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Assessing the Impact of Climate Change on the Sustainability of the Maritime Environment's Fragmentation

Oluwatosin Osaloni, PhD.
University of Salford, Salford, Manchester, M5 4WT
E-mail of the corresponding author: o.osaloni@salford.ac.uk

Abstract

The maritime environment is facing unprecedented environmental and security challenges. Sustainable maritime environmental development remains a pivotal issue in addressing marine environmental protection challenges. This is due to multifaceted activities being carried out within the marine environment. The current study investigated the fragmentation of the existing legislations and policies on maritime environment sustainability, which has significantly contributed to their inefficiency. To achieve that, the study employs a qualitative analysis of legal texts, case studies, and policy reviews surrounding the various provisions of the UNCLOS and its relationship to the SDG-14 while paying attention to the implementation at national and regional levels, especially in developing countries. It was discovered that the majority of current reports appear to demonstrate how slowly the sustainable development goals are being met. Communities that depend on the marine environment for their livelihoods are seriously in danger in developing nations along the coast. This study discovered that many developing nations face significant obstacles in fully implementing UNCLOS provisions due to limited financial, technological, and human resources. The challenges in monitoring vast ocean territories and enforcing compliance, particularly concerning illegal activities like overfishing and marine pollution, hinder the effective realization of UNCLOS's goals. Further, emerging issues such as deep seabed mining, ocean noise pollution, and the integrated impacts of climate change highlight the necessity for legal frameworks like UNCLOS to be adaptable. Finally, the study made an impression that global and regional cooperation, as emphasized in Part XIII of UNCLOS, is essential for addressing transboundary issues like marine pollution, biodiversity loss, and the shared management of migratory fish stocks. While the legal frameworks and international agreements provide a foundation for addressing ocean sustainability, the real-world implementation of these laws demands global commitment to enforcement for success to be realized.

***Key Terms**: SDG 14 (Sustainable Development Goal 14), UNCLOS (United Nations Convention on the Law of the Sea), IMO (International Maritime Organization), Regional Seas Conventions, UN Fish Stocks Agreement, Rio Declaration, Coastal zone management, Integrated maritime policies, Exclusive economic zones (EEZs)*

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1.0 Introduction

The maritime industry is one of the vital segments in the world economy which provides a major part of international shipping and commerce and accounts for about 80% of the international trade. In each year, this sector facilitates billions of dollars of economic activity and is fundamental for cross national trade. Nonetheless, this sector also contributes significantly to environmental pollution, with ship source pollutants like nitrogen oxides, sulphur oxides, greenhouse gases (GHG), and particulate matter. According to the Clear Seas Update (2024), the shipping sector contributes to 2.9% of GHG, 19% nitrogen oxides pollutants, and 9% sulphur oxides pollutants on a global scale. Bulk carriers and oil are used on big ship where they use high-sulfur fuels that produce some lethal gases such as sulfur oxides, nitrogen oxides and particulate material and failure to control these emissions thus pose a risk to public health and exacerbate the effects of climate change (Tsimplis, 2020, 126).

Due to the above environmental impacts, the international community has endeavored to put into place measures to increase sustainability of the marine environment. Generally, through the IMO, countries have adopted measures which include declaring of emission control areas of high standards of emissions. Similarly, the United Nations Sustainable Development Goals (UNSDGs) also focus on the concept of conserving and making efficient use of oceans and marine lives in some of its goals such as SGD 14. Nevertheless, the effective implementation of such goals and regulations is still a challenge especially given limited and technical capacity

of many developing countries. The aim of this paper is to assess the progress made so far in meeting the objectives of SDG 14 for protecting the maritime environment from pollution and degradation. It will analyze the role of key international maritime conventions like the United Nations Convention on the Law of the Sea (UNCLOS) in translating these global goals into practical legal frameworks and on-ground actions. The discussion will focus on the contextual challenges faced by communities dependent on the maritime sector and the legal and policy approaches needed to enhance climate resilience in coastal regions worldwide

2.0. Maritime environmental protection and SDG-14 Policy: Current Challenges

2.1 Threats to coastal and marine ecosystems

One of the focal points of the maritime environmental protection is the preservation of the coastal and marine ecosystems which are essential for the sustainability of marine life (Zhai et al., 2020, 2). Coastal habitats that are crucial for maintenance of marine biodiversity and shoreline protection are facing degradation. Mangrove forests, coral reefs and seagrass beds have suffered considerable damage due to pollution from industrial effluents, plastics and untreated sewage that is discharged into oceans (Pinheiro et al., 2019, 19). Overexploitation for firewood, aquaculture and land reclamation has also reduced mangrove cover. Corals are bleaching under more acidic waters, which has led to the destruction of nursery and spawning habitats negatively impacts fisheries and livelihoods (Zhai et al., 2020, 3).

Overfishing, particularly of top predators and large fish species, has led to declining fish stocks around the world (Hilborn et al., 2020, 2221). This loss of biodiversity poses challenges for long-term food security. According to Food and Agriculture Organisation (FAO), about one-third of fish stocks are currently being harvested at biologically unsustainable levels. If unaddressed, collapsed fisheries would have significant social and economic consequences for coastal communities highly dependent on seafood. The climatic effects of rising greenhouse gas emissions are severely threatening coastal livelihoods and infrastructure (Argüello, 2019, 39). Sea-level rise, coupled with intensive storms due to warmer oceans, increases the risk of floods, salinization of farmlands and damage to housing. Corals are being stressed by increasingly acidic conditions as they struggle to form their skeletons and reef structures (Hoegh-Guldberg, Pendleton & Kaup, 2019). Higher ocean temperatures induce mass coral bleaching events. The resultant habitat loss impacts fish populations and tourism revenue in many tropical nations. These climate change impacts require adaptation actions across sectors.

2.2 Challenges of integrating maritime and coastal management

Effective maritime and coastal management requires coordination between the numerous government agencies and sectors that operate in coastal regions and ocean spaces. However, in many countries there exists poor communication and integration between bodies regulating areas such as fisheries, environment protection, maritime transportation, offshore mining and tourism (Ullah et al., 2021, 4). This leads to fragmented or overlapping policies and regulations, creating loopholes which undermine environmental sustainability. For example, an agency promoting maritime trade may frame rules that fail to sufficiently consider impacts on coastal habitats. Without comprehensive coordination, conflicting objectives can cause degradation of ecosystems.

Local communities who depend directly on coastal and marine resources have inadequate opportunities to participate meaningfully in decision making processes. Their traditional ecological knowledge is often not given due importance when plans are crafted. As a result, policies or projects may disregard social and cultural factors, creating resentment and non-compliance, which undermines management effectiveness (Ullah et al., 2021 6). Giving local populations a role in planning through organized stakeholder engagements and co-management models could improve sustainable practices on the ground. There is also a significant lack of monitoring, control and surveillance data regarding the health of coasts and oceans. Ecosystem changes and the impacts of various stressors can only be addressed with long-term scientific data on aspects like water quality, fisheries and biodiversity (Sanon et al., 2020, 1). But such knowledge and consistent datasets are missing in many countries due to limited technical and financial capacities. This impedes evidence-based regulation, compliance efforts and makes it difficult to track progress of environmental management initiatives. International cooperation is required to build robust national monitoring system.

2.3 Difficulties in monitoring and surveillance of sea areas

Coastal nations are tasked with managing and regulating vast ocean territories extending hundreds of nautical miles from their shores under the Law of the Sea. However, monitoring such huge expanses with limited surveillance technologies and budgetary allocations poses major challenges. Coast Guards and Navies have to fulfil multiple roles with limited patrol vessels, aircraft and advanced sensing equipment (Kim, 2020, 117). This makes it difficult to detect violations over widely dispersed exclusive economic zones. Spatial management

plans and enforcement of regulations remain weak in remote offshore regions. Questions of jurisdiction over maritime activities complicate governance. Mobile fleets operate across zones with unclear oversight in border areas (Nyman, 2019, 31). While UNCLOS provides a framework, implications of distance from shore, seabed mining and bioprospecting in the high seas are contentious. Illegal activities like poaching slip through as they transit multiple zones overnight. Untraced foreign vessels also pose sovereign jurisdiction issues. Regional maritime security agreements may be necessary for the international cooperation, but the pace of work is still very slow (Tsimplis, 2020, 411). Over fishing outside legal frame work, pollutions and dumping of wastes harm the marine ecosystem although offenders often do not get nailed for crimes because it's hard to capture the perpetrators on the open sea. While poachers hunt endangered marine species for sale and profit, trawlers strip particular fish populations especially the waters of developing states that lack the capacity to patrol and monitor (Hilborn et al., 2020, 2223). Illegally disposed of wastes affect benthic habitats by sinking and polluting the water; however, identifying dumpsites is difficult. From this it is apparent that the international community has to step up its efforts and employ more technologies to enhance maritime law enforcement.

2.4 Obstacles in achieving sustainable livelihoods

Another issue concerning the management of the seas is the problem of how to develop sustainable economy. Marine ecosystems have been important socio-economic drivers for coastal regions through such economic activities as fishing, aquaculture and tourism. Nevertheless, natural assets have been over exploited and polluted (Stacey et al., 2019, 362). The problem of shifting these vulnerable populations to other more resilient careers is, however, hampered by issues of skills and upfront capital investment. The theory of sustainable development requires interdisciplinary approaches that offers reasonable options for the populace. Technological advancement provides means for environmentally friendly and disaster resistant livelihood adaptation but unfortunately these technologies are a luxury due to lack of funds for most of the coastal communities (Gyawali et al., 2020, 629). Liberal technologies such as renewable sources of power, energy efficient fishing vessels and warning gadgets are unaffordable. Insufficient financing and regulatory credit make green investment difficult; a lack of technological prowess hinders green investment as well. The rapidly growing international climate funds and the expanded utilization of public-private models that provide affordable solutions are required to be scaled up. Moreover, the adverse effects of climate change such natural disasters affect health, food and shelter security in vulnerable populations (Ullah et al., 2021, 17). Growing poverty leads to poor individuals such as the women, children and the elderly persons to take risky careers.

3.0. Effectiveness of Maritime environmental protection in promoting SDG-14

According to the 2022 UN Environment Program report, marine biodiversity loss and habitat degradation continue at alarming rates despite global commitments. Overfishing remains rampant with around one-third of fish stocks overexploited. However, integrated coastal management has boosted coral cover by 10% in 54 countries (Gustavson, Huber, & Ruitenbeek, 2000, 15). Ecosystem-based fisheries have helped 30% of stocks recover to sustainable levels. The Global Ocean Alliance aims to scale up marine protected area coverage to 30% by 2030 (Marine Conservation Institute, 2024)

There is a continuous decline in the percentage of fish stocks that are overfished with a notable drop from 90% sustainably fished stocks in 1974 to barely 68% (FAO, 2022). The south pacific levels had the higher unsustainable fishing at 66.7% followed by the Mediterranean and black sea at 63.4%. Enforcement of quotas and gear restrictions have shown success in rebuilding stocks like tuna. However, illegal and unreported fishing still drains $23 billion annually worldwide. International cooperation under agreements like the FAO Compliance Agreement will need strengthening (UN, 2021). On the economic front, the value of marine fisheries and aquaculture crossed $250 billion globally per year according to the Organization for Economic Co-operation and Development. Coastal tourism revenues reached $3.5 trillion in 2015 supporting over 60 million jobs (UN, 2021). The rapid growth of renewable energy plants at sea promises additional green employment. Integrated coastal zone planning frameworks have augmented food security and livelihoods of up to 6.5 million people. But impacts of climate change threaten to undermine these gains if emissions are left uncurbed.

Several regional agreements have enhanced cooperation between neighboring states on issues impacting shared ocean basins. In the Caribbean, the Cartagena Convention facilitates ecosystem-based management and resilience programs among over 20 parties (Giro, 2021, 136). In Africa, the Nairobi Convention supports Integrated Coastal Zone Management and pollution control initiatives amongst states bordering the Western Indian Ocean (Techera, 2023, 2). The United for Oceans coalition brings together groups from the Mediterranean, Baltic and Southeast Asia to collaborate on marine protection and sustainable blue economies. Targeted capacity building by these partnerships through trainings and shared resources have strengthened national implementation of SDG14.

Crucial partnerships for technology transfer are helping close monitoring gaps in developing states. For example, the Global Ocean Observing System regional alliances share buoy networks, satellite data and ocean acidification sensors across nations (Moltmann et al., 2019). Projects under the GEF Coral Triangle Initiative coat-finance patrolling vessels, pollution control infrastructure and databases. The European Union funded SWIOFC program aids data collection and sustainable fisheries management among East African coastal communities (Russell, 2022, 13). Such initiatives are complemented by training over 7,000 officials, scientists and local groups in 75 countries on integrated coastal management approaches by UN Environment. Coordinated marine spatial planning and disaster response is being scaled up amongst neighboring countries. Almost 40% of the world's marine protected areas are now linked through transboundary networks, enhancing biodiversity protection across political boundaries. After the devastating 2004 Indian Ocean tsunami, regional preparedness centers were set up through the Indian Ocean Tsunami Warning and Mitigation System to share early warning information (Pal et al., 2023, 5). Joint annual exercises provide an opportunity for neighboring navies to cooperate in oil spill response incidents spanning exclusive economic zones.

4.0 integrating sustainable practices in Maritime security to enhance climate changes

Integrating the different sustainable practices in the maritime security to enhance climate changes is associated with many challenges, some of which are related to the member states and others on the absolute approach of the policies. Firstly, maritime security operations have traditionally focused on responding to immediate threats like piracy, terrorism, armed robbery and illegal fishing. Resources and strategies are oriented towards maintaining visible patrols, intervention capacity and intelligence gathering to curb such threats (Autsadee, et al., 2023). Nonetheless, priorities for environmental sustainability for instance, combatting marine pollution and greenhouse gas emissions, conserving species and addresses long-term climate threats remain rather recent additions to the security agencies' knowledge. Sustainability thus requires that these objectives be optimized: measures such as speed reduction or clean fuel could be perceived to slow down response time. The potential reason for this is the lack of overall national objectives that require the agencies to be pulled in different directions (Autsadee, et al., 2023).

Secondly, the budgets for maritime security cut better for the capacity of operations in the near terms, not for investment with the longer return periods. Manpower is given more importance in procurement than fuel efficiency which is considered an important factor. Switching over fleets and the ports' physical structures to renewable energy and zero-emissions is capital intensive as compared to a gradual improvement plan (Kılkış et al., 2022). It also requires a consistent commitment to political will especially during the first years of the lower returns.

Furthermore, green technology for the maritime industry, which is essential for the transformation of fleets and ports around the world, remains unavailable today at a level that can be globally admitted as low and affordable (Sarantopoulos, 2024). Renewable energy solutions advanced emission control system and smart monitoring gadgets remain close to being exotic. National and port authorities in the developing regions have reduced funding capacities for R&D and pilot projects (Sarantopoulos, 2024). The risks associated with the maritime sector are also considered to be above those considered in other more traditional renewable investments such as solar and wind (Mallouppas & Yfantis, 2021). Psychological barriers such as this technological lag and financial barriers slow down transition without international coordinated investment and companionship to bridge these gaps.

Moreover, effective integration of maritime security and ocean sustainability visions demands cooperation across traditional divides. However, multiple government agencies and ministries with compartmentalized mandates currently dictate different spheres. Navy, coast guard, port authorities, fisheries and environmental departments each face institutional obstacles collaborating (Leuprecht, Kölling & Hataley, 2019). Non-state actors from industries, technology developers and environmental groups also need platforms to input. Silos persist due to unclear leadership and lack of inclusive coordination bodies at national and regional levels. Overcoming fragmented approaches requires high-level directives, shared roadmaps, joint programs and data-hubs to maximize synergies and resolve conflicts.

5.0 Legal and Theoretical Framework and relevant (UNCLOS) Provisions Regarding SDG-14.

The United Nations Convention on the Law of the Sea (UNCLOS) is an international treaty established in 1982 that provides a comprehensive legal framework governing the rights and responsibilities of states in relation to the world's oceans. UNCLOS was intended to provide solutions to various problems pertaining to maritime zones, use and management of marine living and non-living resources, environmental conservation regime and control of activities such as navigation, fishing and exploitation of the seabed. Its primary aim is to narrow regional and international conflict of interest by setting rules for access as well as orderly use of oceans and the

sea by coastal and other states thus enhancing international cooperation on ocean affairs. UNCLOS does also provide for other maritime zones including the territorial sea, the exclusive economic zone (EEZs), and the high seas; these provide for the different rights accorded to a state and the freedoms of navigation and functional exploration of the seas.

Key provisions of UNCLOS include Articles 192 and 194 are the most significant because they require states from harming the marine environment and provide a basis for conserving the world's seas. Articles 61-68 protects the exclusivity of zones 200 nautical miles from shore for coastal states on the use of natural resources and include the fishing rights to ensure sustainable use policies and to prevent overfishing. Further, Articles 76-85 pertain to rights of coastal states over the continental shelf and the authority to manage natural resources such as minerals and hydrocarbons on the seabed while Articles 145-147 deal with deep seabed mining through must be done through the International Seabed Authority in a fair and environmentally sound manner. Part XIII explores underlines the need for conduct of multinational cooperation as states are enjoined to collaborate in areas such as marine scientific research, transfer of technology as well as the protection of the environment. All these provisions are important in addressing the objectives of Sustainable Development Goal (SDG) 14, which aims at 'Conservation and sustainable use of the oceans, seas and marine resources. However, due to implementation barriers such as enforcement, unequal capacity of states and political or economic rivalry.

There is major international legislation of ocean activities which is the United Nations Law of the Sea convention adopted or concluded in 1982. Non-technical pieces of information from UNCLOS include sovereignty and jurisdiction on maritime areas as well as conservation and management of the living and non-living resources (Spalding & de Ycaza, 2020 6). It deals with matters that are in regard to certain aspects of the targets of SDG 14 for example, pollution and marine scientific research as well as transfer of marine technology. For instance, not all the countries of the world are parties to UNCLOS but most of the provisions of the convention have been recognized as principles of customary international law (Spalding & de Ycaza, 2020). In that context, it offers a basic legal framework fixing an appropriate development course of oceans, seas and their marine resources in line with the goals of SDG 14. Some specific UNCLOS provisions that support achieving SDG 14 targets include the following

5.1. Articles 192 and 194 State Responsibilities for Conservation and Pollution Abatement

Articles 192 and 194 set the framework for the protection and enhancement of the marine environment concerning the elimination of pollution from various activities. Article 192 provides that states have the obligation to safeguard the marine environment, acknowledging the tenet of stewardship and affirming the role of states in discouraging acts within their territory that might harm the ocean environment. Also, article 194 calls for states to ensure that measures to prevent, reduce, and control cases of marine pollution arising from such areas, and seabed activities, dumping, and vessels are implemented. This broad responsibility offers legal support to the national and global initiatives in the fight against pollution of the marine environment, including the SDG-14 that aims at combating marine pollution. Although these provisions themselves can set legal grounds for combating pollution properly, they are not as effective due to the discrepancies in the implementation and compliance with these provisions, especially among developing states that do not possess the adequate resources and skills to meet all the obligations prescribed by these laws adequately. However, despite the fact that the articles lay the legal framework for the regulation of GMOS, there are no clear enforcement mechanisms or specific goals and targets that need to be met for full implementation, which creates an uneven legal picture where some states are more active in this area than others.

5.2. Articles 61-68 Exclusive Economic Zones (EEZs) and Sustainable Use Policies

Articles 61-68 of UNCLOS provide that restricting the rights of coastal states in the water column, seabed, and subsoil, as well as in the regulation of certain activities such as fishing, mining, and scientific research. This paper is to put it is important to consider the EEZs as an important aspect of the existing global maritime framework, which enable the coastal states to manage the resources within the 200nm zone efficiently, effectively and sustainably. These requirements are pertinent to as SDG 14 that aim at eliminating over fishing and misuse of marine resources. This is mainly through placing most of the authority of such key measures as fishing quotas, conservation, and resource management in the hands of the state to protect and manage the marine environments hence the effectiveness of EEZs. Thus, legal frameworks and frameworks for the sustainable management of EEZs remain limited in practice when it comes to the issue of compliance with sustainable fishing practices. Overfishing, illegal, unreported, and unregulated (IUU) fishing, and disputes over boundaries can undermine the objectives of sustainable resource use within EEZs. Moreover, the effectiveness of implementing such policies is likely to vary across coastal states and the inability of states to address the problem of IUU fishing constrains the accomplishment of sustainable management goals within EEZs. However,

the efficiency of the EEZs remains dependent on effective enforcement, regional cooperation, and available resources to monitor and control the activities occurring in the maritime space.

5.3. Articles 76-85 States' Rights Over Continental Shelf Resources

Articles 76- 85 of the UNCLOS shed light on the rights of coastal nations to exercise jurisdiction over the resources that are located in the seabed and subsoil of the continental shelf beyond the jurisdictional limit of the EEZ of 200 miles and up to 350 nautical miles or up to the outer limit of the continental margin. These articles are needed to enable the states to effectively and sustainably use resources such as hydrocarbons and minerals for which the extension of the continental shelves is being proposed for minable purposes in the deep sea. These provisions are in line with SDG 14, especially the aspect that focuses on the conservation and utilization of the oceans, seas and marine resources. These provisions enable deployment of sustainable management measures such as adopting environmental impact studies, managing mining companies, and preserving the continental shelf marine environment. However, the provisions have their challenges, which include the inability of some states to govern the deep-sea resources efficiently; the technological constraints on the sustainable mining; and the effects of deep-sea mining on the sensitive ecosystem. Nevertheless, UNCLOS remains the legal framework necessary for regulating these resources; still, global controversy persists on the most effective ways of managing the exploitation of the resources and more so due to the consequences of deep-sea mining on marine ecosystems.

5.4 Part XIII: International and Regional Cooperation on Marine Issues

Part XIII of UNCLOS provides that states should cooperate on a multilateral as well as regional basis for various purposes including scientific research, transfer of marine technology and protection of marine environment. This collaboration is relevant with regards to SDG14 where it underlines the necessity of cooperation in protecting the world's ocean, combating marine pollution and supporting sustainable use of marine resources for fisheries. Through the provision that obligates states to exchange information, studies, and technologies involving ocean management, Part XIII fosters the dissemination of best practices that can enhance the protection of marine environment. In practice, this cooperation assists in the enhancement of capability to observe and safeguard the terrestrial and marine environments in developing nations. Also, it emphasizes collaboration in directly overseeing shared global resources like migratory fish population or pollution that affect more than one country cannot be met by just one state. However, this paper has shown that the instrument could only succeed of the states are willing to cooperate and have resources to support their cooperation. One of them is the imbalance in the research or technology transfer ability of various states especially with states that cannot afford to invest in such activities. However, as it has been mentioned Part XIII aims at promoting legitimate cooperation and therefore sometimes political and economic motives that defend certain interest can act as a barrier to sufficient cooperation in areas like fisheries or ocean mining. To achieve the targets in line with SDG 14, major improvements to international cooperation are required: establishment of regulatory binding and stable reporting systems.

5.5. Articles 200-201: Protection of Global Commons and Cooperation on Shared Marine Resources

The articles 200-201 of the Convention also support the Post-Cambrian common heritage notion by stating that states should protect develop and sustain rare or delicate marine areas. These clauses are most relevant with regard to the 14th SDG, which aims at conserving and sustainably using the ocean's resources. According to Article 200 of the 1992 stipulates that each state shall ensure proper measures are put in place to protect and maintain the health of the marine environment especially those that are special, sensitive and endangered. Such include coral reefs, deep-sea ecosystems, and others that are essential for the survival of many forms of marine lives. Moreover, Articles 200 and 201 compel states to consult on measures aimed at the conservation and management of fish stocks that cross the regions or migrate from one region to another. These resources are of international significance and their conservation is best done on an international level. Therefore, there is a need to work closely to control threats likely to lead to overfishing hence damaging the marine ecosystem and their sustainable utilization. Collective responsibility is evident in these articles to meet the goals and objectives of SDG 14 by rallying for the collaborative management activities like RFMOs and multilateral fisheries agreements and arrangements. Still, despite, clear legal requirements, enforcement is not easy also because it is a politically sensitive issue, states do not cooperate fully, and because controlling and regulating activities in the vast ocean areas, many of them distant and marginal, is difficult. Many of these provisions are still threatened today with overfishing and illegal, unreported, and unregulated (IUU) fishing activities which are not acceptable.

5.6. Articles 145-147: Regulation of Deep Seabed Mining

Articles 145-147 of UNCLOS contains the legal provisions for the regulation of deep seabed mining through the International Seabed Authority (ISA). Procedures of extracting these minerals have been provided so that is

carried out in an environmentally friendly method thus helps in achieving the objective of SDG 14 which aims at the conservation and sustainable use of ocean resources. The ISA shall also adopt rule and regulation to prevent any adverse impact by mining on the marine environment, thereby disallowing 'seabed mining from destabilizing deep-sea ecosystems. This clause is rather significant because combined with the growing demand for resources like polymetallic nodules deep sea mining legal activities are carried out without any knowledge about their negative impact on marine life. Articles 146 and 147 are additional and they explain additional responsibilities of this international agency: establishing conditions for missional environmentalism and guaranteeing that its benefits would be fairly distributed among all states. The ISA is also responsible for overseeing mining activities and see that such exercises are conducted within the specified environmental compliance. However, there are still strong doubts as to whether the ISA is well equipped to stem unsustainable practices within deep-sea mining activities. The current gap in the regulatory and legal framework can be attributed to a lack of scientific data about the deep-sea ecosystems and the kinds of impacts that can be expected and sustained over time from mining, and secondly due to the technological and practicalities of observing the mining operations from a central control point. In addition, due to the fact that mining operations attract the political and economic interests of states, it is not uncommon to see that these provisions may at time be severely weakened and fail to receive a proper enforcement. To be consistent with the provisions of SDG 14, it is necessary for the ISA increase its efficiency in regulation, improve its environmental impact assessment, and guarantee that the seabed mining is sustainable, as well as the way to minimize adverse impacts on the environment.

Aside from UNCLOS, the 1992 Rio Declaration and Agenda 21 emphasized coastal zone management and integrated maritime policies. The 2002 Johannesburg Plan of Implementation called for action to protect marine ecosystems and combat destructive fishing practices. The 1992 Convention on Biological Diversity also supports conservation of marine biodiversity, a key target of SDG 14 (Watson, 2021). At the regional level, treaties exist under regional seas programs like OSPAR, Barcelona Convention, etc. that implement global commitments through regional frameworks. Platforms like the Regional Fisheries Management Organizations coordinate members' actions on sustainable fisheries (Tang, Chen & Zhang, 2021, 23). Furthermore, the UNCLOS established important concepts like common heritage of mankind for seabed resources, laying foundations for equitable benefit-sharing those developing countries later built upon. Other relevant legal instruments include IMO conventions on pollution, dumping, ballast water management etc. FAO's Code of Conduct for Responsible Fisheries aims to harmonize fishing practices.

Domestically, many countries have coastal zone management laws, pollution control acts, fisheries legislation and integrated maritime policies aligned with international agreements. For example, the US Coastal Zone Management Act uses a voluntary, incentive-based program for balancing conservation and development goals in coastal waters (Fonner & Warlick, 2018). However, implementation gaps remain due to conflicting development priorities, lack of enforcement capacity, and weak regional coordination in some areas. To improve implementation, principles of ecosystem-based management and development of coastal communities now guide integrated projects. Compliance mechanisms are also being strengthened through actions plans, monitoring frameworks and dispute settlement processes. Therefore, while SDG 14 itself is non-binding, its targets draw support from existing international legal instruments, particularly UNCLOS (Spalding & de Ycaza, 2020, 3). Regional and domestic laws help further operationalize global commitments. However, turning principles into action still requires political will, adequate resourcing and participatory governance. Litigation and agenda-setting by civil society help hold governments accountable. Meanwhile, projects showcasing win-win solutions encourage uptake of blue economy practices respecting planetary boundaries. Overall, a regime complex of soft and hard laws, multi-stakeholder initiatives and partnerships may be needed to achieve the 2030 vision of oceans stewardship envisioned under SDG 14 and supporting frameworks. Legal reforms, financial instruments and coordinated M&E will play key roles to realize this vision and leave no one behind.

6.0 Effectiveness and Strength of the Current Legal Frameworks on SDG-14

It is clear therefore that although existing ocean laws such as UNCLOS and various regional conventions offer a solid framework for attaining the objectives of ocean sustainability and the SDG 14, there are challenges that accompany the effective implementation of the current ocean laws (Rossi, 2022). Policy implementation, particularly in the area of compliance and enforcement, remains a problem; new issues crop up often, and this makes constant procedural adjustment necessary. All the same, current policy trends suggest that the regime is consolidating to have a far stronger ability for safeguarding oceans as threats to the marine environment increase. In the UNCLOS, the dispute settlement mechanisms, for that reason, have had relatively few cases, which, as this exploration has demonstrated, depicts some uncertainties and hidden knowledges parties prefer not to challenge (Rossi, 2022). Similarly, regional seas programs have varying commitment and funding and have only variable success in managing threats such as pollution or over fishing. Attempts to extend enforcement of

regulation to the farther distances from the coast or to the international waters is almost impossible due to the question of jurisdiction.

Domestically, integrated oceans management is still a work in progress into the 21st century. Regulations by sectors prescribe single use and do not have cohesiveness. There is also low stakeholder participation especially the coastal communities when it comes to decision makings (Carneiro, & Henry, 2024). Most countries today find it difficult to strike a balance between exploitation of resources and protection of such resources from destruction in the face of increasing developments. Over a hundred billion dollars of resources are lost yearly through I&U fishing. However, there is some encouraging signs which suggest that with correct investments and with the political will in the contemporary population the regime can only improve (Rossi, 2022). For instance, the measures of conservation are increasing the extent of seascape area under protection as per international targets. The decision of the UN to convene the negotiations of the legally binding instrument for BBNJ concerns in the high seas proves the regime is constant in responding to new challenges. These regional organs are now coordinating on compliance, sharing of enforcement gear and even harmonizing laws.

7.0 Lapses of the Current Legal Frameworks

7.1. Lack of Universal Participation Across Countries

The United Nations Convention on the Law of the Sea (UNCLOS) stands as the primary international legal framework governing the use and conservation of marine resources. As of July 2021, UNCLOS has been ratified by 168 parties, encompassing 167 states, including 164 United Nations member states, the UN Observer State Palestine, the Cook Islands, Niue, and the European Union (International Seabed, 2024). Despite its widespread acceptance, several significant nations have yet to become parties to UNCLOS. Notably, the United States, under the Reagan Administration, chose not to participate in UNCLOS in the early 1980s due to provisions dealing with deep-seabed resources beyond national jurisdiction (Keating-Bitonti, 2023, 1). As of 2023, the U.S. remains a non-participant in the Convention, despite its close adherence to most of the treaty's provisions (The SAIS Review of International Affairs, 2023). This lack of universal participation results in a fragmented legal landscape, where certain countries are bound by the comprehensive provisions of UNCLOS, while others operate under different legal regimes or customary international law. Such disparities can lead to inconsistent enforcement of maritime environmental standards, complicating international cooperation and the effective management of marine resources (Tuerk, 2021, 12). The proliferation of overlapping hard and soft laws at international, regional, and national levels has led to fragmentation within international environmental law. This fragmentation arises from the emergence of specialized and relatively autonomous rules or rule complexes, resulting in a patchwork character of contemporary environmental dispute settlement. International environmental law consists of a vast collection of treaties, conventions and agreements that address several issue s that concern the environment. Public international law has the advantage of having a more diverse range of actors focused on different issues, causing tension and conflicting mandates across legal documents (Stephens, 2012, p.207). In particular, the focus will be made on such examples as the United Nations Framework Convention on Climate Change and the Convention on Biological Diversity while noting their differences, such as divergent purposes and approaches. In particular, there is no clear strategy for coordinating these instruments so these may become ineffective and fail to address multifaceted environmental problems.

Furthermore, many sectoral laws do not consider interactions between different problems and only address individual aspects of climate change, biography, and sustainable development. This kind of fragmentation may prevent the creation of the systematic approaches that are required to address issues of environmental governance. For instance, measures that are put in place to address climate change may have implications on conservation of biological diversity provided that these measures are not well coordinated. This it views regimes and institutions are disconnected entailing a fragmented yet competitive regime structure having multiple regimes and institutions generating different legal and policy responsibilities (Scott, 2011, 11).

There has been an increase of international environmental agreements thus creating a web of institutions each with the mandate and mode of working. This can lead to issues of duplication of roles, rivalry on the available resources, and confusing policies and measures. For instance, the United Nations Environment Program (UNEP) which is a major international organization in the regulation of environmental issues has been perceived to be a weak organization for many reasons some of which include the following institutional changes that have occurred over the past decades (Stephan & Zelli, 2018, 58). Problems related to fragmentation arise since there are several GGEs with public and private actors involved in a policy area, thus resulting in overlapping jurisdictions and potential incoherence in their actions. This can make it harder to establish legally binding, internationally accepted regulation.

In addition, the concept of sustainable development that emphasizes interdependence of the environmental, social, and economic aspects should be embraced. This perspective is consistent with the concept of the sustainable development that incorporates interrelated approaches to environmental management. Thus, the deficiencies in current legal instruments including the failure to include all states and the fragmentation of modern international environmental law creates a major hindrance to the regulation of the maritime environmental sustainability agencies from a governance perspective, as suggested by Scott (2011, p5). To address all these challenges, there is need for multilateralism to be established in addressing these challenged through harmonization of legal frameworks, increasing the number of players in international environmental law and coming up with frameworks that address issues in a comprehensive manner since issues in environment are bound to occur in a combined manner. All these measures are important to meet the targets of the 14th SDG and guarantee the ocean's future state.

7.2. Capacity and Compliance Challenges

The management of maritime environment has become a contentious issue hence relies heavily on the capacity and compliance of the states, especially the developing ones. Most of these countries struggle to write policies, domesticate conventions, and adopt coherent management frameworks because of incompetence and lack of funds. Moreover, it is challenging to monitor large sea areas and apply sanctions to non-compliance even if it is legal to have strong laws (Nguyen, 2024, 89). Although people have argued that community involvement is crucial to solve various issues, the adequate prescriptions and recommendations lag behind, and the actual decentralization of power and profit remains rather symbolic.

Challenges faced by the developing states include; limited financial capital, human capital, technical knowledge, and weak institutional capacity required to achieve sound maritime environment management. This makes it hard for them to develop good legislation, domestication of international conventions, and to implement overall management strategies. These challenges are compounded by the fact that there is often limited specialized knowledge and trained staff in these spheres, which means that there can be huge gaps in the formation and implementation of the necessary policies. Also, the vast ocean spaces are difficult to monitor and patrol as developing countries are not adequately prepared and enabled with the technological tools and fiscal capacity needed for surveillance, which inhibits its ability to recognize and deal with violations (Cremers, Wright & Rochette, 2020, 5). This hinders compliance with environmental laws despite their existence in letter and spirit. This has also discouraged the development and implementation of proper monitoring systems, through which data needed for decision-making and application of alternative management approaches would be retrieved (Campbell & Gray, 2019, 5).

While the concept of community engagement for marine conservation is well understood and accepted, but the tools and mechanisms are in the process of development. Often, there is an illusion of the decentralization of power and advantages, which does not give local communities that rely on the oceans enough incentives to support sustainability goals. Due to the absence of specific framework and procedural frameworks for the proper inclusion of communities in development projects, most communities are only given symbolic roles in decision-making processes (Parsons, Taylor & Crease, 2021, p.15). For instance, Panama has been accused of allowing some restricted nations such as Russia, Iran, and Venezuela to register their vessels. Panama's Maritime Authority stressed on its commitment to de-register substandard ships and reiterated that the registry is not for sanctions dumping. However, these efforts shed light on the issues of compliance that are always encountered in the maritime registries (Mossop, 2018, 13). Marine pollution control is not an easy process as it requires cooperation from all the countries and groups in the world and it also involves effective enforcement. They include the following challenges They include lack of personnel and necessary equipment to implement the laws, complexities in sharing of responsibilities since different bodies have jurisdiction over pollution control , lack of adequate knowledge and data on the polluters and their activities, low level of awareness among the public and the political will. These factors play a significant role in explaining why there has been a lot of challenge in addressing the issue of marine pollution.

There are various ways of addressing the capacity and compliance challenges as follows. The first of these strategies is the capacity building whereby the development of human and institutional capital is required. This encompasses personnel development, building of technical capacity, and procuring of finances for the purpose of enforcing legal frameworks in environmental management. Another external factor, which would stem from the strategic consideration, would concern technological support extending access to platforms to monitor and enforce compliance, resulting in higher compliance rates (Bilawal Khaskheli et al., 2023, 3). Further, it can also help to improve hereby approaches to local involvement in marine conservation when clear rules for participation are to be established. Thus, for empowering an African community it has been observed that they only achieve lasting and meaningful power if they are given real power with real incentives and benefits. Last

but not least, international cooperation may facilitate avail technical expertise, disseminate experience, and provide funds to the developing states so that they could address the marine environmental issues more efficiently. According to Bilawal Khaskheli et al. (2023, p5), solving the problems of capacity and compliance of the states in the maritime environment is necessary to successfully manage marine resources. By strengthening capacity, using technology, mobilizing community and raising international cooperation, it is common to make legal frameworks more effective and to guarantee conservation of the ocean environment for future generations.

7.3. Lack of Efficient and Adequate implementation frameworks

The formulation of laws and policies on maritime environmental authorities is an appreciable step towards achieving the worthy goal of conserving and managing ocean resources. Still, it must be clear that the existence of these laws in given states is no guarantee that they will actually be enforced. A notable deficiency in the current organizational practices involves minimal and substandard implementation frameworks (Whomersley, 2021, 5). This can be seen in the areas such as underestimation of funds, technologies, and human resources; lack of well-coordinated mechanisms towards enhancement of sufficient funding, technology acquisition, and capacity development; and finally, the failure of the current framework to address emerging issues like deep seabed mining, noise pollution, and an integrated approach to impacts of climate change. Moreover, managers' strategies risk being myopic and do not allow for nonlinear changes to be taken into consideration or perceived tipping points.

The enforcement of the maritime environmental laws requires a lot of capital, technology, and manpower. Unfortunately, these considerations are often overlooked, thus, there are high chances of lacking proper preparation, and lack of enough resources (Cremers, Wright, & Rochette, 2020 4). For instance, the constantly developing countries may not afford to invest in some types of necessary technologies or recruit enough human resources to write and implement impressive legislation. This leads to a disagreement between policy goals and policy achievements reducing the efficiency of environmental laws.

Environmental issues, therefore, change with time, and this has an implication that legal systems and structures to deal with them also have to evolve. However, since the treaty amendment processes are slow, there is a delay in formulating regulations that address emerging challenges. Some of these new phenomena, including deep seabed mining, ocean noise pollution, and the combined effects of climate change are not necessarily recognized and, therefore not given adequate consideration, hence leading to inadequate regulation. For instance, there has been significant progress in advancement of technologies in deep-sea mining that has seen the international legal frameworks lag behind resulting to concerns in degradation of environmental impact in areas that were initially not affected. Top-down and linear management structures do not take into consideration the non-linear process of system changes and thresholds.

Such trend is reflected across the world with repercussions on the marine environment as explained by the following cases. Today the search for minerals on the seabed has begun with different countries and companies initiating deep sea mining. Nevertheless, due to their absence of stringent international legal rules, as well as the sluggishness of the process of treaties, there appear concerns including habitat degradation and the issue of biodiversity. Loss (Levin, Amon & Lily, 2020, 785). Recently, mining activities in the area have raised eyebrows for not being regulated by the International Seabed Authority (ISA), which reveals the difficulties of implementing legal frameworks to overcome fresh technological breakthroughs. Also, with the expansion of human activities like transport through ships, military activities and other industrial processes additional underwater noise pollution has been witnessed. This pollution poses a major impact on the lives of marine organisms especially those that require sound to communicate or foraging(guidance). However, it is only in recent years that these impacts have started to surface and due to that, the international legal instruments have only recently begun to provide a coherent approach to combating noise pollution in terms of oceans. Additionally, the compound effects of climate change that influence the factors such as ocean acidity, rise in sea levels, shift of marine system combine together for the governance issues (Naseeb, 2024, 45). Traditional law provides limited means for handling these issues since most legal initiatives do not have the broad and complex jurisdiction necessary to address them. The lack of timely treaty amendments and inadequate assessments of the resources needed to implement them have hampered the establishment of proper adaptive management to fight the diverse effects of climate change.

In response to these challenges, the following are some of the possible strategies which can be considered The above mentioned recommended strategies would constitute a broad framework for a comprehensive resource assessment to be undertaken effectively and accurately in order to determine the financial, technology and human resource inputs that would be required in the implementation of environmental laws. This should help in preparing the appropriate budget and resource management plan. Hence, there is a need to build and strengthen

systems for financing for development, technology transfer, and capacity development. This includes development of international funds, involving the private sector and coming up with technology-sharing platforms for the developing countries. The challenges can also be solved by developing legal statutes that can accommodate them as they arise in the future. This can be done by implementing adaptive management, response standards, reporting for periodic reevaluation, and allows for treaty modification on a time-sensitive basis. It is therefore imperative for the development of proper management techniques that take into consideration non-linearity of environments and the presence of threshold shifts. This involves embracing the ecosystem management principles, using modeling techniques, and using precaution measures that help in preventing environmental shocks.

8.0 Sustainable Development Goal 14 Prospects and Way-Forward

The prospects for achieving SDG 14 targets by 2030 appear mixed. Significant scale-up of efforts will be needed given the growing pressures on oceans. However, buoyed by recent successes and with the right strategies, the goal remains attainable. Promoting continuing implementation of these approved frameworks that adapts to the governance, which invests, and which mobilizes multi-stakeholders is the most realistic approach. This proves that, the concept of drawing lessons from other projects enables one to understand that, incorporating aspects of local economy and indigenous knowledge systems improves sustainability regimen. The strategy of transitioning these current small commodity-exporting coastal economies to competitive climate resilient blue industries needs just policies, and skills development. It will also feature in increasing blue foods production by using precision fish farming techniques and traceability systems; or by deterring IUU fishing using satellite monitoring. New models involving private players that leverage impact financing sources for conservation, or "blue bonds" can take solutions to the next level.

Meeting such concerns such as transboundary pollution will call for even more cooperation. It is therefore important to note that measures aimed to addressing governance challenges on biodiversity in ABNJ require to be stepped up. Such checks and balances should comprise of an investigation into the implementation shortfall and revisions of the regional plans in accord with current science. There is also a need to develop strategies on how to reduce vulnerabilities of some livelihoods that will be affected by ocean change impacts through putting in place some inbuilt resilience and adaptation mechanisms. With ambitious goals in view, the decade ahead is an opportunity to redesign the human interaction with the sea for everybody's sustainable benefit in the long term. Only forceful and synergistic action will decide whether or not the ocean's inhabitants and the communities that depend on them are preserved.

9.0 Policy recommendations and future directions

(a) Strengthened Implementation and Compliance: Regional bodies should be supported through upgraded action plans, monitoring frameworks, and dispute mediation mechanisms. National plans require better localization factoring local priorities and risk assessments. Compliance can be fostered via regional cooperation in surveillance, standardized monitoring protocols, and open data sharing platforms. Enforcement of MPAs and fisheries restrictions requires stepping up regional patrols and financial deterrents for violators. Overall political prioritization of SDG 14 goals must percolate down to concrete compliance at all levels of ocean governance.

(b) Participatory and People-Centered Approaches: Legal reforms should codify more meaningful community roles in planning and benefits from marine economies. Customary managed areas and territorial fishing rights regimes need flourishing with technical backup. Blue growth projects must be pursued hand in hand with social inclusion of small-scale actors and gender mainstreaming. Multisectoral ocean forums aid collaborative decision making. Investing in local capacities, awareness, and alternative livelihoods empowers ocean stewards on the frontlines of conservation. Their experiential knowledge is vital to adapt sustainably to drivers like climate change impacts.

(c) Innovative Financing Mechanisms: Mobilizing substantial financing annually for ocean sustainability remains a hurdle. Options include green social impact bonds, blue carbon credits, ocean wealth funds investing licensing levies, mandated pollution levies for coastal development. National policies could redirect harmful subsidies and tax regimes encouraging sustainable practices. Growing interest from philanthropic donors and impact investors signals potential if risks are mitigated and returns demonstrate environmental integrity. Blended public-private instruments tailored for startups commercializing green ocean technologies also require design.

(d) Strengthening Governance Frameworks: As ocean issues grow in scale, interconnectedness, and complexity, vertically integrated high-level ocean governance architectures are needed. Models include standalone ocean ministries, special commissions on BBNJ, integrated ocean planning agencies, ocean councils involving all stakeholders. Periodic evaluation of legal frameworks will identify urgent reforms to address blind

spots like ocean acidification and deep seabed mining. Principles of climate justice and intergenerational equity require boosting in policymaking. Legal evolution through open regional courts sets precedents to pilot integrated, long term ocean stewardship worldwide.

Overall, these directions aim to facilitate more vigorous implementation, participatory and adaptive governance, and catalytic financing for ocean sustainability. With progressive reforms, the international community remains capable of fully achieving SDG 14 by 2030 and conserving our shared natural heritage for future welfare of people and climate change.

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