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# Authors Statement

# Comparative Coastal and Marine Tourism, Climate Change and Blue Economy in African Large Marine Ecosystems

The Authors wish to state that the review of the article has been done and concluded in accordance with all the comments provided and received from the three reviewers. The revision of the article has been carried out within the stipulated timeframe. The authors wish to express thanks to the reviewers for commendable insights and the Editor-in-Chief of the Journal on Environmental Development for following up and ensuring that the Editor and Reviewer Comments were received and addressed in time.

Comparative Coastal and Marine Tourism, Climate Change, and the Blue Economy in African
Large Marine Ecosystems

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# *Abstract*

This paper outlines potential opportunities for Africa's Large Marine Ecosystems (LMEs) development driven by blue economy from key strategic sectors including: Coastal and Marine Tourism; Climate Resilience; Environment; Blue Carbon and Ecosystem Services and Infrastructure. The sectoral approach is key to economic development in Africa with potential for income generation, employment creation and poverty reduction, as well as creating blue and green carbon sinks to address climate change problem and environmental management in African LMEs. The sectors establish linkages to countries' established Nationally Determined Contributions (NDCs) under the 2015 Paris Agreement on Climate Change making it possible to promote Integrated Approach at national, regional and continental sustainable development in Africa. The approach is complemented by the utilizing desk-top literature review and secondary data source on LMEs in Africa for blue economy. This approach is supplemented with professional experts' views and opinions, and additional data gathered from field visits to 13 African countries in August 2019 and Nairobi, Kenya Africa Blue Economy Strategy Consultative Workshop in October 2019. The Blue Economy approach development in Africa will benefit both inland and coastal countries. It is recommended that a strong development of the continental tourism will boost the demand for tourism services and infrastructures. The development of eco-tourism will contribute to the conservation of ecosystems and reduce the ecological footprint. Blue Carbon and Ecosystem Services offer an opportunity to develop coastal wetland projects to mitigating climate change. Coastal protection, biomass production and water purification are among the most important ecosystem services delivered by African LMEs. Their current value is estimated to the average monetary value of carbon sequestration of about USD 130,000 per $km^2$ of mangrove, salt marshes and sea grasses.

*Keywords:*

Blue Economy, Coastal and Marine Tourism, Climate Resilience, Environment, Blue Carbon &
Ecosystem Services, Infrastructure, Development, Large Marine Ecosystems (LMEs), Africa

## 1. Introduction and context

The objective of this paper is to contribute to the understanding of how Africa's Large Marine Ecosystems can potentially contribute to harnessing and growth of Blue Economy. However, this paper is not about the whole Blue economy, but, only a few components as discussed in the Africa Blue Economy Strategy. The African Union InterAfrican Bureau for Animal Resources (AU-IBAR) has developed a Blue Economy Strategy for Africa. The Strategy includes Coastal & Ma-

rine Tourism, Climate Resilience, Environment, Blue Carbon & Ecosystem Services and Infrastructure as key sectors within the Large Marine Ecosystems (LMEs) of Africa (Canary Current LME, Mediterranean Sea LME, Red Sea LME, Somali Coastal Current LME, Agulhas Current LME, Benguela Current LME, Guinea Current LME). The LMEs in nature cover coastal and Mediterranean while the Blue Economy extends to inland water masses as stipulated in the Blue Economy Concept recognising harvesting both living and non living resources in water bodies (World Bank-UN 2017; UNECA 2016; UNEP 2016; UNEP 2015). The Blue Economy is defined as: sustainable development that incorporates socio-economic benefits and ecological conservation and essentially seeks to promote economic growth, social inclusion and the preservation or improvement of livelihoods while at the same time ensuring environmental sustainability of the lakes, rivers, oceans and coastal areas (Frontiers in Marine Research, 2020; Tralac, 2018; UNECA, 2016; UN, 2013). Both coastal and inland coverage show potential for prosperity and with ability to generate and provide economic gains and benefits to local communities. In order for gains and benefits to be optimized in blue economy, some incentives including monetary and fiscal policies targeting LMEs need to be developed. These incentives inform of subsidies, discounts, tax rebates, tax holidays, tax waivers to actors in blue economy would contribute to and enhance resource mobilization efforts applicable to green bond initiative best practices and emerging blue bond instrument linked to both water seagrass and wetland ecosystem services potentially sequestering carbon as sink to generate carbon credits with linkage to Nationally Determined Contributions (NDCs).

Effective implementation of NDCs that incorporate LMEs in Africa for blue economy require monetary and fiscal tools. The tools inform of incentives (subsidies, taxes), legal, regulatory and institutional framework for governance and economic stimulus are essential. The application of these tools is necessary for mainstreaming the economics of environmental policy in blue economy. The application builds on tools developed for natural resource accounting, economic instruments, incentive measures, governance and management. The application is mirrored in tools as applied to carbon trading and environmental services and anchors the LMEs in Africa to the blue economy growth and development. The LMEs in Africa, potentially, enables blue economy to be more equitable, sustainable and utilizing tourism resources. Tourism is important to most African countries' economy. Economy with expansive potential to coastal and marine tourism. Economy coverage including inland tourism with freshwater, springs, mountains among other ecosystem services and sceneries. Tourism and other sectors impacts environment causing marine litter pollution related issues and impact on infrastructure resilience. Tourism within LMEs should not be viewed in the context of business of Euros and Dollars. Should be viewed more in the perception of environmental, biodiversity, ecosystem and cultural services. This perception should ensure to promote domestic tourism for long-term sustainability and new market niche. The mapping-out of tourism resources in Africa with relevant linkages to Blue Economy should incorporate climate resilience, blue carbon and ecosystem services. This will enhance economic value of oceans and inland freshwaters with carbon sequestration potential and linkages to eco-tourism. The application of integrated approach includes local communities' participation in

coastal and marine tourism that is essential in protection of the marine environment. In this regard, integrated approach refers to the Blue Economy framework that offers an combined, systemic, dynamic, inclusive, participatory, and ecosystem-based approach in which sectoral barriers are minimized at the activity and governance level, and environmental, social, and economic dimensions are intertwined and pursued for all Blue Economy activities (UNECA, 2016). The integrated approach dwells on the ecosystem and includes the principles of the Green Economy in a Blue World report and sustainable development (World Bank-UN, 2017). This takes in to account the three pillars of environmental, economic, and social sustainability (UNEP, 2016). Integrated approach establishes a basis for the Blue Economy to promote the conservation of aquatic, coastal and marine ecosystems and sustainable use and management of associated resources and builds on principles of equity, low carbon development, resource efficiency, and social inclusion (UNECA, 2016; World Bank-UN 2017). Integrated approach as applied in this study, recognizes the Blue Economy sectors through a socially inclusive process aimed at triggering utilisation of LMEs in Africa's structural transformation, promoting integrated development, and improved regional cooperation and coordination. Coordinated continental efforts will attribute to coastal and marine litter prevention in LMEs including: beach cleaning, collection of plastics to conserve marine ecosystem/biodiversity, resource recovery for re-use and recycling by small business enterprises.

## 2. The Significance of Africa Blue Economy Sectors

Generally, coastal tourism includes a range of tourism, leisure, and recreationally oriented activities that occur in the coastal zone and immediate offshore coastal waters. These include tourism-related development infrastructure (accommodation, restaurants and food services, attractions, and second homes), and the infrastructure supporting coastal and marine tourism development (e.g., retail businesses, transport hubs, marinas, and activity suppliers) (Belhabib et. al., 2016). Also included are tourism activities such as recreational boating, coast- and marine-based eco-tourism, cruises, swimming, recreational fishing, snorkeling, and diving among other water sports. In the context of Blue Economy, the concept is central to sustainable development that incorporates socio-economic benefits and ecological conservation and essentially seeks to promote economic growth, social inclusion and the preservation or improvement of livelihoods while at the same time ensuring environmental sustainability of the lakes, rivers, oceans and coastal areas (Frontiers in Marine Research, 2020; Tralac, 2018; UNECA, 2016; UN, 2013). African countries have vast natural and undisturbed LMEs (Satia, 2016) attractive to coastal and marine tourism.

In the LMEs of Somali and Natal Basins, the Western Indian Ocean bordering, South Africa, Mozambique, Tanzania, Kenya, Somalia, Seychelles, Madagascar and Mauritius is a well-known destination in tourism market that is under-exploited. Only approximately 3.9 million tourists' arrivals in 2012 (UNWTO, 2013) were registered. According to Africa Tourism Monitor (2018), Africa international tourism arrivals increased slightly to 62.9 million in 2016 which is about 0.64% increase. In 2016, The Africa Tourism Monitor (2018) indicates that Africa held 5.1% share in worldwide tourism arrivals, and 3.0% share of worldwide tourism revenues. The tourism sector shows potential to develop with a projected growth of 3.3% up to the year 2030, resulting in US$1.4 billion in 2020 and US$1.8 billion by 2030. The contribution of tourism sector differs

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from country to country. African Union (2012) in Africa's Integrated Maritime (AIM) Strategy 2050, indicates that South Africa registered 29.8% of tourist arrivals and 67.9% of tourist receipts in 2012.

South Africa has the greatest share of tourist arrivals and receipts followed by Seychelles registering 26.4% of GDP (Sustainable Tourism Governance and Management in Coastal Areas of Africa Commission de l'OcéanIndien, 2007).In 2010, 200,000 tourists accessed the Seychelles in cruise vessels (UNWTO, 2013).

The LMEs (Somali Coastal Current, Agulhas Current and Natal Basin) of Western Indian Ocean Africa offer various tourism products including traditional leisure destinations (Madagascar, Mauritius and the Seychelles), Penguins (South Africa), whale and dolphin watching (Zanzibar and Mozambique), diving (Kenya), and nature-based tourism in many locations of the continent. In some African countries, tourism focuses on inland circuits (safaris in Kenya and Tanzania), nature trails in (Uganda, Rwanda, Burundi, Democratic Republic of Congo and Cameroon).

In the North Africa region within the Mediterranean Sea LME, is the largest of the semi-closed sharing environmental, climatic, historical and cultural ties, over 46,000 km of coastline (UN-WTO, 2013). The region is characterized by strong imbalances in economic, humanitarian crises, climate change and population growth, which create a rift between the North and South shores of the Mediterranean, creating a highly unequal regional context. The Mediterranean region is home to about 480 million people spread across three continents, with an extremely varied population density (UNWTO, 2013). Approximately, one third of the Mediterranean population live in coastal areas, where tourism is concentrated, leading to urban sprawl and infrastructure development of the coastal areas. Tourism is the main economic sector in the Mediterranean region, representing 30% of global tourism flow and it is the world's principal regional tourist destination (UNWTO, 2013). This puts the LMEs in the Mediterranean and the Red Sea under ecosystem pressure and ecological fragility.

The Mediterranean Sea LME hosts between 7% and 9% of the world's marine biodiversity of which 20-30% endemic species, and benefits from strong protection with 1,231 marine protected areas covering 179,798 km$^2$(IUCN, 2013). Pressures contributing to the loss of habitats include unsustainable exploitation of resources, pollution, climate change, eutrophication and invasive marine species. Biodiversity is fundamental for the Mediterranean economy, with benefits derived from ecosystem services and from tourism and value derived from nature.

The Canary and Angola Basins in the Atlantic Ocean as part of the LMEs in Africa, experience limited tourism activities in some countries, although with potential for exploration and exploitation. Canary Basin experience favourable climate resulting in tourism activities in Morocco, Mauritania, The Gambia and Senegal. Angola Basin cold current limits coastal tourism to Namibia resulting in more inland tourism activities in Zambia, Botswana, Zimbabwe and South Africa.

## 2.1 Coastal Tourism

Coastal tourism is one of the largest components of the global tourism industry and one of the most vulnerable economic sectors to climate variability as it is extremely dependent and sensitive to climate and weather factors, which influence the decision-making process of tourists and

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the success of tourism businesses. Simultaneously, it is one of the largest activities that contribute to climate change as estimated between 2009 and 2013 the overall carbon footprint of tourism increased from 3.9 to 4.5 GtCO2e, representing 8% of global greenhouse gas emissions (UNWTO, 2013).

Tourist destinations will be affected by climate change, but coastal and island destinations will be the most vulnerable to the impact and risks caused by climate change (World Risk Report, 2018; Lam, et. al., 2012). Its causes are the constant presence of tourist infrastructures and high dependence on tourism, the concentration of the population present at the coasts, the intensity of extreme events, which cause a sudden interruption of tourism. The impact of climate change varies according to the territorial elements and climatic requirements (Sumaila, et. al., 2019). The world's climate change hotspots correspond to the geographic areas with the most intensive coastal and maritime tourism activities, in particular in the Mediterranean Sea, and Indian Ocean. Over 60% of tourists prefer beach holidays and beach tourism provides more than 80% of U.S. tourism receipts (UNEP 2009).Coral reefs contributed an estimated US$11.5 billion to global tourism (Burke et al. 2011). However, if estimates of tourism's contribution to the global economy are applied to the WWF estimates, then tourism proportionate share is approximately US$225billion worth of the value of ocean goods and services.

## 2.2. Marine Tourism

Marine tourism resources exist under a range of global systemic threats to marine and ocean systems that are primarily anthropogenically driven. These include climate change, overfishing, bottom trawling (towing a trawl, which is a fishing net along the sea floor), transfer of exotic species, changes in waste, nutrient and sediment inputs into coastal and marine ecosystems, coastal infrastructure development and loss of natural capital in coastal areas, in particular, coastal wetlands. The experiences of these threats are "uneven", for example, while they are global in scale their effects on tourism development and the tourist experience varies from location to location, hence, impact is local in nature (Belhabib et. al., 2016; Bennett, et. al., 2019). In the long term-their effects are systemic in that over time they affect not only destinations but also source regions as well.

## 2.3. Climate Resilience

Climate change is one of the main concerns with respect to the future of marine in general, and LMEs in particular. The Intergovernmental panel on Climate Change (IPCC) 2014 concluded that: coastal tourism continues to be highly vulnerable to weather, climate extremes, and rising sea levels with the additional sensitivity to ocean temperature and acidity for the sectors that rely on reef tourism. Developing countries and small island states within the tropics relying on coastal tourism are most vulnerable to present and future weather and climate extremes, future sea level rise, and the added impacts of coral bleaching and ocean acidification (IPCC 2014; Sumaila, et. al., 2019; Lam, et. al., 2012).

Africa also recognizes that certain adaptation investments have significant mitigation dynamics as well. For example, when watersheds and catchment areas conserved through further investments, they tend to foster resilience and strengthen the adaptive capacities of nearby communities (experienced less floods, improved local climate stability among others). The conservation investments also contribute to enhancement of the carbon sink function of the watersheds and water catchment resources, resulting in more carbon sequestration.

Coming into effect, the Paris Agreement (2015) to support climate resilience provides space for investments. African countries have prepared and submitted Nationally Determined Contributions (NDC) action plans with ambitious targets, and with potential for investment (Sumaila, et. al., 2019). NDCs consider both mitigation and adaptation projects where renewable energy, such as solar, wind, waste to energy power, will be introduced to replace the burning of coal and charcoal. The investment will reduce emission of carbon dioxide gases and deforestation avoided. Restoration of beaches by reducing erosion, management of mangroves and protection of coral reefs will result into increased fish stocks due to better breeding grounds, hence local fisher communities' livelihood sustained (Belhabib, et. al., 2016). As a result, the adaptive capacity of a nearby community enhanced.

## 2.4. Blue Carbon and other ecosystem services

Blue Carbon is part of a Blue Economy with an opportunity to develop coastal wetland projects to mitigating climate change. The planning of blue carbon conservation projects and evaluating how ecosystems can be more effectively included within existing policy frameworks, carbon financing mechanisms such as Reducing Emissions from Deforestation and Land Degradation and agriculture (REDD+) and other United Nations Framework Convention on Climate Change (UNFCCC, 1992) mechanisms are essential to restoring and protecting LMEs. There is also a great opportunity for Nationally Determined Contributions (NDCs) for adapting and mitigating climate change in existing frameworks for carbon offsets referred to as carbon credits. Coastal protection, biomass production, water purification, seagrass, mangroves and wetlands in the context of blue carbon are among the most important ecosystem services delivered by LMEs. Their current value is estimated to the average monetary value of carbon sequestration of about USD 13, 000 per $km^2$ of mangrove, salt marshes and sea grasses. At the scale of Africa, the value is estimated at USD 40 billion in 2018 annually with a potential growth to USD 45 billion in 2030 and to USD 70 billion in 2063. In addition, with value of an effective protection and restoration of coastal, marine and freshwater ecosystems.

## 3. Application of Integrated Approach to Blue Economy in African LMEs

The context in which Coastal & Marine Tourism; Climate Resilience; Environment, Blue Carbon & Ecosystem Services and Infrastructure operate and emerging issues thereof, compounded in the framework of Drivers, Pressure, State change, Impact and Response (DPSIR). This integrated framework summarized in the figure below, shows dependency and interdependency on each of the concepts in interactive system with integrated approach.

Figure 1: Framework for Integrated Blue Economy Concepts in Large Marine Ecosystems
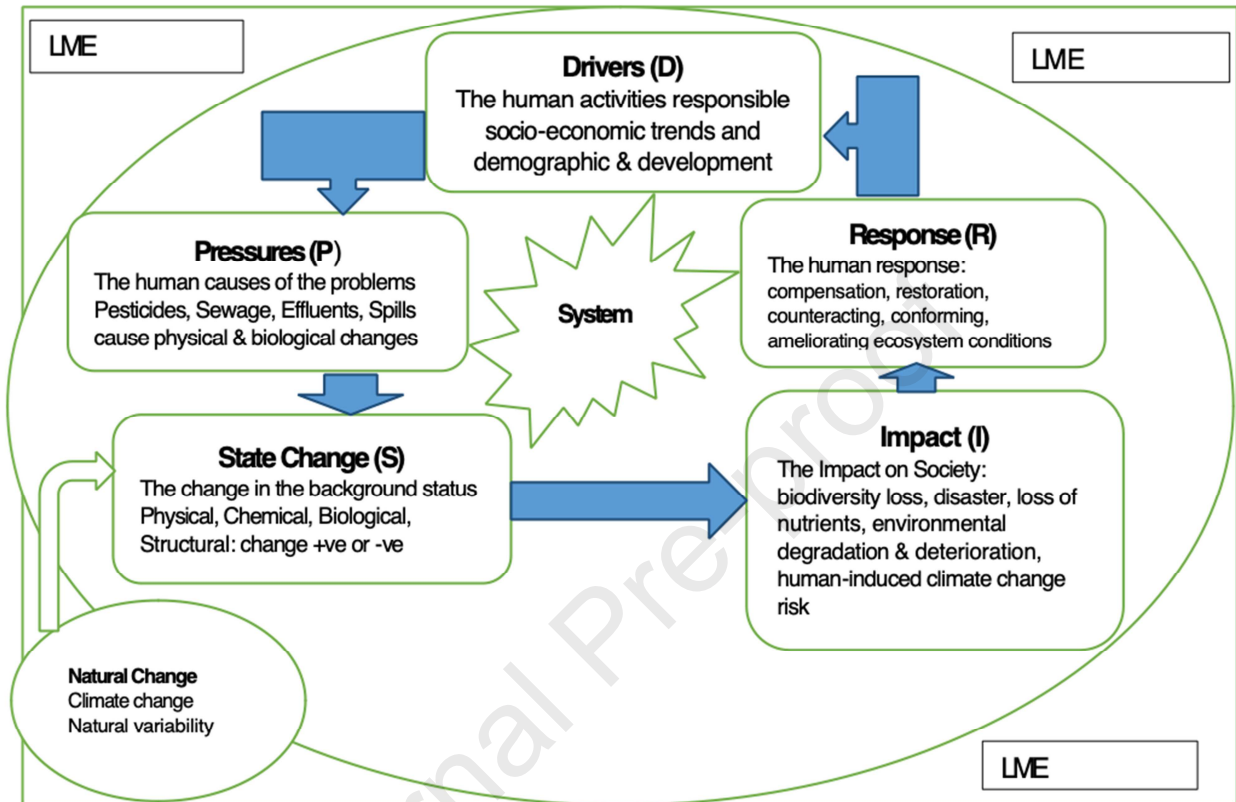


Source: Modified from Driver-Pressure-State-Impact Response Framework, UNEP 2011 and Activities of Blue Economy, World Bank—UN, 2017

The integrated and interactive framework portrays a mechanism operating in LMEs. In this regard, coastal and marine tourism include shore-based activities, such as land based, whale watching, reef walking, cruise ship supply and yachting events, within the overall context of marine tourism. Tourism stimulates infrastructure development accelerating economic growth by increasing the number of available jobs in a tourism sector, both directly and indirectly. The sector needs to be climate resilient and environmentally friendly. The sector has a multiplier effect within the industry. For example, the Guinea Current System represents a Large Marine Ecosystem (LME) ranked among the most productive coastal and offshore waters in the world with rich fishery resources, oil and gas reserves, precious minerals, a high potential for tourism and serves as an important reservoir of marine biological diversity of global significance (Chika, et. al., 2006). In part, results into: a large and diversified workforce with a varied skill profile in the tourism sector; jobs involved in direct administration of hotels, restaurants, stores, transportation and security; the creation of new employment opportunities for the youth and women and livelihood support to local communities (Ibrahim, 2018; Belhabib et. al., 2016). The outcome of the sector, results in an increase in the standard of living of the local population, which, in turn, leads to an increase in consumption of goods and services and increased spending in the economy.

However, these economic drivers put pressure on ecosystems resulting in state of change of both biological and physical environment and ecosystem impacted by climate change and variability requiring institutional responses in form of financial, policy and governance (Bennett, et. al., 2019).

## *Summary of Blue Economy Contributions*

**Table 1: Economic and social contribution of the Coastal and Marine Tourism sector in 2018**

| Global Overview | 2018 USD billion | 2018 % of total | 2019 Growth |
|---|---|---|---|
| Direct contribution to GDP | 2,750.7 | 3.2 | 3.6 |
| Total contribution to GDP | 8,811.0 | 10.4 | 3.6 |
| Direct contribution to employment | 122,891 | 3.8 | 2.2 |
| Total contribution to employment | 318,811 | 10.0 | 2.9 |
| Visitor exports | 1,643.2 | 6.5 | 4.0 |
| Domestic spending | 4,060.1 | 4.8 | 3.5 |
| Leisure spending | 4,475.3 | 2.5 | 3.8 |
| Business spending | 1,228.0 | 0.7 | 3.0 |
| Capital investment | 940.9 | 4.4 | 4.4 |

Source: World Travel & Tourism Council: Economic Impact 2019

In 2018 the sector contributed USD80 billion, about 3.4% of the GDP at annual growth rate of 1.3% over the last decade (Attri, 6-8 May 2018). The sector has potential for expansion and growth as most areas are yet to be exploited. The contribution to employment in 2018 was estimated at 24 million jobs in Africa at annual growth rate of 5.6% compared to global average of 3.9% (AfDB 2018; EC 2018). This provides potential opportunity for economic development. The development of eco-tourism will contribute to the conservation of ecosystems and reduce the ecological footprint. In addition, it will employ about 10% with impact on services and capital investment.

Table 12: Economic and social contribution of the Coastal and Marine Tourism sector in 2030

| Global Overview | USD billion | 2030 % of total | Growth |
|---|---|---|---|
| Direct contribution to GDP | 4,065.0 | 3.5 | 3.6 |
| Total contribution to GDP | 13,085.7 | 11.5 | 3.7 |
| Direct contribution to employment | 154,060 | 4.3 | 2.1 |
| Total contribution to employment | 420,659 | 11.7 | 2.5 |
| Visitor exports | 2,483.9 | 7.2 | 3.8 |
| Domestic spending | 6,031.9 | 5.3 | 3.7 |
| Leisure spending | 6,780.7 | 2.8 | 3.9 |
| Business spending | 1,735.1 | 0.7 | 3.2 |
| Capital investment | 1,489.5 | 5.0 | 4.2 |

Source: World Travel & Tourism Council: Economic Impact 2019

The projections of the sector growth by the year 2030 are relatively minimal or almost constant on global average, while Africa expected to grow by 3.5% (Attri, 6-8 May 2018). In 2030 the value added generated by the coastal tourism should exceed 100 billion with 28 million people employed while in 2063, it should generate 138 billion of value added with an employment figure of 35 million. The strong development of the continental tourism will boost the demand for tourism services and infrastructures. The coastal and the marine environment as a whole has become one of the new frontiers and fastest growing areas of the world's tourism industry, and Africa is likely to be the most beneficiary. The key drivers for Africa's benefits are related to:Ecological sustainability; Social and cultural sustainability and Economic sustainability that are functional and less polluted and advancing green low-carbon and blue economy.

Blue Carbon is part of a Blue Economy with an opportunity to develop coastal wetland projects to mitigating climate change. The planning of blue carbon conservation projects and evaluating how ecosystems can be more effectively included within existing policy frameworks, carbon financing mechanisms such as Reducing Emissions from Deforestation and Land Degradation (REDD+) and other UNFCCC mechanisms are essential to restoring and protecting marine ecosystems. There is also a great opportunity for Nationally Determined Contributions (NDCs) for adapting and mitigating climate change in existing frameworks for carbon offsets referred to as carbon credits. Coastal protection, biomass production, water purification, etc., are among the most important ecosystem services delivered by Large Marine Ecosystemaquatic ecosystems. Their current value is estimated to the average monetary value of carbon sequestration of about USD 130 000 per $km^2$ of mangrove, salt marshes and sea grasses (Failler, et al., 2019). At the scale of Africa, the value is estimated at USD 40 billion in 2018 annually with a potential growth to USD 45 billion in 2030 to USD 70 billion in 2063 with an effective protection and restoration of coastal, marine and freshwater ecosystems.

# *4. Challenges and interventions*

In unlocking the potential of sustainable blue economy for coastal and marine tourism, climate resilience, environment and infrastructure, challenges emerge. However, the challenges are identified and potential strategic interventions suggested. The challenges are regarded as issues the African continent is facing in respective sectors. Some of these challenges are technical, institutional and data in nature. In this regard, they constrain the understanding of the Blue Economy concept and application of its framework to different institutional objectives and a range of economic policies and sectors necessary for the utilization and sustainability of LME resources.

LME sustainability achievement is underpinned by application of policies supporting cooperation among countries, networking and partnerships across public-private entities at a transformative and an unprecedented scale. Inability of institutions for effective coordination, transparency and efficient governance challenge growth of blue economy. Since blue economy explores opportunities to stimulate socio-economic development and improving the livelihood of people and considering the sustainability of large marine ecosystems and coastal communities, institutional capacity needs to be developed and strengthened.

Institutional scope for blue economy is broad and has numerous institutional facets with varied roles and responsibilities. These cut across research and development; the ocean economy including: shipping, maritime transport and fisheries; and also the emerging and new economies in offshore aquaculture, sea bed mineral and petroleum mining, bioprospecting and marine biotechnology. In addressing the challenges to LMEs in relation to blue economy, some strategic interventions relate to "non-economic goods and services" that contribute to livelihoods of local communities and other economic activities including: management, conservation and protection of coastal and marine ecosystems, waste disposal, carbon sequestration and biodiversity.

LMEs in the context of blue economy vary in each country and coastal communities. This is due to different circumstances and priorities that do exists across institutions and geographical locations. However, the core components of blue economy aim at providing strategic interventions to remove barriers and challenges and generate benefits for social and economic gains. In addition, enhancing and strengthening institutions with abilities required for restoring, conserving, protecting and managing the LMEs' diversity, functions and values, and reducing waste and promoting sustainable development. In order to mitigate the challenges, some suggestions are provided for potential strategies necessary to address these challenges and recognize opportunities of the blue economy sectors in LMEs.

## 4.1.Challenges

The challenges are experienced as both technical and strategic in nature. The technical challenges relate to data, information, reliability, validity, accuracy and relevance. Technical data is necessary but not sufficient for exploitation of blue economy in LMEs. LMEs are vast and complex in nature. Data required transcends Geographical Information System (GIS), Geographical Referencing, Spatial Mapping, Remote Sensing, Satellite Image, but, understanding and interpretation of data for appropriate application to the concept of blue economy.
Available secondary data obtained through desk top review of the literature and applied in this study is global and indirectly correlate to LMEs in Africa. Inadequacy of data on LMEs in Africa, perpetuate risk of data and information. In regard, spanning into challenges of data reliability, validity, accuracy and relevance in discourse of LMEs in Africa.

LMEs in Africa for blue economy are driven by important factors and facilitated through various sectors requiring sound technical data. An overview of some of the blue economy sectors in LMEs in Africa dependent on data include: harvesting of living resources. In this regard, reliable, valid, accurate and relevant data is necessary. Data enables accuracy in mapping out LMEs with fisheries and aquaculture potential, and hence informing the policy and decision makers to design relevant, reliable and valid mechanisms for the provision of marine biotechnology with the view of developing a blue economy supporting the pharmaceutical and chemical industries.

Technical data is essential in LMEs in Africa seeking to explore the development of a blue economy for extraction of non-living resources, conservation, protection and management of coastal and marine ecosystems. The technical data is required for informing relevant blue economy sectors including mineral sand and gravel for sea bed mining with consideration for environmental integrity, the energy sector for fossil fuel, oil and gas exploration, the energy sector for renewables and clean technologies, and freshwater for the desalination and purification of water resources with relevancy to conservation of biodiversity and management of the environment.

Technical data that is reliable, valid, accurate and relevant informs policy and decision makers to effectively and efficiently manage LMEs with potential to develop blue economy attractive to tourism and trade. Essentially, the LME services is relevant to tourism and recreation with the key blue economy sectors being coastal and marine tourism development, and associated infrastructure as well as transport and trade with the economic activities including shipping, port and hotel infrastructure and auxiliary service. Reliable, valid, accurate and relevant data help policy and decision makers to determine indirect contribution of LMEs in Africa to blue economy activities, environment, climate resilience and climate change. The blue economy involves the non-market based coastal and marine services and the data for relevant sectors for carbon sequestration is critical. The carbon sequestration through blue carbon, ecosystem habitat protection , conservation, management and restoration, waste disposal from shipping and for land-based industry through assimilation of land-based effluents and the existence of biodiversity through protection of species habitat, are further complicated by climate change.

## 4.1.1.Climate change

Climate change resilience requires application of codes and standards that will contribute to building capacity necessary to enhance resiliency of coastal and marine tourism infrastructure. However, there is limited knowledge and awareness on application of climate resilient building codes and standards in Africa. In addition, attempts to apply ecological standards to solve environmental challenges or problems of coastal and marine tourism infrastructure provide potential opportunity. The Blue Economy strategy will ensure incorporating natural elements of marine ecosystem (e.g. wetland vegetation; sea-grass, coral reefs, mangroves) into shoreline stabilization in order to reduce environmental challenges and ecological impacts, minimizing fragility of the ecosystems, and stopping coastal erosion. Thus the Blue Economy strategy will enhance value addition and improving the ecological value of man-made structures by adding features of coastal and marine tourism that are generally missing from such structures at design level and can contribute to reduction, minimization, avoidance, mitigation and management of the detrimental effects of coastal and marine tourism on biodiversity. Management of man-made disturbances including maintenance works; noise pollution; harvesting; discharge of effluents to artificial coastal and marine space (Bennett, et. al., 2019).

## 4.1.2.LME Environment

LME environments are emerging as economic hubs and continuously under physical end environmental transformation is a consequence of the increasing demand for tourism infrastructure to sustain commercial, residential and tourist activities. A number of coastal countries are developing infrastructure that including: breakwaters, jetties and seawalls that have become features of intertidal and shallow sub-tidal marine features (Artkins et. al., 2011). Thus far, coastal and marine tourism transformation is increasing in response to the exponential growth of coastal populations and to African changes, such as sea-level rise and increased frequency of extreme weather events (e.g. cyclones, storms). As a result, the environmental challenge is the ecological effects of increasing infrastructure to coastal and marine tourism. Hence, the blue economy strategy will provide future research and development (R&D) directions for advancing knowledge and data for coastal and marine tourism ecosystems and highlight how alternative management options might mitigate their environmental impacts (Bennett, et. al., 2019). Coastal and marine tourism infrastructure supports different in-situ and ex-situ marine biodiversity. Its introduction in the intertidal zone or in near-shore waters result into fragmentation and loss of natural biodiversity. In addition, the provision of hard substrata along sedimentary shores alter local and regional biodiversity by modifying natural patterns of dispersal of species, or by facilitating the establishment and spread of exotic species. The blue economy strategy will make provisions for guidelines for coastal and marine tourism conservation and protection.

In spite of being economically profitable, this sector generates considerable environmental damages and it is overly dependent on natural resources (Lam, et. al., 2012). To supply visitors with a variety of goods and services, pressure on natural resources can become quickly unsustainable. For instance, the additional demand of water, energy or food —extremely scarce resources in many coastal areas— cause pressure on local territories and communities, leading to overfishing (Belhabib, et. al., 2016), water shortages, as well as expensive electricity and cooling/heating costs. In addition, coastal and maritime tourism causes marine and freshwater pollution through the discharge of sewage and the disposal of considerable quantities of solid waste. Coastal and marine tourism generates indirect land activities linked to infrastructure constructions that are responsible of considerable amounts of pollution and destruction of natural habitats, as well as of pressure on natural resources such as water but also sand, limestone and wood.

## 4.2.Interventions

Challenges are complex in nature and require multidisciplinary interventions and actions to match the need for strategic solutions.Thus, though the suggested interventions are sectorial, it should be noted that, the multi-sectoral approach and synergy among blue economy sectors are critical for effective outcomes. Some of the strategic interventions to provide solutions are suggested below.

### 4.2.1 Integrated and Perspective Approach to Marine Ecosystem Sustainability

Integrated and Prospective Approach to LME Sustainability is complex and requires adequate data for assessing marine ecosystem changing conditions to understanding the functioning of the marine ecosystem (Jobstvotgt et. al., 2014). There is lack of spatial data necessary for effective and efficient planning. Marine ecosystems suffer from a scarcity of spatial data relative to terrestrial counterparts. In terrestrial systems the spatial patterns of land-use/land-cover (LULC) are relatively straight forward to access via satellite and have been used as proxy indicators of eco-

system service provisions. In contrast, remote sensing tools used to study the surface of the earth are much less effective at capturing images of the seabed, and by extension marine habitats. Marine ecosystems such as waters and their constituents are frequently driven great distances by winds, tides, and currents unlike terrestrial ecosystems. This creates a challenge for management as the identification and protection of areas where ecosystem services are exploited is not necessarily sufficient to ensure sustained service delivery. Further complications arise from the three-dimensional uses of marine systems, incorporating activities that use the sea surface, the water column and the benthic habitats. However, satellite remote sensing of LME chlorophyll, productivity ($gCm^2y^{-1}$) and temperature have proved important means for monitoring and assessing changing states of LME conditions (Sherman et al., 2011, Belkin, 2009; UNEP, 2016).

### 4.2.2 Maritime spatial planning and better coordination and synergy

Maritime spatial planning requires effective and efficient coordination. In order to guide marine conservation actions more effectively, there is the need to use species distribution models for example for studies on biological invasions, the identification of critical habitats, among others (UNEP, 2015). The management of marine systems, including the assessment of their overall health status increasingly by applying ecosystem-based and impact assessment approaches (Bennett, et. al., 2019). The protection and conservation of marine ecosystems, together with the sustainable use of the services they provide, are of fundamental importance to the maintenance of marine health (Bennett, et. al., 2019). The goal of ecosystem-based management is to maintain an ecosystem in healthy, productive, and resilient conditions so that it can provide the services needed for the well-being of society.

### 4.2.3. Improving Marine Knowledge

Enhance progress to supplement technological advancements resulting in the accessing and acquisition of spatial data readily and at higher resolutions. Develop capacity to map, model and value an increasing number of marine ecosystem services with initiatives such as principle-based modelling. Create awareness required around the progress in marine ecosystems to increase knowledge on the value of the biosphere and the relative proportion between biomes. Establish a mechanism for effective long-term monitoring of populations and communities supported to understand marine ecosystem functioning and its responses to environmental and anthropogenic pressures. Develop a coding system to provide ways to get reliable, verifiable, efficient and cost-effective monitoring of marine species. Obtain current information on a regular basis, complete maps of marine habitats, ecosystem services, among others, supporting a better understanding of spatial ecology and marine management. This information requires data integration of the different ecosystem components in order to understand large-scale patterns and long-term changes.

## 5. Conclusions

The Blue Economy development of coastal and maritime tourism, climate resilience, environmental, blue carbon and ecosystem services and infrastructure support the notion of Wealth Creation and LME Sustainability with aspirations of a prosperous Africa, promoting inclusive growth and sustainable development. Establishing linkages to NDCs with overarching coverage of LMEs will potentially generate benefits in relation to:

- Environmentally sustainable and climate resilient economies and communities;

- Integrated and sustainable coastal and marine tourism; and

- Resilient infrastructure, Blue Carbon & other ecosystem services.

These components require an integrated and interactive framework to be applied. This framework has potential to set and establish new priorities in emerging climate change market, blue carbon and ecosystem services new frontiers for development in Africa with possibilities to generate income, create employment and reduce poverty. In addition, creating public policy for awareness on blue economy, promoting education and information dissemination are inevitable to protection of LMEs and promotion of integrated approach to sustainable development in Africa.

## *Acknowledgements*

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**Declaration of interests**

☒ The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

☐The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: