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The Blue Economy Technology and Inclusive Industrialization: Imperatives for the Sustainable Development of Coastal Nigeria

by

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Abstract

The paper explored the blue economy concept and its capacity to generate growth and development in the coastal areas of Nigeria. Using a theoretical research approach and exploring the theoretical frameworks and models of successful and sustainable practices in the blue economy environment, the paper finds out that blue economy has the capacity to generate growth, prosperity and development in a sustainable manner. It also presented the Nigerian coastal areas as having enormous potential for a blue economy revolution. Particularly, the paper identifies Akwa Ibom State as one of the foremost States that has really prepared to take advantage of the blue economy with interesting and blue economy enabling infrastructure.

Key words: Blue economy, growth, prosperity, infrastructure

1. Introduction

Genesis Chapter 1 verse 9 records how God created the earth:

Let the waters under the heavens be gathered together into one place, and let the dry land appear; and it was so.

In Genesis 1:10, God went further to say thus:

And God called the dry land Earth (Green Economy), and the gathering together of the waters He called Seas (Blue Economy). And God saw that it was good.

God, through nature created an earth planet that was in equilibrium. All things were so organized that they complemented each other. Human nature intake oxygen for life and excel carbon dioxide. Trees and plants intake carbon dioxide for life and excel oxygen. Human nature, trees and plants die and decompose to form minerals for use by human nature, plants and trees. Weather is so regulated to support livelihood, with seasonal moods that allow for sustainable livelihood. Human nature so adapted to living in the dry land

earth (Green Economy) created for them by God, started using the resources therefrom for economic livelihood. Drawing from the biblical injunction of Gen 1:28:

Be fruitful and multiply; fill the earth and subdue it; have dominion over the fish of the sea, over the birds of the air, and over every living thing that moves on the earth,

human nature's population started growing in multiple proportions.

Population increase started putting pressure on livelihood resources of the Green Economy. Thomas Malthus (2016) experiencing this in Europe drew the warning to indicate that population was growing at a rate faster than growth in food resources to feed the population sustainably.

In search of a sustainable livelihood, man had always craved sustainable conditions and environment that can carry its needs, wants, and demand. In a pressing world of insatiable wants for scarce resources, there is need for search by societies and its governments to build economies where these wants are provided with the scarce resources such that a 'pareto optimal' situation is attained (where if some are better off, non will be worse off).

As defined in the Charter on Maritime Security and Safety and Development in Africa (Lomé Charter), the term "blue economy" encompasses economic activities from marine and aquatic spaces in oceans, coasts, seas, rivers, lakes, groundwater, wetlands, floodplains and associated water resources. The Charter furthers that African Governments are increasingly implementing a blue or ocean-based economy as a strategy for creating economic development with a view to improving human well-being and social equity, while significantly reducing environmental risks and ecological scarcities. The African Union defines a blue or ocean economy as "sustainable economic development of oceans using such technics as regional development to integrate the use of seas and oceans, coasts, lakes, rivers and underground water for economic purposes, including, but without being limited to fisheries, mining, energy, aquaculture and maritime transport, while protecting the sea to improve social well-being", thus highlighting features that make a blue or ocean economy more locally based and more resilient, to minimize the likelihood of shocks such as economic or environmental disturbances developing into regional or even global crises, as is presently the case (AUDA-NEPAD, 2019). According to The Center for the Blue Economy, "it is now a widely used term around the world with three related but distinct meanings- the overall contribution of the oceans to economies, the need to address the environmental and ecological sustainability of the oceans, and the ocean economy as a growth opportunity for both developed and developing countries." (MIIS, 2018). The United Nations (UN) defines the blue economy as an ocean economy that aims at the improvement of human well-being and social equity, while significantly reducing environmental risks and ecological scarcities (UN, 2014).

Prior to the emergence of the blue economy concept, the green economy had been heavily touted as that which could save and sustain the earth environment with technology and industrialization that does not hurt its future; that a sustainable use of the green economy will be the only asset that may save the world from extinction in the nearest future. Resulting from this, serious cases had been made for reduction or zero use of fossil fuels,

zero emission of effluents from gas and aluminum processes, elimination of indiscriminate waste disposal, etc. Recent economic development theorizing had revolved around the green economy. Environmentalists had seen the green economy as the only means to sustainable existence of the world. This conception informed the Sustainable Development Goals of the World Bank. The key argument supporting the green economy had always been that the unsustainable use of the green resources, mostly through industrialization and harmful human activities for economic gains may destroy the equilibrium of the world's ecosystem which will eventually result in serious negative consequences. To buttress the point and conviction of these pro-green activists, the climate change mantra had been widely agreed as resulting from the unsustainable use of the environment.

Interestingly, before the announcement by scientists of the grave misuse of the green economy and its damaging consequences, which is currently manifesting in confusing climate change scenario: earthquakes; flooding; air pollution; and other natural disasters, the world had already gone deep into technology and industrialization that did not consider the life of its ecosystem. While grappling to re-calibrate and return the world's ecosystem to its natural equilibrium, heavily constrained by economic growth demands of nations of the world, the BLUE ECONOMY emerged. The Blue Economy which offers similar or even better opportunity as the Green Economy for the sustainable use of earth's resources and option for easy adjustment to its equilibrium had come at a time knowledge had abound for sustainability in the development drive of world economies.

A sustainable economy of water bodies, therefore, seeks to promote economic growth, responsible production and consumption, social inclusion, the preservation or improvement of livelihoods and the environmental sustainability of aquatic, marine and coastal areas. In Africa, the 2050 Africa's Integrated Maritime Strategy, adopted by the African Union in January 2014, guides and sharpens the focus of the continent in delivering an integrated and multidimensional blue or ocean economy (AU-NEPAD, 2018).

2. Objectives of the Study

This paper sought to explore the concept of the blue economy, its capacity to generate growth, prosperity and development to coastal states in Nigeria, like Akwa Ibom State, and the need to adopt technologies and industrialization strategies that will not be harmful to the sustainable growth of the economy.

3. Technology, Sustainable Development and Inclusive Industrialization

Technology is simply defined as the application of scientific knowledge for practical purposes, to solve problems or invent useful tools (<http://www.yourdictionary.com>). Technology affects almost every aspect of the 21st century life. Technology can be the knowledge of techniques, processes, and the like, or it can be embedded in machines to allow for operation without detailed knowledge of their workings. Systems (e.g. machines) applying technology by taking an input, changing it according to the system's use, and then producing an outcome are referred to as technology systems or technological systems (en.m.wikipedia, 2021). The simplest form of technology is the development and use of basic tools.

Technology has many effects. It has helped develop more advanced economies and has allowed the rise of leisure class. Many technological processes produce unwanted by-products known as pollution and deplete natural resources to the detriment of earth's environment. Innovations have always influenced the values of a society and raised new questions in the ethics of technology. Examples include the rise of the notion of efficiency in terms of human productivity, and the challenges of bioethics.

Philosophical debates have arisen over the use of technology, with disagreement over whether technology improves the human condition or worsens it. Neo-Luddism, anarcho-primitivism, and similar reactionary movements criticize the pervasiveness of technology, arguing that it harms the environment and alienates people; proponents of ideologies such as trans-humanism and technological progressivism view continued technological progress as beneficial to society and the human condition. To benefit from the positivism of technology, however, economies must raise its knowledge level through deepening education content of its population. If labour, for instance, still remain mostly subsistent, technology may create serious unemployment conditions (Frassen, Maarten, Gert-Jan Lokhorst, and Ibo van de Poel, 2018).

Sustainable development is the idea that human societies must live and meet their needs without compromising the ability of future generations to meet their own needs. It is a way of organizing society so that it can exist in the long term (<https://youmatter.world/definition>).

Sustainable development is further defined as an approach to developing or growing by using resources in a way that allows for them to renew or continue existing for others. For example, using recycled materials or renewable resources when building is an example of sustainable development.

The Sustainable Development Goals (SDGs), also known as the global goals, were adopted by all United Nations Member States in 2015 as a universal call to action to end poverty, protect the planet and ensure that all people enjoy peace and prosperity by 2030.

Inclusive Industrialization means that industrial development must include all countries and all peoples, as well as the private sector.

The Lima Declaration, adopted by UNIDO Member States in December 2013, set the foundation for a new vision of inclusive and sustainable industrial development (ISID) and highlighted the role of industrialization as a driver for development (UNIDO, 2013). UNIDO opines that ISID is the primary source of income generation and that it allows for rapid and sustained increases in living standards for all people, and provides the technological solutions to environmentally sound industrialization. Technological progress is the foundation of efforts to achieve environmental objectives, such as increased resource and energy-efficiency. Without technology and innovation, industrialization, development will not happen (UNIDO, 2021).

Inclusive in this context, UNIDO said, means that industrial development must include all countries and all peoples, as well as the private sector, civil society multinational development institutions, and all parts of the UN system, and offer equal opportunities and equitable distribution of the benefits of industrialization to all stakeholders. The term sustainable addresses the need to decouple the prosperity generated from industrial

activities from industrial progress, which also provides the means for tackling critical social and humanitarian needs.

UNIDO's mandate is reflected in Sustainable Development Goal (SDG) 9: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.

4. Current Growth Theories and Development Models

Current development theorizing had derived its origin from growth theories. They are anchored more on how growth can regenerate economic wealth of nations. Arguments that build the nexus between growth and development are anchored on the general assumption that when growth takes place and become mainstreamed into all sectors of a nation's economy, it will bring about development. Growth models generally emphasize the augmentation of the traditional production function with technology to ensure rapid growth. These theories further emphasize industrialization as the means of generating real and inclusive growth and therefore development. This paper summarizes these theories in this section and furthers to undertake the theoretical underpinning for establishment of a sustainable blue economy.

4.1 Linear Stages of Growth Theory

The linear stages' of growth model is an economic model heavily inspired by the Marshall Plan which was used to revitalize Europe's economy after the Second World War. It assumes that economic growth can only be achieved by industrialization. According to the linear stages of growth model, a correctly designed massive injection of capital coupled with intervention by the public sector would ultimately lead to industrialization and economic development of a developing nation (Caincross, 1961). Public sector investment is emphasized as market may not aggregate the required resources to allocate to public sector investments to generate growth and development. The Rostow stages' of growth model is the most well-known example of the linear stages of growth model. Rostow (1960) identified five stages through which developing countries had to pass to reach an advanced economy status: (1) Traditional society, (2) Preconditions for take-off, (3) Take-off, (4) Drive to maturity, (5) Age of high mass consumption.

4.2 The Big Push Theory

Heavy state involvement has often been considered necessary for successful development in economic modernization theory; Paul Rosenstein-Rodan, Ragnar Nurkse and Kurt Mandelbaum argued that a big push model in infrastructure investment and planning was necessary for the stimulation of industrialization, and that the private sector would not be able to provide the resources for this on its own (Khunen, 1979). Also, in his model, Lewis (1954), while further deepening the need for modernization and how countries can attain it explained how the traditional stagnant rural sector is gradually replaced by a growing modern and dynamic manufacturing and service economy.

4.3 Structuralism

Structuralism is a development theory which focuses on structural (operational) aspects which impede the economic growth of developing countries. Structuralism is concerned with the transformation of a country's economy from a mainly subsistent agriculture to a modern, urbanized manufacturing and service economy. Policy prescriptions resulting from structuralists' thinking include major government intervention in the economy to fuel the industrial sector, known as import substitution industrialization (ISI). This structural transformation of the developing country is pursued in order to create an economy which in the end enjoys self-sustaining growth. This can only be reached by ending the reliance of the underdeveloped country on exports of primary goods (agricultural and mining products), and pursuing inward-oriented development by shielding the domestic economy from that of the developed economies

The Prebisch-Singer hypothesis states that over time the terms of trade for commodities deteriorate compared to those for manufactured goods, because the income elasticity of demand of manufactured goods is greater than that of primary products. This hypothesis lends strong support to the ISI strategy.

Recent statistical studies have given support for the idea developed by Raul Prebisch and Hans Singer in the 1940s (Rabah Arezki, Kaddour Hadri, Prakash Loungani, Yao Rao (2013) and David I. Harvey, Neil M. Kellard, Jakob B. Madsen, Mark E. Wohar (2010)

Structuralists' argue that the only way Third World countries can develop is through action by the State. That the private sector will not be able to provide the lumpy capital needed for the expected massive investment in social capital needed for growth and development. Third world countries have to push industrialization and have to reduce their dependency on trade with the First World, while encouraging trading amongst them.

4.4 The Solow or Neo-Classical Growth Model

The Solow growth model is an exogenous model of economic growth that analyzes changes in the level of output in an economy over time as a result of changes in the population growth rate, the savings rate, and the rate of technological progress. The Solow growth model was the first neoclassical growth model and was built upon the Keynesian Harrod-Domar model (Acemoglu, 2009).

Solow's model assumes constant population growth rate, constant proportion of savings, constant level of technology for all firms, and that the production function exhibits constant returns to scale. The implication of the model is that there is no growth in the long run. If countries have the same population growth, savings, and capital depreciation rates, then they have the same steady state, so they converge, that is, Solow Growth model predicts conditional convergence. Along this convergence path, a poorer country grows faster (Corporate Finance Institute, 2021).

4.5 The New-classical or Endogenous Growth Model

The new classical growth theory argues that factor inputs are endogenously determined (Aghion and Howitt, 1998). The theory maintains that economic growth is primarily the result of internal forces, rather than external ones. It argues that improvements in productivity can be tied directly to faster innovation and more investments in human

capital from government and private sector institutions. The Arrow or AK model of economic growth is used to explain economic changes as a result of innovation and technology. Endogenous technologies refer to new technologies developed within (or based on the initiative of) a country through research, development, and demonstration. It also refers to technologies acquired through understanding, adapting, utilizing, and replicating already-existing technologies.

The endogenous growth theory also focuses on positive externalities and spillover effects of a knowledge-based economy which will lead to economic development. The endogenous growth theory primarily holds that the long run growth rate of an economy depends on policy measures. For example, subsidies for research and development or education increase the growth rate in some endogenous growth models by increasing the incentive for innovation.

4.6 Acemoglu's Growth Constraint Hypothesis

In addressing the fundamental determinants of differences in economic performance among countries of the world, Acemoglu (2009), who opined that cross country income differences are due to a combination of technology differences and differences in physical capital per worker and human capital per worker, himself drawing deeply from Solow (1956), however, considered these sources as only close causes of economic growth and economic success. Acemoglu (2009) questioned the illusion by accepting the proximate causes as the factors that drive economic growth and economic success by asking thus: if technology, physical capital and human capital differences are so important in understanding differences in the wealth of nations and if they account for the multiple fold differences in income per capita across countries, then why is it that some societies do not improve their technologies, invest in physical capital, and accumulate human capital as much as others?

Acemoglu (2009) asserted the incompleteness of these factors in engaging desired growth by nations, rather, he concluded by referring to what he termed, “fundamental causes” of economic growth. He defined the “fundamental causes” as reasons that are preventing many countries from investing enough in technology, physical capital, and human development. He concluded that the “fundamental causes” which are the emerging reasons for non-growth inclusiveness include:

- (i) The Luck hypothesis
- (ii) The Geography hypothesis
- (iii) The culture hypothesis
- (iv) The Institutions hypothesis

4.7 Dependency Theory

Dependency theory is essentially a follow up to structuralists' thinking, and shares many of its core ideas. Whereas structuralists' did not consider that development would be possible at all unless a strategy of delinking and rigorous Import Substitution Industrialization (ISI) was pursued, dependency thinking could allow development with

external links with the developed parts of the globe. However, this kind of development is considered to be "dependent development", that is, it does not have some internal domestic dynamics in the developing country and thus remains highly vulnerable to the economic vagaries of the world market. Dependency theory states that poor nations provide natural resources and cheap labour for developed nations, without which the developed nations could not have the standard of living which they enjoy. When underdeveloped countries try to remove the Core's influence, the developed countries hinder their attempts to keep control. This means that poverty of developing nations is not the result of the disintegration of these countries in the world system, but because of the way in which they are integrated into this system.

4.8 Post Development Theory

This school of thought questions the idea of national economic development altogether. According to post-development scholars, the goal of improving living standards leans on arbitrary claims as to the desirability and possibility of that goal. Post-development theory arose in the 1980s and 1990s. They see the idea of development as just a 'mental structure' which has resulted in a hierarchy of developed and underdeveloped nations, of which the underdeveloped nations desire to be like developed nations (Wolfgang, 1992). Development thinking has been dominated by the West and is very ethnocentric (belief in the superiority of a social or cultural group that someone belongs over the other), according to Wolfgang (1992). The Western lifestyle may neither be a realistic nor a desirable goal for the world's population, post-development theorists argue.

Post Development theorists see development as being a loss of a country's own culture, people's perception of them and their modes of life. According to Rahnema (2003), another leading post-development scholar, things like notions of poverty are very culturally embedded and can differ a lot among cultures. The institutes which voice the concern over underdevelopment are very Western-oriented, and post-development calls for a broader cultural involvement in development thinking.

Post-development proposes a vision of society which removes itself from the ideas which currently dominate it. According to Escobar (1995), post-development is interested instead in local culture and knowledge, a critical view against established sciences and the promotion of local grassroots movements.

This theory although striking some reason for nationalism and self-esteem, seems to be misunderstood by many, especially in the developing world, who seeks a radical departure from imported western culture and lifestyles. The Nigerian Boko Haram sect and many others that had existed before them are negative testimonies of what a push for this kind of theorizing could bring.

4.9 Sustainable Development Theory

The idea of sustainability came to the public attention after a 1972 report, "Limits to Growth," issued by the international think tank Club of Rome (Meadows, et. al 1972). It, however, became a benchmark for international action in 1980 through the report 'Living Resource Conservation for Sustainable Development' of the Swiss-based World

Conservation Union. This development methodology is more concerned about environmental sustainability as the race for development through industrialization rages.

Opponents of the implications of sustainable development often point to the environmental Kuznets curve. The idea behind this curve is that, as an economy grows, it shifts towards more capital and knowledge-intensive production. This means that as an economy grows, its pollution output increases, but only until it reaches a particular threshold where production becomes less resource-intensive and more sustainable. This means that a pro-growth, not an anti-growth policy is needed to solve the environmental problem. But the evidence for the environmental Kuznets curve is quite weak (Ekong and Onye, 2012).

However, the concept of sustainable development has been subjected to wide criticism by industrial revolutionists. They argue that there is no such thing as sustainable use of non-renewable natural resources, since any positive rate of exploitation will eventually lead to the exhaustion of earth's finite stock (Turner, 1988) and this perspective renders the Industrial Revolution as a whole unsustainable (Georgescu-Roegan, 1971; Rifkin, 1980).

In Nigeria however, both public and private sectors have invested concerted efforts at sustainable development. Mostly anchored by international aid agencies like the World Bank, United Nations, and other Donor agencies, implementation of programs and projects have always been designed and aligned by and with sustainable development methodologies. The expectation of the result from sustainable development strategy application would have been a more robust and sustainable economy. Instead of the desired expectation, the Nigerian scenario gets more confusing and chaotic.

4.10 Human Development Theory

Human development theory is that which uses ideas from different origins, such as ecology, sustainable development, feminism, and welfare economics. It wants to avoid normative politics and is focused on how social capital and instructional capital can be deployed to optimize the overall value of human capital in an economy.

Amartya Sen (2001) and Mahbub ul Haq (1996) are the most well-known human development theorists. The work of Sen (2001) is focused on capabilities: what people can do and be. It is these capabilities, rather than the income or goods that they receive (as in the Basic Needs approach), that determine their well-being

The World Bank and UNDP noted in their reports (2017) that Nigeria has failed in investing in human development; that it is expenditure or investment in this critical area that would have boosted the country's productivity. Expenditure on health and education are said to be appalling. This was even noted by Bill Gates when he visited the President of Nigeria, Muhammadu Buhari in 2018.

Even when government had tried to explain commendable investments in this sector, given the availability of funds, the conspicuous issue of brain drain had been located as a key factor that has depressed the objective of backward assimilation of the investment in Nigeria, as trained human capital in many cases exited Nigeria or refused to return after training abroad.

This critique does not however, consider States and Local Governments spending on Human Capital.

5. Theoretical Framework for Establishing Sustainable Blue Economy

In this section, the paper theoretically reviews extant frameworks that will best birth a robust sustainable Blue Economy in Nigeria. The theoretical cases are founded on successful experiments that could be easily replicated. The theoretical cases will focus on three aspects: national macroeconomic management, policy framework and management technology.

(a) National Macro-Economic Strategies

Since 2012, blue economy has entered the phase of practice and exploration. Some countries and regions have proposed strategic frameworks and action plans for developing the blue economy. The macro-economic blue economy strategies of two economies will be discussed in this paper: the European Union (EU) and Indonesia. They are highly rated as very successful blue economy strategies in the world for now. This is to compare the strategies from a regional perspective (having many countries in the plan) and a country specific perspective.

(i) European Union's Blue Growth Strategy and Blue Innovation Plan

The European Union proposed the "Blue Growth" strategy in 2012. The Union specified that Blue Growth will be the core of marine policies; stating clearly key development areas and specific measures for the future. Blue Growth Strategy has launched initiatives in many policy areas related to Europe's oceans, seas and coasts, facilitating the cooperation between maritime business and public authorities across borders and sectors, and stakeholders to ensure the sustainability of the marine environment.

In 2014, the Blue Economy Innovation Plan was launched. The plan was designed for execution in three specific aspects:

- (i) To develop sectors that have a high potential for sustainable jobs and growth,
- (ii) To build essential components to provide knowledge, legal certainty and security in the blue economy; and
- (iii) To develop Sea basin strategies to ensure tailor-made measures and to foster cooperation between countries.

In 2017, the EU issued the Report on the Blue Growth Strategy toward more Sustainable Growth and Jobs in the Blue Economy. The report examined what had been achieved and what had been learnt since 2012. The report also considered what was ongoing and what is still missing.

The report described these five aspects:

- (i) pushing for growth in five focus areas, including blue energy, aquaculture, coastal and maritime tourism, blue biotechnology, sea bed mineral resources;
- (ii) the benefits of marine data, spatial planning and maritime surveillance to facilitate growth in the blue economy;
- (iii) promoting a partnership approach;
- (iv) boosting investment; and
- (v) making blue growth strategy fit future challenge.

(i) Indonesia's Sustainable and Equal Growth of Marine and Coastal Regions

Indonesia proposed the principles of developing marine and fishing industries based on their blue economy concept:

- (i) to formulate comprehensive economy and environment protection policies; and
- (ii) to boost regional economic development; realize sustainable development by promoting clean production systems and encourage creative and innovative investment.

The highlights of developing blue economy in Indonesia included:

- (i) to develop marine fishery, marine transportation, tourism, energy and material production industries based on the blue economy concept;
- (ii) to further improve and coordinate marine and land economy national policies;
- (iii) to develop blue economy demonstration zone; and
- (iv) to strengthen connections between trade and infrastructure and promote the development of technology and human resources.

In addition, Indonesia also planned to set up blue economy demonstration zones in Lombok and Anamabs islands and Tomini bay, for exploring the blue economy model featured with marine industry, fishery, breeding, seaside tourism industries, small island collective, regional and bay development.

6. Blue Economy Development Policy Guidelines

(a) Scientific Innovation of the Marine Industry

China has been pushing forward scientific innovations of the marine industry and has established six national marine economic innovation and development demonstration areas and seven national industrial demonstration bases for rejuvenating marine industry with science and technology, of which several projects have achieved commendable results. Such include: Shandong Peninsula Blue Economic Zone, Blue Silicon Valley and the strategic cooperation among marine parks and bases in the Yangtze River Delta region.

(b) Shandong Peninsula Blue Economic Zone

This is China's first regional development strategy to focus on the marine economy which was officially approved by the Chinese State of Council in 2011 (National Development and Reform Commission, 2011). The strategic positioning of Shandong Peninsula Blue Economic Zone is to nurture it to develop into the following:

- (i) a modern marine industrial cluster with relatively strong international competitiveness;
- (ii) a world-leading education center of marine science;
- (iii) a pilot zone for national marine economic reform; and
- (iv) a national key demonstration zone of marine ecological civilization.

By 2015, Shandong Peninsula Blue Economic Zone has established a basic system of modern marine industry, with a significantly strengthened comprehensive economic strength, highly improved innovation capability of marine science and technology, highly improved quality of ocean and land ecological environment, and constantly improved landscape of the opening up of marine economy. The Shandong Blue Economy Zone had

led other areas to achieve the general requirements of building a moderately prosperous society in all aspects.

(c) Blue Silicon Valley

The work and management committees of Qingdao Blue Silicon Valley core area were officially established on January 31, 2012. This marked the commencement of the overall planning and construction of Qingdao Blue Silicon Valley (Qingdao Municipal Government, 2012). Aiming to establish “China Qingdao Blue Silicon Valley, a new town of marine science and technology” and highlighting the functions of incubating scientific achievements and driving forward innovation, the project was planned to build five new towns that deeply integrate scientific research, education and living. It also centrally planned:

- (i) key platform projects of marine science and research, education;
- (ii) achieve conversion and academic exchanges;
- (iii) speeds up the clustering of marine high-tech research and development;
- (iv) to develop high-tech talents;
- (v) high-tech industry and service organizations;
- (vi) significantly improving the abilities of independent innovation;
- (vii) achievement conversion and industry cultivation;
- (viii) to establish world-leading centers for marine scientific and technological research and development,
- (ix) to establish centers for incubating and trading marine achievements;
- (x) to establish centers for cultivating emerging marine industries,
- (xi) to establish centers for clustering blue education and talents,
- (xii) to establish centers for blue tourism and healthcare; and
- (xiii) to become an innovation platform that enables China to scientifically develop and utilize marine resources and links global marine scientific research resources.

(d) Strategic cooperation among marine parks and bases in the Yangtze River Delta Region

On June 8, 2018, several marine industrial parks and bases in the Yangtze River Delta region signed agreements to implement regional strategic cooperation. The strategic cooperation of marine industries in the Yangtze River Delta include five parks and bases in Nantong, Zhoushan, Shanghai Pudong, and Ningbo.

The establishment of these parks and bases has two major emphases:

- (i) to elevate industrial cooperation, comprehensively manage industrial projects and resources to facilitate necessity-based selections, build service functions to guide project practices, promote orderly transfer and cluster development of marine industry within the region; and
- (ii) to deepen cooperation between scientific innovation and talents, encourage colleges and institutions, scientific institutes and enterprises to establish cooperative research and development institutions and joint centers for technology transfer, achieve communications and integration in introducing marine talents, build joint mechanism for educating and cultivating talents and establish common criteria in recognizing talents (Chinese State of Council, 2014).

(e) Widen Space for Blue Economy

The 13th Five-Year Plan for Economic and Social Development of the People's Republic of China requires widening space for the blue economy. In supporting industrial development, the Plan suggests to complement domestic fishery with distant water fishery to protect and maintain coastal fishery resources, restore marine ecological environment and effectively improve the on-going healthy development of distant water fishery. The Plan proposed several key maritime projects:

- (i) Dragon in the deep-seas achieve breakthroughs in key technological development of the Dragon Palace-I deep-sea experimental platform and construct deep-sea mobile and bottom-supported experimental platforms. Research and develop a system for integrated deep-sea environmental monitoring and activity exploration. Develop a shared platform for deep-sea equipment applications (China's search, 2018).
- (ii) Snow Dragon's Polar Exploration establish a new shore-based observation station at Arctic Pole through cooperation, establish a new research station at Antarctic Pole, build new advanced icebreakers, improve Antarctic aviation capabilities, and complete the basic framework for land-sea-air observation platform in the polar regions (Science 24 hours, 2016). Research and develop exploration technology and equipment suitable to the polar environments, establish a service platform for the provision and application of information regarding the polar environments and potential polar resources.
- (iii) The multi-dimensional global ocean observation network make overall planning for the layout of the national ocean observation (monitoring) network, move ahead with the development of real-time online monitoring systems and overseas observation (monitoring) stations for the marine environment, work toward establishing a multidimensional global ocean observation (monitoring) system, and strengthen observation and research of marine ecosystems, ocean currents, and maritime meteorology.

(f) Blue economy in deep ocean stewardship initiative

A potential and topical sector for the promotion of the Blue Economy in our deep oceans is that of deep seabed mining for marine minerals and trace metals Cuyver et al (2018). The demand for minerals is increasing owing to reserves in land-based mines dwindling, as well as the potentially extensive environmental and social consequences of mining on land. Some suggest that land-based mining and recycling existing minerals alone may not fulfill the future demand for these resources (Hein, et al, 2013). Minerals have potential for diverse industrial applications, including for green technologies, hence there is increasing attention to their extraction from the deep sea. Consequently, significant investments have already been made by some countries in terms of exploration for deep seabed mineral resources, developing sophisticated technology and conducting feasibility studies (for example the Japanese conducted their first test mining in 2017), and developing economic models under different commodity price scenarios and other geologic and financial considerations (Van Nijen et al, 2018). The exploitation of materials such as polymetallic sulfides, polymetallic nodules, cobalt-rich ferromanganese crusts (for nickel, copper, cobalt, zinc, manganese, gold, silver and other metals), as well as rare-earth

elements, are of economic interest especially as these marine sources are often high-grade ores and therefore very valuable. Some of the main focus areas for this industry are the polymetallic nodules on the abyssal plain in the Clarion-Clipperton Zone (CCZ) in the Central Pacific Ocean, the seafloor massive sulfide deposits associated with hydrothermal vents in the Indian Ocean, and ferromanganese cobalt-rich crusts associated with seamounts in the West Pacific Ocean (Levin et al., 2016; Cuyvers et al., 2018). In the Atlantic Ocean, bromine and magnesium are found in commercial quantity. Off the east of Florida in the Atlantic Ocean, there are minerals such as monazite, titanium and off the Coast of Africa, tin; sea salt; and other metal ores are found (<https://worldinfoone.com>).

Mining activities within national jurisdictions are governed locally but the extensive resources of those outside EEZs in the area are under the jurisdiction of the International Seabed Authority (an intergovernmental body established by UNCLOS in 1982 to organize and regulate all mineral-related activities). Although deep-seabed mining may generate income for some nations, it will come at a high environmental cost with many unknown risks, some of which may become apparent only in the distant future (Gollner et al., 2017).

Deep-seabed mining comes with significant regulatory challenges. The environmental and social costs and future risks must be as fully understood as possible and be weighed against the short-term monetary gain. In addition to obvious destruction of sea life living at the mine site, there are other adverse effects on biodiversity and ecological processes such as those associated with sediment-plume generation, toxic chemical release, noise, etc. Gollner, et al (2017). The cumulative effects of these, along with other ocean pressures such as climate change (Guidetti and Danovaro, 2017) and pollution, need to be considered during this pre-mining phase in order to properly assess impacts. Integrated management of multiple economic sectors is a central tenet of blue growth and socially optimal use of ocean-based natural resources, but the mechanisms of implementation remain poorly understood (Klinger, et al (2018)). Open access to environmental data is essential (Voyer et al., 2018) in order to achieve industry transparency and sound environmental management.

Deep-sea mining is, however, rapidly approaching the commercial mining phase in multiple oceans, both in areas within and beyond national jurisdiction. There is an urgent need to identify and develop comprehensive, ecosystem-based management practices for deep-ocean environments subject to mineral extraction (Durden et al., 2017; Tunnicliffe et al., 2018). While overarching environmental objectives are needed, some practices will be resource and locality-specific. Transparent criteria for deep-sea institutional and corporate social responsibility also need to be established to respond to the challenges associated with sustainable use of resources Ardon et al., 2018). Proactive development of environmentally considerate extractive technologies, practices, frameworks and policies prior to the onset of commercial mining (and taking into account the precautionary principle) will help to ensure effective stewardship and preservation of the marine environment, whilst enabling the use of seabed mineral resources (Durden et al., 2017).

While deep-seabed mining is discussed as a case study here, the deep ocean features in numerous other elements of the Blue Economy (Ramirez-Llodra et al., 2011; Mengerink

et al., 2014). Deep-water fishing, which takes the form of bottom trawling, long lining, and now new mesopelagic fisheries are increasingly subject to ecosystem-based management. The designation of protections (e.g., vulnerable marine ecosystems, marine protected areas, areas of particular environmental interest), the preparation of environmental impact assessments, stock assessment, fisheries regulations and other facets will all benefit from increased scientific input and stewardship approaches (Mengerink et al., 2014). Exploitation of gas hydrates or hydrothermal gradients as energy sources, of marine genetic resources for biopharmaceutical or industrial uses, and use of space for telecommunications cables are additional opportunities that would benefit as well. There is also a growing need for consciousness and regulation about carbon emissions and other climate impacts, debris, pollutants and contaminants introduced to the deep ocean associated with blue industries (Ramirez-Llodra et al., 2011).

7. Blue Economy Management Technology

(i) Data Analysis and Information Delivery Support Observing Enterprises

The great lakes observing system (GLOS) is 1 of 11 Regional Associations in the integrated ocean observing system (IOOS). As certified regional information coordination entities, IOOS regions play a crucial role in coordinating their science and technology communities around the data and information priorities of resource managers and policy makers. In a geography as large as the Great Lakes, there are many academic, government and private entities that work in monitoring and science, and GLOS serves a role that is more focused on data management and aggregation services. Limited resources have also influenced the scope of GLOS' role in the region. Like other IOOS regions, GLOS provides direct resources to the sustained operations of local observing systems but in a more limited capacity. Similarly, GLOS has provided grants to partners for the development of models and information products or developed data tools and products directly, but typically as discrete projects that require further investment for sustained operations and maintenance.

The experience in the governance and management of GLOS provides a case study for why diversifying revenue is inherently important to sustaining and observing data management systems. Moreover, it has become critical for GLOS in a competitive market; one where organizations with similar names and broad missions can make it difficult to identify the best group for the job. GLOS is positioning itself to stay true to its mission while including non-traditional partners to achieve better results. The small size and 501c3 status of GLOS allows a less traditional approach to seeking partners and funding. GLOS addresses challenges in achieving its mission by applying creative funding and business models to areas of operations. Examples include:

- (i) crowdsource funding to support the costs of ongoing operations and maintenance of observing assets;
- (ii) multi-sector stakeholder agreements; and
- (iii) service-based business models.

While each of these examples has mixed success, they provide important insight into how the larger ocean observing enterprise might broaden its impact and grow the Blue Economy.

(ii) Delimitation Technology for China's Marine Spatial Planning

Faced with tight resource constraints, serious environmental pollution, and degraded ecosystems, the Chinese government is taking the road of sustainable development. The concept of ecological civilization that respects nature, conforms to nature, and protects nature is established. In March 2018, China launched the largest reform of the State Council in the past 40 years, in which resources and environmental reforms were prominent. The Ministry of Natural Resources has been assembled, and performed the responsibilities of owning all natural resource assets, managing all territory utilization, protecting and rehabilitating ecological environment uniformly. The “two unification” responsibilities start a new era in natural resource management in China.

China is in a critical period transferring from high-speed development to high-quality development. The resource and environmental carrying capacity and the territory space development suitability are important scientific propositions which represent the interaction and coordinated development between man and nature. Since 2010, it has gradually become a basic work for central and local governments to determine regional strategies and policies, and make development planning. The resource and environmental carrying capacity refers to the comprehensive support levels of natural resource endowment conditions to human activities in a certain space, and is characterized by four aspects: resources, environment, ecology and disasters. We can evaluate the relative level of carrying capacity and identify the problems and risks of current utilization, thus promoting harmonious development of man and nature. The territory space development suitability is oriented to different development and utilization, considering spatial integrity and connectivity, location advantage, traffic convenience and other indicators, to judge the appropriateness of different development and utilization modes. It can provide scientific planning for development and utilization, and promote high quality development. At present, China has taken the assessment of resource and environmental carrying capacity and the territory space development suitability as the basis and premise of territory space planning. The dual evaluation and territory space planning at all levels will be launched soon, guiding scientific planning with resources and environment constrains, and leading green and high quality development with scientific planning (National Development and Reform Commission, 2017; China Research Intelligence Group, 2018).

(iii) Comprehensive Governance of Marine Environment

The Chinese Government attaches great importance to the prevention and control of marine environmental pollution. On November 30, 2018, the Ministry of Ecology and Environment, the National Development and Reform Commission and the Ministry of Natural Resources jointly issued the Action Plan for the Struggle of Comprehensive Governance of the Bohai Sea (Ministry of Ecology and Environment et al., 2018)). The Action Plan clearly defined the overall requirements, scope and objectives, key tasks and safeguards for the comprehensive governance of the Bohai Sea, and put forward the timetable and roadmap for the Struggle of Comprehensive Governance of the Bohai Sea. The Action Plan proposes to improve the ecological environment quality of the Bohai Sea through comprehensive three-year management and solve the outstanding ecological and environmental problems in the Bohai Sea. By 2020, the proportion of the coastal waters in

the Bohai Sea with good water quality (first and second water quality) will reach about 73%, the natural coastline retention rate will remain around 35%, the coastal wetland rehabilitation scale will not be less than 6900 hectares, and the coastline rehabilitation will increase by about 70 km.

The Action Plan calls for four key actions: land-based pollution control action, marine pollution control action, ecological protection and restoration action, and environmental risk prevention action. The land-based pollution control actions include: pollution control of rivers entering the sea; strict control of industrial pollution source discharge, completion of illegal and unreasonable clean-up of sewage outlets; promotion of agriculture, rural and urban pollution prevention and control; and reduction of land-based pollutants into the sea. The marine pollution control actions include: implementing marine aquaculture pollution control; implementing ship and port pollution control; carrying out comprehensive improvement of fishing port environment; marine garbage pollution prevention; and establishing a division of responsibilities and coordination mechanism for land and sea planning. The ecological protection and restoration actions include: ecological protection of coastal zones, delineation and strict observance of the red line of marine ecological protection in the Bohai Sea, comprehensive regulation and restoration of estuaries and bays, comprehensive management and restoration of coastal and shoreline, and conservation of marine living resources. Environmental risk prevention actions include: implementation of land-based emergency environmental incident risk prevention; implementation of marine oil spill risk prevention; marine ecological disaster warning and emergency response.

8. Blue Economy Application Cases (Management Policy)

Drawing from science-based products and services that can underpin the development of the Blue Economy, and China's marine integrated management based on ecological environment, the paper classifies all the cases into disaster prevention, pollution prevention, Marine industry support, system platform and ecological restoration.

(a) Disaster Prevention

(i) Assessing Harmful Algal Bloom Evolution in EU Atlantic Shelf Seas

Aquaculture is identified as a Blue Growth priority to ensure the sustainable supply of seafood to help meet increased food demands of the growing global population. Harmful Algal Blooms (HABs) are a recognized global problem with annual losses to aquaculture running into billions of Euros (Bernard, et al., 2014). The AtlantOS HAB use case focuses on creating a weekly HAB bulletin for three European study areas in Norway, Ireland, and Spain. Experts who prepare the bulletins use the *in situ* ocean observing system, satellite data, and available numerical marine hydrodynamic modeling to provide a science-based product to indicate the current HAB status in areas of interest, accompanied by text describing the likely HAB occurrences in the days ahead (Cusack et al., 2018); example bulletins). Efforts in other parts of the world, the importance of co-development, and future expectations are discussed in Anderson et al (2019). In Europe, a key

driver for HAB bulletins is to support industry on-site management decisions, such as optimizing farm practices and planning business activities to mitigate/reduce shellfish and finfish mortalities due to HABs.

(ii) Assessing and Mapping Ocean Hazards Related to Coastal Flooding and Storm Surges

Coastal flooding is one of the major challenges of global climate change for humanity. It is estimated that by 2070, approximately 150 million people and \$35,000 billion of assets will be exposed to a 1 in 100 year flood event (WMO, 2021). Storm surges and oceanic waves are the major cause of extreme sea levels and devastating coastal impacts along many coastlines around the world with a significant human and economic cost. In order to improve our ability to assess the potential change of storm surge, it is critical to have a well-established baseline of the storm surge climate, based on consistent techniques. AtlantOS, an oil spill hazard maritime transportation estimator in the Atlantic Ocean basin coast, is laying the framework for a complementary international effort; developing a global storm surge climate has been adopted as a project under the Intergovernmental Oceanographic Commission (IOC)/World Meteorological Organization (WMO), Joint WMO-IOC Commission for Oceanography and Marine Meteorology (JCOMM) Expert Team for Waves and Coastal Hazards. Statistical methods to both tide gauge data and multi-decadal runs of hydrodynamical numerical models are a “main” activity for the Sendai Framework of Disaster Risk Reduction. In this use case improvements were made to estimate extreme sea levels around the Atlantic and more widely with a new understanding gained about how storm surges and high tides interact, providing proof that any storm surge can occur on any tide (Williams et al, 2016). The sciences based products developed in this use case will help to enhance the safety of coastal communities by supporting the decision making process related to planning coastal defenses and emergency response to severe coastal flooding.

(b) Pollution Governance

(i) Mapping Ship Based Oil Spills to Estimate the Hazard That Maritime Transportation Represents to Atlantic Basin Coasts

The AtlantOS “oil spill hazard mapping and disaster risk reduction best practices” use case developed a large ensemble oil spill simulation experiment to guide oil spill risk assessments and emergency management. Risk maps can now be rapidly produced, within five minutes, to help evaluate an oil spill hazard (S-Neves et al, 2018). The hazard/risk mapping and production of oil spill hazard bulletins in the Atlantic are generated in an open access oil spill hazard map portal called glamor. In emergency situations, the users can map the oil spill hazard spatial distribution for any Atlantic coastal area based on the average oil spill concentration found at the coastline. The product provides a decision support tool to coastal managers and governments to help guide emergency clean-up operations and decisions on the allocation of resources to targeted high risk areas.

(ii) Overall Planning of Land and Sea to Strictly Control Pollutants

China appoints local government heads as river chiefs and bay chiefs across the nation to clean up and protect its water resources. Shandong proposed new pollution prevention idea of “governing river first, treating land and sea in a coordinated way.” In Shandong, 15 rivers flowed into Laizhou Bay. In order to implement the responsibility of management and protection, Laizhou established a three-level “river chief” organization system of city, town and village. A total of 13 city-level “river chief,” 44 town-level “river chief,” and 662 village-level “river chief” were established. Since 2017, Laizhou has concentrated on the comprehensive management of Baisha River, Nanyang River and Zhenzhu River basins. A total of 42 million yuan has been invested, and about 25,000 meters of silt has been cleared up, more than 30 sewage outlets have been closed, and 64 polluted aquaculture households have been banned. After the linkage of the “river chief” and the “bay chief,” the problem of repeated pollution in the Bay has been fundamentally solved (People’s Daily, 2018). The current humanitarian payments to unemployed people in Nigeria could be easily directed to areas like this to engage the people.

9. Exploring the Economic Potential of the Blue Economy

- (i) Scientists estimate that **50-80%** of the oxygen production on Earth comes from the ocean. The majority of this production is from oceanic plankton — drifting plants, algae, and some bacteria that can photosynthesize (Hahana, 2021).
- (ii) In addition to its crucial role for regulating the climate and weather, the ocean is vital to the world's economy, with more than 90% of trade using sea routes and as a source of jobs for millions of people (<https://www.oecd.org/ocean/topics>)
- (iii) Globally, the Blue Economy has an asset base of over \$24 trillion and it is said to generate at least \$2.5 trillion each year from the combination of fishing and aquaculture, shipping, tourism, and other activities. Coastal tourists alone are estimated at six £6 billion.
- (iv) Water bodies such as oceans, seas, rivers, lakes, marshes and bays collectively hosts about 2.2 million plant species, diverse wildlife and other life-forms that represent over 50% of life on earth.
- (v) The total “ocean asset base” of the Western Indian Ocean region including Comoros, France, Kenya, Madagascar, Mozambique, Seychelles, Somalia, South Africa and Tanzania is estimated at \$20.8 billion (Africanews, 2018).
- (vi) It is estimated that 80% of global trade by volume is carried by the sea. Also, 350 million jobs world-wide are linked to fisheries. It is estimated that by 2025, 34% of crude oil production will come from offshore fields (thecommonwealth.org, 2021)
- (vii) Blue economy can have a tremendous impact on a country’s economy: Industries from the blue economy include: fishing & boating, tourism & recreation, ocean transport, etc. The United States of America maritime transport carries 95% of the nation's foreign trade. Ships move 2 billion tons of freight in and out of U.S. ports (Oceans Impact the Economy, oceanpolicy.com)

- (viii) Nigeria is among tropical countries endowed with rich shrimp resources. According to Dublin-Green and Tobor (1992) reported in Zabbey, Erondu and Hart (2018), Nigeria is among the tropical countries endowed with rich shrimp resources; that the coastal waters of Nigeria are characterized by abundance of important living resources like shrimps. Zabbey, et al (2018) went on to state that with increasing human population and increasing high per capita demand for shrimps that the Nigerian Rivers Deltas (Niger Delta, the Tana Delta and the Rufiji Delta) has a great potential for shrimp farming.

The commercial penaeid shrimps being exploited in the Nigeria coastal waters predominantly inhabit the soft mud substrate of the Niger Delta and eastwards to Cross River. They occur too in Lagos West Grounds (Ogbonna, 2001)

Nigeria, for instance, has been identified as a potential new frontier for the expansion of shrimps farming. In Nigeria, oil corporations like Shell Petroleum Development Company (SPDC) have indicated interest in investing in shrimp culture in the Niger Delta as it has a potential of about \$384m (<https://www.tridge.com>)

10. The Potential of Africa for a Blue Economy Revolution

- (i) Africa is endowed with a vast network of aquatic resources and extensive interconnected oceans. The African lake zones cover approximately 240,000 km², while its trans-boundary river basins cover approximately 64 per cent of the continent's land area.
- (ii) The total length of Africa's coastline is some 26,000 km, making the African maritime domain extremely important for commercial maritime business.
- (iii) There are more than 100 ports in Africa, 52 of which handle containers and transnational trade. The continent's maritime economy is estimated to represent some 90 per cent of its total commerce. The throughput of African ports is projected to rise from 265 million tons in 2009 to 2 billion tons in 2040 (African Union–NEPAD, 2014).
- (iv) For three-quarters of the African continent, the blue or ocean economy is its principal economy and, if well used, could be a potent engine for economic growth. The new and developing industries in a blue or ocean economy include aquaculture; marine renewable energy technologies for wind, wave and tidal energy; bioproducts (pharmaceutical and agrichemical); blue or ocean carbon (carbon storage in mangroves, seagrass and saltmarsh); and desalination. A blue or ocean economy will open doors for Africa's industrialization and economic development. Fresh water and marine fish contribute to the food security of over 200 million people in Africa and provide an income for over 10 million people (ECA, 2019).
- (v) In May 2014, the African Union estimated the first-sale value of African fisheries (marine, inland and aquaculture) to be US\$19.7 billion per annum. It is also estimated that there would be an additional US\$2 billion available annually for African economies if the fisheries sector were to be managed sustainably (Leijenaar, 2012)

- (vi) In the Nairobi Statement of Intent on Advancing the Global Sustainable Blue Economy, the outcome document of the Sustainable Blue Economy Conference, held in Nairobi from 26 to 28 November 2018, countries charted a new paradigm for an economically vibrant, socially inclusive and environmentally resilient blue or ocean economy. The statement underscores the fact that a sustainable blue or ocean economy holds great promise for contributing towards the success of the 2030 Agenda for Sustainable Development and the Sustainable Development Goals (ECA, 2019).

11. Why is the blue economy approach important for Africa?

- (i) In the next 50 years, Africa will need to increase food production against a backdrop of chronic water scarcity and an increased cost of living. Its youth population is projected to reach 830 million by 2050, with over 300 million joining the labour market by 2035.
- (ii) Consumer spending is projected to reach US\$1.4 trillion by 2025 and the value of agriculture and agribusiness US\$1 trillion by 2030.
- (iii) If the continent's current trend in unsustainable use of marine resources is not curbed, the potential of the ocean's resources will be severely compromised.
- (iv) Sustainable and equitable solutions are required to address the interconnected challenges of protecting the health of the natural environment and protecting the health of human populations. With regard to African oceans, there is a great deal of hope, because certain ocean and aquatic resources are potentially renewable given the proper mechanisms, and a country can achieve economic growth without depleting resources or making its communities vulnerable. To make a community resilient is to empower its members to generate wealth using locally available resources, which Africa still has in abundance, and to do so without exposing themselves to dangers resulting from their activities.
- (v) African countries are endowed with a vast coastline and abundant fish resources from oceans, seas, lakes, rivers, floodplains and fish farms, which generate a range of benefits including food and nutrition security, livelihood, exportation and biodiversity. In the abundance of business opportunities deriving from marine and coastal resources, young people must know where to look for those opportunities.
- (vi) Small-scale projects will be a mainstay for coastal communities, ensuring food and income, and providing important ecological and biodiversity components that offer opportunities for individual or collective engagement.
- (vii) The strength of Africa lies in its youth; the continent has the largest number of young people than any other continent, currently estimated at 200 million, and young people will influence the economic revival of the continent over the next 15 years. When harnessed positively, this combination can unlock opportunities for wealth for Africa's young people in the affluent consolidated global market.
- (viii) The African population is largely poor and is thus the worst affected by environmental degradation and the least able to rebound. The degradation of ocean

and aquatic resources has significant implications for human well-being and health, with the resulting environmental risks accounting for approximately 28 per cent of the disease burden in Africa.

12. Nigeria and the Blue Economy Revolution

It is interesting to note that although Nigeria is fully aware of the mega advantages of the blue economy as well as being adequately endowed with a long coastline of approximately 853km that would have supported serious derivation from Blue resources of the Blue economy; the country is doing quite dismally in attracting such incentives and benefits (Nwilo and Badejo, 2015).

Apart from the Lagos Ports, which is still unfortunately deficit in depth, the Port Harcourt, Warri, and Calabar Ports are not optimally utilized. The Ebughu and Ibaka fishing terminals that were conceptualized to reap fishery resources from that vast Ocean economy had since been abandoned. Fishing in Nigeria's territorial ocean water is indiscriminately done by foreigners, many who have no tax commitments to Nigeria. Nigeria loses approximately \$70 million annually to illegal fishing by the Chinese and European trawlers in the nation's territorial waters (Oluwatula, 2021).

Sadly, Nigeria is ranked the fourth largest importer of fish in the world, following China, Japan and the United States. With annual domestic fish supply of about 400,000 tons, the fisheries sector account for about 3-5% of the country's GDP. It also contributes to 40% of animal protein intake and substantial proportion of employment. According to the Central Bank of Nigeria (CBN), Nigeria's current fish production stands at dismal 0.8million metric tons, with a deficit of 1.9 million metric tons, as local demand for the protein is 2.7 million tons annually and \$1.2billion worth of fish is imported annually into the country (Oluwatola, 2021)

Security of the maritime territories of the Nigeria's territorial ocean waters is non-existent, thus, leaving the few commuters and fisher-folks in the country's territorial water to the vagaries of bandits, kidnappers and pirates. Indiscriminate disposal of plastic and other solid and liquid waste into our oceanic water body does not concern authorities.

However, blight the Nigerian situation seems, there is a lining of hope. I want to say with all sense of responsibility that it is only Akwa Ibom State that have laid the infrastructure and conditioning for embracing the benefits and incentives of the Blue Economy in Nigeria. As a State, she has put in place the following infrastructures and facilities that can take full advantage of the Blue economy in the immediate and near future.

13. Akwa Ibom State: The Emerging Blue Economy in Nigeria

Akwa Ibom is a state in Nigeria that had already started locating herself to take advantage of the blue economy prospects. Lying between latitudes 4⁰32'N and 5⁰33'N, and longitudes 7⁰25'E and 8⁰25'E. Akwa Ibom State land area is 7,081km². It has a coastline distance of 120km, the longest coastline in Nigeria that borders the Atlantic Ocean. The State is located in the South-South geopolitical zone of Nigeria, and is bordered on the east by Cross River State, on the west by Rivers State and Abia state, and on the south by the Atlantic Ocean and the Cameroun (Akwa Ibom State History, 2016).

13.1 Outstanding Blue Economy Natural Endowments of Akwa Ibom State

These include:

- (a) **A natural coastline of 120km along Atlantic Ocean** – that provides opportunities for fishing, tourism, marine transportation, and aquaculture.
- (ii) Locational advantage as a gateway to the Gulf of Guinea.
- (iii) Triple water regime – Fresh, Brackish, and Salt water regimes
- (iv) Mineral deposits on and off shore including: crude oil, gas, salt, etc.
- (v) A shrimp resource base.
- (vi) An extensive salt water mangrove swamps along the coast and tropical rain forest inland, with huge forestry prospects
- (vii) A tributary of inland rivers, streams and lakes that dot and interconnect all sections of the State.

To complement these natural resources and set the stage for the Blue Economy revolution, the State built the following infrastructures:

(b) Ibom Deep Seaport (IDSP)

Akwa Ibom prides as the only State in Nigeria that will eventually own a seaport when Ibom Deep Seaport comes into operations. Although it is developed through the PPP strategy, with the Akwa Ibom State, Federal Government of Nigeria and other Consortiums as partners, the State stands a great advantage of derivable benefits from the Seaport. IDSP will eventually become the Eastern Gateway of Nigeria. The port is expected to serve countries such as Sao Tome Joint Development Zone, Equatorial Guinea, Cameroun, Angola, Gabon, Democratic Republic of Congo, Niger, and Chad. The port has a complimentary industrial city which will be focusing on agriculture, petrochemicals, marine, auto assembly plants and power plants (sheep.technology.com). The economic benefits of the seaport cannot be over-emphasized. Several activities will be generated in the Seaport that has the capacity of generating employment and inclusive growth with increased endogenized technology acquired by locals from learning and practice.

(c) International Airport

This airport which is wholly owned by the State has a 3.km runway with designation 03/21 and an ILS Category 11 (Airport Information for QUO at Great Circle Mapper). The airport has a constructed Maintenance, Repair and Overhaul (MRO) facility capable of handling aircraft maintenance and overhaul of heavy commercial aircraft. The facility can conduct the A, B, C, and D check. It is confirmed that the facility can conveniently accommodate two Boeing 747-400 that are parked juxtaposed, nose-in, and fully contained within the building. That the facility's equipment, arrangement, clearance and supporting workshops allow for flexibility of servicing of a wide range of commercial aircraft. Future expansion of the airport includes building a cargo terminal and a 3 to 5 Star airport hotel.

(d) Boat Building Industry

The State government in 2008 launched the Ibom Dock Company Limited for the purposes of building boats for Nigerian waterways to serve oil and gas industry. This vision did not actually yield expected result but it did not die. Thus, in 2020, the State Government

again commissioned another ship building company, yet in Oruk Anam, Norfin Offshore Shipyard Ltd. The Governor of Akwa Ibom State, His Excellency Udom Gabriel Emmanuel inaugurated a 9 meter fast security escort vessel, 'MV Norfin Swift' built by Norfin Offshore Shipyard Ltd. in Oruk Anam with a resolve to attract more private investments to the State.

The boat building industry will be a very powerful tool in developing, nurturing and tapping into the resources and benefits of the blue economy. With the ability to transfer technology to indigenous people on boat building over time the State economy will secure endogeneity of the technology to the local people while ensuring marching towards national inclusiveness.

(c) Ibom Science and Technology Park

The Park which had been renamed Ibom Blue Sea Science and Technology Park is to be built by China Blue Sea International. This Park which was envisioned by former Governor, Obong Victor Attah in 2005 has undergone some structural modifications in the new conceptualization. The Park will have a University of Technology, Vocational Centre, a Five Star Hotel, a hospital, and power plant. The full commencement of the construction of this park has been said to be delayed by the global impact of the Corona Virus pandemic. This park is designed to mimic the Silicon Valley.

(d) Aluminum Smelter Company (ALSCON)

Although owned by the Federal Government of Nigeria, the Company is located in the Blue area of Akwa Ibom State. The company which had been enmeshed in ownership for several years now will restart operations by the end of 2023, as stated by the Minister of State for Mines and Steel on the 7th of May, 2021 when he paid a courtesy visit to the Governor of Akwa Ibom State.

This company was founded in 1989. The company was established to manufacture the following products: aluminum sheets, aluminum extruded products, aluminum casting, aluminum conductors, aluminum fitting and other related products, enabling clients to receive quality products (Pitchbook Data, 2021). The location of the company was for her to take advantage of the marine sector for easy export of her products - itself a blue economy content.

(e) Tertiary institutions

The tertiary institutions in the State that can build capacity by endogenizing technology and technical capacity to run blue economy include:

- (i) University of Uyo
- (ii) Akwa Ibom State University
- (iii) Maritime Academy
- (iv) Federal University of Science and Technology
- (v) Akwa Ibom State Polytechnic
- (vi) College of Education

14. How Akwa Ibom State Can Take Advantage of Its Endowment to Reap Maximally from the Blue Economy

The basic rules of how nations grow their economies had been shown in the theoretical background explored in this paper. The paper discusses the Blue Economy: Technology and Inclusive Industrialization: Imperatives for the Sustainable Development of Coastal Nigeria. The theories have indicated how technology through the production function can create industrialization. The theories have also indicated how industrialization can bring growth and sustainable development of nations. This paper sees the endogenous growth theory and sustainable development theory as better theorizing options in leading the industrialization prospect that secure our derivation of optimal benefit from the Blue economy.

Describing the theoretical cases further, the paper had taken time to discuss practical implementation theories of blue economy, which focused on national macroeconomic management, policy framework and management technology. The theories have indicated successful case studies which Nigeria and particularly Akwa Ibom State can anchor on to build a strong and virile Blue economy.

With the resource and infrastructure endowment of Akwa Ibom State, all she needs are sound policies, strong political will, and governmental development focus to outpace even Nigeria in deriving maximal benefits from the Blue Economy. Also, the strong infrastructural base of the state, outlined in the preceding sub-section (7.1) provides a base for smooth incubation of the blue economy.

15. Threats to the development of the blue or ocean economy in Africa

- (i) Across Africa, important fish stocks have declined, with 70 per cent of species estimated to be at or over the sustainable limit.
- (ii) Most larger fish and invertebrates have been overfished, to supply a population that is doubling in size every 10 to 15 years. Population education is here reiterated.
- (iii) In 2014, the United Nations Environment Programme (UNEP) assessed that global mangrove deforestation was resulting in economic losses valued at US\$42 billion annually. In the Western Indian Ocean region, coral cover, which is a major tourist attraction in the countries of the region, had declined to 30 per cent by 2017.
- (iv) Litter reaching the ocean from land-based sources represents a major problem for the natural beauty of beaches and marine life. It is estimated that by 2050, there may be more plastics, by weight, than fish in the ocean.
- (v) The visibility of plastics and the length of time that they take to degrade means that they remain a sore sight for decades, with a visible and highly detrimental impact on the ocean, thus detrimental to the blue economy concern of the region.

16. Threats to Blue Economy Revolution in Nigeria

- (i) Restrictive power transmission policy of the Federal Government
- (ii) Insecurity on our maritime route
- (iii) Corruption
- (iv) Uncertain economic and political environment impeding long term contract decisions
- (v) The right and transparent legal framework

17. Conclusion and Recommendations

The emerging blue economy renders to the world yet another opportunity to derive benefits from nature just like the abused Green Economy did. Unsustainable use of the green resources for economic benefits is claimed to have caused untold damage to the world's ecosystem, resulting in the much touted and discussed global Climate Change and other negative environmental outcomes shocking the world today. If the Oceans and water bodies are protected and sustainably used, the over 50% oxygen stored in the Oceans will be there to maintain the ecological balance of climate. If marine resources are sustainably exploited, the food needs of global population will never be threatened. If extant and emerging growth theories and models are shocked with sustainability variables as discussed in the theoretical framework of this paper, the new Blue development consciousness of China and Europe, then a sustainable global system will be the outcome. If renewable natural resources are protected and sustainably renewed, its natural function of use by man and for the ecosystem balance and remediation will not be threatened. Sustainable use of Blue resources will ensure the rights of the Blue. Therefore, harmful technological processes that anchor on industrialization that does not protect the Blue economy's environment must be discouraged. The theoretical conception of Kuznets inverted U hypothesis, earlier discussed, must be discouraged, as growth that compromises sustainability will always bring a disastrous future.

Africa has enormous potential and is advantageous enough to benefit greatly from the Blue Economy if the right strategies are put in place. The time is now!

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