

Impact of Climate Change on Maritime Security



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Abstract: *Climate change has become a major threat to the security of the world's seas and oceans affecting structures, politics, and people. This paper aims at discussing the connection between climate change and maritime security with emphasis on effects and threats. Climate change impacts, including increased sea level, more frequent and intense storms, and changes in marine environment pose direct threats to key maritime facilities including ports, harbors, and offshore structures affecting international commerce and economic activities. The thawing of the polar ice caps is making new sea ways in the Arctic region, increasing the political rivalry among the key players such as Russia, the United States, Canada, and China and raising the stakes over the access to resources and control of the strategic waterways. Furthermore, shifts in the marine environment are increasing tensions over territorial claims in areas such as the South China Sea where competition for scarce resources is expected to rise. Small Island Developing States (SIDS) are vulnerable to climate change impacts including flooding, loss of land, and threats to freshwater sources, and therefore need specific measures to address these effects. The study therefore calls for a coordinated and comprehensive approach to the improvement of the resilience of the maritime structures, the naval and coast guard forces, and the international cooperation. The implications of the findings are that there is need for new approaches and preventive measures to protect the seas and oceans for sustainable management and security in light of the emerging climate change issues.*

Keywords: Climate change, maritime security, sea-level rise, geopolitical tensions, adaptation strategies, international cooperation, naval preparedness

Introduction

Climate change is a long-term alteration of the earth's climate characterized by changes in temperature, precipitation, wind patterns, and other aspects of the earth's climate system, mainly caused by human activities like burning of fossil fuels, cutting down trees, and industrial processes. These activities emit greenhouse gases such as carbon dioxide and methane into the atmosphere causing global warming and other climatic changes. Climate change has shifted from being an environmental issue to a global security threat that affects geopolitical stability, migration, and resources. Climate change has become more central to global security as it has the potential to increase competition for resources, increase the severity

of natural disasters, and cause displacement, which will only worsen the situation in already volatile areas (Kakaki, 2013).

Maritime security therefore refers to the processes and measures that are put in place to safeguard a country's territorial sea, assets, sea lines of communication and marine resources. It entails protection of ports, coastal areas, offshore structures and the marine environment against threats like piracy, terrorism, poaching, smuggling and pollution. Maritime environments are essential for world trade, energy security, and economic well-being, and their stability and safety are paramount. Maritime security can be defined as the safeguarding of territorial integrity, ship navigation, combating of unlawful activities and

the proper utilization of marine resources (Bateman, 2016).

The threats of climate change are real and evolving, and there is a need to establish how they relate to maritime security. Coastal structures, ports, and offshore oil and gas platforms are at risk from sea level rise, ocean acidification, and more frequent and intense storms. Fluctuations in sea temperature and currents affect marine life and fishing activities, distribution and abundance of resources, thus leading to competition and possible conflict over territorial waters and resources. In addition, the thawing of polar ice caps creates new avenues for navigation, which may increase conflict over resources in the Arctic and other areas. It is crucial to comprehend the multifaceted connection between climate change and maritime security since climate-related threats are becoming more frequent and severe (Jinxin et al., 2022).

The purpose of this paper is to assess the effects of climate change on maritime security by defining new threats and risks that the climate change poses to coastal and maritime areas. The goals include identifying the exposure of maritime assets to climate change events, analyzing the consequences of the opening of new shipping lanes in the Arctic, and estimating the threats arising from climate change-induced movements and illicit actions in the seas. Furthermore, the paper aims at identifying measures of adaptation and measures of mitigation to improve maritime security in the context of climate change. These strategies will respond to the call for increased collaboration, technology advancement, and policies to manage risks and promote sustainable maritime management.

Literature Review

Scholarly work on climate change and its implications for international and regional security has grown rapidly in the last decade. Several works show that climate change aggravates existing risks and tensions, especially in areas experiencing socio-political unrest and resource scarcity. For instance, the United Nations Intergovernmental Panel on

Climate Change (IPCC) 2021 report gives ample information on how climate change impacts global security by increasing competition for resources, causing migration, and conflict over arable land and fresh water. Furthermore, the U. S. Department of Defense has recognized climate change as a “threat multiplier,” which may increase conflict in unstable areas (Ramirez, 2024).

Nevertheless, there is a relative dearth of literature on the effects of climate change on maritime security despite the increasing literature on climate change and global security. Although some works, including those of the Center for Climate and Security (2023), have started to address the effects of climate change on the management of the seas, sea lanes, and coastal facilities, these topics remain relatively unexplored. While most of the current literature is more inclined towards the analysis of the effects of climate change on the ground, there is relatively less emphasis on the effects on sea, including rise in piracy, fishing, and smuggling activities (Germond & Mazaris, 2019).

There are several theoretical frameworks and models that have been proposed to explain the relationship between climate change and security. The Human Security approach focuses on how climate change affects people and communities, resulting in challenges like displacement, health risks, and loss of income (Barnett & Adger, 2021). On the other hand, the Environmental Security framework focuses on the effects of environmental changes on state stability and security in relation to resources and environment. This framework considers climate change as a direct threat to national and regional security since it impacts on basic needs such as water and food (Mathew, 2014).

The Climate Security approach is based on the human and environmental approach, which explores how climate change interacts with other social, political, and economic risks to produce multifaceted security issues. This framework is especially useful when analyzing maritime security since it takes into account the consequences of security threats on people (displacement of coastal populations) and the environment (shifts in fish stocks and marine

ecosystems) in the maritime domains (Tayebi & Mazinanian, 2024).

Prior studies show that climate change increases both conventional and emerging threats in the maritime domain. Climate change, particularly the increase in sea levels and the frequency of severe weather conditions, is a direct threat to the stability of coastal and offshore structures, which affects the safety and functionality of ports, shipping lanes, and oil rigs (Bueger & Edmunds, 2023). In addition, shifts in fish distribution due to warming of the oceans will lead to more cases of IUU fishing since fishing vessels will be forced to fish in new areas, which may be in the territorial waters of other countries thus causing conflict (Bosello & De Cian, 2014).

Also, climate change may lead to other non-conventional security risks like piracy, smuggling, and human trafficking. When coastal areas are threatened by storms or floods, or when sea levels rise, there is a likelihood of people being forced to move, and this may create room for human trafficking and other related crimes. Terrorist organizations may also take advantage of these weaknesses, using climate-related disasters to consolidate their positions in unstable countries or to destabilize sea trade (Akhtar & Inamullah, 2023).

Historical Background

Maritime security has been defined in the past in terms of state security, which is the security of sovereignty, sea boundaries, and important sea lanes against conventional threats including sea power, piracy, and sea boundary disputes. However, in the last few decades, the idea has expanded to encompass a range of non-conventional threats, due to the increased understanding of the interconnection between human security, environmental factors, and economic development. Modern threats include piracy, smuggling of goods and persons, fishing in the high seas, pollution of the environment, and the effects of climate change. This shift is due to a broader perspective of security that is not only military but also environmental, economic, and social security of the ecosystems, sustainable use of the marine resources, and the coastal communities. These frameworks

acknowledge the fact that threats to maritime security are complex and are interrelated hence the need for a multi-sectoral and multi-dimensional approach (Prashanthi & Pandey, 2023).

Real-life examples of climate-related difficulties in maritime areas demonstrate the increasing effects of severe weather conditions on maritime activities. For instance, Hurricane Katrina in 2005 destroyed many ports along the Gulf of Mexico and affected the global supply chain by disrupting the shipping channels. Likewise, the Typhoon Haiyan in 2013 had a devastating impact on the maritime transport in the South East Asia region and led to a huge loss of money and also affected the naval forces in the region. Sea level rise has also in the past affected naval operations and coastal security, making nations to reconsider the location of military assets and facilities. For instance, the U. S. Naval Station Norfolk, which is the largest naval base in the world, experiences regular flooding, and therefore, has made significant investments in adaptation. These events show how climate change has influenced maritime security threats in the past and why it still requires the reconsideration of strategies (Maria & Elisabeth, 2008)

Due to the increasing awareness of climate change as a major threat to maritime security, climate factors have been integrated into international maritime policies. For instance, the IMO has implemented measures like the 2020 Sulphur Cap under the MARPOL Convention to curb greenhouse gas emissions from ships, which shows that the shipping industry is concerned with the environment. Moreover, the Paris Climate Accord and other regional cooperative arrangements in the Arctic and the Pacific have started to incorporate provisions on climate change and maritime security. Attempts to build the long-term policy, improve the ability to respond to natural disasters, and encourage cooperation between the countries of the sea are becoming more and more important for the development of the international maritime policy, which indicates the transition to the consideration of environmental and security aspects in the management system (Zulfiqar &

Chang, 2023).

Impact of Climate Change on Maritime Environments

Climate change is one of the factors that has led to increased sea levels, which is a danger to ports, naval facilities, and other crucial water structures. With the increase in sea level, the coastal regions are more vulnerable to flooding, erosion, and intrusion of saltwater to the ports and other marine structures, supply chain, and maintenance costs. This is especially the case with strategic naval bases that are set along the coastal lines; any form of deterioration of the land on which the bases are built impacts on their stability and functionality. Furthermore, sea level rise threatens traditional coastal protection measures like seawalls and levees that are built for lower sea levels and may need to be strengthened or rebuilt at extra expenses. Maritime resources may have to be relocated because the effectiveness of the assets may be impacted by the increase in water levels, in the case of coastal barriers and naval operations (Mimura, 2013).

Climate change has also resulted in more frequent storms and their severity such as hurricanes, typhoons, cyclones that affect maritime operations. Extreme weather conditions affect the shipping channels, delays the movement of products and poses serious threats to the crew, products and the ships. Some ports may be closed for some time, ships may be rerouted or slowed down, which will lead to massive losses. The same applies to naval preparedness because storms can capsize ships, slow down operations, and hamper naval movements. The number of people who have been killed at sea through violent storms and other related disasters has been on the rise and this has called for better safety measures, better weather forecasting and better ship designs that can withstand the force of the storms (Waish, 2012).

Global warming is leading to changes in currents and increasing sea temperatures, which affects shipping, fishing, and marine life. New currents can open new opportunities, alter the direction of the existing currents and become a

threat to ships as they move through the waters they are unfamiliar with. The sea temperatures are rising and this has an impact on the distribution of marine species and this has implications on the world's fisheries and may lead to competition for fish resources. The loss of underwater habitats like coral reefs and kelp forests affects maritime activities and other species, which affects the economy and societies that rely on marine resources. These changes are more threatening to maritime security since new trends in shipping are likely to develop, competition for resources is likely to increase, and the likelihood of conflict is likely to increase in the disputed waters (Lewis-Brown et al., 2008).

Emerging Maritime Security Threats Due to Climate Change

Resource depletion due to climate change, economic fluctuations, and forced migration are factors that are leading to an increase in piracy and other maritime crimes. When climate change impacts agricultural yields and water availability, people in high-risk areas may resort to criminal activities such as piracy to feed themselves. Climate change through the increase in sea levels and cyclones can force people to move from their homes, and this makes them vulnerable to being exploited by criminals such as human traffickers and smugglers. Furthermore, the reduction in fish stocks due to the increase in ocean temperatures and ocean acidification may force some fishermen to engage in IUU fishing or other forms of piracy. Areas like the Gulf of Guinea and the Horn of Africa, which are already experiencing the effects of climate change, may experience increased piracy and other criminal activities due to worsening socio-economic conditions (Warner et al., 2009).

Climate change intensifies existing maritime territorial disputes by changing the strategic and economic significance of maritime areas. In the Arctic, the ice has melted and created new routes like the Northern Sea Route which are shorter and may be more profitable than the traditional ones. This has led to geopolitical rivalry between the Arctic states such as Russia, the United States and Canada over the new routes and the

huge underwater resources such as oil and gas that are becoming available. Likewise, in the South China Sea, the issues of sea level rise and fish migration will further complicate the territorial waters issues as countries will strive to gain control over the fishing grounds and energy resources. With climate change altering the geography of the seas, there is a possibility that conflict may arise over the newly available space and resources, and this will call for new ways of managing conflict (Bayirhan & Gazioglu, 2021).

Climate change poses several risks to naval and coast guard operations because of the effects of extreme weather, changes in sea conditions, and shifts in geopolitical factors. More storms, hurricanes, and typhoons can sink ships, interrupt the delivery of goods and services, and reduce the effectiveness of naval forces to perform routine patrols, search and rescue operations, and other missions. New conditions of the sea, including the increased level of the sea and the shift of currents, make navigation and maritime security more challenging. Furthermore, the new regions such as the Arctic and the Indian Ocean may be critical for naval forces, and the climate change may force the naval forces to operate in new environments, which may call for improved capabilities, cooperation, and new strategic doctrines to maintain maritime security in the climate change era (Glicksman, 2006).

Vulnerabilities of Maritime Infrastructure

Coastal facilities such as ports and harbors are more susceptible to climate change impacts such as sea level rise, storm surges and coastal erosion. The increase in sea levels is a major concern to the stability of the ports and their infrastructure such as the docks, storage facilities and transport systems that are crucial in the global economy. Climate change leads to storm surges that enhance the possibility of floods, which in turn affect infrastructure and other essential facilities. Coastal erosion also poses a threat to the sustainability of ports by eroding the base on which they are established. Interferences in port operations as a result of these factors have significant economic impacts. Ports are strategic links in the global supply

chain networks and their disruption results in disruptions, cost escalation and unpredictability in trade corridors, domestic and international (Burden et al., 2020).

Climate change poses a major threat to offshore energy structures like oil and gas platforms and renewable energy structures like wind farms. Storm surges and hurricanes, and other natural disasters, pose a significant risk to the stability of these structures and their eventual collapse. Also, changes in ocean temperatures and currents may impact the functionality of these platforms for operations. The consequences for energy security are rather severe, as the destruction of these facilities can affect the supply of energy resources and entail considerable losses. The rising incidence and intensity of storms and hurricanes could also lead to higher costs of operating and protecting these vital structures, which would present long-term problems for energy providers and countries that rely on offshore energy sources (Burkett, 2011).

Climate change has a considerable impact on the dependability of maritime surveillance and communication systems, which are essential for monitoring and protecting maritime areas. The effects of climate change, including increased sea levels and adverse weather conditions like fog, heavy rains, and high winds, can reduce the efficiency of radar and satellite systems for real-time tracking. Also, the underwater communication cables which are used for data transmission are vulnerable to the moving seabeds and the rising levels of coastal erosion. Interference with these systems may hinder the capacity to identify and effectively respond to maritime risks including piracy, smuggling, and poaching. This reduction in surveillance capacity could potentially erode national and international security structures, and increase the exploitation of maritime threats by hostile actors (Koetse & Rietveld, 2009).

Human Security and Migration

Some of the causes of displacement and migration include climate change through the effects of global warming such as the rise in sea levels, increased cases of natural disasters, and

loss of habitats in coastal and island areas. This is because the sea levels are increasing and this leads to flooding of the coastal areas and this affects the houses, agricultural land and other basic facilities. The areas are already facing poverty and other social problems, and natural disasters such as hurricanes, cyclones, and tsunamis are becoming more frequent and severe. This leads to loss of habitat, water and agricultural land pollution, and people being forced to move to other areas due to coastal erosion and saltwater intrusion. These climate induced factors have a great impact on mass migration and therefore have a great impact on maritime security. More people are crossing the seas and this increases the pressure on the maritime security forces as they are forced to search and rescue. It also poses a challenge to the question of borders because authorities are left with many refugees to attend to at the same time they have a humanitarian disaster to attend to. Humanitarian aid requirements increase, which puts more pressure on the ability and cooperation between the coastal countries, the international organizations, and the NGOs (McLeman, 2018).

The impact of climate change is very severe on the socio-economic status of the coastal and island people. The industries that are most affected are those that rely on stable climate conditions such as fishing, tourism, and agriculture. Climate change affects fisheries, which are a source of income and food for many coastal communities through changes in sea temperature, ocean acidity, and fish movements. Likewise, the storms become more frequent and intense, and the sea level rises. Food insecurity is as a result of reduced crop yields due to soil salinization, erosion, and fluctuating weather conditions. When these communities fail to embrace these changes, they are left to bear the brunt of the change which is high levels of poverty and social vulnerability. The consequences for the stability and security of the region are far-reaching. Resettlement of people in the coastal and island areas may lead to competition for resources, accommodation and jobs in the receiving areas. This could lead to social unrest, increased crime rates, and political

instability, which would make it even more difficult to achieve and maintain regional peace and security. These challenges will compel governments and regional organizations to seek for other strategies of handling the problem, improve on international relations between nations, and encourage the use of sustainable development to reduce the impacts of climate change migration (Molua, 2018).

Adaptation and Mitigation Strategies

The following are some of the measures that can be taken to improve the resilience of ports, harbors and offshore installations to climate change impacts. These include modification of existing ports and their structures to adapt to the rising sea level and storm surges, and the development of new breakwaters and seawalls that can effectively protect the coastal structures from erosion and flooding. Technologies such as digital monitoring systems can assist in obtaining real time information on the weather and sea level changes and the structural integrity of the port and act on threats as soon as possible. There is also the need to ensure that the infrastructure designs incorporate materials and construction techniques that can be adapted to the existing climate. Offshore installations can also use floating platforms that are more appropriate for the rising sea levels and harsher conditions and also by reinforcing the current structures to be able to withstand harsher weather conditions. These innovations will be crucial for the preservation of the functionality of the maritime structures in the context of climate change (Narandran Nair et al., 2024).

The following are the measures that need to be taken in order to enhance the capacity of naval and coast guard forces to deal with climate change. It is important to spend more on climate adaptive vessels and equipment, particularly those that are suitable for operation in extreme weather and in different sea conditions. Forces should also incorporate modern technologies such as unmanned systems and satellite-based monitoring for surveillance, early warning, and quick response. Simulation of climate related situations through the use of tabletop exercises can help in preparedness for situations like forced displacement, disasters, and search and

rescue. Sharing of information at the regional level, formation of cooperation in patrols and disaster management contingency plans can improve the overall preparedness. Training and sharing of resources are crucial in capacity enhancement particularly for countries that have a small navy (Lassiter & Shealy, 2017).

Strengthening the international legal instruments and cooperation is crucial to address the impacts of climate change on maritime security. It is necessary to work out a common approach to the challenges' mitigation and the improvement of the situation in the regions of the world ocean. Global organizations such as the United Nations and the International Maritime Organization (IMO) play a crucial role in creating a forum for dialogue, setting standards, and promoting the implementation of best practices. Regional cooperation can also improve the effectiveness of specific measures for the given geographical and climatic conditions. For instance, the formulation of regional climate change action plans and response frameworks can enhance the capacity to deal with maritime security threats. The conclusion of legally binding climate change adaptation and emissions reduction treaties and sustainable maritime practices will play a crucial role in fostering international cooperation and ensuring stability and security in the maritime environment in the context of climate change (El Bawab & Tonbol, 2021).

Case Studies and Regional Perspectives

The decrease in the amount of ice in the Arctic region is opening up new opportunities for navigation such as the Northern Sea Route and the Northwest Passage, which is altering the security and geopolitical dynamics of the Arctic region. These new passages reduce the time taken by ships to move from Asia to Europe and therefore, the attention of the global shipping business and economic activities is attracted. However, they also raise geopolitical volatility among the key players including Russia, the United States, Canada, and China. Russia, with its extensive Arctic maritime exposure, is increasing its Arctic footprint, capacity, and capability, and enhancing its icebreaker fleet to navigate and leverage the NSR. The United

States and Canada emphasize the need to maintain the freedom of navigation and to ensure that these new routes do not lead to pollution or emergence of uncontrolled shipping. China is not an Arctic state but has recently declared itself as a near-Arctic state and has been in search of new passages and resources. These countries have been increasing their operations in the Arctic and the struggle for resources such as oil, gas and rare earth metals has made the region a geo-political sensitive area that needs to strike a balance between economic benefits, security and conservation (Pharand, 2006).

Climate change through the rise in sea levels and changes in the marine environment is intensifying the territorial dispute in the South China Sea that is occupied by China, Vietnam, the Philippines, Malaysia, and Brunei. Climate change is also exacerbating these disputes by eroding the geographical foundations of sovereignty, such as islands and reefs that are vulnerable to flooding. Also, the changes in water temperatures and the distribution of marine species impact the supply of fish in the fisheries of the region and the competition for the limited resources. China for instance has made large claims as seen by the construction of artificial islands and military build up which has led to the US and its allies conducting FONOPs and building up their alliances in the region. The two main threats to the maritime security are the increasing militarization and the territorial issues because any conflict may result to war affecting the world trade and stability (Laila, 2024).

Small Island Developing States (SIDS) are the most vulnerable to climate change and rising sea levels because of issues such as flooding, loss of territory, and water sources. These impacts directly impact their economies, which are largely based on tourism, agriculture, and fisheries. SIDS are using several adaptation strategies like constructing sea walls, erecting structures that are climate change proof, and considering the use of renewable energy to reduce the use of fossil fuels that are imported from other countries. Such structures as the Alliance of Small Island States (AOSIS) show

that regional cooperation is vital in making sure that their voices are heard in international climate change negotiations and to seek for resources to finance adaptation activities. It is therefore important for SIDS to cooperate with each other multilaterally and with support from international financing in order to address security threats and to come up with measures to counter the effects of climate change which is on the rise (Kos-Stanisic et al., 2021).

Conclusion

Climate change poses current and future risks to maritime security across the domains of ports, offshore infrastructure, and naval operations. Climate change through the effects of global warming such as the rise in sea levels, extreme weather conditions, and changes in the marine environment pose a threat to the stability of maritime structures, navigation, and security from piracy and other related vices. The opening of new sea routes in the Arctic and increasing tensions over territories in areas such as the South China Sea are examples of how climate change is changing the geopolitics. Furthermore, small island developing states are vulnerable to issues like loss of land and water resources and therefore require immediate adaptation. In conclusion, the main conclusions highlighted the relationship between climate change and the growing risks in maritime areas.

The complex nature of climate change as a threat to maritime security cannot be solved by a single solution. This includes improving the readiness of maritime structures, increasing the readiness of naval and coast guard forces, and encouraging sustainability. The need to adapt to the changing conditions is possible through technological development, including monitoring systems and climate-resistant designs. Furthermore, regional cooperation and joint training are essential for capacity development and adequate preparedness for climate-related disasters. It is therefore important that there be a concerted effort by governments, international organizations and the private sectors to address the risks and ensure that the maritime environments remain secure.

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