu and Osoro, 2013).

Erosion and Flood

Over sixty five percent of soil on earth is said to have displayed degradation due to soil erosion, salinity and desertification (Okin, 2002). Much in the rain forest belt of the world, rain drops on the shallow streams, splash the soil, increase turbulence and sediment carrying capacity. The transition to agriculture from natural vegetation often does not provide protective cover to the soil. Soil erosion is one of the most serious environmental and public health problems facing human society. Humans obtain more than 99.7% of their food (calories) from the land and less than 0.3% from the oceans and other aquatic ecosystems. Each year about 10 million ha of cropland are lost due to soil erosion, thus reducing the cropland available for food production. The loss of cropland is a serious problem because the World Health Organization reports that more than 3.7 billion people are malnourished in the world. Overall soil is being lost from land areas 10 to 40 times faster than the rate of soil renewal imperiling future human food security and environmental quality (Pimentel (2006).

Flood: Floods are among the most frequent and costly natural disasters in terms of human hardship and economic loss. As much as 90 percent of the damage related to all natural disasters (excluding droughts) is caused by floods and associated debris flows. Melting snow can combine with rain in the winter and early spring; severe thunderstorms can bring heavy rain in the spring and summer; or tropical cyclone scan bring intense rainfall to

the coastal area. Floods are one of the leading causes of death from natural disasters in the United States. Over 200 flood-related fatalities are reported each year with over half being vehicle-related as people try to drive through floodwaters. Floods can damage and devastate homes and farms, displace families as well as pets and livestock, damage crops, and disrupt agriculture processing and business. Heavy rains have in recent time unleashed floods in parts of Nigeria and other tropical rain forest belt of West Africa, testing the countries' emergency preparedness for flood events. The 2012 floods affected about 7 million people.

Diseases

The combination of climate change and environmental degradation has created ideal conditions for the emergence, resurgence and spread of infectious diseases - diseases which kill more than 17 million people annually. Increased climate change has also altered the functional balance among predators and prey, which is important for controlling the proliferation of pests and pathogens. Warmer and sometimes wetter weather may already be extending the range of infectious diseases beyond regions where they are endemic. These were some of the disturbing conclusions of a study by Epstein and Ferber (2011) of the Centre for Health and Global Environment, Massachusetts, USA in a book titled: Changing Planet, Changing Health. Global warming may cause one million additional deaths from malaria each year,' the book warns. The prevalence of human diseases is increasing rapidly worldwide, as is the number of deaths from diseases. The rapid expansion of human populations is a major factor in the rise of human diseases: Humans living in crowded, urban areas are in an ecosystem that is ideal for the resurgence and rapid spread of old diseases as well as for the development and spread of new diseases. Sustainability study this century must emphasize disease surveillance along environmental degradation.

Biodiversity

In ecology, the word sustainability describes how biological systems remain diverse and productive over time. Long-lived and healthy wetlands and forests are examples of sustainable biological systems. For humans, sustainability is the potential for long-term maintenance of well being, which has ecological, economic, political and cultural dimensions. Sustainability requires the reconciliation of environmental, social equity and economic demands. Healthy ecosystems and environments are necessary to the survival and flourishing of humans and other organisms. Human activity is having a significant and escalating impact on the biodiversity of world ecosystems, reducing both their resilience and biocapacity (Walter, 2006). Loss of biodiversity stems largely from the habitat loss and fragmentation produced by the human appropriation of land for development, forestry and agriculture as natural capital is progressively converted to man-made capital. Land use change is fundamental to the operations of the biosphere. This is because alterations in the relative proportions of land dedicated to urbanization, agriculture, forest, woodland, grassland and pasture have negative effects. The extended effects on the global water, carbon and nitrogen biogeochemical cycles can impacts natural and human systems (Kreb, 2001).

Ecosystem

A system formed by the interaction of a community of organisms with their environment. It is a complex set of relationships among the living resources, habitats and residents of an area. It includes plants, trees, animals, fish, birds, micro-organisms, water, soil and people, each depending somehow with the other. Ecosystem varies greatly in size and composition and if one part of an ecosystem is destroyed or disappears, the rest will feel the impact. To this effect therefore has ecosystem become the complex of a community of organisms and its environment functioning as an ecological unit. Ecosystems are essential to our well-being and prosperity as they provide us with food, clean air and fresh water. Ecosystem management is a process that aims to conserve major ecological services and restore natural resources while meeting the socioeconomic, political and cultural needs of current and future generations. The ecosystem services concept itself was popularized by the Millennium Ecosystem Assessment (MA) in the early 2005. This grouped ecosystem services into four broad categories: provisioning, such as the production of food and water; regulation, such as the control of flood, climate and disease; environmental supporting services, such as nutrient cycles and crop pollination; and cultural, such as spiritual and recreational ethics as illustrated in Figure 7.

Deforestation and desertification

Africa is particularly vulnerable to desertification. About two thirds of the continent consists of desert or dry lands. The obvious causes of desertification and deforestation consist of major ecosystem changes, such as land conversion for various purposes, over-dependence on natural resources and several forms of unsustainable land use. However, the issue of desertification is inseparable from social problems such as poverty and land tenure issues. Politics, war and national disasters affect the movements of people and thus impact on the land. A coalition of non-governmental organizations, Civil Rights

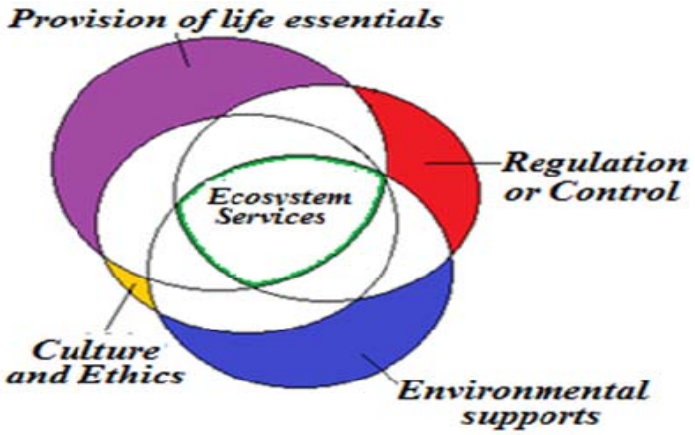

Figure 7. Four categories of Ecosystem services

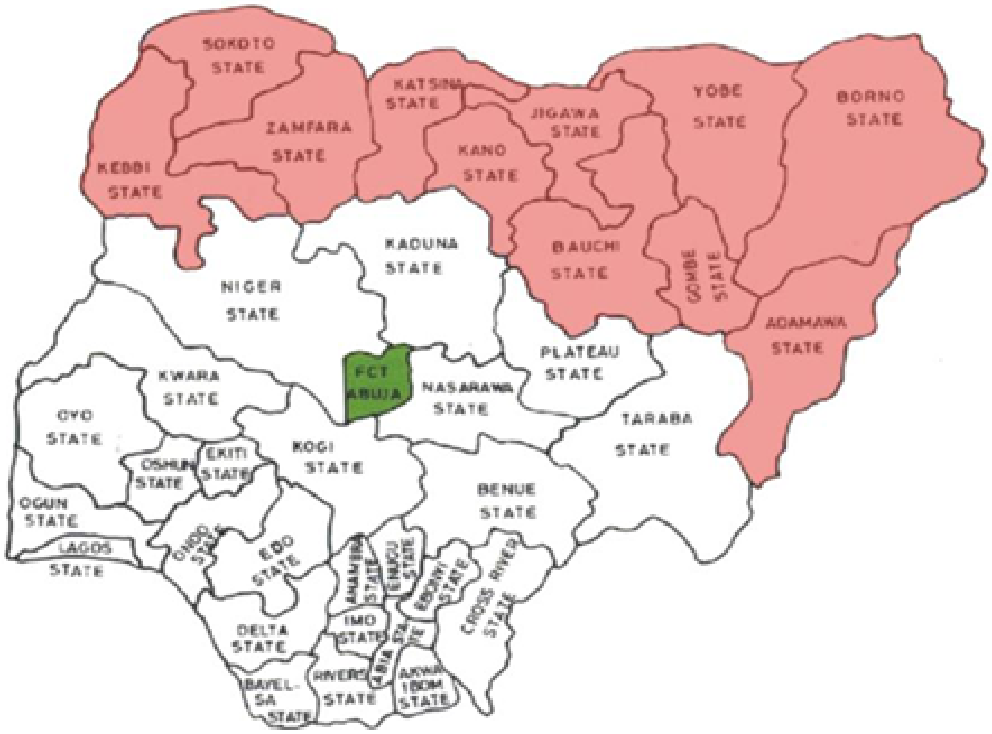

Figure 8. Map of Nigeria showing the desert prone states

Congress (CRC) and Climate Change West Africa Region Network (CLICWAN),have in 2009 stated that the Northern Nigeria stand to be wiped off, following the persistent desert encroachment of the region. Statistics have shown that desert is encroaching with about 20 to 30 kilometers annually or more than that in contrast to 10 years back when there was a shelterbelt program. The northern states so affected are shown in figure 8, due to their North West geographical locations. The Federal Government says it has set aside N10 billion to halt desert encroachment in the Northern part of the country.

Sustainability studies

These are studies related to the interdisciplinary perspectives of the sustainability concept. It is education for sustainable development. Programs include instruction in sustainable development, earth science, environmental policies, ethics, ecology, landscape architecture, city and

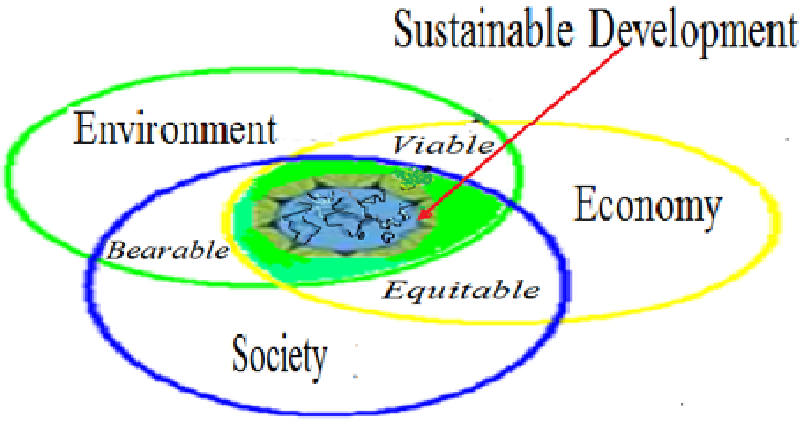

Figure 9. Sustainable Development indicators

regional planning, economics, natural resources, sociology, and anthropology. The world is facing greater challenge in the 21st century: we need to redesign and rethink much of our way of life to make itsustainable given the planet's limited and fragile resources. Rigorous science has explained that current consumption trends threaten the planet with several issues such as climate change by placing hardships on vulnerable peoples. Modern systems ranging from transportation networks to community building to food production will need to be significantly changed and adapted to this new reality. The leaders of this critical effort will be the next generation of college-educated students. Sustainability studies prepare students for global citizenship while providing the knowledge and skill sets that are increasingly in demand.

According to the International Institute for Sustainable Development; "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains within it two key concepts:

A). the concept of needs, in particular the essential needs of the world's poor, to which overriding priority should be given; and
B). the idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and future needs." Few examples of sustainable initiative:

i. The one man one tree planting program
ii. The shallow aquifer decontamination program
iii. The environmentally friendly automobile mechanic village concept
iv. The hybrid automobile technology program
The environmentally friendly alternative energy programs

Sustainability develops indicators that measure progress toward a sustainable economy, society and environment. These three important keywords of sustainability (figure 9) address issues of sustainable development along UN programs. Sustainability study should addresses the integration of cultural, economic, environmental, and energy components and supports projects and perspectives that have positive impacts on future resources, ecosystem health, and human wellbeing. It is essential for all engineers to consider environmental influences caused by their work and products. The issue of sustainability can be summarized into: Sustainable Environment/Health and Safety; Sustainable Science; Sustainable Architecture; Sustainable Engineering; Sustainable Agriculture; Sustainable Urban and Regional Planning; Sustainable Building and Housing and Sustainable Management.

Conclusion

The idea about this wall chart/manual stems from lack of awareness observed among students of primary, secondary and tertiary institutions about the state of earth environment, its resources and development. Awareness creation of global environmental issues and sustainability concept is now a global challenge. This situation is critical to lack of sustainable development programs in many African countries. The 'ultimate' aim of this wall chart/ manual is to provide a simplified general environmental education material for all. It is important 'for each university or college graduate and school leaver in Africa to have formulated a responsible attitude towards the sustainable development of Planet Earth. The need to appreciate its beauty, conserve its resources and preserve its natural landscape. This manual and the analysis on which it rests provide the material base for individuals to acquire a general knowledge and disposition to make decisions on regional, national, and global environmental issues. The goal is for human population to support all United Nations programs to save planet earth. This wall chart and its manual are treasure in homes, classrooms, libraries and offices and material set for teaching environmental science in schools, colleges and universities.

Universities are required to integrate sustainability studies as: sustainability science, sustainable engineering, sustainable agriculture, and sustainable management, in order to achieve sustainable development. The role of universities in the 21st century will include conducting sustainability studies and research reporting directly to the target audience. Universities this century may not base academic output only on journal publications, but include public lectures and direct research reporting via center for sustainability studies. It is necessary that all future graduates of African higher institutions: universities, polytechnics, and colleges take ESS 200 or its equivalent. Environmental issues as contained in this wall chart and its manual will make ESS 200.

Conflict of Interests

The authors have not declared any conflict of interests.

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