/CHAPTER 2

Sustainability Science and the Issue of Sustainable Development in Nigeria

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Preamble

One of the most conspicuous themes of the 2015-2030 global development agendas is sustainable environmental management. This is expressed in the varied nomenclatures of different development goals aimed at addressing issues surrounding environmental sustainability. The Sustainable Development Goals (SDGs) addressed the need for development to take into consideration clean energy, water and sanitation, climate change, as well as terrestrial ecosystems and biodiversity. These issues present daunting challenges to Nigeria (Gbadegesin, 2017). The basic question is what has been the role of Science in mitigating some of these challenges to human survival on earth? As a community of Scientists are we really impacting positively on our environment and the society? Unfortunately, the capacity of our ecosystem is not limitless and this has implications for future generations on how to meet their needs the way we are able now. This is where the role of science becomes crucial especially as far as sustainability of the earth resources and reducing humans risk to natural disasters are concerned. In the rest of the paper, I examine the main dimensions of sustainable development and later discuss the main features of sustainability science and its benefits for environmentally sustainable development. In addition, the paper examines the main challenges in incorporating sustainability science into African Development strategies and concluded with suggestions on how to incorporate Sustainability Science into the Nigerian educational system.

Sustainable Development

There are more than a hundred definitions of sustainable development but the simplest and the most widely used is the one presented by the World Commission on Environment and Development in 1987. It defines sustainable development as *Development that meets the needs of the present without compromising the ability of future generations to meet their own needs*. Although simply defined, the term has different meanings to different Development Practitioners and Scientists. For example***, in ecology***, it is defined as development that preserves the diversity of biological species, ecological processes and ecosystem services***. In economics*** it is development ensuring that the per capita income of future generations is not lower than that of the present generation***. The sociologists*** define sustainable development as development that preserves and maintains close relationships in communities. In technical terms, it is a development path along which the maximization of human well-being for today's generations does not lead to declines in

future wellbeing. In summary, sustainable development constantly seeks to achieve social and economic progress in ways that will not exhaust the earth's finite resources. As noted by van den Bergh (2007), the needs of the world today are real and immediate, yet it is necessary to develop ways to meet these needs that do not disregard the future.

Sustainable national development can be seen as a process of improving the range of opportunities that will enable people to achieve their aspirations and full potential over a period of time while maintaining the resilience of economic, social and environmental systems. Basically it involves a knowledge base which revolves round three basic concepts which are the economy, the environment, and the society. The members of a society are financially empowered and responsible to not damage the environment so that our children's future is not compromised (McKeown, 2002). As noted by Ciegis *et al.* (2009), sustainable development encompasses three fundamental approaches. These are the economic, environmental and social development approaches as well as three dimensions of wellbeing i.e. economic, ecological, and social and their complex interrelations.

Economic sustainability is aimed at maximizing the flow of income and consumption that could be generated while at the same time maintaining the stock of assets which yield beneficial outputs (see Solow, 1993, Maler, 1990). The problem is how do we guarantee optimal distribution of capital accumulation among generations? On the contrary, the ecological sustainability focuses on general vitality and health of ecosystems. It emphasizes the significance of preserving biological variety in order to secure balanced nature, elasticity of ecosystems at a global level and their ability to adapt to changes in the biosphere (Ciegis, ibid). The sociocultural sustainability concept is people oriented. According to Chambers (1989), this reflects the interface between development and dominating social norms and strives to maintain the stability of social systems. In other words, socio-cultural sustainability seeks to reduce vulnerability and maintain the health of social and cultural systems and their ability to withstand shocks.

A combination of these three approaches produces what some people during a chat on the Internet referred to as the seven key concepts for a sustainable future:

- *Interdependence:* This involves an understanding of how people, the environment and the economy are inextricably linked at all levels from local to global.
- *Citizenship and Stewardship*: Here, every individual is recognized and responsible for his/her action to ensure that the world is a better place.
- *Needs and Rights of Future Generations*: As global citizens we must understand our own basic needs and the implications for the needs of the future generations of our actions today.
- *Diversity*: Respecting and valuing human diversity (cultural, social and economic) and biodiversity.
- *Quality of Life*: Acknowledging that global equity and justice are essential elements of sustainability and that basic needs must be met universally.
- *Sustainable Change*: This is an old but still very relevant ecological principle that recognizes the fact that resources are finite and that this has implications for people's lifestyles, commerce and industry.

- *Uncertainty and Precautions*: Acknowledging that there is a range of possible approaches to sustainability. There is therefore the need for flexibility and lifelong learning on sustainable development issue.

Sustainability Science

Sustainability involves the interdisciplinary integration of knowledge, insights, skills and practices from the natural, social and engineering disciplines that are directed toward contemporary and long-term protection and well-being of the Earth, its environment and its nonhuman and human inhabitants (Bacon *et al*., 2011). A major consideration in addressing sustainable development is the increasing population and the requirement for meeting their needs. The current world population is just over six billion and is projected to reach the 10 billion mark by 2050 (UNPF, 1998). About half of the people live in cities, with the accompanying concerns brought about by rapid urbanization and the growth of megacities.

In sub-Saharan Africa, the current population of 600 million is projected to reach 1.7 billion by 2050, displaying the fastest rate of increase of any major sub-region in the world. The rate of population growth is double that of food production, thus necessitating food importation. For Nigeria, the population is projected to more than double and to reach approximately 244 million in 2050. Lagos is already one of the world's megacities with a projected population of 25 million this year (Godwin 2001).

The emerging public philosophy of sustainability is a call to ethical responsibility. It focuses directly on the values that are a precondition to a just and sustainable world. These values should not be confused with mere individual preferences; rather they arise naturally and continuously from the fact of our participation in community and in nature. We each belong to a community; every self is a social self; and every human community depends on nature for sustenance. Nurtured by community and nature, we experience inescapable moral claims; other humans and other creatures command our respect and demand to be valued.

In seeking a philosophy for sustainability, it has been affirmed that sustainability itself is a moral value because it is a condition in which natural systems and social systems survive and thrive together indefinitely. Sustainability represents a distinctively contemporary imperative, stemming from persistent, unfulfilled claims of solidarity and justice, a deepening understanding of the interrelatedness of life, and the stark realities of the destruction of nature. Today, it becomes a basic human responsibility to ensure that both natural and human systems are sustained in a condition of health – for the sake of the earth and its people.

Furthermore, sustainability requires a new standard of "enough for all" without excess and wastefulness. It demands that first the basic needs of all be met and additional goods shared with some measure of equity. Traditional economic growth, enriching primarily those with more than enough, has failed to narrow the gap between the rich and the poor and can no longer be trusted to overcome poverty. Sustainability Science therefore requires an infusion of new values into the workings of the political economy.

Benefits of Sustainability Science for Sustainable Development

Sustainability science probes interactions between global, social, and human systems, the complex degradation mechanisms of these systems, and the concomitant risks to human wellbeing. By identifying and addressing complex challenges that are not typically considered in traditional academic disciplines, this trans-disciplinary science provides the way forward to a sustainable global society. After more than two decades of the establishment of Sustainability Science, this science can no longer be considered a new discipline. Given more than a decade of development of sustainability science approach, now is the right time to consider what has been learned from this scholarly exchange on research and methodologies and to apply this knowledge to the current sustainability challenges and to the attainment of the United Nations Sustainable Development Goals (SDGs) (United Nations2015).

It has been increasingly recognized that to meet the needs of society and its growing population and to avoid further undermining the Earth's essential life-support systems, a new paradigm of scientific inquiry needs to be invoked. It is a paradigm that addresses the complex interaction between the various components of the Earth system, the interaction with society together with the impact of society on the Earth system. This paradigm has now been referred to as sustainability science, that is, *science and technology in service of a transition towards sustainability.* This requires in-depth exploration of goals, trends and transition on the pathway towards sustainability, including consideration of environmental threats and opportunities, and relevant actions. A very crucial element is the recognition of the multi-dimensional interactions, including the human dimension; hence, the necessity for the participation of not only those in the natural sciences, but also of those in the social sciences.

Sustainability science is a multi-disciplinary approach to science that recognizes the limitations of traditional scientific inquiry in dealing with the complex reality of social institutions interacting with natural phenomena. It seeks to improve on the substantial, but still limited understating of nature-society interactions gained over time. This will be achieved through work in the environmental sciences estimating and evaluating human impacts, and evidence from social and development studies that takes into account environmental influences on human wellbeing. What is urgently needed now is a better understanding of the complex dynamic interactions between society and nature so that the alarming trend towards increasing vulnerability is reversed. This will require major advances in our ability to analyze and predict the behaviour of complex self-organizing systems, characterize the irreversible impacts of interacting stresses, interpret multiple scales of organization, and assess the roles of various social actors with divergent expectations.

Much contemporary experience points to the need to address these issues through integrated scientific efforts focused on the social and ecological characteristics of particular places or regions. Thus, answers to some set of core questions that examines the combinational character of nature society interactions, our ability to guide those interactions along more sustainable trajectories, and ways to promote and implement the social learning that will be essential to the navigation of a transition to sustainability will perhaps be the major contributions of the emerging paradigm of

sustainability science. Sustainability science seeks to understand the fundamental character of interactions between nature and society and to encourage those interactions along more sustainable trajectories (Kates and Parris, 2003). Such an integrated, place-based science requires new research strategies and institutional innovations to enable them, especially in developing countries that are still separated by deepening divides from mainstream science.

Therefore, Sustainability Science refers to the cultivation, integration, and application of knowledge about Earth systems gained especially from the holistic and historical sciences (such as geology, ecology, climatology, oceanography) coordinated with knowledge about human interrelationships gained from the social sciences and humanities, in order to evaluate, mitigate and minimize the consequences, regionally and worldwide, of human impacts on planetary systems and on societies across the globe and into the future (Kieffer *et al.,* 2003). Understanding Earth systems and applying the best possible technologies, based on local and global policies attuned to geo-ecological limitations, will require unprecedented success in educating people at all levels, continuous and effective communication with the public aided by informed media, and uncommon wisdom among policymakers. This, at best, will be a formidable task, but will be impossible without a change in the dominant worldview that has led to our addiction to growing consumption.

By structure, method and content, Sustainability Science differs fundamentally from most science as we know it. It is becoming increasingly clear that familiar approaches to developing and testing hypotheses are inadequate because of non-linearity, complexity, and long time lags between actions and their consequences. In addition, complications arise from the recognition that humans cannot stand outside the nature-society system. The common sequential analytical phases of scientific inquiry such as conceptualizing the problem, collecting data, developing theories and applying the results will become parallel functions of social learning, which incorporate the elements of action, adaptive management and policy as experiment.

Sustainability Science therefore employs new methodologies that generate the semi-quantitative models of qualitative data, build upon lessons from case studies and extract inverse approaches that work backwards from undesirable consequences to identify pathways that can avoid such outcomes. Scientists and practitioners will need to work together with the public at large to produce trustworthy knowledge and judgment that is scientifically sound and rooted in social understanding. *Thus, unlike the classical sciences, sustainability science emphasizes action and social learning, in addition to the scientific approach involving hypotheses formulation, observation, verification, understanding and prediction.*

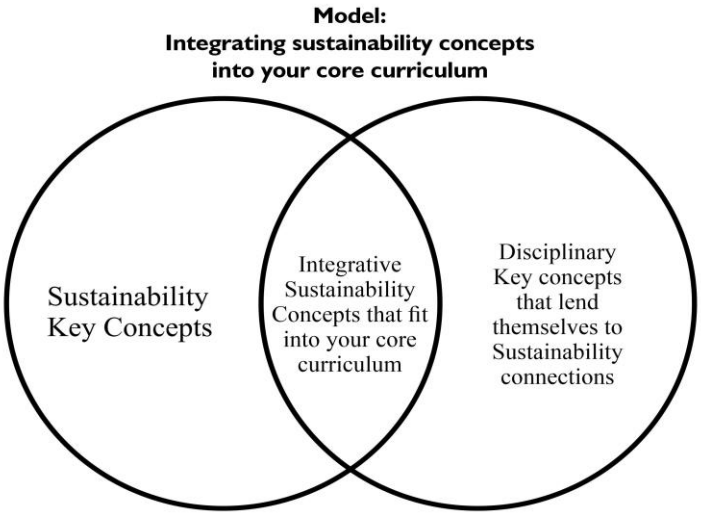
Furthermore, sustainability science examines all manners of social groups to recognize how they come to gain knowledge, establish certainty of outlooks, and adjust their perception as they relate to each other's needs. This in turn will require sustainability science to determine how best governments should respond, how democracies are improving and how citizens generally act to play out the sustainability transition (Euston and William, 1995). Therefore, meeting the challenge of sustainability science requires new styles of institutional organization to foster and support interdisciplinary research over the long term; to build capacity for such research, especially in developing countries; and to integrate such research in coherent systems of research planning,

assessment and decision support. We need to be able to involve scientists, practitioners, and citizens in setting priorities, creating new knowledge, evaluating its possible consequences, and testing it in action. This will require integration of this new active knowledge in particular locations and cultural settings through broader networks of research and monitoring (Euston and William, 1995)

Challenges in incorporating Sustainability Science into African Development

A basic premise of education for sustainability is that just as there is a wholeness and interdependence to life in all its forms, so must there be a unity and wholeness to efforts to understand it and ensure its continuation. This calls for both interdisciplinary inquiry and action. It does not, of course, imply an end to work within traditional disciplines (UNESCO, 1997). Universities play a fundamental role in addressing global environmental challenges as their education, research and community involvement can produce long-lasting environmental effects and societal change (Ralph and Stubs, 2014). Sustainability is an inherently interdisciplinary concept covering the interplay between different kinds of systems (See Figure 1[1]).

Unlike other continents of the World, Africa's desire to achieve its development objectives through heavy reliance on natural resources has implications on the environment and has left adverse footprints for future generations. The need to minimize these adverse effects is more critical than ever. That is why the time is ripe as Scientists to evolve approaches to development that will be both sustainable and ecologically friendly. This could be achieved if as discussed earlier, we shift a bit from familiar scientific approach to approaches that will involve working together with the public at large to produce trustworthy knowledge and judgment that is scientifically sound and rooted in social understanding.



[1] https://serc.carleton.edu/integrate/teaching_materials/themes/infuse/index.html

As far as Africa is concerned, the combined indicators of the economic, environmental, sociocultural and institutional dimensions of sustainability show that African countries and their economies are less sustainable today than they were about two decades ago. The reasons for this low level of sustainability in the continent as itemized by the Princeton Colloquium on Public and International Affairs in 2008 include:

- *Extreme poverty*: It is no longer news that almost 350 million people in Africa, or half its population, live on less than US$ 1 per day. What is worrisome however is that poverty has remained the foremost development challenge confronting Africa for more than a century now despite several scientific discoveries and breakthroughs in food production all over the World. In fact, many studies tend to link poverty in Africa to the natural resourcebased economies of the continent. This is because about 60% of African populations live in the rural areas deriving their main income from agriculture.
- *Environmental impact of extractive industries*: The methods of extraction of nonrenewable resources such as gold, diamonds and crude oil have had an untold impact on the environment. In Nigeria, oil spills and gas flares have polluted the Niger Delta environment for more than 50 years degrading the environment for the present and coming generations. The magic year 2008 set as target to eliminate gas flaring has come to pass without positive impact on the environment and the inhabitants of the Niger Delta region. As community of Scientists, where have we missed it?
- *Rapid population growth and Urbanization*: One of the major challenges to sustainable development is the ever-increasing population and the requirements for meeting the needs of the inhabitants of Africa. The current world population is just over six billion and is projected to reach the 10 billion mark by 2050 (UNPF, 1998). About half of the people live in cities, with the accompanying concerns brought about by rapid urbanization and the growth of megacities. Rapid population has put a lot of stress on Africa's ecosystems. Similarly, rapid urbanization in Africa has been accompanied by new and challenging environmental problems. A significant proportion of African urban dwellers live in slum conditions, without durable housing rights nor have access to electricity and potable water.
- *Food Security*: Africa is the only region in the developing world where the regional average of food production per person has been declining over the last 40 years since the beginning of this century (UN, 2001). Population in most African countries has been growing at an alarming rate beyond the rate of food production leading to scarcity of food. The food shortage has even been worsening by drought conditions in some countries in Africa. This situation has led to extensive migration of a number of people from their country of origin to another country in search of food. In some other cases, the shortage of food both for human and animal consumption has led to the death of a number of people particularly in the North African countries
- *Desertification and Deforestation*: Linked to the issue of food scarcity and drought is the challenging issue of desertification. Desertification has assumed a greater dimension in most African countries. This process can be directly linked with both the global climatic

change and the impact of various anthropogenic forces on the developing world where the regional average of food production per person has been declining over the last 40 years. In Africa as a whole, food consumption exceeded domestic production by 50 per cent during the mid-1980s and more than 30 percent in the 1990s (Obasi, 2001). While desertification occurs in the arid zone, deforestation occurs in the forest region. Deforestation indeed can be adduced as one of the factors responsible for desertification. The rate of deforestation has been on the increase in recent time due to the little attention paid to natural resources conservation by both the local people and the policy decision makers.

- Other additional challenges which have major implications for sustainable development facing Africa continent according to Obasi (*ibid*) include globalization, unfavourable terms of trade, increasing debt burdens, declining agricultural production, political instability and civil strife. These are exacerbated by recurrent floods and drought as well as by other natural disasters, which set back the economies of a number of countries and thus sustainable development. Moreover, there is a wide spectrum of concerns relating to the health and well-being of the people, particularly the pervasive HIV/AIDS crisis and malaria.
- Furthermore, science and technology have been poorly funded, Laboratory equipment is inadequate in many institutions of higher learning. Advanced research infrastructure is non-existent in many Universities, a factor that has contributed to brain drain in Africa.

Conclusion

There is no ending to learning about Sustainability as long as people live on this planet. Universities can only comprehensively address sustainability issues, with government support, by linking campus management to research, curriculum and administrative practice, such that a learning for sustainability approach is embedded across every aspect of institutional operations in a synergistic way' (Tilbury and Cooke, 2005). Therefore our role as a Community of Scientists is to provide leadership and produce tomorrow's leaders that will bring together the economic, social, and environmental understanding globally, regionally and at the national level.

In order to achieve these, and at the same time incorporate the benefits inherent in Sustainability Science into our research efforts, the following suggestions may be helpful in our Tertiary Institutions:

- Establishment of regional framework for integration of scientific research in Nigerian Universities: It is imperative that a regional institution that will coordinate the various research efforts in Nigeria be put in place. This institution will liaise with Governments to formulate Strategic Scientific Policies and programmes that will help reduce duplication and harmonize various research efforts across Universities in Nigeria. Neither the present Ministries of Education, Science and Technology nor National University Commission (NUC) and Tertiary Education Trust Fund (TETFund) could perform this role because of their present schedule and politics of appointment into these agencies. Rather, it is the National Academies including those of Science, Humanities and the Social Sciences that will come together and channel a new course for scientific enquiries in the country.

- A country with a large number of unskilled workers will have limited development options. Indeed, if communities and nations hope to identify and work towards sustainability goals, they must focus on skills, values, and perspectives that encourage and support public participation and community decision making. To achieve this, basic education must be restructured to address sustainability, and expanded to include criticalthinking skills, skills to organize and interpret data and information, skills to formulate questions, and the ability to analyze issues that confront communities
- I strongly believe that if Africa is to meet its scientific, environment, economic and sociocultural challenges, it must take action at the community, national and global levels. At the global level, there is the need to strengthen the continent's capacity to implement relevant multi-lateral developmental agreements. At the same time, there is the need to improve effectiveness of institutions, policies and regulatory capacity at the national level. In addition, the need to engage the private sector effectively in order to provide business solutions to scientific, environmental and economic sector challenges cannot be over emphasized. Finally, whether we see sustainability science as a path to our developmental efforts or not, the need to involve civil societies at the community level to monitor the sustainability of our developmental programmes is very paramount.
- Lastly, government will also play a major role by developing national policies and/or programs to enhance and support the strategic directions of universities to integrate environmental sustainability into their curriculums.

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