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Climate Ambition and Sustainability Action

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Climate Risks to India's Holistic Maritime Security

Rising Sea Level

Pushp Bajaj, Associate Fellow, National Maritime Foundation
Email: climatechange2.nmf@gmail.com

Key Messages >>>

- Indirectly observed historical sea-level changes (through the study of ice cores, ocean sediments, cave rock samples, and fossils) suggest that the Earth has undergone astonishing transformations, in some cases at relatively fast geological timescales.
- Climate-change-induced sea level rise will affect coastal populations who could be displaced and forced to migrate inland due to frequent flooding, coastal erosion, agricultural failure, and increasing extreme weather events. Presently, national and sub-national plans in India barely examine the impacts of human displacement due to sea level rise.
- In the Indian Ocean Region, deteriorating conditions of island and coastal nations have geopolitical implications for India as they are important components of India's geo-strategies.
- The role of Indian Navy and the Indian Coast Guard as primary responders in times of emergencies and humanitarian crises will become even more important along with agencies such as the National Disaster Response Force.
- Ecosystem-based adaptation measures that focus on the conservation and restoration of natural coastal ecosystems, such as wetlands and reefs, are essential to any sea level rise adaptation plans.

Climate Change as a Security Threat

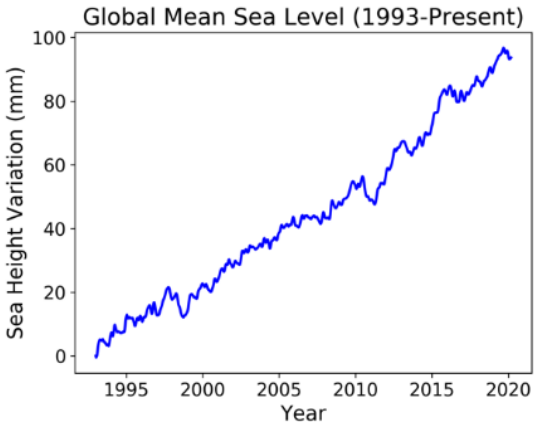
In recent decades, climate change has evolved from a supposed distant problem for future generations to a major imminent security threat for all nations worldwide. Climate-change-induced food and water shortages, combined with sea level rise and extreme weather shocks, are potentially powerful destabilizing forces within countries and across international borders. The increasing frequency and intensity of extreme weather events including heatwaves, floods, droughts, and tropical storms, driven by climate change, are threatening ways of life for billions of people on the planet. Moreover, climate change often acts as a threat multiplier by amplifying existing stresses, and, could push already unstable and ill-equipped regions over the edge. In this context, the National Maritime Foundation has undertaken a new research endeavor to study the impacts of climate change on India's holistic maritime security. This series of articles will address some of the key security-threats posed by climate change and the vulnerabilities in India's maritime domain. This is the first article of the series and will focus entirely on arguably the most daunting of the challenges associated with climate change—sea-level rise, and its implications for maritime security, and will propose mitigation and adaptive measures to ensure continued security and prosperity in the future.

Sea Level Rise: Past, Present, and Future

Our planet has had a remarkable climate history, during which the sea level has changed by hundreds of meters to even a kilometer over periods of hundreds to thousands of years. In the most dramatic case, around 635 million years ago, when the planet was coming out of a 'deep freeze' state, scientists estimate that sea level rose at an extraordinary rate of 0.2-0.3 meters (m) per year. This was during what is known as the Neoproterozoic deglaciation. Most recently, after the last glacial period nearly 20,000 years ago, global mean sea level is estimated to have risen by as much as 135 m before it reached current levels. These indirectly observed historical sea-level changes (through the study of ice cores, ocean sediments, cave rock samples, and fossils) suggest that the Earth has undergone astonishing transformations, in some cases at relatively fast geological timescales. Periods of warm climates in the past also provide insights into what we can expect in the future as global warming continues. During the last interglacial period, around 129-116 thousand years ago, the global average temperature was about 0.5° C to 1.0° C warmer than today and the sea level is estimated to have been around 6-9 m higher than today's levels. Going further back, during the mid-Pliocene Warm Period, around 3.3-3.0 million years ago when global average temperature was 2°-4° C higher than today, sea level is estimated to have been around 25 m higher than today.

Current trends, based on satellite and tide-gauge measurements, irrefutably show that the global mean sea level (GMSL) is rising, and that the rate of rise is accelerating (Figure 1). The pace of sea-level rise increased from 1.4 mm/year over the period 1901-1990 to 2.1 mm/year over 1970-2015 to 3.2 mm/year to 3.6 mm/year over the period 2005-2015. Overwhelming scientific evidence confirms that anthropogenic climate change is the primary driver of sea level rise since 1970. There are two main sources of current sea level rise: (1) Thermal expansion of the ocean due to increasing ocean temperatures, and (2) The melting of land-based ice sheets in Greenland and in Antarctica, and the glaciers in high altitude regions around the world. The latter is presently the dominating contribution to global mean sea level rise. Greenland and Antarctic ice sheets together hold most of the freshwater on the planet. Greenland holds enough ice to raise sea level by nearly 7 m, if all of it were to melt. The Antarctic ice sheet, on the other hand, contains nearly eight times more ice than Greenland, and if this ice were to melt completely, it would cause around 60 m of sea level rise. Although it is unlikely that either of them will melt completely anytime soon, any significant changes will have huge repercussions.

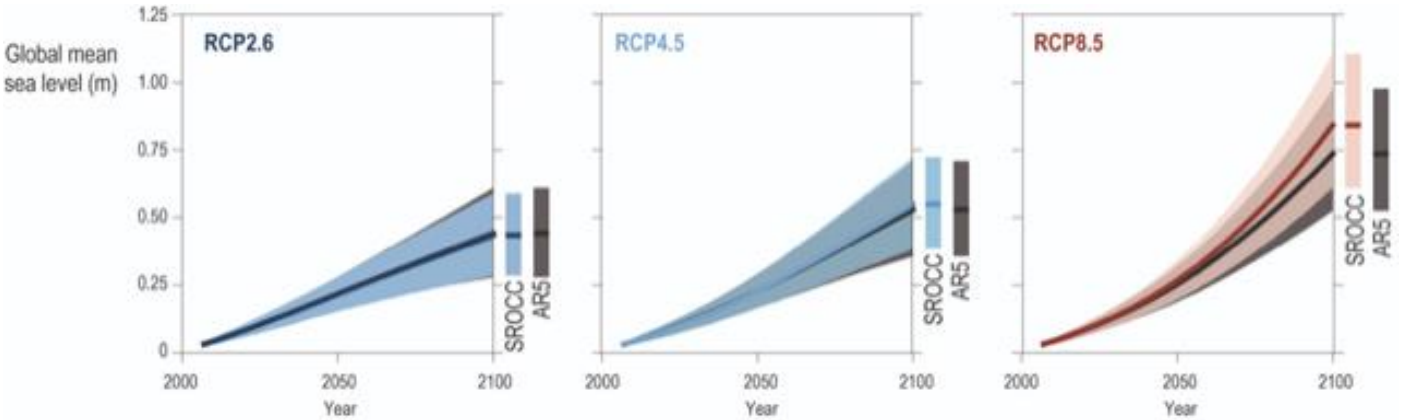
Figure 1: Time series of global mean sea level rise obtained from satellite-based measurements from 1993 to present



Source: Image created by author. Data Source: GSFC. 2017. Global Mean Sea Level Trend from Integrated Multi-Mission Ocean Altimeters TOPEX/Poseidon, Jason-1, OSTM/Jason-2 Version 4.2 Ver. 4.2 PO.DAAC, CA, USA. Dataset accessed [2020-06-20] at http://dx.doi.org/10.5067/GMSLM-TJ42

The GMSL is expected to continue to rise at an accelerating pace through the 21st century and beyond, if climate change continues unabated. In its latest Special Report on *"The Ocean and Cryosphere in a Changing Climate"*, published in 2019, the United Nations' Intergovernmental Panel on Climate Change (IPCC) projects that the GMSL could rise by around 0.84 m (likely range 0.61-1.10 m), by the year 2100, if no mitigating action is taken (a scenario denoted as 'Representative Concentration Pathway 8.5' or RCP8.5). With aggressive and transformative action to reduce global greenhouse gas emissions (a scenario denoted as RCP2.6) the potential sea-level rise could be brought down to around 0.39 m (likely range 0.29-0.59 m), (see Fig 2). The report also states that "*extreme sea level events that are historically rare (once per century in the recent past) are projected to occur frequently (at least once per year) at many locations by 2050 in all RCP scenarios, especially in tropical regions.*" The predictions are primarily based on computer simulations using sophisticated climate models and while they certainly serve as a guide to policy makers and governments to make appropriate strategies, any model-based predictions must be understood within the context of observational trends, and inherent limitations of climate models, while simultaneously acknowledging the possibility of abrupt changes in the future.

Figure 2: Future projections through 2100 of global mean sea level rise for the RCP2.6, RCP4.5, and RCP8.5 scenarios, as defined by the IPCC



Source: Image taken from Chapter 4 of the UN IPCC Special Report on the Ocean and the Cryosphere in a Changing Climate (SROCC) (2019)
Note: Comparisons are made between the SROCC and the IPCC AR5

Contrary to common intuition, sea level does not and will not rise uniformly around the planet. Although the major climate-change assessment studies and reports focus on GMSL change, it is the regional variations that are of greater concern to India's national security. Regional sea level can be significantly different from the global average, due to varying ocean temperature and salinity (both of which alter the density of water), ocean dynamics, local subsidence caused by groundwater extraction, and, change in tidal heights and periods. A recent climate-change assessment report produced by the Ministry of Earth Sciences of the Government of India notes that sea level of the North Indian Ocean rose at a rate of 1.06-1.75 mm/year during 1874-2004 and has accelerated to 3.3 mm/year during 1993-2017, which happens to be comparable to the rate of global sea level rise. However, unlike current global sea-level rise, the regional sea-level rise in the Indian Ocean has been driven primarily by thermal expansion of the ocean due to increasing temperatures.

Implications for India's Maritime Security

Sea-level rise affects nearly all aspects of India's maritime security, either directly or indirectly. Every fraction of a meter of rise in sea level, compounded by an increase in probability of extreme sea-level events (such as high tides, storm surges, and cyclones), poses a direct threat to the infrastructure and population along India's 7516 km long coastline. A 2019 study on global vulnerability to sea-level rise and coastal flooding estimates that nearly 35 million Indians will be exposed to annual flooding by the year 2050 and that number will grow to 51 million Indians by 2100 (based on 2010 census), in the absence of effective mitigation and/or adaptive measures. The study also estimates that parts of the coastal regions that are currently home to 21 million Indians will be permanently inundated by sea-level rise by mid-century, and regions inhabited by nearly 38 million Indians will be permanently inundated by the end of the current century. According to another recent global study, the annual economic losses due to coastal flooding in India could be anywhere between 1.5-2 per cent of the annual GDP by the end of the century, depending on how much the global average temperature rises.

In addition to economic security, sea-level rise threatens India's food- and water-security as well. Amongst other impacts of higher flood levels, storm surges, and land erosion, salt-water intrusion into coastal lands due to sea-level rise increases salinity levels in agricultural soils damaging crops and contaminating underground drinking water aquifers. In this context, sugarcane and rice are two particularly important crops grown in low-lying coastal regions, which are highly vulnerable to the impacts of sea-level rise. Compounding the effects of increasing temperatures, changing rainfall patterns, and extreme weather events, sea-level rise poses a unique challenge to coastal agriculture.

The affected population will eventually be displaced and forced to migrate inland due to frequent flooding, coastal erosion, agricultural failure, and increasing extreme weather events. This is already happening in nearly all coastal states of India. The coastal population of Odisha and Andhra Pradesh are increasingly facing powerful cyclones against the backdrop of continually rising sea level. The Lakshadweep island group, with an elevation of 1-2 m, is very much at the frontlines of vulnerability to sea level rise. In an ongoing pattern of heavy monsoonal rainfall, Kerala was battered for two consecutive years in 2018 and 2019, questioning the resolve of the residents to stay their ground. Nowhere in India is forced migration becoming a more serious concern than in the Sunderbans region in the Bengal Delta where sea level is rising much faster than the national average, and the region is frequently hit by powerful cyclones. Just this year in May, the region was struck by the monstrous Category 4 Cyclone Amphan that killed nearly 100 people, destroyed hundreds of thousands of homes, and affected millions of Indians. The Sunderbans area is shared between India and Bangladesh, with millions of Bangladeshis living in the region facing the same threats and being pushed out of their homes. As sea level continues to rise, more and

more coastal residents in India and the neighboring countries will have to make the difficult choice between staying put and dealing with the consequences of frequent flooding or leaving their homes in search of safer living conditions.

The island nations in the Indo-Pacific are extremely susceptible to sea level rise. These include the Democratic Socialist Republic of Sri Lanka, the Republic of Maldives, the Republic of Seychelles, the Republic of Indonesia and the Republic of Philippines, all of which lie within India's maritime areas of interest. Over 80 per cent of the land area of the Maldives is less than one meter above sea level. Even small changes in sea level would be disastrous for the population of Maldives. This fact is not lost on the national government, which has been exploring creative options for the future, including building fortified artificial islands at higher elevations, and purchasing land in other countries to relocate its population. Given that the Maldives located a mere 250 nm south-west of India, it is not hard to imagine that a significant proportion of the population of that country, and other island nations in the region, may seek refuge in India. In addition to the possibility of an influx of migrants, deteriorating conditions in the Maldives and other small island nations in the Indian Ocean Region will have geopolitical implications for India as they are important components of India's geo-strategies. The internal struggles of individual nations could potentially spill over to the broader Indo-Pacific region. Whether the affected nations then come together harmoniously and support each other to secure their common interests, or, increasing competition for dwindling resources translates into political instability and subsequently into conflicts, will very much depend on the geopolitical relations we establish today.

In the midst of the growing security challenges arising from accelerating climate change, the role of India's maritime security agencies, especially the Indian Navy and the Indian Coast Guard, will be of paramount importance. The Indian Navy and the Indian Coast Guard are the primary responders in times of emergencies and humanitarian crises within India. Beyond the Maritime Zones of India (MZI), the Indian Navy is the primary first-responder for the region at large. With climate change loading the dice for extreme weather events such as floods and cyclones, both services will have to participate in increasing numbers of humanitarian assistance, disaster relief and evacuation operations. It is important to remember, however, that the Indian Navy and Indian Coast Guard are themselves vulnerable to the impacts of sea level rise. A vast majority of the Indian Navy's and the Indian Coast Guard's bases, headquarters, and hospitals are located in high-risk regions along the coastlines of Mumbai, Goa, Karwar, Kochi, Chennai, Vishakhapatnam, Kolkata, as also in islands of the Lakshadweep and the A &N chains. Any damage incurred by critical infrastructure or support facilities such as power and communication lines, will seriously hamper the ability of the Indian Navy and the Indian Coast Guard to provide timely and effective assistance. Without concrete short-term and long-term strategies to mitigate and adapt to climate change-induced sea level rise, all the aforementioned security threats could easily become overwhelming.

Avoiding the Intractable while Adapting to the Inevitable

Sea-level rise is not a one-time event, but a continuous and accelerating process. While some degree of sea-level rise is already "locked-in" due to the climatic changes that have occurred so far, any future warming will further add to the misery at an accelerating pace. More importantly, scientists warn that there are certain "thresholds" or "points-of-no-return", in terms of the global average temperature, which, if crossed, will commit the planet to irreversible multi-meter sea-level rise over a period of decades or centuries. What is not clear, however, is where exactly these thresholds lie, whether at 1.5° C or 2° C or 3° C of global warming above pre-industrial levels. Consequently, it is in our best interest to limit future warming as much as we can in order to avoid these worst-case scenarios. It is imperative for India to take drastic measures to mitigate its

carbon emissions and, through international negotiations, apply pressure on other countries to do the same. India's current pledges to the global Paris Climate Agreement signed in 2015 include: (1) A 33-35 per cent reduction in emissions intensity below 2005 levels by 2030; (2) An increase in non-fossil share of cumulative power generation capacity to 40 per cent by 2030, and (3) The creation of additional carbon-sink capacity of 2.5-3 Gt CO2 equivalent by 2030. Promisingly, current trends suggest that India will meet these targets, and might even surpass them. As per the Paris Agreement, member nations are expected to ratchet-up their pledges and submit revised and more ambitious targets every five years. The first such revision is due in 2020 itself, but India is yet to submit its revised targets to the UNFCCC. This could be an excellent opportunity for India to display its continued commitment to climate change mitigation by raising its ambition, and lead the global climate action movement.

Mitigation, although absolutely essential, is not, in and of itself, enough. Any comprehensive action plan should include dynamic and adaptive measures to manage the impacts of sea-level rise that has already occurred and that that is projected to occur in the near future. In this regard, India is grossly underprepared to protect even its most developed coastal cities. In order to be effective, adaptation policies must be informed by the latest and best available climate science and include a national-, state-, and regional-level vulnerability assessment of the short-term and long-term impacts of sea-level rise. A number of different responses could be considered, such as, protecting the coast using dykes, seawalls, barriers, etc., boosting the resilience of coastal infrastructure, advancing seaward by land-fill, using sand or other material or by planting vegetation, and, retreating and relocating from areas that cannot be protected. Additionally, ecosystem-based adaptation measures that focus on the conservation and restoration of natural coastal ecosystems, such as wetlands and reefs, are essential to any adaptation plans. These ecosystems are extremely effective natural defenses against storm-surges and coastal erosion. Of course, the feasibility and practicality of a particular approach will depend on the geographical limitations of the particular region and the associated economic, technological, and human costs.

India must simultaneously brace for the eventuality of sea-level-rise induced human migration of unparalleled proportions, both within India and from neighboring nations, and the geopolitical chaos that will follow. It is crucial that an appropriate policy framework is put into place now, so as to prepare for the consequences of sea-level rise in the future. Currently, there is no legal or institutional framework that explicitly addresses inter-state or international migration due to climate change or other environmental reasons. While India does have a National Action Plan on Climate Change (NAPCC), that was published in 2008, and all coastal states have policies at the state-level called the State Action Plan on Climate Change (SAPCC) which stem from the NAPCC, these plans barely examine the impacts of human displacement due to sea level rise. As discussed above, a climate action plan should be dynamic in order to keep up with the accelerating changes in the climate. Therefore, there is much need for the NAPCC of 2008 to be updated to reflect current scientific understanding. India must also strengthen relations with its maritime partners in the Indo-Pacific and adopt policies to address climate-change induced migration in the future to ensure security in its maritime neighborhood.

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Climate Ambition and Sustainability Action

The Climate Ambition and Sustainability Action (CASA) series, brought out jointly by the World Sustainable Development Forum (WSDF) and the Protect our Planet (POP) Movement, seeks to highlight a topical issue relevant to the realization of the sustainable development goals and climate actions. Through briefs, discussion papers and articles, the CASA series aims to contribute to the discursive process of sustainability by engaging with civil society organizations, thought leaders and political leaders. This discussion paper is a part of CASA Partner Series which seeks to showcase research and thought-pieces by partner organizations of WSDF and POP Movement. This piece was published by the National Maritime Foundation in the article section of their website and is hosted on the WSDF website with due permission.

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About POP Movement

Protect our Planet (POP) Movement believes that the impacts of climate change will not affect a single country but the planet, in its entirety. POP has confidence that the power of the youth of the world will unite to address this challenge. POP believes that the time to act is now and that knowledge is the true currency of changing the future.

About CASA Partner – National Maritime Foundation

The National Maritime Foundation, in New Delhi, India is a non-governmental, non-political maritime think-tank, which aims to undertake studies and analyses on various issues of concern in the maritime domain with a view to formulate and present options for a vibrant and evolving national maritime policy.

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