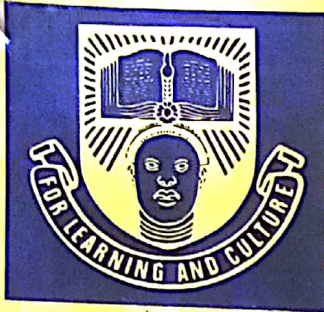




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JUNE, 2016

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M.A.O ALUKO

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THE ROLE OF ENVIRONMENTAL TECHNOLOGY IN SUSTAINABLE DEVELOPMENT IN NIGERIA

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ABSTRACT

The study considered the key role of environmental technology in sustainable development in Nigeria. It reviews concepts and techniques that examine national development and the application of environmental methods improve sustainable development in Nigeria. Attempts to improve and make use of environmental technologies to value and expand the rate of national development in developing countries are increasing. For this reason, it is imperative to understand the nature of environmental technology as it can be a major guide in achieving the nationally established developmental plans and sustainable goals in Nigeria. Any reasonable growth and desirable development may be an elusive fantasy without a good environmental policy in place. For this reason, this paper examines how national development can be improved through the effective application of environmental technology in Nigeria.

Keywords: Environmental Technology, National Development, Environmental Resources, Sustainability

INTRODUCTION

In the beginning, man was dependent on what the environment could offer. As population increased, human's needs escalated and possibilities were sought. This resulted into technological inventions useful for the provision of needs. In the process of providing for the increasing population through technological advancement, injuries are being inflicted on the environment leading to environmental degradation.

Environmental degradation such as loss of biodiversity, greenhouse gas emissions, worldwide deforestation, depletion of stratospheric ozone, urban air pollution, acid rain, pollution of freshwater and the oceans, contamination of arable land and loss of topsoil and shortages of water, food, materials, and fuels in many parts of the world are of growing international concern. While there are great uncertainties about the causes and effects of global environmental changes, the consequences of these changes for national economies, human health, and quality of life could be severe (Srinivas, 2015).

Industrial activities of the past half century have created serious ecological problems. The list includes global warming, ozone depletion, loss of biodiversity, natural resource scarcity, air pollution, acid rain, toxic wastes, and industrial accidents. Currently across the globe, 780 million people have no supply of drinking water, around 3.5 million tonnes of waste are produced every day and energy consumption is due to increase by around one-third by 2035. These problems are expected to worsen in the next 50 years when the world population is expected to be 11 billion as reported by Messe (2015).

It is believed that this is tantamount to disrupting the development process in concerned nations of the world. For the attainment of sustainable development in any nation, which seems to be the order of the day, it becomes imperative to develop appropriate technologies to address these environmental problems. According to the report from Brundtland (1989), "sustainable development is the development that meets the needs of the present without compromising the ability of future generations to meet their needs". It means the balancing of economic, social, environmental, and technological considerations, as well as the incorporation of a set of ethical values.

Sustainability can be achieved only if great attention is given to key areas: environmental quality and economic development. In general, the primary opportunities to pursue these twin goals are technological in nature. Therefore, in both developed and developing economies, technology and engineering issues are pivotal for

economic growth and development. The environmental problems addressed by these technologies are widespread; consequently these technologies have wide applicability across industries. Since environmental problems are likely to last a long time, environmental technologies will have sustained impacts as reported by Ahuja and Tatsutani(2009). In the coming years, we will see these technologies affecting the competitiveness of many industries and countries. In recognition of this important role of environmental technologies, countries such as Japan, Germany, Sweden, and Denmark are targeting them for rapid development. Nigeria's approach to sustainable development received a boost from the establishment of the Vision 2010 Committee, a body charged with the articulation of a long-term sectoral economic development programme designed to usher the nation into the third millennium. The National Agenda 21 document was prepared to address the environmental implications of any developmental programme. This is in the right direction to attaining improved national development yet their impact in improving economic, social and environmental development of the nation is not felt.

It is to this extent that this paper tends to focus on evaluating the importance of environmental technology to the development of nations of the world and in particularly Nigeria by considering the roles of environmental technology to mitigating degradation problems as well as provide strategic pathways for effective for environmental technology programme in Nigeria.

CONCEPTUAL ISSUES

National Development

Over the years, the socio-economic activities of humans have disrupted the ecosystem. As human population increases, the habitat is altered and destroyed. There is a continuous impact on natural resources, food, clean fresh water, space, environment, energy among others. They get compromised and depleted. Most African countries, Nigeria inclusive are still on the part of struggle to attain the desired level of development and this is why they have been tagged third world or developing nations by the West (Adekoya and Ajilore, 2012). Some of the predominant features of developing countries, according to Thirlwall (2003, cited in Adekoya and Ajilore, 2012) include: low level of capital accumulation, the dominance of agriculture and petty services, rapid population growth, exports dominated by primary commodities, unemployment, national income distribution, poverty weighted growth rate, lack of basic welfare needs, stages of development and structural change, industrialization and growth among others.

The term national development is used to refer to the ability of a nation to improve the lives of its citizens. Measures of improvement may be material (e.g. an increase in the gross domestic product) or social (e.g. literacy rates and availability of healthcare). In defining the concept, the third National Development Plan of 1980 says:

"True development must mean the development of man, the unfolding and realization of his creative potentials, enabling him to improve his material conditions of living through the use of resources available to him. It is a process by which mans personality is enhanced, and it is that enhanced personality creative, organized and disciplined-which is the moving force behind the socioeconomic transformation of any society."

The notion of 'national development' according Audu (2008), comes with it the implications of valued and positive changes that bring about a better quality of life for the population as a whole, concomitant with this notion are economic and social development. Thus, development related to increasing the efficiency of the production system of a nation, meeting the basic needs and satisfaction of the population, reducing poverty, creating employment and creating equality of opportunities and increasing the welfare of all social groups are embraced within the concept of national development. This presupposes that national development is a multi-dimensional process that involves 'economic growth' and 'economic development.' It encompasses the economic, social and political systems of a nation.

Lawal and Abe (2011) asserted that human beings are not only interested in the political aspects of lives, but also in

their standard of living at any point in time and over a period of time. In other words, people tend to care not only about improvements in the current quality of their lives, but also want such improvement to be enhanced in the future. This suggests a dynamic setting whereby an improvement in the standard of living in the current period should lead to further improvement in living standards in the medium to long term. However, such improvements in the quality of life can only happen when economic growth and development also improve.

Environmental Technology

Technology is the application of knowledge to the practical aims of human life or to changing and manipulating the human environment. Technology includes the use of materials, tools, techniques, and sources of power to make life easier or more pleasant and work more productive. Whereas science is concerned with how and why things happen, technology focuses on making things happen. The word technology is a combination of two Greek words, *techne* and *logos*. *Techne* means art, craft, or skill. *Logos* means "to speak of." Some have since taken the word *logos* to imply the practical application of *techne*, but others say that is stretching its etymological roots.

According to the European Commission (2004), Environmental Technologies are defined as:

"all technologies whose use is less environmentally harmful than relevant alternatives. They include technologies to manage pollution (e.g. air pollution control, waste management), less polluting and less resource intensive products and services (e.g. fuel cells) and ways to manage resources more efficiently (e.g. water supply, energy-saving technologies)."

Shrivastava (1995) also defined Environmental technologies as the production equipment, methods and procedures, product designs, and product delivery mechanisms that conserve energy and natural resources, minimize environmental load of human activities, and protect the natural environment. They include both *hardware*, such as pollution control equipment, ecological measurement instrumentation, and cleaner production technologies. They also include *operating methods*, such as waste management practices (materials recycling, waste exchange) and conservation-oriented work arrangements (car pooling, flextime), used to conserve and enhance nature (Shrivastava, 1995).

As techniques, they are used for pollution abatement, waste management, energy, water and material conservation, and for improving technological efficiency of production. As a management orientation, environmental technologies have spawned environmentally responsible approaches towards product design, manufacturing, environmental management, technology choice and design of industrial systems. Environmental technologies refer to analytical instrumentation for environmental monitoring, geophysical and meteorological techniques, and alternative ways to produce and store energy.

Methods and Roles of Environmental Technology

Good practices in the environmental management will go a long way to reducing our vulnerability to natural and human-induced disaster and degradation (Srinivas, 2016). According to King Abdulaziz City for Science and Technology (KACST) 2005, four general types of environmental technology are:

1. **Avoidance Technologies:** Technologies (equipment and processes) used to prevent or minimize generation of pollutants. These are general methods and tools (sustainability assessment and indicators that are used to carry out life cycles assessment (LCA) on bio-fuels, testing, etc.) that are applicable to all technologies in order to make them more environmentally friendly.
2. **Monitoring and Assessment Technologies:** These are technologies used to establish and monitor the condition of the environment. They include technologies for environmental monitoring and analysis such as online sampling and monitoring devices within integrated water resource management, sensors for groundwater condition and flows, remote sensing among others.

3. Control Technologies: Technologies that render hazardous substance harmless before they enter the environment.
4. Remediation and Restoration Technologies: Technologies used to render hazardous substances harmless and specific technology development to reduce harmful environmental effects such as solid waste management, environmental restoration/remediation, technologies for landscape management and sustainable agriculture among others.

Sustainable Development

In the broadest sense, sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their needs (Brundtland, 1989). It means the balancing of economic, social, environmental, and technological considerations, as well as the incorporation of a set of ethical values.

Sustainable development is more topical than ever. Climate change, impacts on biodiversity and depletion of natural resources, local, regional, and global environmental degradation are of growing international concern and are mankind's major challenges. While there are great uncertainties about the causes and effects of global environmental changes, the consequences of these changes for national economies, human health and quality of life could be severe if sustainable growth and development is not pursued (EU, 2004).

Sustainable development involves considering environmental, economic, and social objectives when developing and implementing public policies and programmes. It also involves considering the needs of the present as well as the needs of future generations. Integrated decision making and a long-term approach to planning are defining characteristics of sustainable development and represent the key management challenges (UN, 2012).

Sustainable development needs cleaner and resource efficient environmental technologies which can decrease material inputs, reduce energy consumption and emissions, recover valuable by-products, and minimize waste disposal problems or some combination of these. This paper believes that sustainability can be achieved only if great attention is given to two key areas: environmental quality and economic development. In general, the primary opportunities to pursue these twin goals are technological in nature. Therefore, in both developed and developing economies, technology and engineering issues are pivotal.

Energy is a key aspect of sustainable development. The present energy system in Nigeria is mainly based on fossil fuels. This trend is unsustainable for a number of reasons: threats of man-made climate change by greenhouse gas emissions, the rapid depletion of fossil fuels, rising energy prices due to increasing demand, geopolitical uncertainty, and threat of instability in oil-rich countries. Solutions will be found in massive energy efficiency; development of renewable energy based on sun, wind, biomass, and tides; and improvements in energy storage technologies, such as batteries and flywheels. Carbon capture and storage is not yet proven feasible but could help to mitigate increasing CO₂ emissions (Stephens and Zwaan, 2005).

Technological learning and innovation capacity that is critical to enable the provision of essential amenities to all is fundamental to ensuring overall sustainable development. Simply put, a country develops capabilities to innovate, and the absence of such capabilities results in limitations to apply existing technologies in all sectors, including those of public importance, such as health, agriculture and climate change. Building technology and innovation capacity within countries as a whole should therefore be considered as an important international priority in the post-2015 agenda as reported by UN (2012).

Environmental Technology and National Development

Technology is a double-edged sword. It is both a cause of many environmental problems and a key to solving them (CAETS (1995)). It is a matter of fact that the technologies of the past, still dominating in transport, energy, industry and agriculture, are undermining our basic life supporting systems – clean water, fresh air and fertile soil. However, in each of these sectors there are new technologies available or emerging that may, if widely used, essentially solve the environmental problems.

Technology development is generally regarded as a catalyst for national development, because it offers among other things, the necessary support for change in all the major sectors of the economy, most especially in agricultural and industrial sectors. Therefore, it is unarguably the prime source of change, that is, of innovations and adaptations required for improving production methods needed to propel growth and development.

According to Werber (2005), environmental technology contributes to sustainable development by protecting the environment and maintaining welfare. The key issue in environmental technology development is to identify promising technologies while taking into account all life cycle stages of the product or service, from raw material extraction to disposal. Due to the holistic nature of environmental technology, concepts such as eco-efficiency, life cycle assessment (LCA) and eco-design are all needed in the successful creation of environmental technologies. A strategic research objective is to develop these concepts and make them operational in, for example, integrated assessment of technological scenarios.

The United Nations Conference on Sustainable Development ("Rio+20") in 2012 set as one of its themes: "a green economy in the context of sustainable development. One of the outcomes of the plenary sessions on this theme is stated thus:

"We emphasize the importance of technology transfer to developing countries and recall the provisions on technology transfer, finance, access to information, and intellectual property rights as agreed in the Johannesburg Plan of Implementation, in particular its call to promote, facilitate and finance, as appropriate, access to and the development, transfer and diffusion of environmentally sound technologies and corresponding know-how, in particular to developing countries, on favourable terms, including on concessional and preferential terms, as mutually agreed"(UN,2012).

Countries across the world have adopted the Green initiative as governments can now reduce cost of governance by building long lasting eco-friendly cities, adopting environmental-friendly technologies and cutting emissions where possible. According to PEER (2015), this environmental technology research issues can be linked to several European initiatives like the European Commission's Environmental Action Plan (ETAP) and Integrated Product Policy (IPP) as reported by European Commission (2004). ETAP sets the groundwork to stimulate the development and uptake of environmental technologies where as IPP seeks to minimise the environmental impacts of products by looking at all phases of a products' life-cycle and taking action where it is most effective. To reach the goals stated in ETAP and IPP there are serious research needs on many different levels throughout Europe. It is therefore imperative that Africa and Nigeria in context adopt a blueprint for environmentally sustainable and friendly technology to aid in decision making and facilitate governance (PEER, 2015).

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Strategic Priorities for Effective Environmental Technology Programme

Response to key environmental concern can be done by establishing an advanced environmental technology industry, enhancing the competitiveness of the nation in the world environmental technology market, and joining the international community to protect the environment and promote sustainable environmental development.

Environmental technologies are particularly important in a nation, where waste, pollution, air quality and degradation of natural resources have significant environmental implications. The importance of advanced

environmental technologies is to protect the environment and maintain a high quality of life within a nation (PEER, 2015). The Environmental Technology Programme should be based on input from a variety of stakeholders and representatives from the nation's institutions with a vested interest in developing a platform for environmental technology in the nation.

The planning process includes the following steps:

- * Identifying the key needs of the nation for environmental technologies.
- * Assessing the strengths, weaknesses, opportunities, and threats for the programme, including an analysis of the nation's environmental technology publications and patents, and
- * An assessment of international research institutes.
- * Defining a mission and vision for the nation's Environmental Technologies Programme.
- * Defining the key technologies and other program areas needed to address the nation's needs in Environmental Technologies research, development and innovation.

Following this process, the key environmental needs of the nation can be grouped into four main categories as shown in Table 1. In each of these areas, avoidance technologies, monitoring and assessment technologies, control technologies, and remediation and restoration technologies would need to be considered and prioritized based on multiple criteria (Table 1). To this extent, Nigeria as a nation can then decide to transfer, localize, and develop relevant environmental technologies:

Table 1: Nigeria's Key Environmental Needs and Relevant Environmental Technologies
Source: Adapted from KACST (2008)

S/N	Key Need	Type	Required Technology	Environmental
A	Waste	Municipal waste water	Remediation and restoration	
		Municipal solid waste	Remediation and restoration	
		Industrial waste water	Remediation and restoration	
		Hazardous medical waste	Remediation and restoration	
		Hazardous waste	Remediation and restoration	
		Industrial solid waste	Remediation and restoration	
		Agricultural waste	Remediation and restoration	
B	Pollution	Food contamination	Avoidance	
		Oil contamination	Avoidance	
		Radioactive contamination	Avoidance	
		Thermal pollution	Avoidance	
		Noise Pollution	Avoidance	
C	Air Quality	Ambient air quality	Avoidance, monitoring & assessment	
		Greenhouse gases	Avoidance, monitoring & assessment	
D	Natural Resources Degradation	Desertification	Monitoring & assessment	
		Degradation of coastal areas	Monitoring & assessment	
		Biodiversity	Monitoring & assessment	
		Degradation of water resources	Monitoring & assessment	
			Monitoring & assessment	

According to Rejeski (2004), environmental technologies strategy is imperative for economic development. The pursue of environmental technology in Nigeria will depend largely on government action. The government must pursue aggressive national and regional strategies that support renewable energy technologies. Such action include specific funding programs to support the clean-up of contaminated sites and provide water and waste-water treatment among others. They must include strict regulatory enforcement which gives industries and investors the impression that the Nigerian government is serious about environmental protection.

Also, we need a new regulatory paradigm that anticipates environmental problems rather than merely reacts to them. One of the greatest governance challenges Nigeria as a country will face is the need to build a capacity for fast anticipatory learning that can identify and head off potential, environmental and ethical problems that they may come across in the implementation of these strategies. An environmental technologies strategy is needed that will achieve a difficult balance between providing solutions to existing environmental problems and simultaneously shaping the emerging technological infrastructure to avoid or minimize future problems. Adapted from Rejeki (2007), a few steps to attaining environmental strategy by the Nigerian government are stated below.

1. Providing appropriate leadership to underscore the pressing need for innovation in environmental technology.
2. Creating a federal one-stop shop to help companies commercialize environmental technologies.
3. Boosting demand for environmental technologies with aggressive government procurement program.
4. Promoting environmental science and technology research.
5. Creating centers of excellence to drive generation of environmental policies.
6. Improving the Federal Environmental Protection Agency (FEPA) capacity to recruit and retain promising young researches.

Many developed countries of the world achieved their level of development through the adaptation of environmental technology. There is no doubt that the importance of environmental technologies to national development have been recognized by nations who currently are in the forefront of human development index (European Commission (2004). Environmental awareness among the public and policymakers has been growing since the 1960s, when it became widely recognized that human activities were having harmful and large-scale effects on the environment. Consequently, human and national sustainable development are determined largely by the level of technological research, the communication of research results and on the knowledge acquired and brought to bear on policy-making, programme formulation, project implementation, monitoring and impact assessment.

Governments will play important roles by regulating adverse technological consequences, investing in research and development (R & D) and in new technological innovative forms, purchasing sustainable products and services in order to pave the way for broad market introduction, setting criteria that foster sustainable and appropriate technologies, curbing excessive private interests-driven research, setting long-term goals, and communicating about science and technology issues with the public at large (Vergragt, 2006).

Environmentally sustainable economic development can be achieved through adequate technical education at all levels on how to strike a balance between economic, social, and environmental goals. The full uses of environmentally advantageous technologies are needed. Such technologies will utilize resources as efficiently as possible and minimize environmental harm while increasing industrial productivity and improving quality of life as reported by CAETS (1995).

It has been observed that the Nigerian society lacks an in-depth understanding of the role of technology in national development plans (Onipede, 2010). The need to integrate environmental technology policy into national planning has been overemphasized. The incapacity of Nigeria to use environmental technological research as dynamic elements for social development is a consequence of the characteristics of the prevailing national projects. Unless the approach to implementation of national projects takes into consideration the aspirations of the majority of Nigerian populace, scientific resource will continue to be cultural luxury.

In harnessing technologies for environmentally sustainable development in Nigeria, effective national and multilateral economic policies and management strategies that have sustainability as their primary objective are needed. Building of indigenous technological capacity, which includes trained experts that understand and take advantage of existing technological knowledge is very important. While governments play a critical part in the attainment of sustainable development, the extensive capabilities of the private sector particularly in relation to technology development and technology transfer also have a key role.

CONCLUSION AND RECOMMENDATIONS

This paper has carefully discussed the role of environmental technology in national development in Nigeria. It also examined strategies and priorities that can be put in place for an effective environmental technologies programme in Nigeria. This paper suggests integration of environmental technology policy into national planning. Also, focus should be directed to cleaner technologies, higher efficiency and production techniques that minimize waste at source and maximizing fuel and energy efficiency. Also, environmentally sustainable economic development can be achieved through adequate technical education at all levels on how to strike a balance between economic, social and environmental goals. Lastly, the planet must be regarded as a single complex system whose interests are best served by coordinated international action with both developed and developing nations have a common interest in resolving global environmental issues.

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