Available online at www.koozakar.com/journal/ajspim

African Journal of Science Policy and Innovation Management
OPEN ACCESS | PEER REVIEWED

Science Policy and Sustainability: Musings about Nigeria

Victor Imevbore
Environmental Resources Managers Limited, Lagos, Nigeria

Email: voi@erml.net

Article information

https://doi.org/10.69798/72266682

3066 – 3997

Published by Koozakar LLC. Norcross GA 30071, United States

A Journal of the African Institute for Science Policy and Innovation, AISPI, Obafemi Awolowo University, Ile-Ife.

ABSTRACT

This study examines the dual role of science and its applications in the pursuit of sustainable development in Nigeria. It discusses how science is a pathway to mitigating risks of scientific innovation and attaining environmental sustainability. The importance of science in maintaining the rule of law is also highlighted. Focusing on the intersection of science policy and sustainable development, the study assesses Nigeria's efforts in aligning science, technology and innovation with the Sustainable Development Goals (SDGs) and identifies key implementation challenges. Findings reveal critical gaps in governance across national, state, and local levels, funding academic research, poorly focused research, corruption, brain-drain and policy incoherence among others. To address these challenges, the study recommends strengthening multi-level governance, increasing investment in science and technology, enhancing policy monitoring and evaluation. Additionally, it emphasizes the need for a reliable collection system of national development indicators, improved tracking of university research output, and curricular reforms in higher education to better support sustainability-driven innovation. These measures aim to optimize Nigeria's scientific and technological capabilities in achieving long-term sustainability and developmental goals.

Keywords: Science policy, Environmental sustainability, Sustainable development goals, Technological capabilities, Nigeria

INTRODUCTION

The value of science to human development worldwide is ubiquitous. Science is the economic engine of a country and Science and Technology (S&T), has been the driving force behind the rise of countries in Asia such as Korea, which transformed from a developing to a developed country and from an aid recipient nation in the 60s and 70s to a donor nation (Lee, 2022). The importance of science to the trajectory of human development is perhaps best captured by Neal *et al.* (2008) as follows: Over the course of the last century, numerous societal advances have been driven by progress in science; devastating diseases have been conquered, our quality of life and national security have been enhanced, and new economic and intellectual frontiers have been opened.

It is therefore readily appreciated that science and its applications are important to national development. In other words, knowledge is central to development. The application of science is what led to innovation, technological advancement, the Industrial Revolution, and numerous engineering feats that have benefitted mankind around the world since the Industrial Revolution. With it also came a new understanding of how mankind has negatively altered and is still altering the natural environment over time and the resultant quest for sustainable development or sustainability (Both terms are herein used interchangeably).

Though beneficial to mankind, science and its applications have, on the one hand, threatened the earth and on the other, offered a pathway to save it. This paper will specifically highlight Nigeria's precarious environmental situation and examine the extent to which the country has applied and/or ignored the application of science as it has strived to pursue sustainable development as a nation. Finally, it proffers recommendations on how science policy should be used to progress sustainability.

Science Policy

Science Policy essentially focuses on the use of science research, technology, and innovation to shape national policy for National Development across several themes. The definition by the University of Edinburgh Career Services (https://www.ed.ac.uk/files/atoms/files/science_policy_careers) describes Science Policy as an area of public policy, which is concerned with the policies that affect the conduct of the science and research enterprise, often in pursuit of other national policy goals such as technological innovation, weapons development, health care, and environmental monitoring. Science policy also refers to the act of applying scientific knowledge and consensus to the development of public policies.

Most developed countries have propelled their economies and national productivity by deploying science in policymaking and ensuring that they run knowledge-based economies. The story of Singapore is well known. The government was not only intentional about educating its citizenry but also ensuring that the knowledge was put to use. This is readily appreciated from the words, of Lee Kuan Yew, who in 1966 stated as follows: ".There are half a million pupils in schools and every year, thirty to forty thousand are coming out from the schools – educated: they can read, they can write. But I hope they can also think – not just read and write. It is very important that you should be able to think".

In the USA, State support for scientific research took a strong foothold in the 1800s when the Land Grant Colleges were established. However, the real benefits of science policy came after World War II, largely in response to threats, needs, and priorities at the time including the launching of the Sputnik by Russia, (US Congress, 1998; Holbrow, 2007; Neal *et al.*, 2008). Today, the US government's investment in science has yielded amazing benefits including among others, new products, new industries, and making the country a world economic power. China, Korea, the United Arab Emirates (UAE), and many European Countries are also examples among many others. Science Policy has therefore been used by nations to encourage research, and technological innovation, which have propelled their economies and improved the well-being of their citizens.

Sustainability

The most widely used definition of sustainability (or sustainable development) is captured in the UN Brundtland Commission Report (1987). The report defines sustainable development as "meeting the needs of the present without compromising the ability of future generations to meet their own needs". A broader definition goes beyond the environmental dimension, incorporating three

pillars, environmental (i.e., biophysical), social, and economic. Other definitions exist. However, all definitions point to the need to balance human development activities, consumption patterns, and the integrity of the natural environment. It also suggests the need to pursue the well-being of humans.

Just as science and its application have improved the lives of humans on earth, it is also being used to develop solutions that could help stem and/or mitigate the adverse impacts of human activity over time. In this regard, government policies and advancements in medical technology, renewables, reforestation and/or afforestation efforts, energy efficient machines, pollution prevention technology, recycling, and carbon mitigation among others are worth mentioning. Indeed, Science Policy is becoming increasingly critical for sustainable development given the growing environmental burden associated with ensuring good living conditions for over 8 billion people on a global scale and within ecological limits. As Schneidewind *et al.* (2016) argue, this goal cannot be reached by continuing today's economic and societal development patterns.

The Nexus between Science Policy and Sustainability

The linkage between science policy and sustainability lies in the fabric of human existence as determined by the interlinkages between society, economic development, and the natural environment. On its website, the United Nations Education, Science and Cultural Organization (UNESCO, 2024) points out that today's complex economic, societal, environmental, and cultural challenges require science, technology, and innovation (STI) to be woven into the fabric of the society (https://en.unesco.org/science-policy/science_policy_society). These challenges it suggests require a society where knowledge is co-created through science-policy-society interfaces, processes that connect and allow for fertile exchanges between the three. UNESCO further argues that only through strong linkages between science, policy, and society, can knowledge societies be created where policy and decision-makers and citizens alike have the capacity and power to decide the future of the planet and all its inhabitants. When considered in the context of its three pillars, sustainability is a multi and interdisciplinary field. This is also evident from the suite of professionals across disciplines that are typically involved in conducting environmental and social studies.

Science policies could contribute to all possible scientific or technological development pathways across all dimensions of human life such as fostering economic development, solving societal or environmental problems or making better political decisions (Schwachula, 2019). Moreover, as pointed out by Schneidewind (2016), if the objective of science is not only to analyze the ecological state of the global system but also to contribute to the development of sustainability-oriented transformation processes, new fields of science would have to be included, such as knowledge on economic processes, as well as social and cultural dynamics. Science policy for sustainability, therefore, requires policy-making that supports research for innovation across themes. Sarewitz (2009) argues that it is the responsibility of science policy to guarantee that knowledge is produced, which helps societies to develop in more sustainable ways.It is also well known that sustainable development cannot be achieved without pursuing the rule of law (Michel, 2020). To this end, science has increasingly become an important tool for dealing with international and local disputes as well as enforcing ecological responsibility (Maria and António, 2023).

Science Policy in Nigeria

Nigeria has also made notable efforts in developing its Science Policy towards the development of technology and innovation. Nigeria's first National Science and Technology (S&T) Policy was released in 1986. It was designed to create harmony in the pursuit of knowledge about the environment through research and development (R&D). Its goal was to use S&T knowledge to ensure a better quality of life for the Nigerian people. Policy reviews in 1997, 2003, and 2005 sought to address lapses observed in the implementation of earlier versions, address important institutional frameworks to support scientific innovation and improve the culture and the harmonization of S&T policy with other socio-economic policies. The 2011 version of the policy is described as a product of a novel, all-inclusive, participatory policy-making approach, which also emphasizes

innovation as a global tool for fast-tracking sustainable development.

In 2018, Nigeria released its National Policy on National Science and Technology (S&T) Education. Spearheaded by the Federal Ministry of Environment, and developed through strategic consultative workshops and meetings with other stakeholders including other ministries, departments and agencies (MDAs), schools of tertiary education, and non-governmental organizations, the document and associated implementation guidelines, seek to outline a pathway to effective teaching of science and technology and how to mobilize the required human and material resources to achieve the national goal. Its overarching aim is to create a critical S&T workforce in Nigeria that can transform the nation's economic landscape into a world-class economy.

In addition to the faculties of science, technology, and engineering in over 170 higher institutions of learning, additional efforts to leverage S&T for economic development include the establishment and operation of various national research institutes (Appendix Table 1). Some of the listed institutions date back to 1960, when Nigeria gained independence, while most have been in existence for over 35 years. A review of their individual mandates suggests well-thought-out institutional arrangements and intended outcomes at the time. By now, these and other newer research institutes should have supported Nigeria's food security, development of vaccines, innovations in medicine, energy security, advancements in space, home-grown infrastructure solutions, and the general design of solutions to many of our developmental and environmental challenges.

Thus, despite these efforts, to what extent has Nigeria deployed knowledge or evidence-based policy making (EBPM)? The answers may lie in where the country is as a nation in terms of economic development (or the lack thereof) and dealing with our environmental problems. Nigeria's distance to targets on UN Sustainable Development Goals (SDGs), and its ranking on the Global Competitive Index (GCI) are useful assessment yardsticks. Available information suggests that Nigeria is facing an arduous journey to attaining sustainable development. As will be discussed later, the country is stagnating on most of the SDGs and lagging on the GCI. Nigeria ranked 116 out of 161 countries and 114 out of 134 on the GCI in 2019 and 2020 respectively (World Economic Forum (WEF)). The WEF defines GCI as a set of institutions, policies, and factors that determine the level of productivity of a country. There is a general view that the relevance of Nigeria's research institutions and citadels of knowledge to the development of the nation has increasingly waned over time.

Global Sustainability Indicators

The Brundtland Commission Report (1987) is perhaps the first major global recognition of how human activity has over the years, led to changes that threaten the natural ecological balances and related interlinkages on Earth. There is a broad consensus among academics, captains of the corporate world, political leaders, and most rational and informed private citizens that the changes are happening at a frightening scale. This recognition led to a host of other initiatives and recommendations arising from the Brundtland Commission Report including, Agenda 21, the Millennium Development Goals (MDG, 2000), the Kyoto Protocol (2005), the UN Sustainable Development Goals (SDG, 2015), the Paris Agreement (2016), and numerous international treaties and agreements on various environmental themes.

Across the world, countries have developed new laws and stricter regulatory instruments and tools. For example, the Environmental Impact Assessment (EIA) process to curb or minimize the risks of infrastructural and/or industrial projects to the natural environment and human beings, carbon emission limits, laws to protect biodiversity, and others. A review of where we are more than 30 years after the Brundtland Report tells us that sustainability is not yet mainstreamed. That is, relevant environmental concerns are not fully part of the decisions of institutions that drive national, local, and sectoral development policies, rules, plans, investments, and actions across the world.

As summarized by Imevbore (2023a), a report by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES, 2019), provides the following statistics on important global sustainability themes;

- 75% of the terrestrial and 66% of marine environments have been "severely altered" by human actions;
- there has been a 47% decline in global indicators of ecosystem extent and condition against their estimated natural baselines, with many continuing to decline by at least 4% per decade;
- about 60 billion tons of renewable and non-renewable resources are extracted globally each year (up by nearly 100% since 1980);
- approximately 15% increase in global per capita consumption of materials since 1980;
- about 85% of wetlands present in 1700 had been lost by 2000 – loss of wetlands is currently three times faster, in percentage terms than forest loss;
- up to 1 million species are threatened with extinction - many within the timescale of just decades;
- about 23% of global land areas have seen a reduction in productivity due to land degradation;
- there has been a 105% increase in the global human population (from 3.7 to 7.6 billion) since 1970 - though this has been uneven across countries and regions;
- although 75% of global food crop types rely on animal pollination, USD577 billion worth of global crop output is at risk due to pollinator loss;
- an estimated 11% of the world's population is undernourished and more than one billion people still rely on wood fuel to meet their primary energy needs;
- only 68% of global forest are left compared with the estimated pre-industrial levels;
- the average global temperature difference in 2017 compared to pre-industrial levels is about 1 degree Celsius, rising +/-0.2 (+/-0.1) degrees Celsius per decade; and
- the world has experienced over 3mm annual average global sea level rise over the past two decades.

The report also concludes that goals for conserving and sustainably using nature and achieving sustainability cannot be met by current trajectories, while goals for 2030 and beyond may only be achieved through transformative changes across economic, social, political, and technological factors.

Nigeria's Sustainability Efforts

Like many other nations, Nigeria has taken steps towards sustainable development. These efforts date back to the first National Policy on Environment enacted by the Federal Environmental Protection Agency (FEPA) in 1989. It considered strategies for implementing the National Policy in the various sectors of the Nigerian economy. Before then, there were sectorial regulations made to strengthen environmental governance in Agriculture, Industries, Oil and Gas, and Civil Works, (Ivbijaro, *et al.*, 2006). Other notable measures include the enactment of the Environmental Impact Assessment (EIA) law (1992), the Climate Change Act (2021), the establishment of the Federal Ministry of Environment (1999), and setting up of various Environmental Protection Agencies by most State Governments. The National Environmental Standards and Regulatory Enforcement Agency (NESREA) were also set up in 2017 to enforce standards, while sectoral regulations and environmental standards for the petroleum industry and manufacturing sectors among others, have been issued. In addition, Nigeria is a signatory to numerous international agreements on national, regional, and global environmental protection. Some of these efforts as outlined by Imevbore (2023b) are summarized in Appendix Table 2.

Nigeria's Precarious Situation

Although not well-reported as should be, Nigeria's environmental and social problems are well-known. Available literature on Nigeria's environmental problems such as Imevbore and Zagi (2018), Mba (2004), Federal Government of Nigeria State of the Nigerian Environment Report (2008), World Bank (2023), FAO (2023), and others indicate that the major ones are the alarming rate of deforestation nationwide, desertification in the Northern parts of the country; air pollution, particularly in the cities and the oil-rich Niger Delta, wildlife extinction; gully and coastal erosion in the Southeast and along sections of the Country's outer coastline respectively. Others are pollution of inland water bodies across the country from sewage, industrial effluent, oil spills, and boat traffic, overfishing mostly in the marine environment, invasion of exotic species, and poor

solid waste management including the ubiquity of plastic and styrofoam pollution, not only in cities but also across the entire country. Nigeria is now experiencing extreme weather events and has been previously described as the deforestation capital of the world (Butler, 2005). In 2018, the Director General of the Nigerian Conservation Foundation, Dr Muhtari Aminu-Kano stated that Nigeria had lost 96 % of its forest due to deforestation. Nigeria is among the most vulnerable countries in the world. These vulnerable countries are home to 1.26 billion people across 30 countries and suffering from both extreme ecological risk and low levels of resilience (Institute for Economics & Peace, 2021).

Nigeria's population growth is compounding its environmental problems. IEP (2021) also states that worsening droughts, erratic rainfall, and desertification across the world have been confounded by an unprecedented security crisis driven by persistent terrorist and violent extremist attacks, as well as ethnic, religious, and farmer-herder conflicts over land use and that in Nigeria this conflict is driven in part by population growth which has contributed to resource scarcity and desertification.

Furthermore, although Nigeria has enacted laws, issued regulations and standards, set up agencies, and signed numerous international treaties to protect the environment, the country is performing poorly on the UN SDGs, the universal call to action to end poverty, protect the planet, and ensure that by 2030, all people enjoy peace and prosperity. In 2019, Nigeria ranked 139 out of 163 countries, and in 2023, 146 out of 166 (i.e., only better than 24 and 20 countries in 2019 and 2023 respectively) on the UN's SDG Report (Sachs *et al.*, 2019, 2023), which provides an assessment of countries' distance to SDG targets.

As summarized in Figure 1, the report shows that Nigeria's overall performance is stagnating across most SDGs such as Poverty (SDG -1), Zero Hunger (SDG -2), Good Health (SDG -3), Gender Equality (SDG-4), Affordable and Clean Energy (SDG -7), Decent Work and Economic Growth (SDG-8), Sustainable Cities (SDG-11), Responsible Consumption (SDG-12), Climate Action (SDG-13) and others. The country has made moderate progress only on Clean Water and Sanitation (SDG-6), Industry Innovation and Infrastructure (SDG-9), Reduced Inequalities (SDG-10), and Life Below Water (SDG-14), while the Country's performance has worsened on Life on Land (SDG-15) largely due to deforestation. The report suggests that Nigeria is not on track to meet targets on any of the goals. It is worthy of note that performance on Quality Education (SDG-4) could not be assessed in 2019 and 2023 due to lack of relevant data on Nigeria. The absence of environmental justice and poorly incentivized environmental practitioners are also adversely affecting Nigeria's sustainable development efforts (Imevbore, 2023a).

Figure 1: Nigeria's SDG Performance Dashboard
(**Source:** Sachs *et al.*, 2023)

Science Policy and Sustainability - The Disconnect

According to UNEP (2017), there is a growing disconnect that has emerged in a global political context where scientific evidence is not often understood or used by policymakers and this not only dismisses but excludes opportunities for collaboration. There is evidence that the impact of science on policymaking in Nigeria is at best, inadequate, and at the same time, there is an urgent need to mainstream scientific knowledge to deal with attendant developmental and environmental challenges. A review of relevant literature e.g., Adubifa (1988), US Congress (1998), Neal *et al.* (2008), Bolaji and Gray (2015), United Nations Environmental Program (2017), Edler *et al.* (2022), and Kalama and Solomon (2022) provides key insights into the possible reasons for failures in the utilization of STI in policy-making and implementation worldwide and Nigeria in particular. These challenges include:

a) Poor Funding – In the absence of adequate funding, the production of scientific knowledge will be stifled. Over the years, Nigeria's funding of research and development has been abysmal. World Bank data (2023) shows that Nigeria spends 0.13% of its GDP on research, which is significantly low compared to France (2.2%), Germany (3.14%), Israel (5.56%), Korea (4.93%), South Africa (0.6%), Singapore (2.16%), USA (3.46%) and UK (2.91%). It is noted also that data used in the referenced World Bank report are for 2007, pointing to the absence of data for tracking Nigeria's progress.
b) Poorly Focused Research - Science and research can only be useful in addressing sustainable development challenges if they provide convincing solution-oriented outcomes. There seems to be a dearth of research focused on addressing sustainability issues in Nigeria. For instance, how much research has gone into dealing with the impact of Styrofoam on the environment, deforestation, and coastal and gully erosion?
c) Actors' Selfish Interests – When either or both researchers and policymakers pursue purely selfish interests and narrow opportunities, the common good is sacrificed due to the narrow lens guiding decisions around research works and/or related policy. Such selfish interests and superiority mindsets are also responsible for the poor collaboration between Nigeria's numerous research centers and tertiary institutions.
d) Corruption – The role of corruption in Nigeria's development challenges has been echoed time and again. Its systemic nature is most worrisome. Estimates show that in over 60 years since independence, corruption has cost the Nigerian economy more than US$550 billion (World Justice Project, 2023). A 2019 survey of corruption in Nigeria by the United Nations Office of Drugs and Crime (UNDOC) and the National Bureau of Statistics (NBS) showed that out of all Nigerian citizens who had at least one contact with a public official within 12 months, 30.2 % paid a bribe to, or were asked to pay a bribe by a public official. Figure 2 shows a cross-section and prevalence among categories of Nigerian public officials who collect bribes.
e) Lack of Political Will and Instability - Abazović and Mujkić (2015) define Political Will as the extent of committed support among key decision-makers for a particular policy solution to a particular problem. Changes in government at the National and State levels in Nigeria have also led to the abandonment of policies, which truncate otherwise desirable policy outcomes. In the case of science policy and sustainability, the political will pertains to pursuing all key actions required to mainstream knowledge into policy making and more importantly, policy implementation.

a) Poorly Suited Policies – Some of Nigeria's policies have been developed in response to pressures from international influence such as donor agencies and other countries, exerting influence driven by a hegemonic approach to international relations. Some policies on technology, economic growth, and development have indeed failed because they were not well suited to Nigeria. According to Mytelka (1989), over-dependence on external sources of finance and the diversion of such funds by political elites in Africa accounts for the poor state of science and technology infrastructure on the continent.
b) Poor Understanding between the Scientific Community and Policymakers. Despite the power of science to influence policy, there is an inherent tension between science and policymaking.

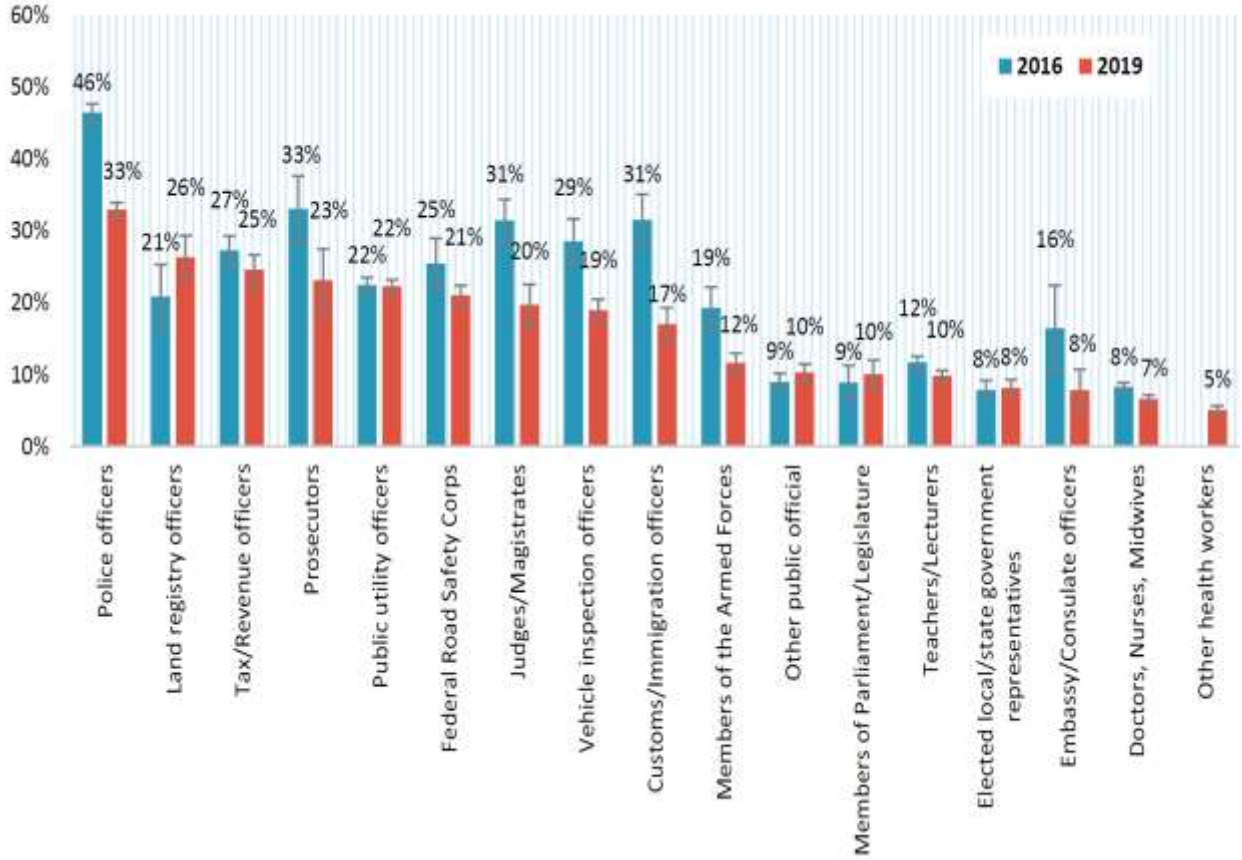

Figure 2: Prevalence of Bribery, By Type of Public Official, Nigeria, 2016 and 2019
(**Source:** United Nations Office Drugs and Crime (UNDOC) & National Bureau of Statistics (NBS), 2019)

c) The norms and processes that drive science are profoundly different from the politics of democratic institutions (Neal *et al.*, 2008). Religion, ethnocentric biases, and culture further hinder the benefits of science in policymaking. Additionally, many members of the scientific community have little or no understanding of the policymaking process and/or how their work can influence policy – this is true for Nigeria.

d) Brain Drain – While some opinions differ, there is ample evidence that Nigeria has been losing its skilled human resource assets. The number of international migrants from Nigeria increased from around 450,000 in 1990 to 1.4 million in 2019 (Adhikari *et al.*, 2021). This "Japa" syndrome as it is now called is in response to improved economic opportunities and living conditions for skilled personnel mostly in western countries. The country's academia, healthcare and Information Technology (IT) sectors are the worst hit. Another important indicator of an economy that suffers from low human capacity and brain drain is the number of researchers per million inhabitants. Selected country estimates for 2019 available from UNESCO (2023) are China (1485), Denmark, (7727.2), Japan (5409.5), Republic of Korea (8322), Singapore (7224.7), South Africa (491.4), Togo (45.3), UAE (2536.5), UK (4491), USA (4308) and Nigeria (22.8).

e) Lack of Data/Access to Data – Reliable data and access to data on various Nigerian thematic issues pose challenges to the public, researchers and policymakers. For instance, a significant amount of environmental information has been generated since the early 1990s but data sets are scattered across various MDAs, private companies, donor agencies, and individual offices/computers. Without data, it is impossible to appreciate the full nature and scale of environmental and/or development problems that need intervention. The absence of monitoring data also hinders the evaluation of S&T policy effectiveness.

RECOMMENDATIONS

Below are recommendations to address the disconnect between Nigeria's STI policies, their implementation, and sustainable development. Some recommendations are general, while others apply to specific actors, e.g., tertiary institutions, and our policymakers.

a. Improve Governance. There is a systemic failure of governance across National, State, and Local Government affairs, public institutions, and the private sector. The ubiquity of this failure lies in insecurity, lawlessness, high levels of unemployment, a culture of mediocrity, poor social infrastructure, declining educational standards, and a pauperized citizenry among others. Governance is the way Agenda 2030 will be translated at national and subnational levels. Thus, its importance for SDG achievement is incontestable (Meuleman and Niestroy, 2015). Important areas for improved governance in Nigeria are:
   - Within our individual spaces and spheres of influence. This applies to corporate organizations, learning institutions, and government offices.
   - Reject and abhor the culture of impunity that has come to characterize our polity.
   - Embrace and celebrate meritocracy.
   - Hold our leaders accountable - the leaders work for the citizenry and not the other way around.
   - Stop the culture of sycophancy, which feeds tyranny.
   - The government should lead by example in terms of compliance with laws and policies.

b. Improved Collaboration. The world is increasingly being faced with environmental challenges which are exacerbated by an absence of coordination among different actors around the globe (UNEP, 2017). Co-production is widely hailed as the most likely way to promote the use of research evidence in policy, as it would enable researchers to respond to policy agenda, and support more agile multidisciplinary teams to coalesce around topical policy problems (Olivier and Cairney, 2019). Tertiary institutions and the various research institutes set up by the government must also improve their collaboration, while efforts should be made to encourage synergy and minimize duplicity of functions across MDAs. Through intentionality, fears associated with ceding control of the research focus, agenda, and interpretations can be addressed. This is yet another call to improve the "Town and Gown" interface for the common good and increased relevance of our tertiary institutions in the country's development and vice versa.

c. Improved Funding. Nigeria needs to prioritize the entire STI value chain from research through policymaking, to implementation by increasing its budgetary allocation to education and research. It is worth mentioning that in January, 2024, the Nigerian Government approved the sum of N5.1 billion Naira (about $3.6m) for the funding of 185 successful research proposals under the Tertiary Education Trust Fund (TETFund) National Research Fund (NRF) 2023 Grant Cycle. The successful proposals were selected out of 4,287 concept notes after a screening exercise. About 74% of the fund will be spent on Science, Engineering, Technology and Innovation (SETI) projects while the rest will be on Humanities, Social Science (HSS), and cross-cutting themes. Although a welcome development, this amount is still considered meager. The President's directive earlier this month for the country to establish a National Research Fund is also most welcome but should be followed up with action and monitoring.

d. Reward and Incentivize Science, Research, Innovation and Sustainability. Like many other countries, Nigeria recognizes and rewards citizens for their contribution to society. Such awardees are often drawn from different walks of life and include politicians, judges, senior government officials, and those accomplished in various professions such as, banking, law, entrepreneurship, sports, music, literature, the film industry, and other arts, among others. In recent times, the criteria for selecting National honors awardees have been widely questioned. It is sad to note that Nigeria rarely (if ever) rewards individuals and/or organizations that have contributed significantly to sustainability. This is evident from the profile of past recipients of National honors. Apart from the general National honors, the Nigerian National Merit Award, which was established in 1979,

is perhaps the only national award that rewards the academic and intellectual excellence of Nigerians involved in Science, Medicine, Engineering/ Technology, and Humanities including Arts and Culture. Since its inception 45 years ago, only 79 persons have received the award. That is about 1.75 persons per year. It is strongly recommended that this award be reviewed and more established to further incentivize knowledge for sustainable development in addition to rewards for brilliant student essays and scholarship in sustainability science.

e. Policy Evaluation. The primary goals of policy evaluation are to assess outcomes, accountability, and learning. Nigeria's policymakers need to develop metrics for tracking the progress and effectiveness of policies and as may be necessary, learn from the findings. OECD (2020) identifies the following five (5) key criteria for policy evaluation:
   - Relevance - to what extent do the (original) objectives (still) correspond to needs and issues?
   - Effectiveness - to what extent did a policy/public intervention generate observed effects and changes? To what extent do the observed effects correspond to the objectives?
   - Efficiency - were the costs involved justified, given the changes and effects achieved?
   - Sustainability - does the policy/public intervention present net benefits in the long term?
   - Impact - what are the effects produced by an intervention (i.e. positive or negative, primary and secondary long-term effects produced, directly or indirectly, intended or unintended)?

With regard to Nigeria's STI policies, we must ask specific questions about, and report on the extent to which our policies have:

- Appreciated and responded to the Nation's specific needs;
- Improved Science, Technology, Engineering, and Mathematics (STEM) education of children;
- Supported and ensured the availability of the requisite funding for science, research, and innovation that will catalyze sustainable development including problem-solving. This could require increased budgetary allocation and innovative ways of crowding in funding to support government efforts;
- Supported the institutional conditions that will promote sustainable development;
- Encouraged and provided the foundation for key partnerships and collaboration among key actors in the science-policy-society interface; and
- Assisted the delivery of justice.

Policy evaluation should lead to policy amendments and/or implementation approaches and should be continuous. Government-established research institutions should also be appraised using similar criteria. Those with overlapping functions should be merged or synergies worked out while others strengthened in weak areas.

f. Establish Reliable and Accessible Data Centers. Measuring progress on meeting SDG targets and by extension, policy effectiveness also requires making extra efforts to improve the quality of data, explore new sets of metrics, and their use to provide indicators of progress that may help to construct impact assessment of different policies (Rafols *et al.*, 2021). Nigeria must be intentional about setting up, populating, and maintaining databases that are readily accessible to all stakeholders. Databases can be set up across sectors and/or disciplines, but they should also leverage Geographical Information System (GIS) technology for improved data utility.

g. Embrace a Transdisciplinary Approach. A transdisciplinary approach to science for sustainability is increasingly being espoused across the world (UNEP, 2017; Lawerence *et al.*, 2022; Schneider *et al.*, 2023). The approach attempts to create solutions to complex, context-specific issues by combining the knowledge and ideas of both experts and non-academic key stakeholders (Levesque, 2019). Nigerian policymakers and the scientific community need to embrace this approach, which finds a role for all key actors including civil society and the incorporation of traditional knowledge.

Borrowing from Lawrence *et al.* (2021), transdisciplinary research, should embrace the following defining characteristics:

- Unity of knowledge, which aims to transcend individual disciplines
- The inclusion of multi and interdisciplinary approaches
- Involvement of other societal actors
- Focus on complex real-world problems
- Thinking beyond research to transformative outcomes
- Focusing on the common good
- Being reflexive, i.e., understanding the broader context and implications of the research work and output.

h. Change in the thinking of Social Actor. For science policy to be more relevant to Nigeria's national development there needs to be a change in the thinking or behaviour of societal actors (Hessels and Lente, 2010). Although there are numerous other challenges facing our institutions of higher learning, these should not defeat the need and desire for change in the following areas:
   - Conduct high-quality research that is timely, solution-oriented, policy-relevant, and readily understood. It is important to use research methods, metrics and/or models, systematic reviews, and analysis of evidence that is considered useful for policymakers.
   - Embrace transdisciplinary Approaches to Research
   - Improve Dissemination of Scientific Output
   - Understand Policy Processes and Key Actors
   - Engage with Policy Makers
   - Incorporate Traditional Knowledge
   - Have an Entrepreneurial Mindset

i. Review the Pedagogy. In recent times, questions have been asked about the relevance of University Education and teaching techniques in today's world and the future workplace (Macken *et al.*, 2021; Forbes, 2024; Munip and Klien-Collins, 2024). Concerns center around high tuition fees, uncertain returns on investment in terms of employment opportunities, and the role of technology. Nigeria's science policy and related pedagogy should therefore aim to review and align teaching methods and curricula to attendant realities, and equip students with competencies that prepare them for employability, entrepreneurship, and innovation. Important competencies include data analyses, project management, coding, artificial intelligence, and financial analysis in addition to soft skills such as good communication, teamwork, and leadership.

j. Track Research in Universities. Institutions of higher learning in the country should aim to blaze the trail in monitoring their research output. In this regard, Universities should be encouraged to develop or if existing, amend research tracking procedures from the conceptual stage to improve the utility of S&T outputs. Such tracking should include the areas earlier outlined, such as funding, works involving co-production, findings that reached and/or influenced policy and/or policymakers, and those that reached commercial application.

CONCLUSION

The roles of science, technology, and innovation (STI) in a nation's economic development are well established. Examples abound of nations that have improved the well-being of their citizens through policy-driven STI. While human activities and STI have threatened and continue to put pressure on the world's ecological balance, STI and other policy instruments offer solutions to address global environmental challenges. Science is also important for maintaining the rule of law. Like many other countries, Nigeria has since independence in 1960, developed STI policies and progressed initiatives to manage environmental problems. However, the country's economic development remains stifled while its environmental problems are worsening and the nation is stagnant in the race to meet SDG targets by 2030.

A disconnect exists between STI policy, its implementation, and the use of knowledge in addressing economic and environmental challenges, and the general pursuit of sustainable development or sustainability. Factors responsible for the disconnect include poor governance, corruption, political instability, poorly focused research, ineffective collaboration among key actors, ill-suited policies, brain drain, and a general lack of data. For Nigeria to achieve sustainable development, such as the key SDG targets, and improved productivity, there needs to be a change

in the thinking and behaviour of key actors in the development and implementation of STI-related policies.

Nigeria's budgetary allocation to STI policy implementation and research is abysmal and needs to be increased, while research and innovation are poorly incentivized. Additionally, existing STI efforts and related policies need to be evaluated in terms of relevance, effectiveness, efficiency, sustainability, and impact, and as may be necessary, amended. The academic community should seek to become more relevant by conducting high-quality solution-oriented research, embracing transdisciplinary research, and intentionally engaging with and involving policymakers in research co-production. In addition, science policies and related pedagogies should aim to equip students with key competencies in addition to knowledge. Access to reliable data remains an important foundation for running a knowledge-based economy.

REFERENCES

Abazović, D. & Mujkić, A. (2015). Political will: A Short Introduction Case Study - Bosnia and Herzegovina. Fredrich-Ebert-Stiftung (FES), Sarajevo

Adhikari, M., Clemens, M., Dempster, H. & Ekeator, N. L. (2021). Expanding Legal Pathways from Nigeria to Europe: From Brain Drain to Brain Gain. World Bank and the Center for Global Development (CGD). Washington, DC.

Adubifa, A. (1988). Technology Policy Failures in Nigeria. Manuscript Report 186e. International Development Research Center (IDRC), Ottawa. Pp-129

Bolaji, S., Gray, J. & Campbell-Evans, G. (2015). Why do Policies fail in Africa? Journal of Educational and Social Policy, 2(5), 57–66.

Brondizio E. S., Settele J., Díaz S., and Ngo H. T., (Eds). IPBES secretariat, Bonn, Germany. 1148 pages.

Brundtland, G. (1987). Report of the World Commission on Environment and Development: Our Common Future. United Nations General Assembly document A/42/427.

Butler, R.A. (2005). World Deforestation Rates and Forest Cover Statistics, 2000- 2005, http://news.mongabay.com/2005/1115-forests.html, Accessed May 20, 2023.

Cornell, S., Berkhout, F., Tuinstra, W., T'abara, J. D., Jäger, J., Chabay, I., de Wit, B., Langlais, R., Mills, D., Moll, P., Otto, I. M., Petersen, A., Pohl, C. & van Kerkhoff, L. (2013). Opening up Knowledge Systems for better Responses to Global Environmental Change. Environmental Science & Policy, 28, 60-70. https://doi.org/10.1016/j.envsci.2012.11.008.

David (2021). Focused Research on the Challenges and Productivity of Researchers in Nigerian Academic Institutions Without Funding. Frontiers in Research Metrics and Analytics, 10, 1–29. doi:10.3389/frma.2021.727228.

Edler, J., Karaulova, M. & Barker, K. (2022). Understanding Conceptual Impact of Scientific Knowledge on Policy: The Role of Policymaking Conditions. Minerva, 60, 209–233. doi:10.1007/s11024-022-09459-8.

Federal Government of Nigeria (2008). Nigeria State of the Environment Report

Food and Agricultural Organization (FAO, 2023). https://www.fao.org/in-action/action- against-desertification/countries/africa/nigeria/en Accessed May 22, 2023

Forbes (2024). https://www.forbes.com/sites/benjaminlaker/2024/01/28/major-blow-to-uk-universities-the-decline-of-international-students/?sh=60db8ce67996. Accessed March 25, 2024.

Hessels, L. K. & Lente, H. V. (2010). The Mixed Blessing of Mode 2 Knowledge Production. Science, Technology & Innovation Studies, 6(1), 65–69.

Holbrow, C. (2007). Sputnik's Impact on Science Education in America.

Imevbore, A. M. A. (2023b). Ecology and the Nigerian Society. Lecture delivered at the 40th Anniversary of the Institute of Ecology, Obafemi Awolowo University, Ile-Ife, May 31, 2023

Imevbore, V. O. (2023a). Transcending Barriers to Environmental Mainstreaming in Nigeria. Presented as the inaugural lecture of the Centre for Environmental Human Resource and Development (CENHURD) of the University of Lagos, Nigeria, July 20, 2023

Imevbore, V. O. & Zagi, M. M. (2018). Environmental stewardship in Nigeria's oil and gas industry: Myth or reality. Paper presented at the 18th International Biennial Oil and Gas HSE Conference, Eko Hotel Lagos, 26-28 November 2018.

Institute for Economics & Peace. Ecological Threat Report (2021). Understanding ecological threats, Resilience and Peace, Sydney, October 2021. Available from http://visionofhumanity.org

Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (2019). Global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services.

Ivbijaro, M.F., Akintola, A & Okechukwu, R. (2006). Sustainable Environmental Management in Nigeria, Mattivi Production Ibadan Nigeria. 465pp

Kalama, J. & Solomon, C. (2022). Problems and Challenges of Science and Technology Development in Nigeria. International Journal of Development Strategies in Humanities, Management and Social Sciences, 12, 121-130. doi:10.48028/iiprds/ijdshmss.v12.i2.09.

Lawrence, M. G., Williams, S., Nanz, P. & Renn, O. (2022). Characteristics, Potentials, and Challenges of Transdisciplinary Research. One Earth, 5(1), 44-61. doi:10.1016/j.oneear.2021.12.010.

Lee, S.M. (2022). Scientific Policies of Developing Countries and Mid-level Entry Strategy: from the Perspective of a Marine Scientist. Geoscience Letters, 9, 31 doi:10.1186/s40562-022-00242-x.

Levesque, V. (2019). Sustainability Method and Perspectives, an Open Educational Resource.

Macken, C., Hare, J., Souter, K. (2021). Higher Education in the time of Disruption. In: Seven Radical Ideas for the Future of Higher Education. Springer Briefs in Education. Springer, Singapore. https://doi.org/10.1007/978-981-16-4428-3_1

Maria da Glória Garcia and António Cortês. (2023). Blue Planet Law – The Ecology of our Economic and Technological World. Springer International, Switzerland

MBA, H. C. (2004). Management of Environmental Problems and Hazards in Nigeria. Aldershot, Ashgate

Merton, R. K. (1973). The sociology of science: Theoretical and empirical investigations. Chicago: University of Chicago Press.

Meuleman, L. & Niestroy, I. (2015). Common but Differentiated Governance: A Meta- Governance Approach to make the SDGs work. Sustainability, 7, 12295–12321. doi:10.3390/su70912295.

Michel, J. (2020). The Rule of Law and Sustainable Development. A Report of the CSIS Program on Prosperity and Development. Center for Strategic Studies (CSIS). Washington D.C. pp- 63

Munip, L. & Klein-Collins, R. (2024). Comprehensive Learner Records: Empowering Lifelong Learning in the Digital Age. Postsecondary Perspectives of Preparation for the Implementation of CLRS. Council for Adult and Experiental Learning. Chicago

Mytelka, L. K. (1989). The Unfulfilled Promise of African Industrialization in The African Studies Review, 32(3), 77-137.

Neal, H. A., Smith, T. L. & McCormick, J. B. (2008). Beyond Sputnik: U.S. Science Policy in the Twenty-First Century. University of Michigan Press. Ann Harbour, Michigan doi:10.3998/mpub.22958.

OECD (2020). Improving Governance with Policy Evaluation: Lessons from Country Experiences. Organization for Economic Cooperation and Development (OECD) Public Governance Reviews. https://doi.org/10.1787/89b1577d-en

Oliver, K. & Cairney, P. (2019). The Dos and Don'ts of Influencing Policy: A Systematic Review of Advice to Academics. Palgrave Communications, 5, 21. doi:10.1057/s41599- 019-0232-y.

Rafols, I., Noyons, E., Confraria, H. & Ciarli, T. (2021). Visualising Plural Mappings of Science for Sustainable Development Goals (SDGs). 10.31235/osf.io/yfqbd.

Sachs, J. D., Lafortune, G., Fuller, G. & Drumm, E. (2023). Implementing the SDG Stimulus. Sustainable Development Report 2023. Paris: SDSN, Dublin: Dublin University Press. doi:10.25546/102924.

Sachs, J., Schmidt-Traub, G., Kroll, C., Lafortune, G. & Fuller, G. (2019). Sustainable Development Report 2019. New York: Bertelsmann Stiftung and Sustainable Development Solutions Network (SDSN).

Sarewitz, D. (2009). A Tale of Two Sciences. Nature, 462, 566. doi.org/10.1038/462566a

Schneider, F., Patel, Z. & Paulavets, K. (2023). Fostering Transdisciplinary Research for Sustainability in the Global South: Pathways to Impact for Funding Programmes. Humanities and Social Sciences Communications, 10, 620. doi:10.1057/s41599-023- 02138-3.

Schneidewind, U., Singer-Brodowksi, M. & Augenstein, K. (2016). Sustainability and Science Policy. In: H. Heinrichs, P. Martens, G. Michelsen & A. Wiek (Eds.), Sustainability Science. Springer, Dordrecht. doi:10.1007/978-94-017-7242-6_13.

Schwachula, A. (2019). Sustainable Development in Science Policy-Making: The German Federal Ministry of Education and Research's Policies for International Cooperation in Sustainability Research (1st ed.). Transcript Verlag.

UNESCO (2023). https://uis.unesco.org/en/news/launch-2023-survey-research-experimental-development-statistics-sdg9.5. Accessed March 20, 2024.

UNESCO (2024). https://en.unesco.org/science-policy/science_policy_society. Accessed March 20, 2024.

United Nations Environment Programme. (2017). Strengthening the Science-policy Interface: A Gap Analysis. Nairobi.

United Nations Office on Drugs and Crime (UNODC). National Bureau of Statistics (2019). Corruption in Nigeria, Patterns and Trends.

US Congress (1998). Unlocking Our Future: Towards A New National Science Policy. Report by the

Committee on Science, U.S. House of Representatives, One Hundred Fifth Congress, September 1998.

World Bank (2023). https://data.worldbank.org/indicator/GB.XPD.RSDV.GD.ZS. Accessed March 24, 2024.

World Justice Project (2023). https://worldjusticeproject.org/news-year-impact-transparencit-nigeria-corruption. Accessed March 18, 2024.

APPENDIX I

S/N	Table 1: Research Centers and Organizations in Nigeria	Year Established
1	Nigerian Institute of Social and Economic Research	1950
2	Federal Institute of Industrial Research (FIIRO)	1956
3	Nigerian Institute for Trypanosomiasis Research (NITR)	1960
4	Nigerian Stored Products Research Institute (NSPRI)	1960
5	Rubber Research Institute of Nigeria (RRIN)	1961
6	Cocoa Research Institute of Nigeria	1964
7	Nigerian Institute for Oil Palm Research (NIFOR)	1964
8	International Institute of Tropical Agriculture (IITA)	1967
9	National Institute for Freshwater Fisheries Research (NIFFR)	1968
10	Institute of Agricultural Research and Training (IART)	1969
11	Projects Development Institute (PRODA)	1971
12	Centre for Management Development	1973
13	Lake Chad Research Institute (LCRI)	1975
14	National Agricultural Extension and Research Liaison Services	1975
15	National Veterinary Research Institute (NVRI)	1975
16	National Cereals Research Institute (NCRI)	1975
17	National Horticultural Research Institute (NIHORT)	1975
18	Nigerian Institute for Oceanography and Marine Research (NIOMR)	1975
19	National Animal Production Research Institute (NAPRI)	1976
20	National Root Crops Research Institute (NRCRI)	1976
21	Forestry Research Institute of Nigeria (FRIN)	1977
22	Nigerian Academy of Science	1977
23	Nigerian Institute of Medical Research (NIMR)	1977
24	Nigerian Building and Road Research Institute (NBRRI)	1978
25	National Centre for Energy Research and Development	1980
26	Social Sciences Academy of Nigeria	1983
27	National Centre for Genetic Resources and Biotechnology (NACGRAB)	1987
28	Raw Materials Research and Development Council (RMRDC)	1987
29	Nigerian Educational Research Council	1988
30	National Research Institute for Chemical Technology (NARICT)	1988
31	National Institute of Pharmaceutical Research and Development (NIPRD)	1989
32	National Centre for Agricultural Mechanization	1990
33	International Livestock Research Institute	1994
34	National Space Research and Development Agency (NASRDA)	2010

Source: https://www.commonwealthofnations.org/sectors-nigeria/education/research_institutes/

APPENDIX II

Table 2: Various Actions/Initiatives Taken by Nigeria Towards Environmental Governance and Sustainability.

Action/Initiative Taken	Summary Description
Enactment of the Environmental Impact Assessment (EIA) Act in 1992.	EIA is a widely used tool to assess the environmental effects of planned development activities before progressing the project.
Establishment of the Federal Ministry of Environment (1999).	The functions of FEPA were taken up by the Federal Ministry of Environment in 1999 when the agency was incorporated into its structure. The ministry's structure includes the following thematic area departments headed by directors; Climate change, Desertification, Land Degradation and Drought Management, Environmental Assessment, Erosion, Flood and Coastal Zone Management, Forestry, Pollution Control, and Environmental Health
State Environmental Protection Agencies (SEPA).	Most States in Nigeria have set up either SEPAs or Ministries of Environment, which aim to domesticate some national laws and decentralize environmental governance initiatives.
National Environmental and Standards Regulatory and Enforcement Agency (NESREA) in 2017.	This body was established to strengthen the enforcement of environmental laws and regulations following the scrapping of FEPA, which created a gap in the effective enforcement of environmental laws, standards, and regulations in the country.
Issuance of National Environmental Regulations.	Pursuant to the enactment of the FEPA and NESREA laws, Nigeria issued several regulations to mitigate environmental pollution, and curb the impacts of effluent discharge, hazardous wastes, industrial wastes, air emissions, and ambient noise. Standards for environmental components such as air, noise, surface water, and groundwater have also been released.
Enactment of the Climate Change Act (2021).	This Act seeks to mainstream climate change actions into national development, achieve low greenhouse gas emissions, green and sustainable growth, and the implementation of Nigeria's commitment to net zero emissions declared at COP26 in 2021.
International Agreements.	Nigeria has also accented to several international conventions, agreements, and/or treaties aimed at supporting the world's ecological balance. Some of the notable ones include the London Dumping Convention (1975), Convention on Trade in Endangered Species (1987), Convention on Biodiversity (1992), Convention on Hazardous Waste (1992), Montreal Protocol on Ozone Layer (1996), Paris Agreement on Climate Change (2015).
Sectoral Guidelines/Regulations	The most important sectoral guidelines focused on the peculiar ecological impacts of key sectors are the: - Environmental Guidelines and Standards for the Petroleum Industry in Nigeria (EGASPIN) EIA sectoral Guidelines, such as those developed for the oil and gas industry, renewable energy, urban development, pesticides, and food and beverages.

Table 2: Various Actions/Initiatives Taken by Nigeria Towards Environmental Governance and Sustainability.

Action/Initiative Taken	Summary Description
Other Actions.	Other actions worth mentioning include the issuance of the country's Report on our Nationally Determined Contributions to Climate Action (2021), participation in the Bonn Challenge, a global goal to bring 150 million hectares of degraded and deforested landscapes into restoration by 2020, and 350 million hectares by 2030, collaboration on Global Plastic Action Partnership (GPAP), and more.

Source: Imevbore, 2023b