

p-ISSN : 2708-2121 | e-ISSN : 2708-3616

DOI(Journal): 10.31703/gsssr
DOI(Volume): 10.31703/gsssr/.2024(IX)
DOI(Issue): 10.31703/gsssr.2024(IX.I)



GSSSR

GLOBAL STRATEGIC & SECURITY STUDIES REVIEW

VOL. IX, ISSUE I, WINTER (MARCH-2024)



Double-blind Peer-review Research Journal
www.gsssrjournal.com
© Global Strategic & Security Studies Review

Article Title

Environmental Challenge as a Common Threat Impacting Maritime Security Operations

Global Strategic & Security Studies Review

p-ISSN: 2708-2121 e-ISSN: 2708-3616

DOI(journal): 10.31703/gsssr

Volume: IX (2024)

DOI (volume): 10.31703/gsssr.2024(IX)

Issue: I Winter (March-2024)

DOI(Issue): 10.31703/gsssr.2024(IX-I)

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www.gsssrjournal.com

Volume: IX (2024)

<https://www.gsssrjournal.com/Current-issues>

Issue: I-Winter (March-2024)

<https://www.gsssrjournal.com/Current-issues/9/1/2024>

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Abstract

This research employs document studies to investigate the significant environmental and climate change threats facing the Indian Ocean Region (IOR). The littoral states of the IOR contribute to oceanic contamination through poor sanitation, inadequate waste management, and increased waste production due to population expansion. The resulting ocean pollution severely impacts marine ecosystems, depleting fish species and threatening food sources and livelihoods for coastal populations. Additionally, climate change exacerbates human migration and poses risks to maritime security and naval operations by increasing atmospheric and sea temperatures. The study highlights the need for collaborative efforts among IOR states to address these environmental challenges, emphasizing that the consequences of one state's environmental practices can affect the entire region.

Keywords: Indian Ocean. Environment. Pollution. Climate Change. Maritime Security. Naval Operations

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Pages: 94-105

DOI: 10.31703/gsssr.2024(IX-I).09

DOI link: [https://dx.doi.org/10.31703/gsssr.2024\(IX-I\).09](https://dx.doi.org/10.31703/gsssr.2024(IX-I).09)

Article link: <http://www.gsssrjournal.com/article/A-b-c>

Full-text Link: <https://gsssrjournal.com/fulltext/>

Pdf link: <https://www.gsssrjournal.com/jadmin/Author/31rv1olA2.pdf>

Citing this Article

		Environmental Challenge as a Common Threat Impacting Maritime Security Operations					
09	Author	Abdur Rehman Mohammad Irfan Ali Sadaf Irtaza		DOI	10.31703/gsssr.2024(IX-1).09		
Pages	94-105	Year	2024	Volume	IX	Issue	I
Referencing & Citing Styles	APA	Rehman, A., Ali, M. I., & Irtaza, S. (2024). Environmental Challenge as a Common Threat Impacting Maritime Security Operations. <i>Global Strategic & Security Studies Review</i> , IX(1), 94-105. https://doi.org/10.31703/gsssr.2024(IX-1).09					
	CHICAGO	Rehman, Abdur, Mohammad Irfan Ali, and Sadaf Irtaza. 2024. "Environmental Challenge as a Common Threat Impacting Maritime Security Operations." <i>Global Strategic & Security Studies Review</i> IX (1):94-105. doi: 10.31703/gsssr.2024(IX-1).09.					
	HARVARD	REHMAN, A., ALI, M. I. & IRTAZA, S. 2024. Environmental Challenge as a Common Threat Impacting Maritime Security Operations. <i>Global Strategic & Security Studies Review</i> , IX, 94-105.					
	MHRA	Rehman, Abdur, Mohammad Irfan Ali, and Sadaf Irtaza. 2024. 'Environmental Challenge as a Common Threat Impacting Maritime Security Operations', <i>Global Strategic & Security Studies Review</i> , IX: 94-105.					
	MLA	Rehman, Abdur, Mohammad Irfan Ali, and Sadaf Irtaza. "Environmental Challenge as a Common Threat Impacting Maritime Security Operations." <i>Global Strategic & Security Studies Review</i> IX.I (2024): 94-105. Print.					
	OXFORD	Rehman, Abdur, Ali, Mohammad Irfan, and Irtaza, Sadaf (2024), 'Environmental Challenge as a Common Threat Impacting Maritime Security Operations', <i>Global Strategic & Security Studies Review</i> , IX (1), 94-105.					
TURABIAN	Rehman, Abdur, Mohammad Irfan Ali, and Sadaf Irtaza. "Environmental Challenge as a Common Threat Impacting Maritime Security Operations." <i>Global Strategic & Security Studies Review</i> IX, no. I (2024): 94-105. https://dx.doi.org/10.31703/gsssr.2024(IX-1).09 .						



Global Strategic & Security Studies Review

www.gsssrjournal.com

DOI: <http://dx.doi.org/10.31703/gsssr>



Pages: 94-105

URL:[https://doi.org/10.31703/gsssr.2024\(IX-I\).09](https://doi.org/10.31703/gsssr.2024(IX-I).09)

Doi: [10.31703/gsssr.2024\(IX-I\).09](https://doi.org/10.31703/gsssr.2024(IX-I).09)



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Abstract

This research employs document studies to investigate the significant environmental and climate change threats facing the Indian Ocean Region (IOR). The littoral states of the IOR contribute to oceanic contamination through poor sanitation, inadequate waste management, and increased waste production due to population expansion. The resulting ocean pollution severely impacts marine ecosystems, depleting fish species and threatening food sources and livelihoods for coastal populations. Additionally, climate change exacerbates human migration and poses risks to maritime security and naval operations by increasing atmospheric and sea temperatures. The study highlights the need for collaborative efforts among IOR states to address these environmental challenges, emphasizing that the consequences of one state's environmental practices can affect the entire region.

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Keywords: [Indian Ocean](#), [Environment](#), [Pollution](#), [Climate Change](#), [Maritime Security](#), [Naval Operations](#)

Introduction

For some time, it has been clear that our planet's climate is changing dramatically. One hundred years ago, when the weather records began, various studies and surveys estimated that the previous decade had been the most active and warmest climatologically (Hansen et al., 2010). The world has experienced one of the most extreme events in the last 500 years since 2011. Despite the fact that the intensity of severe weather events is increasing exponentially, every year establishes a new

precedence for extreme weather and heat waves. The year 2013 was among the warmest in recent history, with more hurricanes than the year before in the contemporary satellite era (World Meteorological Organization, 2013).

The Indian Ocean region depicts the inability of the international community to deal with rising global temperatures and subsequent sea-level rise (GABLE et al., 1991). Inter-governmental Panel on Climate Change conducted a research study highlighting the hazards of a rise in temperature



that can cause havoc in the littoral states of IOR (IPCC2014). The report signifies the dangers and impacts of a large amount of carbon released into the environment and if not addressed properly, the irreversible damage will lead to drought, water, and food shortages, hunger, and floods. Many research reports claim that climate change tends to exacerbate the "inter-state" and "intra-state" struggles for fresh water and natural resources in the region. It is estimated that four billion residents of Asia accumulate to 40% of the population are living within 100 kilometers of coastline and are adversely prone to sea-level rise (Chatterjee, 2014).

The rise in sea temperatures in the Indian Ocean is far greater than anywhere else in the world. It is evident from the research that the frequency of melting glaciers and snow from mountains is increasing which is causing floods in the rivers and ends up in sea level rise. This phenomenon hurts hydroelectric generation and power shortages. Under this phenomenon, it is much more likely that climate change will cause coastal erosion, coastal flooding, and coastal submergence of low-lying areas as revealed in (IPCC Report, 2014). Hence, the risk of submergence due to climatic changes in low-lying littoral states like Kiribati, Tuvalu, and the Maldives has presented as an existential threat. Low-lying areas of Indonesia, Myanmar, Vietnam, India, Sri Lanka, Pakistan, and Bangladesh are the most vulnerable littoral nations in the IOR (Dr Vijay Sakhuja & Prabhakar, 2023).

The environmental and ecologically complex areas such as coastal wetlands, beaches, and mangroves are facing a serious threat of coastal depletion. Around half of all-natural disasters in the Indian Ocean region are affected by global warming and environmental degradation. The "Economic and Social Commission for Asia and the Pacific (ESCAP)" designated the Indian Ocean as the "World's Hazards Belt" in a 1995 report due to massive neglect and vulnerability to serious environmental challenges (Dr Vijay Sakhuja & Prabhakar, 2023). The most dangerous and devastating natural hazards are typhoons, floods, Cyclones, Earthquakes, and Tsunamis that hit the region frequently. Littoral countries of the IOR are not only facing climatic and environmental challenges; however major competition for natural resources will exacerbate major maritime security implications.

Environmental challenges combined with climate change become a greater threat to food security in IOR. As livelihoods of a large population in littoral states are linked and dependent upon fisheries, human security, and food chain management are interlinked in IOR. Marine pollution and the dumping of hazardous waste in the ocean by littoral states are contaminating the marine ecosystem. Lack of vision and maritime blindness in the closest littoral states is the prime factor for environmental degradation.

Due to a lack of best practices for reprocessing waste and management policies, states resort to the easy way of dealing with the waste is to dump into the ocean. When a littoral state dumps sewerage and municipal waste without any processing, it causes microbial contamination. The run-off water from agricultural areas of western Indian Ocean states carries huge amounts of chemicals and heavy metal traces that destroy microbial growth.

Suspended solid waste in the Western Indian Ocean creates huge challenges for coastal communities. Dumping of industrial waste and run-off toxic water when reaches the ocean, creates odor on beaches and deteriorates esthetics. Plastic bottles and litter on beaches tarnish the beauty of beaches and reduce the attractiveness of aquaculture adversely affecting coastal tourism and revenue decline.

Human migration caused by Climate Change is the next big challenge that is in the making. As reports suggest that South Asia is one of the most densely populated regions and will be the prime affected areas in the world. The migration due to a polluted environment may not be faced by a single state. Hence, the regional and extra-regional states will be facing the brunt of population exodus.

Environmental and climate change presents challenges to maritime security for littoral states. In the Indian Ocean, climatic degradation poses a greater threat and demands collaborative efforts. As the vast IO is shared by many states in one way or the other. Therefore, not a single state can stay idle to greater environmental challenges. The number of research conducted on climate change has highlighted the transformation in weather conditions in IOR is altering the operational maritime situation. Therefore, the operational readiness of individual navies of states needs the

assistance of coastal populations for the success of naval operations.

This study aims to investigate how changes in the environment and climate affect the IOR. The paper explains how the fast-deteriorating environment in the Indian Ocean will soon cause harm, but it also aims to show how environmental challenges pose a threat to all littoral states. Food chain management, marine security, and naval infrastructure in the Indian Ocean Region (IOR) will be covered because every state places a high importance on human security. Most importantly, it aims to provide states with a roadmap for dealing more effectively with environmental deterioration and crises brought on by climate change in the future.

Research Objectives

- To identify and analyze the key root causes of climate change and marine pollution in the IOR.
- To evaluate the social, economic, and environmental implications of climate change and marine pollution on the IOR.
- To review and assess the effectiveness of collaborative measures and initiatives taken by the international community to address climate change and environmental challenges in the IOR.

Research Questions

- What are the primary causes of climate change and marine pollution in the IOR?
- What are the social, economic, and environmental implications of climate change and marine pollution in the IOR?
- What international initiatives and collaborative measures have been implemented to address climate change and marine pollution in the IOR?

Significance of Study

This research is important as it tackles key environmental and climate issues in the Indian Ocean Region. By examining the effects of climate change and marine pollution, the study aims to enhance our understanding of the intricate relationships between human activities and environmental deterioration. The results will offer

crucial information for policymakers, environmental groups, and the global community to create effective strategies to reduce the negative impacts of climate change and marine pollution.

Additionally, by identifying root causes and assessing the implications of these issues, the research will highlight the urgent need for sustainable practices and collaborative efforts to protect marine ecosystems and coastal communities. The study will also underscore the importance of international cooperation in addressing global environmental challenges, offering recommendations for enhancing the effectiveness of existing measures and initiatives. Ultimately, this research aims to contribute to the long-term sustainability and resilience of the Indian Ocean Region in the face of evolving climate and environmental threats.

Literature Review

Generally, it is agreed by the experts that there is a rapid change in the climate; however, there is some skepticism on how much and how fast these changes are taking place. This ambivalence stems largely from a lack of understanding of the true existence of the implications of climate change on human security. There is, however, broad agreement on two points: one, Asia, Africa, and the IOR are experiencing disproportionate disruption from climate change. Second, changes in the IOR's climate have a significant impact on the marine ecosystem health.

The current research demonstrates that IOR is the most vulnerable to changes in the climate. The global ranking of countries vulnerable to climate change over the next three decades shows that the littorals of South Asia will be the most affected regions (Verisk Maplecroft, 2018).

The rapid rise in sea levels in the Indian Ocean is more prominent than in other oceans around the world. According to a 2010 study, this rise in sea level is endangering the IOR's islands and coastal areas (Han et al., 2010). The Indo-Pacific warm pool, a vast region spanning the tropical oceans from the eastern coast of Africa to the International Date Line in the Pacific, played a significant role in this process. Over the past fifty years, the water temperature in this warm pool has risen by 1 degree Fahrenheit, mainly due to harmful human activities such as carbon emissions and greenhouse gases.

These reports and studies match the ones in the “IPCC’s fourth assessment report. The report estimated a 0.18 to 0.59-meter rise in sea level by the end of the twenty-first century (Bernstein et al., 2007). The United Nations report also discovered that the icecaps were in danger of excessive melting, which could be associated with adverse weather conditions. The report maintained that there would be severe food and fresh water scarcity along with the loss of arable land (Yanda et al., 2011).

This rapid climate change can also make IOR prone to frequent storms. Recent research claims that the tropical cyclones in the IOR are likely to grow stronger and harsher. As the threat posed by these storm surges is escalating (Yu et al., 2010), According to a 2009 World Bank paper, four of the ten countries with the largest coastal GDP, six of the ten countries with high levels of coastline urban areas susceptible to risk, and five of the ten countries with the largest ratio of coastline population at risk are all situated in the IO Basins (Dasgupta et al., 2009).

The densely populated coastal cities and infrastructure in South and Southeast Asia face extreme climate change threats. When it comes to regional maritime outlook, the threat becomes more imminent and devastating due to the fact that the states of these regions are ill-equipped to deal with the threat. The experts on climate change are of the view that all the devastation caused by climate change will be faced by ill-prepared governments and to mitigate these threats, already scarce resources will deplete at a faster rate in the future. All these coastal cities and populations are the first targets to be hit by natural disasters and rising sea levels (Dasgupta et al., 2009).

The challenges of climate change are not confined to a single state, as they may face an impact on a global scale. The ocean is taken as the most abundant and sustained source of food accumulation. When the ocean and its surrounding environment become polluted, food security will be drastically impacted (General Assembly, 2014).

As highlighted above the importance of nearshore fisheries are crucial to community survival. Thus, in many cases, fisheries have taken the lead to become an industry with the latest practices involved, but in some areas, it has been done in old-fashioned ways (Bunce et al., 2010). Fishing vessels from Europe and Asia are primarily

attracted to focus on tuna or tuna-like fish species for commercial purposes in the region (World Wide Fund for Nature, 2021). Traditional fish-catching practices occur all over the region and encompass coastal communities retrieving ocean resources for local livelihoods and survival. For instance, animal protein is highly demanded in the form of fish in East Africa (Satia, 2016).

It is a well-established fact that climate change causes a broad spectrum of devastation to the living populations near coastal areas of the Indian Ocean. As one of the higher risks is the shortage of food, daily lives are shattered due to extreme weather conditions, hunger disease, and poverty can strike harder and may consequently lead to human migration to better places (Chellaney, 2010).

In the food chain, fish is the most vital source of protein from the Indian Ocean. Due to high levels of toxic pollutants in the ocean, marine aquaculture is declining at a fast pace. These environmental degrading factors combined with over-fish catch and other illegal activities aggravate marine ecosystem degradation. This has depleted the fish species to a greater number and eventually will affect the food chain in the future (Bijma et al., 2013). As the nations are embarking towards blue economic goals, depletion of fisheries can result in huge economic loss. Therefore, the impacts of climate change pose a multi-faceted challenge to realize economic goals.

Especially, the wetlands and mangrove areas that are considered to be the coastal habitats are eroding at a fast pace leading to damaging juvenile fish growth sanctuaries, declining reproduction, and fish count (Gable et al., 1991). Although the significant issue is climate change caused by environmental contamination of the Indian Ocean, however, the adverse impact is on the fish stock that is directly linked to the socioeconomic conditions of coastal populations.

Research Methodology

The researchers adopted an analytical and descriptive approach, examining a wide range of literature and various studies on the subject. This article is qualitative in nature, utilizing John Scott's model of Document Studies to analyze the causes and implications of climate change in the Indian Ocean Region. The study explores the nature of

threats and the impacts of climate change within the security domain.

Types of Marine Pollution in the Western Indian Ocean Region

Marine contamination from land sources is linked to urbanization and river system discharge into the sea in the western IO. At the moment, urban centers in the western IO region are hundreds of miles apart, resulting in distant pollution hotspots. However, rapid urbanization in the entire region is likely to result in the development of coastal zones. When small coastal areas end up joining the city center and establish big metropolitan zones along the coast.

Contamination at the Microscopic Level

Microbiological infection is a serious problem in many WIO hotspots for marine pollution. It is generally linked with inappropriate disposal of domestic water waste, contaminated surface and subsurface river runoff from cities, agricultural practices, and industry. Analysis of the causes of this microbial contamination in the western IO region has identified the key reasons for this, i.e. tourism, urbanization, industry, transport, and agriculture. Microbial contamination has serious socio-economic consequences in coastal waters including animal and plant life health risks linked with recreation or consumption of seafood.

High Levels of Suspended Solids

A large quantity of undissolved solids load enters the western Indian Ocean's coastal waters from land industrial sources and agro-industrial toxic waste, runoff, and surface runoff. Disposal of toxic waste associated with major ports can also contribute significantly to this issue. Industry, agriculture, and public transit are the three major contributors to high entrapped solid load in the marine environment.

Chemical Contamination

Chemical contaminants are poisonous and persistently accumulating chemical compounds. They are classified as petroleum products, heavy metals, and enduring organic compounds. Agricultural production, industry, and transportation are the industries most held to account for chemical contaminants in the region's

coastal and marine waters. Industrial production, tanneries, the pulp and paper industries, and textiles are major contributors to this category of pollution in the environment. Irresponsible agrochemical use, discharging, and storage are extremely concerning. The result of chemical pollution seriously affects stakeholders in society from the local community to tourist spot development as well as fisheries.

Marine Litter

Irresponsible disposal of solid waste into coastal waters results in marine litter which poses problems in coastal urban centers in the western IO. Major sectors responsible for litter in the marine environment are urban and tourism sectors, transport, and industry. The principal environmental impact of litter is the consumption by or entanglement of marine life leading to the destruction of biodiversity.

Eutrophication

Eutrophication, also known as over-fertilization, is the artificial increase in primary production (e.g., "algal" and "phytoplankton" growth) and rich organic matter loading caused by increased nutrient availability. Wastewater with high levels of organic matter or inorganic nutrients (e.g., "nitrogen" and "phosphate") is a major cause of eutrophication. An environmental consequence of eutrophication and algal growth is harmful algal blooms which affect biodiversity and result in the decoloration of coastal waters. The increase in urbanization and travel industry, agricultural production, and damage to forestry, industrialization, and mining are among the important factors involved in causing marine pollution.

Urbanization and Tourism

Rapid and unchecked urbanization and tourism development are taking place in the WIO region's coastal areas. It is also characterized by an increase in water and sewer and household sewage, domestic sewage, and industrial pollution from fossil fuel combustion and vehicular traffic. These pollutant sources are frequently not managed properly. In many WIO countries, sewage from septic tanks, pit latrines, and nonfunctioning wastewater treatment facilities is a major source of marine water pollution. The main pollutants in untreated municipal sewage are suspended in the

water and microbial contamination. Concentration levels of these constituents are therefore found near main global cities, though higher sewage contamination is common in many rural coastal areas.

Agriculture and Forestry

Agricultural activity contributes to marine pollution by producing high levels of pollutants like suspended solids, inorganic nutrients, and microbial contaminants. Burning weeds and the use of pesticides cause environmental pollution in some countries. These pollutants from these activities generally enter the marine environment through diver discharges, though agricultural activity in the areas near the coast can directly introduce contaminants into the ocean water.

Industry and Mining

Principal mining activities and industries situated close to the coasts of the WIO region are tanneries, textile mills, paper, and pulp mills, cement factories, food processing industry, and chemical factories. These industries add to transboundary marine pollution due to their irresponsible disposal of waste and environmental emissions.

Transportation

Nearly most of the city centers in the western IO arena have big seaports and dockyards. Activities like shipbuilding, conservation and restoration, and dumping of waste add to aquatic contamination. Industries are often situated near major ports and further increase the risk of pollution.

Energy Production

Thermal discharging of cooling water and emissions from combustion render energy production an environmental hazard. Pollutants from these activities have a damaging impact on the environment.

Key Root Causes

The above discussion has established the fact that it can be construed that major areas add to the severity of cross-border toxic waste in the western Indian Ocean. The root causes of this menace are cross-cutting to cross-border pollution issues and their impact on the environment. These can be classified

as population explosion, inequality and poverty, bad governance, lack of knowledge and awareness, and insufficient financial resources.

Population Explosion

Exponential advance in population is a major reason for pressing heavily on oceanic resources in the region. The increasing population disrupts demand and supply for commodities, resources, and facilities. The WIO region has seen fast urbanization and inhabitants' progression in the areas close to coasts, especially the larger areas. Demographic changes and exponential population growth have led to increasing demand for land to cater for housing and related infrastructure. High consumption lifestyle, changing patterns of consumption and rising expectations are major reasons behind environmental degradation.

Inequality and Poverty

The Western Indian Ocean is mainly considered by developing nations along with a conglomeration of weak and failing states. Inadequate financial resources are the primary reasons for worsening sanitary conditions and waste disposal into the seas. Poverty alleviation is a big challenge here which requires progressive development, transparency, and sound management of land and marine resources. It also demands educating the population on effective technology for both subsistence and commercial farming.

Governance

Governance is related to the policies, institutions, and values through which problems are addressed and it determines the principal objectives and structures needed for decision-making and planning. Hence, governance sets the stage and creates a broader framework for management to occur. Poor performance on the standard of governance regarding aquatic contamination varies from country to country. Sadly, in the western IOR, important foundations for efficient governance are not in place.

Implications

Climate Crises and Migration

Climate change can potentially cause large-scale

human migration and it is a serious issue. Research shows that desertification occurring on African coasts and in South Asian countries can create a vicious cycle of environmental degradation and large-scale migration leading to conflict. Recent UN estimates demonstrate that there can be approximately fifty million environmental migrants and refugees by the year 2020 with a majority from Africa and Asia.

The Indian Ocean has developed a 'warm pool' due to its heating rate, which is faster than any other tropical ocean region. This phenomenon is causing weather abnormalities and extreme weather events (Roxy et al., 2014). Within the IOR, South Asian countries are likely to be the most vulnerable to this impending doom (Schwartz & Randall, 2003). Adverse climatic conditions, the study maintained, could potentially lead to large-scale migration, affecting weak countries by putting further strain on already limited governmental capacity.

It is observable that climate-induced population displacement in vulnerable regions is happening in three different ways: displacement of a rapidly deteriorating environment, increasing short-term migration due to climatic conditions, and large-scale population displacement gradually snowballing into a catastrophe due to military conflict and political disturbances (McLeman & Smit, 2006).

The growing migration could heighten the risk of conflicts in coastal regions. Consequently, this may lead to a greater reliance on maritime forces to prevent refugee inflows from the sea and to manage conflicts in these areas. The top 10 countries worldwide facing population displacement risks include India, Bangladesh, China, Indonesia, the Philippines, Nigeria, Vietnam, Japan, South Korea, Myanmar, Malaysia, and Thailand.

Climate Change and Maritime Security

Climate change has destructive potential and can be better considered as a global threat multiplier. Its potential to create instability in the regions, leading to conflict and suffering renders it a global security hazard (UN Chief Ban Ki-Moon 2011).

Climate change-induced catastrophes incline to disturb the balance of strategic interest, by imposing obligations; many of them exist in the naval domain. These obligations contain preventive actions for sea level rise, "humanitarian aid operations" in the

coastline areas, and extra-regional migration prevention.

Unfortunately, IO littoral states have so far not chosen to take the impact of "climate change" as seriously as Western nations (Ackbarally, 2014). In the United States, three policy documents—the National Defense Strategy, the National Security Strategy, and the Quadrennial Defense Review—have all aimed to address issues related to "climate change" and "environmental security." It is worth noting that the US Navy has played a role in strategic planning on climate change and its effects on maritime interests in the US defense establishment. The US Navy's 'Climate Change Roadmap' defines climate-related objectives clearly and identifies conditions of particular naval interest, such as sea-level rise, the frequency of tropical storms, and greenhouse-gas concentrations (US Navy, 2010).

Viewed from a traditional maritime security context, shifting climatic conditions in the IOR have major consequences. It can become a foremost factor for maritime security-related issues. The rising sea levels press heavily on low-lying island states in the IO leading to conflicts over ocean resources. As underlying features are generally used to demarcate borders, their immersion can overthrow all claims by littoral nations on the sea which would then remain outside their Exclusive Economic Zone (EEZ). In the case of a drastic rise in sea level, the low watermarks, important for determining the EEZs of nations, can change creating possibilities for maritime disputes (Paskal, 2010).

However, the major impact of this climate change will be on the ocean environment, which in turn, can impact maritime operations. Experts agree that heating oceanic waters and melting ice are raising sea levels. They are also altering the salinity and temperature of ocean water. The absorption of CO₂ in ocean water increases its acidic content and also seems to be shifting ocean tides. As the ocean environment shifts, maritime forces now acknowledge the dire necessity to alter their operating rules, accordingly. It is agreed upon that this can have bearings on various facets of maritime operations ranging from navigation and operational exercises to maintenance of ships and other equipment (Riebeek & Simmon, 2008).

If the environmental issues continue on this notion, regional maritime forces will have to develop

and study technology, procedures, and skills to curb these negative alterations in the environment. Climate disasters have the potential to disturb seaborne trade activities and can negatively impact port infrastructure. From the vantage point of commercial operations, instabilities of even minor nature in major ports like Colombo, Mumbai, and Singapore can cause serious damage (Burke et al., [2018](#)). Disruption in global shipping and commercial port functions coming from climate change will pose severe threats.

A greater risk to Naval Operations and Infrastructure

While climate change and global warming can have a dire impact on naval operations, it is difficult to manage and predict its sub-processes. Scientists think that a global glacial meltdown can engender a dramatic shift in water density which might result in a huge infusion of fresh water into the oceans. It can result in lower water density in the northern latitudes, and increasing evaporation from warm environments will raise water density in the humid areas. The consequent variation in the salinity in seawater may produce a change in the buoyancy of submarines and the operation of underwater weapons (National Research Council, 2011).

While the concentration of ocean water changes, it can alter acoustical properties underwater which may affect sonar performance. The latest research maintains that in the future, carbon emissions can lead to heightened acidification and a considerable decline in low-frequency sound absorption (Hester et al., [2008](#)). Maritime operations too will be impacted by changing thermoclines which can lead to a considerable change in the array of hot and cold oceanic tides (McDonagh et al., [2005](#)). Currents in the Indian Ocean, for example, could be affected by altering patterns of the monsoon winds.

On surface operations, too, the impact of environmental changes is likely to exert influence demanding shifts in strategy and planning. There is overwhelming evidence that future weather conditions can obstruct naval surface operations and the deployment of forces. Harsh weather conditions do damage crew members' physical and mental health. In warmer climates, for instance, the surface temperature onboard aircraft carriers can reach unbearable levels putting undue pressure on the crew members' ability to perform their duties

and remain safe. Maritime forces train soldiers in this capacity; however, there is a need to re-evaluate this training, according to warming weather conditions.

Lastly, climatic change may have an impact on the durability and accuracy of onboard combat systems, sensors, and ammunition effectiveness. Extreme weather and increasing sea levels are anticipated to put the naval installations and other marine infrastructure required for naval operations in jeopardy (Myers, [2017](#)). With the deterioration of meteorological conditions in the Indian Ocean, there is a greater risk of storms and associated storm surges getting flooded vital coastal and island locations (along with airfields). Crucial low-lying bases may be lost as a result of this.

Typhoon Haiyan, a gigantic cyclone that wreaked havoc in the Philippines in 2013 could be an exemplar of the danger that harsh climate conditions pose to critical maritime infrastructure. This super cyclone wreaked havoc not just in terms of loss of life and property, but also damaged the Philippine Navy's Tacloban naval station (Singer, [2014](#)). Very much like the Philippines, many other Asian countries are not well prepared for such an event.

To address the threat posed by environmental and climate change, maritime forces must prioritize identifying and protecting facilities near shorelines. Recent research on climate change, focusing on two hotspots—Goa and Visakhapatnam—could provide valuable insights in this regard (TERI, [2014](#)).

Collaborative Measures to Deal with Climate and Environmental Challenges A Growing Role for Maritime Forces

Environmental change policy decisions, from a marine perspective, derive information from the cost and enthusiasm associated with the two recommended techniques for dealing with climate change; one adaptation, and second risk mitigation. These must be viewed as two independent ideas that can compensate for the changing environment in various ways. Maritime forces must adapt to changing conditions as environmental deterioration develops. The following measures can be taken:

Threat Assessments

To address the impact of the environment on

maritime safety, a comprehensive threat assessment of naval infrastructure against severe storms and flooding is necessary. These assessments are crucial for preparing a cost-benefit analysis, which is essential for estimating the risk potential of these installations.

Executing Economic Measures

Long-term cost reductions could be realized by improving maritime forces' ability to respond to extreme weather occurrences. In a world where sea levels are increasing, this may necessitate considerable upfront investments. However, it is usually less expensive to build more resilient new naval installations or rebuild aging ones than to pay for the costs of a severe climatic 'event'.

Effective Response Strategy

When naval facilities are temporarily dysfunctional due to storms or rising tides, certain plans are required. Maintenance operations necessitate port readiness in the form of shore transmission lines, hotel facilities, crane facilities, and other infrastructural facilities such as electric power plants. In addition, the strategy must evaluate the businesses that surround coastal bases and identify potential higher or more inland places that could be used as backup sites if a naval station is devastated.

Improving Climate Prediction Capability

Not just for the inputs in taking action, but also for the 'benchmark' it provides to properly analyze the hazards posed by changing weather patterns, having an effective and dependable meteorological department is vital. Maritime forces must obtain improved meteorological equipment and create methods and procedures that will assist them in better interpreting shifting weather.

Road Map for Future

Multi-Level Approaches

Multi-tier governance is required, and it must take geographic ambitions, national goals, as well as the variety of issues affecting diverse communities into account. There are unlikely to be simple solutions to problems encompassing the "fishing industry", "food security", and "climate change". Although international fora and organizations may be useful in mitigating climate change, regional and national

adaptation measures, as well as sustainable fisheries management, are likely to be acknowledged at the regional and national levels.

Likewise, issues in governance, such as the implementation of comprehensive deepwater aquaculture practices, need to be tackled at both the "regional" and "national levels." However, several significant obstacles remain to be addressed. Adopting good governance principles can establish a strong foundation for legislation and practice. In many Indian Ocean countries, poor governance leads to inadequate strategy development, insufficient attention to cross-cutting environmental issues like climate, food security, and livelihoods, and a failure to enforce existing laws and policies.

Integration

Since fishing and climate change both exert pressure on marine resources, management and governance efforts in these areas should be coordinated. Innovative combinations of processes and comprehensive tools, such as maritime spatial planning, will be employed in new ways across the region. (Vivekanandan et al., 2016). Despite the fact that fisheries management is becoming more incorporated with other marine ecosystem laws and policies, climate change policies and regulations have remained separate. Although comprehensive governance and fully integrated alternatives are unlikely, it is critical to avoid compartmentalization whenever possible, particularly during the development of law and policy.

Community Support

The role of community support is crucial. However, government initiatives and environmental conservation projects, such as creating marine parks, have sometimes been perceived as detrimental to local livelihoods. Consequently, laws and policies that restrict current livelihoods should also offer alternatives for those affected. Although the government has promoted offshore fishing, the promised larger boats and equipment have not yet been delivered.

Multi-Disciplinary Focus

It is evident that issues such as food security, fishing industry regulations, and environmental concerns

cannot be tackled solely through legislation and policy. Scientific knowledge and contributions from other fields are also crucial. There is a need for strong institutional and legislative frameworks that incorporate multidisciplinary input. In the context of climate change, key factors include awareness programs, monitoring changes, climate modeling, developing adaptive fishery management practices, and identifying and creating alternative livelihoods. (Clark, 2006).

One of the first steps in identifying viable choices could be to map places that are sensitive to climate change's effects (Chemane et al., 1997). Such modeling must not be restricted to small places that could be flooded as sea levels rise. Only then can we consider interconnected policies and laws that increase security while also trying to address human and environmental security concerns.

Conclusion

Environmental challenges and costs laid by Climate change and repercussions will define the twenty-first century. As the global weather in the Indian Ocean Region grows less predictable and stable, a succession of humanitarian disasters is expected to emerge. The severity of these crises, compounded by weakened state structures and institutions, will put pressure on food chain sustenance, higher risks of mass population migration, and existing maritime security mechanisms, making the question of the future deployment of marine troops crucial. As fleets and coastguards in the Indian Ocean Region address the impacts of climate change, they will need to reassess threats, prioritize missions differently, and update their operational equipment. To tackle these challenges, maritime forces will need to develop innovative solutions. Nevertheless, traditional approaches to mitigating climate change and adapting to evolving environmental conditions will remain essential. Navies must find new strategies to safeguard maritime assets and optimize operations amid rapidly changing climate conditions, while also adjusting their posture and focus. Climate change will have an impact on maritime preparedness, base resilience, and the performance of operational tasks in the coming years. It's also expected that maritime deployments for subsidiary missions and humanitarian missions will rise. Although an integrated response to climate change will be

preferred, marine forces will be required to give immediate relief to vulnerable coastal towns in a stand-alone mode.

The research that follows focuses on the blue economy initiative, which is becoming a more cohesive concern within IOR, and also the growing understanding of fishing industry considerations and climate change realities. There are, however, significant barriers to efficient and effective regional solutions.

Most Indian Ocean States are members of treaties and secretariats to which they can seek assistance from the international community in a variety of sectors. Other regional organizations can offer valuable lessons. For instance, the Pacific has established robust regional institutions like the Pacific Community, the Pacific Islands Forum Secretariat, and the Pacific Environment Programme Secretariat. Indian Ocean states could adopt similar approaches to build a strong regional framework for developing new strategies related to fisheries, climate change, and food security. Regional frameworks can enhance the global influence of developing countries, which make up most of the nations around the Indian Ocean (Rowlands, 1998). These challenges are likely to persist for the foreseeable future. Given the unique conditions of the Indian Ocean region, significant progress can be made through renewed regional cooperation and collaboration. While exact predictions of climate change impacts are difficult, models and observed effects should drive the development of long-term legal frameworks and measures. (Gable et al., 1991).

Environmental conservation is directly linked with human security, food security, and poverty reduction (Walmsley et al., 2006). As a consequence, environmental protection and sustainable food supply chain management are necessary to assure regional stability and prepare coastal communities to respond to climate change. 'There is still a danger that interstate war within IOR in the years ahead will be compelled by competition for scarce resources rather than political influence,' says the report. Given the complexity of the issues, flexible and adaptive approaches that foster adaptability are needed to solve not just food security but also broader human safety and security concerns.

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