

CLIMATE CHANGE AND MARITIME SECURITY: IMPLICATIONS FOR AFRICA'S REGIONAL DEVELOPMENT

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Abstract

Climate change poses a significant threat to maritime security, particularly for coastal and small island African countries. This study explores the relationship between climate change and maritime security by scrutinising the impact of ecological changes on regional stability, economic growth, and security instability across the continent. The study utilised qualitative data from various sources, including textbooks, scholarly journals, magazines, and online resources, to comprehensively understand the complex relationship between climate change and maritime security. The study investigates the implications of rising sea levels, the increased frequency of severe climate actions, and coastal corrosion on Africa's maritime territory and economic activity. The findings show that climate-induced maritime threats worsen existing security challenges, damage regional assets, and underline the pressing need for coordinated responses to maintain economic well-being, watch over vulnerable populations, and improve regional flexibility. This study bestows a growing body of literature on climate change and security, presenting meaningful recommendations for policymakers and stakeholders. These comprise attractive regional collaboration, developing global maritime security strategies, and incorporating climate adaptation measures into national and regional progress plans. African states have better organised their intelligence capabilities to tackle the challenges posed by climate change while ensuring marine security and sustainable development.

Keywords: Climate Change, Maritime Security, Regional Development Sea-level Rise

Introduction

Climate change poses a major warning to global security, mainly in Africa's coastal region, where states rely greatly on maritime wealth. Increasing sea levels and severe weather events aggravate vulnerabilities, frightening livelihoods and escalating rivalry for scarce resources similar to food and water (Barbara & Grzegorz, 2024). Coastal hotspots face distinctive challenges owing to exact vulnerabilities, necessitating integrative investigation and guiding principle approaches (Petzold & Scheffran, 2024). Governance mechanisms focusing on coastal administration as well as a community-based version are vital for illuminating risks and nurturing flexibility (Jan, 2024). Environmental and socioeconomic factors can contribute to public insecurity, highlighting the need for transformative adaptation in areas that are often exaggerated. The complex impacts of climate change on maritime security in Africa require critical, coordinated efforts to improve adaptive capability as well as decrease vulnerabilities (Maria et al., 2024).

The connection between climate change and maritime security is ever more serious in Africa, where development is very much attached to maritime affluence. Climate changes intensify threats to maritime security, including piracy and unlawful fishing in various aquatic environments, while also destabilizing coastal communities. Rising sea temperatures in addition to extreme climate events add to food shortages and increased maritime crime (James & Basil, 2024). Environmental degradation and resource abuse in regions like the western Indian Ocean contribute to uncertainty obsessed by scarcity as well as inadequate governance (McCabe, 2023). The broader implications include intense struggle for resources and possible political tensions (Mihailov et al., 2024), making it essential to deal with these consistent challenges in support of regional stability and sustainable growth in Africa's maritime context (Christian & Timothy, 2024; Amit, 2024).

Statement of the Problem

Africa's coastal regions are progressively vulnerable to climate change, which exacerbates maritime security challenges as well as undermines regional development. Increasing sea levels, coastal attrition, and severe climate measures are displacing communities, frightening maritime infrastructure, and also disturbing fundamental economic activities like fisheries and shipping. However, ecological degradation has consistently served as a catalyst for conflict, prohibited activities such as illegal fishing and piracy, and competition for material commodities. Despite increasing awareness, there remains a significant gap in the integration of climate flexibility into maritime security strategies across the continent. Contemporary regional development initiatives often fail to focus on the diverse impacts of climate change on maritime security, primarily due to a fragmented and reactive approach. The need for harmonisation poses a threat to the resolution and economic development of Africa's coastal states, as well as to broader regional development goals. The inadequate incorporation of climate change considerations into maritime security frameworks impedes the advancement of comprehensive strategies that protect coastal communities and sustain

regional development amidst increasing ecological and defense risks. This article explores the implications of climate change on maritime security in Africa as well as proposes policy recommendations intended for an incorporated, flexible approach to regional development.

Objective of the Study

The objective is to investigate the impact of climate change on maritime security in Africa and its implications for regional development.

Theoretical Framework

Human Security Theory

The study adopted the Human Security Theory, prioritising the safety of individuals and communities facing various forms of terror, including those affected by climate change. Increasing sea levels and resource reduction drastically aggravate vulnerabilities within coastal communities, leading to potential clashes and volatility. The theory of human security, as expressed in the 1994 UN Development Programme report, shifts the focal point from state-centric security to the comfort of persons, stressing the multidimensional scenery of security threats and counting ecological changes (Amedeo 2024). Despite its importance, the relevance of human security ideology frequently faces challenges, as states and institutions may choose the concept for their own agendas, neglecting the contextualised anxiety experienced by individuals. Furthermore, the inadequate provision of high-quality personal safety measures within the international community complicates efforts to effectively address these vulnerabilities. Hence, even as human security theory provides a precious agenda for thoughtful impacts of climate change on communities, its realistic realisation remains burdened with obstacles that must be steered to ensure the safety of vulnerable populations (Ritu, 2022).

Climate change significantly affects the security of individuals and communities in Africa, particularly in relation to food security, water scarcity, and displacement, all of which have a direct impact on regional development. The study implies that climate change ushers in severe weather conditions, such as famine and floods, which have greatly disrupted farming production and exacerbated food shortages across the continent (Evanilde, 2024). For example, in Somalia, irregular climatic patterns have resulted in earth dilapidation, water scarceness, and reduced harvest yields, stressing the pressing need for course of action interventions to improve food security and flexibility (Mohamed & Abdullah 2023). Additionally, the financial implications are significant, given that farming and domestic animal husbandry are the primary sources of income for many Africans, and climate change is a contributing factor to scarcity and food insecurity (Ziyu, 2023). Addressing these challenges requires incorporating actions, sustainable farming practices, and community commitment to foster buoyancy and ensure food stability, which will ultimately support regional development efforts (Adekunle et al., 2024).

Literature Review

Climate Change

Climate change is a significant and long-lasting alteration to the Earth's environment, primarily caused by individual actions like burning fossil fuels, deforestation, and manufacturing processes, all of which led to increased concentrations of greenhouse gases (GHGs) in the atmosphere (Erwan and Thomas, 2022). This occurrence has led to global warming, which is manifested through acute weather conditions, rising sea levels, and disruptions to ecosystems, with significant implications for both human and nonhuman life. The financial impact is significant, as climate-related disasters have resulted in losses of approximately \$4.3 trillion and the displacement of millions from their homes (Rob, 2022).

In addition, the ruin of biodiversity always aggravates these challenges, as hale and hearty ecosystems are decisive in supporting human life and alleviating climate impacts (Selvakumar, 2024). Understanding climate change requires a collaborative global effort to implement effective mitigation and adaptation strategies, underscoring the urgent need for awareness and action at all societal levels (Jyoti et al., 2023).

Maritime Security

Maritime security can be defined as the safety of a state's maritime assets, their trade routes, as well as territorial waters, from diverse threats, which include piracy, unlawful fishing, smuggling, and ecological hazards. Three central dimensions characterise maritime security: inter-state conflict, maritime terrorism, and blue crime, which encompasses both piracy and unlawful fishing (Christian and Timothy, 2022). The relationship between these threats is crucial; for instance, illegal fishing can compel local fishermen to resort to piracy as a means of survival, underscoring a complex fundamental link that connects various activities (Anup et al., 2024). Also, the dominance of maritime security involves a series of strategies, including information distribution and capacity-building, to tackle these versatile challenges successfully. The prevalence of illicit fishing, particularly in regions such as Aceh, exacerbates safety measures, with local governance failures and societal practices playing a significant role (Fadli et al., 2024). Consequently, an inclusive approach to maritime security must think about local and international proportions in order to safeguard maritime interests effectively.

Regional Development

Regional development can be defined as fundamental efforts aimed at developing particular areas within a country, focusing on economic growth and improving community well-being by influencing local assets and capability. Regional development is crucial because it allows for customised economic strategies that optimise local resources and welfare outcomes, ultimately resulting in increased profits and decreased levels of shortage. The exploitation of regional

prospective—such as road and rail network, natural ownership and community capabilities wires reasonable development activities, which are vital for raising livelihood and creating pay opportunities. Furthermore, evaluating regional economic performance using metrics such as the quality of regional manufactured goods and production output sheds light on the effectiveness of development initiatives and pinpoints priority areas for future growth. The strategic move towards regional development will not only address disparities but also contribute to the general quality of lives of inhabitants, making it a decisive focus for policymakers and researchers alike (Ihor & Olena, 2024).

Coastal and Small Island States

Coastal and Small Island States (CSIS), including 58 Small Island Developing States (SIDS), are highly vulnerable due to their limited land area and dependence on natural resources. Climate change has consistently worsened the vulnerabilities of rising sea levels and acute weather conditions (Crystal 2024). The persistent issues of food insecurity, health, and climate change necessitate the implementation of comprehensive policies that integrate change and moderating strategies (Guell 2024). The low-lying reef islands, critical to numerous CSIS, are mainly at risk owing to their dependence on reefs for land arrangement (David 2024). The sustainable supervision practices of marine protected areas are crucial for resilience. Universal policies often overlook the unique requirements of small islands, underscoring the necessity for tailored strategies to tackle particular social-environmental situations (Ortiz et al., 2024).

Methodology

This study uses a qualitative method to examine climate change's impact on maritime security and regional development in Africa. The study made use of secondary data, such as text books, academic articles, magazines, and internet resources. The study also made use of the triangulation method to validate findings by cross-referencing data from multiple sources.

We used content analysis to interpret key texts about climate change-induced maritime threats like rising sea levels and coastal corrosion, and their effects on regional development. The goal is to enhance understanding of how climate change affects maritime security and sustainable regional development in Africa.

Impact of Climate Change on Maritime Security in Africa

The impact of climate change on maritime security in Africa is a growing concern, given the continent's extensive coastlines and reliance on maritime activities for economic development. Here are key points to consider.

1. Rising Sea Levels and Coastal Erosion

Rising sea levels pose significant threats to coastal infrastructure, particularly ports essential for trade and transportation. Research indicates that by 2050, over 1,600 critical infrastructure assets in U.S. coastal communities will face disruptive flooding at least twice annually due to climate change-driven sea level rise, disproportionately affecting disadvantaged communities (Kristina et al., 2024). Additionally, the loss of coastal access, vital for tourism and local economies, is projected to escalate with rising sea levels, particularly in California, where access points may diminish at a rate of approximately 100 opportunities per foot of sea level rise (Kiki and Reineman 2024). In Senegal, local land subsidence compounds flooding risks, potentially inundating significant areas by 2100, which threatens both community displacement and economic assets. Generally, the interplay of rising sea levels and coastal erosion necessitates urgent policy responses to safeguard infrastructure and mitigate economic losses, as nearly half of the global population resides in vulnerable coastal regions (Omur, 2024).

Coastal communities are increasingly vulnerable to displacement due to climate change, particularly from rising sea levels and intensified tropical storms, which are projected to exacerbate forced migration in the coming decades (David et al., 2024). Significant humanitarian crises can arise from this displacement, as disasters force millions from their homes, resulting in 30.7 million new internal displacements in 2020 alone.

The consequences of such dislodgment are severe, affecting not only shelter and livelihoods but also physical and mental health, putting vulnerable populations such as children and the elderly at risk (Sevgi 2022). Additionally, socio-economic factors, along with gentrification and resource struggles, intricately influence the dynamics of coastal dislodgment, potentially intensifying tensions and conflicts over more land and resources (Kristen & Mathew 2024). Therefore, addressing the versatile challenges of coastal displacement requires inclusive strategies that reflect on both instant humanitarian desires and long-term adaptation policy (Amalia et al., 2024).

Table 1: African Countries Affected by Rising Sea Levels, Along with Additional Details Such as Vulnerable Regions, And Potential Impacts:

Country	Vulnerable Regions	Potential Impacts
Egypt	Nile Delta, Alexandria	Coastal erosion, loss of agricultural land, increased salinity in freshwater resources, displacement.
Nigeria	Lagos, Niger Delta	Flooding, displacement, loss of livelihoods, infrastructure damage, contamination of water supplies.
Mauritania	Nouakchott	Flooding, saltwater intrusion, loss of arable land, displacement.
Senegal	Saint-Louis, Dakar	Coastal erosion, loss of homes and infrastructure, displacement, threats to tourism and fishing industries.
Ghana	Ada Foah, Keta	Coastal erosion, loss of property and land, displacement, damage to infrastructure, reduced agricultural productivity.
Mozambique	Beira, Maputo	Increased frequency of cyclones, flooding, displacement, damage to infrastructure and agriculture
Gambia	Banjul, Coastal Areas	Coastal erosion, loss of land, displacement, impact on tourism and agriculture.
Tanzania	Dar es Salaam, Zanzibar	Coastal erosion, displacement, damage to infrastructure, loss of tourism revenue
Kenya	Mombasa, Coastal Regions	Coastal erosion, flooding, displacement, loss of livelihoods, threats to agriculture.
Seychelles	Low-lying Islands	Submergence of land, loss of habitats, impact on tourism, threats to biodiversity
Guinea-Bissau	Bissagos Archipelago	Flooding, loss of land, displacement, impact on fishing and agriculture
Liberia	Monrovia, Buchanan	Coastal erosion, loss of property, displacement, damage to infrastructure.

Source: Researcher Field Work

2. Increased Frequency of Extreme Weather Events

Frequency increases and extreme weather events, such as hurricanes and cyclones, significantly disrupt maritime activities, leading to substantial financial losses. According to a study, there has been a noticeable increase in extreme weather events, with Russia experiencing an increase from 130 to 257 destructive events annually between the 1990s and 2010s. This increase highlights the

growing threat to economic stability in regions that are more vulnerable to these events (Romanovskaya 2022). Severe wind events, primarily from additional tropical cyclones, have disrupted power lines in Portugal, potentially affecting maritime operations by influencing power supply chains (Margarida et al., 2024). Furthermore, the coastal regions of Southwest Europe have reported significant economic reparations, amounting to almost €4000 million from severe weather events between 2009 and 2020, highlighting the vulnerability of maritime activities to such disruptions (Rosa et al., 2023). These results jointly give emphasis to the urgent need for improved monitoring and adaptation strategies to alleviate the impacts of extreme weather conditions on maritime and coastal economies.

The persistent rise in severe weather conditions has significantly complicated search and rescue (SAR) operations, particularly in challenging environments such as the Arctic and maritime settings. Research indicates that harsh conditions like low temperatures, high waves, and limited visibility hinder SAR efforts, particularly in remote areas with inadequate infrastructure (Behroozak et al., 2024). The expansion of independent technologies, as well as search and rescue autonomous vessels (SRVs) and unmanned aerial vehicles (UAVs), shows potential solutions to improve operational efficiency in these adverse conditions (Ovidiu et al., 2023). However, challenges persist in efficiently planning and executing free missions under severe weather conditions, which necessitate the use of superior algorithms and robust robotic designs to optimize performance (Yue et al., 2023). Liang et al. (2024) also say that fact-synthesis techniques for planning paths in complex marine environments are necessary for proper and useful rescue operations. In general, even though technological progress is opening up new ways to make SAR operations more civilised, bad weather still makes things more difficult.

Table 2: Listing Some Significant Extreme Weather Events That Have Occurred In Africa:

Event	Country/Region	Date/Period	Description
Mozambique Cyclone Idai	Mozambique, Zimbabwe, Malawi	March 2019	One of the worst tropical cyclones in Africa, leading to widespread flooding, destruction, and loss of life.
2020 East African Locust Swarm	East Africa (Kenya, Somalia, Ethiopia)	2019-2020	Massive locust outbreak worsened by unusual weather patterns, threatening food security in the region.
Cape Town Water Crisis	South Africa	2017-2018	Severe drought leading to a major water shortage, nearly reaching "Day Zero" when the city would run out of water.
Sahel Drought	Sahel Region (Multiple Countries)	1968-1974	Prolonged drought that caused severe famine and displaced millions of people across several countries.
Cyclone Kenneth	Mozambique, Comoros	April 2019	The strongest tropical cyclone to hit Mozambique, following Cyclone

					Idai, causing severe flooding and destruction.
2019 Indian Ocean Dipole		Eastern Africa (Kenya, Somalia, Ethiopia)	2019-2020		Weather phenomenon causing extreme flooding in East Africa, leading to displacement and loss of life.
		Nigeria, Chad, Cameroon	2012, 2022		Recurrent flooding exacerbated by heavy rains, affecting millions and contributing to the humanitarian crisis.
	Lake Chad Basin Floods				
Sahara Desert Expansion		Northern Africa	Ongoing		Gradual desertification of the Sahara, impacting livelihoods, agriculture, and leading to displacement.
Southern Africa Heat wave		Southern Africa (Multiple Countries)	October-November 2015		Extreme heat wave leading to drought conditions, impacting agriculture and water supply.
Morocco Earthquake		Morocco	September 2023		A powerful earthquake that caused significant destruction and loss of life in Morocco's High Atlas Mountains.

Source: Researcher Field Work

Plate 1: Flooding in Nigeria 33,000 persons affected, 7,353 persons were displaced across 10 states with 1,679 farmlands submerged, according to NEMA



Source: News Central Africa (2023)

Plate 2: Floods in DR Congo and Rwanda.

Death toll hit over 570 and thousands were displaced in both countries. 5000 homes affected



Source: Aljazeera (2023)

Plate 3: Mozambique Cyclone Idai (2019)



Source: World Vision

3. Impact on Fisheries and Marine Resources

Climate change significantly impacts fisheries and marine resources, particularly in African coastal communities, leading to a decline in fish stocks essential for food security and livelihoods. Research indicates that rising ocean temperatures and altered currents disrupt traditional fish migration patterns, exacerbating food insecurity in regions like Tanzania, where communities face moderate to high risks due to these environmental changes (Lara et al., 2024). Climate change has damaged fishing infrastructure in Nigeria's Eastern Niger Delta, affecting local fisheries, although the impacts are considered manageable (Umana, 2023).

Similarly, in Ghana's Coastal Savannah region, an increase in sea surface temperatures and salinity has led to a significant decline in fish populations over the past two decades, highlighting the vulnerability of small-scale fishermen (John et al., 2023). These findings underscore the urgent need for adaptive strategies to mitigate the negative impacts of climate change on fisheries, thereby preserving marine assets and the livelihoods that depend on them (Fernando et al., 2024). Unlawful, unreported, and unregulated (IUU) fishing drastically threatens maritime security and the sustainability of fisheries, mainly as marine resources turn out to be scarce. A decrease in fish stocks exacerbates IUU fishing activities, which are often linked to wider prohibited enterprises and human trafficking, thereby subverting local economies through overexploitation of maritime resources (Samuel et al., 2024). Inadequate resources and equipment among enforcement agencies complicate effective law enforcement against IUU fishing, resulting in a cycle of repeat offences (Maribel et al., 2024). Additionally, the persistence of IUU fishing is bolstered by destructive subsidies from states, a factor that discourages global fishery governance efforts such as the WTO Agreement on Fisheries Subsidies. The regional partnership, particularly within ASEAN, plays a crucial role in addressing setbacks, as conflicts of interest among member states often impede collective achievement (Yulia 2024). Therefore, a multifaceted move towards improved monitoring of international partnerships and legal reforms to combat IUU fishing efficiently.

4. Impact on Maritime Trade Routes

Climate change-related disruptions are increasing the vulnerability of Africa's maritime trade routes, posing significant risks to economic expansion. According to studies, severe weather events such as strong storms and erratic weather patterns have affected the stability of trade routes (Yan et al., 2024). For instance, disruptions in crucial maritime chokepoints like the Suez Canal and Panama Canal can significantly impact global trade, primarily affecting agricultural product prices and GDP in regions similar to North Africa and Sub-Saharan Africa (Ramon et al., 2024). Moreover, the high costs associated with shipping routes and higher insurance premiums exacerbate vulnerabilities, resulting in inefficiencies within the maritime transport industry. The UNCTAD report underscores the significant declines in delivery transits through the critical canals due to geopolitical tensions and climate-induced droughts, highlighting the urgent need for improved flexibility strategies in maritime transport (Francois et al., 2024).

5. Impact on Energy Resources

Africa's offshore oil and gas resources are essential for economic stability; however, they face major terrorisation from climate change. Climate change has led to more severe weather events, such as storms and flooding, which has continuously damaged offshore installations and interrupted production processes, resulting in economic losses and supply chain interruptions (Oyeleke, 2018). The interconnected temperament in the energy sector has been disrupted with widespread implications, as observed by past events like Hurricane Katrina, which caused an international oil price hike as a result of production losses (Nicolas et al., 2018). Furthermore, the economic effects of resource disruption can intensify conflicts over control of these essential resources, underscoring the necessity for robust security measures to safeguard against both ecological threats and human aggression (Reiko et al., 2023). Underdeveloped countries, most especially on the African continent, are more prone to hazards because they lack the capability to implement efficient adaptation and alleviation strategies to curtail these threats. As a result, addressing climate robustness and security is crucial for the conservation of Africa's offshore energy resources.

Implications for Regional Stability and Security

This pertains to the potential impact that a specific event could have on the overall peace and safety of a particular region. These implications also impact the region's population, their well-being, the likelihood of conflict, the balance of power, and the integrity of the government and its institutions.

1. Piracy and Armed Robbery

Climate change-induced economic hardships and dislocation have significantly contributed to the rise in piracy and armed robbery at sea, particularly in regions such as the Gulf of Guinea. Fish production has already declined due to rising sea temperatures, thereby increasing the risk of piracy in regions like East Africa, especially when fishing communities face economic insecurity (Jiang & Garry, 2023)! James and Basil (2024) claim that the increased economic pressures brought by environmental changes and marine crime may have also pushed people to partake in illegal activities in order to earn a living. Political instability, a broader agenda of governance, and economic marginalization also contribute to the dominance of piracy activity, exacerbating issues of inefficient governance (Francis 2023). Due to this, it is imperative to understand how governance, economic hardship, and climatic change interact with the dynamics of marine crime in susceptible areas (Yuanjian 2023).

2. Maritime Border Disputes

As resources become scarcer, the risk of maritime boundary disputes among African nations becomes increasingly delicate, potentially leading to conflicts. The maritime dispute between Kenya and Somalia exemplifies this trend, as overlapping claims within the Indian Ocean have exacerbated

tensions. This tension culminated in a 2021 ruling by the International Court of Justice, which has not yet fully resolved the fundamental issues. Similarly, the competition for marine resources often dominates broader patterns of maritime disputes in Africa, exacerbating existing tensions and leading to violent conflicts (Constantinos 2023). The case of Sudan and South Sudan further demonstrates how resource struggles and border disputes intertwine with the complexity of peace efforts and regional stability (Abubakar & Yahaya, 2021). Furthermore, the discovery of natural resources in disputed areas has now prompted African states to seek out joint management agreements as a possible resolution strategy, stressing the multifaceted interaction between resource scarcity and maritime disputes (Nelly et al., 2020). Therefore, the connection between states over resource struggles and unsettled maritime boundaries poses major risks for conflict in the African region.

3. Increased Conflict over Resources

An important driver of conflict is the increased struggle for freshwater resources, particularly as water scarcity intensifies globally. The literature at our disposal emphasizes the increasing demand for water, which is exacerbated by population growth and climate change, leading to tensions among nations and communities over access to marine resources. For example, our subcontinent faces potential clashes as a result of unequal water distribution, which also exacerbates insecurity and conflict among neighboring countries (Sayeda 203). In the Lake Turkana Basin of Kenya, ethnic tensions and historical grievances over scarce water resources have led to persistent conflicts, underscoring the complex interplay of local and external factors (David et al., 2023). Furthermore, the demands for land and water resources are aimed at enhancing food production. The decline of agricultural productivity leads to shortages of food (Fan 2024). Historical data also reveals a marked increase in water-related hostility, particularly in regions such as the Middle East and southern Asia, where water scarcity has served as a catalyst for armed conflict (Peter & Morgan, 2023). Therefore, addressing water scarcity is crucial for both mitigating potential conflicts and ensuring food security.

4. National Security Concerns

Climate change continues to pose major national security concerns, diverting resources from the military's readiness and the challenge of border security. Governments must allocate funds to address climate-related issues, such as extreme weather events and rising sea levels, which pose a serious threat to military infrastructure and operational readiness (Ross, 2021). The U.S. National Defence Strategy underscores the significant impact of climate change on a multifaceted security environment, and its potential to exacerbate insecurity in vulnerable regions. Additionally, rising sea levels and environmental degradation can lead to increased migration and create challenges for refugees within existing borders (Laurie & Joseph, 2023). The transition from traditional military threats to non-military risks necessitates a reevaluation of national security priorities and resource allocation (Oksana 2021). As nations grapple with these rising challenges, the interaction between climate action and national security will become increasingly crucial in maintaining stability and willingness (Maja, 2019).

5. Humanitarian Crises

Climate change has significantly exacerbated health issues and humanitarian crises, thereby impacting the stability and security of the region. Research has revealed that climate change can increase heat-related illnesses and also spread vector-borne diseases, which in turn pose direct health risks to vulnerable populations, especially in conflict zones and densely populated areas (Alix et al., 2024). The constant destruction of health facilities has interrupted health services, as well as complicated humanitarian efforts (Mike 2019). Furthermore, the recurrence rate of natural disasters has continuously hindered the capabilities of regional responses, which has compounded vulnerabilities and resource shortages. The current humanitarian crisis in Sudan calls for interventions from international organizations to tackle infectious and noncommunicable diseases among the affected populace (Subhash & Prateek 2022). Therefore, it is crucial to implement proactive adaptation strategies and foster international cooperation to mitigate the health impacts and boost resilience during humanitarian crises (Marsono et al., 2022).

Strategies for Addressing Climate Change and Maritime Security in Africa

Addressing climate change and maritime security in Africa requires a comprehensive approach that takes into account the continent's unique vulnerabilities, economic conditions, and geopolitical context.

The following strategies could be explored

1. Strengthening Regional Cooperation and Governance

Regional cooperation and governance in maritime contexts require a versatile approach to building existing frameworks that enhance integrated strategies. The African Union's African Maritime Strategy as well as the Lomé Charter serve as initial agreements that reinforce robust execution mechanisms, promoting the collaboration of maritime security and environmental protection (Marcelo, 2023). The division and poor coordination among various institutions repeatedly stall successful governance in marine environments, necessitating a more integrated approach at both national and regional levels (Margaret, 2023). Integrated maritime strategies prioritize the sustainable management of coastal marine resources to address security concerns. This approach further involves collaborative training initiatives and capacity-building efforts to foster inter-regime harmonisation among stakeholders (Ileana 2022). The governance framework needs the enforcement of formal agreements as well as the adoption of flexible governance practices to adjust to the diverse challenges faced in marine environments.

2. Enhancing Coastal and Marine Ecosystem Resilience

Enhancing coastal marine ecosystem flexibility as well as the promotion of sustainable fishing practices in implementing integrated coastal zone management (ICZM) is very vital. Sustainable fishing practices play a crucial role in preventing overfishing, which has exacerbated the impacts of climate change on marine ecosystems. Research indicates that strict management of anthropogenic factors, including overfishing, can significantly enhance the resilience of temperate coastal systems by up to 27.97% (José et al.,(2024). Furthermore, addressing local stressors such as illegal, unreported, and unregulated (IUU) fishing is crucial for maintaining biodiversity and ecosystem health. The ICZM practice, which involves the restoration of mangroves and coral reefs, is important for managing coastal erosion and flooding. These ecosystems serve as natural defenses against climate impacts, and their restoration can enhance resilience against climate-induced hazards (Wonhyun et al., 2024). Innovation and monitoring techniques provide essential data for informed decision-making and effective management strategies (Yasser et al., 2024). Therefore, a comprehensive approach that combines sustainable fishing and ICZM is required in promoting a durable coastal marine ecosystem.

3. Climate-Smart Infrastructure Development

In the context of green ports, developing climate-smart infrastructure is essential to reducing the effects of climate change. Studies emphasize the need for ports to adopt strategies that will reduce greenhouse gas emissions as well as enhance energy efficiency; such implementation takes place on-shore power supply systems and the setting of GHG reduction targets (Martí et al., 2024). Furthermore, the framework for assessing climate adaptation in port infrastructure emphasizes the importance of tailored adaptation plans to address specific climate risks, ensuring that ports remain functional under changing conditions (Alberto et al., 2024). For climate-resilient infrastructure, there is a need for effective governance that involves the engagement of stakeholders in identifying vulnerabilities as well as interdependencies of the infrastructure systems, which enhances flexibility against climate threats. Additionally, we must plan new infrastructure to withstand climate impacts, and retrofit or transform existing structures to enhance resilience (Divyanshu, 2024). This inclusive approach to integrating renewable energy investments and robust planning is essential for safeguarding coastal communities and critical maritime routes against climate change.

4. Capacity Building and Technology Transfer

In the context of climate change, capacity building as well as technology transfer are critical for enhancing maritime security, mostly in African nations. The training programs developed under the CONFER project aim to equip maritime security personnel and policymakers with the necessary skills to interpret and apply climate information effectively, thereby improving their flexibility against climate variability (Jane & Stefan, 2024). Furthermore, the integration of new technologies is crucial for monitoring and enforcement, as demonstrated by advancements in maritime security,

which have improved field awareness and operational effectiveness in regions such as the Gulf of Guinea (Ifesinachi et al., 2024). Furthermore, the transition from climate-adaptive technologies to renewable energy and environmental monitoring tools is crucial for supporting African countries in their adaptation efforts. The importance of capacity building as painted in recent international agreements underscores the inevitability of giving out technical as well as financial support to guarantee the effective implementation of climate initiatives.

5. Community Involvement and Sustainable Livelihoods

Fostering sustainable lives requires the involvement of coastal communities in maritime security and climate adaptation. Research revealed that community participation has significantly enhanced the effectiveness of sustainable development initiatives. Active engagement in decision-making processes has also empowered communities, as demonstrated by instances where participation has resulted in favourable environmental outcomes (Lutfiah & Isna, 2023). Additionally, research places interest on the importance of leveraging wealth and communal assets to combat poverty and encourage self-sufficiency (Rebecca & Hanna 2023). Communities that solely depend on climate-sensitive sectors such as aquaculture and ecotourism can mitigate their vulnerabilities by promoting renewable energy as alternative sources of income. These alternatives not only broaden revenue streams but also foster environmental sustainability and collaborative management of coastal wealth, a point emphasized in local administration policies that support these initiatives by encouraging collaboration among all stakeholders towards sustainable outcomes (Nurlisa & Julaihi 2023). Therefore, in building flexibility against climate change, it is very important to empower people via education and active involvement.

6. Leveraging International Partnerships

Cooperation and international interaction among institutions such as the World Bank and IMO provide necessary funding, technical assistance, and knowledge sharing, whose ultimate drive is sustainable development.

Partnerships are imperative for implementing the UN Sustainable Development Goals (SDGs) because they unite different stakeholders attracted to resource pooling and expertise sharing. (Walter et al., 2024) Effective partnerships facilitate successful initiatives by creating synergies that enhance impact and foster long-term commitments. Africa should leverage blended finance and international investment treaties to attract transformative investments. By strategically aligning partnerships with production and transformation goals, the establishment of platforms and promotion of linkages can enhance local and national development (OECD et al., 2023). Despite these benefits, international partnerships often face challenges such as unequal power dynamics and a lack of clear agreements, which hinder their sustainability effectiveness. To ensure that all partners are aligned, it is crucial to maintain open and transparent communication channels to foster trust (Maria-B & Namara R 2022). In conclusion, even though international collaborations offer many rewards for sustainable

development, their success also hinges on how international organizations address underlying problems.

7. Policy and Legal Frameworks

Incorporating national policies into climate change adaptation strategies aligning with international agreements like the Paris Agreement can enhance resilience against environmental impacts (Scissa & Martin, 2024). This policy should facilitate the integration of renewable energy in the maritime sector, foster compliance with sustainability goals, and reduce emissions (Portia et al., 2024). Furthermore, legal systems in all countries bear a major responsibility to resolve transboundary issues, combat maritime piracy, and combat environmental pollution (Fahad et al., 2024). A comparative study indicates that improving cooperation and coordination among jurisdictions can significantly improve the enforcement of environmental laws. To ensure that all legislative instruments effectively address environmental justice and sustainable development, policymakers should also prioritize inclusivity and adaptation (Rabith et al., 2023).

The introduction of supervision procedures and compliance standards enhances the usefulness of legal frameworks in combating environmental and marine security offences. Despite the importance of incorporating climate adaptation and maritime security, obstacles have hindered the development of robust and adaptable legal frameworks that can effectively address the complexity of environmental issues and transnational crimes.

Conclusion

Africa is a vulnerable region to climate change, rising sea levels, harsh weather, and the destruction of marine ecosystems due to its vast coasts and reliance on maritime trade. These environmental changes have continuously threatened coastal infrastructure and economic stability, which are crucial for Africa's regional development. As climate change intensifies maritime security threats such as piracy and unlawful fishing, as well as boundary disputes, it undermines regional stability and economic growth. The displacement from coastal erosion, along with the loss of livelihoods, further strains social unity and increases conflict risks in fragile states.

African nations must incorporate climate adaptation into their maritime security frameworks in order to moderate risks in line with the African Union's 2050 Africa's Integrated Maritime Strategy (AIMS). Investing in resilient infrastructure not only promotes sustainable economic activities that safeguard marine environments, but also fosters international partnerships that offer the necessary technical and financial assistance.

Addressing the twin threats of maritime insecurity and climate change is crucial for Africa's regional affluence. This involves defending Africa's coastal areas and utilizing its marine resources for long-term stability and sustainable development. This requires a concerted effort from local, regional, and international players.

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