CLIMATE CHANGE, SEA LEVEL RISE AND TERRITORIAL SECURITY OF INDIA: TRACING THE LINK AND IMPACT

CYRIAC S PAMPACKAL

Climate change and environmental degradation have been major issues of concern to the global community since the latter part of the 20th century. However, countries are quite unwilling to either take responsibility or initiatives to address these challenges. For instance, a country such as the USA has even put a question mark on whether the phenomenon of climate change is real at all. Such debates among the international community seriously undermine the efficacy of the efforts to reduce the intensity of environmental challenges. Meanwhile, connected to the problem of climate change are other real security challenges, including serious threats to the territorial security of countries all over the world, that have largely gone unnoticed until now.

India, a country which is frequently battling environmental crises such as cyclones, earthquakes, tsunamis, landslides, avalanches, etc, will be facing a larger share of environmental challenges in the coming century, as its low elevation land regions are under the threat of sea level rise, increased and irregular patterns of cyclones, etc. India is already facing

Cyriac S Pampackal is a Masters' programme student of International Relations from Mahatma Gandhi University, Kerala. The paper was written during his tenure as a Research Intern at the Centre for Air Power Studies, New Delhi.

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territorial deterioration and will face it on a larger scale as the loss of territory will increase from nearly 100 sq km to a few thousand square kilometres. Several other national security threats will also evolve with a collective intensification of environmental problems. With its good disaster management and response mechanisms and an able civil and military infrastructure, India can cope with most of the natural calamitous conditions, but the question is, how well can India deal with human induced and natural disasters, as well as other mutually intensifying environmental problems? This paper examines some of the challenges that India is likely to face with the rise in the sea level as a result of climate change and its concomitant effect on India's territorial security.

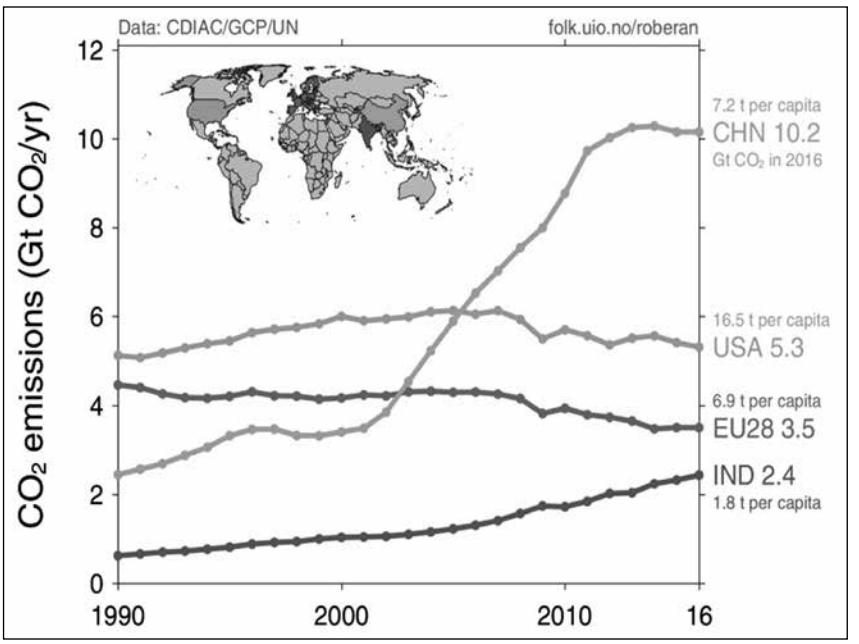
ENVIRONMENTAL CHALLENGES INDUCED BY HUMAN ACTIVITIES

Excessive 'carbon emission' is considered to be the largest contributing factor that fuels most of the environmental problems, including climate change. As of 2017, the whole world collectively emits about 41 billion metric tonnes of carbon[1], with active contribution from all major global players such as China, United States, India, European Union, etc. Even though the world community has been deliberating on the reduction of carbon emissions, it lacks serious binding initiatives to enforce it. Just like most countries around the world, India too burns a lot of fossil fuels for the production of electricity, transportation and industrial purposes. Statistically, the Indian contribution towards the global baggage of

1. Urmi Goswami, "India Emerging as a Climate Performer by Cutting Down on its Emissions," *The Economic Times,* November 13, 2017, https://economictimes.indiatimes.com/articleshow/61630473.cms?utm_source=contentofinterest&utm_medium=text&utm_campaign=cppst. Accessed on May 30, 2018.

atmospheric carbon in 2017 was 2.5 giga tonnes, and it has an emission growth rate of 2 per cent per annum.[2]

Fig 1: Growth of Top 4 Carbon Emission Contributors over the Period 1990-2016 with Per Capita Emission



Source: Robbie Andrew, "Why India's CO2 Emissions Grew Strongly in 2017," *Carbon Brief Clear On Climate*, March 28, 2018, https://www.carbonbrief.org/guest-post-why-indias-co2-emissions-grew-strongly-in-2017. Accessed on May 31, 2018.

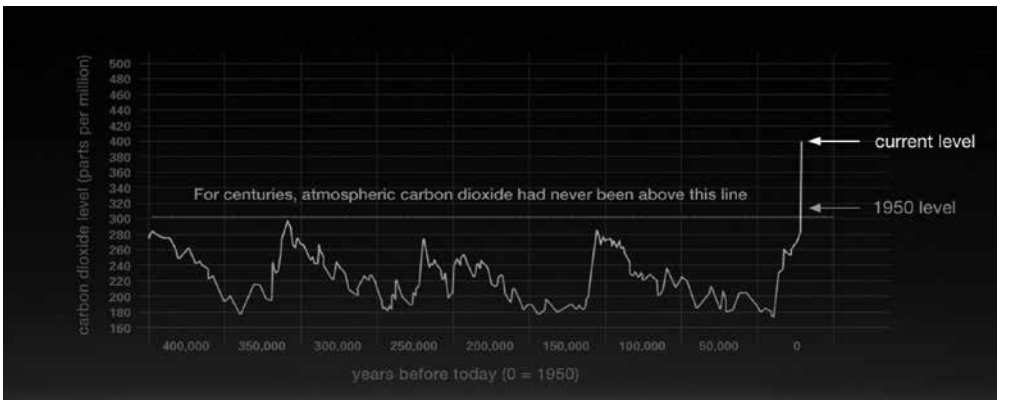
India is one of the countries with a low per capita emission rate (refer Fig. 1) owing to its large population, but the percentage growth in India's carbon emission since 1971 is almost 1,041 per cent, which surpasses the growth rate

2. Down To Earth Staff, "World's CO2 Emissions to Increase by 2 per cent in 2017: Global Carbon Budget," *Down To Earth*, November 14, 2014. http://www.downtoearth.org.in/news/world-s-co2-emissions-to-increase-by-2-per-cent-in-2017-global-carbon-budget-59102. Accessed on May 30, 2018.

of even the largest emitter, China, which is at 1,038 per cent.[3] As a result of the increased emission rates, many cities of the country, especially, the capital New Delhi, suffer from massive pollution problems.

The main adverse effect of high level of carbon emission is an increase in the amount of carbon dioxide in the atmosphere as deforestation levels are clearly degrading the planet's natural ability to reduce the carbon dioxide levels in the atmosphere. According to the Mauna Lao Laboratory, Hawaii, the amount of carbon dioxide was 412.60 parts per million (ppm) as of May 14, 2018 (refer Fig. 2), which happens to be the highest rate in the past 800,000 years.[4]

Fig. 2: Presence of Carbon Dioxide (CO_2) in the Atmosphere (parts per million)[5]



Source: NASA Global Climate Change, "Vital Signs of the Planet", https://climate.nasa.gov/evidence/. Accessed on June 1,2018.

3. Badri Chatterjee, "India's Carbon Emission Jumped 1,041% Since 1971, Says Study," *Hindustan Times*, November 6, 2017, https://www.hindustantimes.com/mumbai-news/carbon-dioxide-emission-from-fuel-combustion-in-india-increased-by-1041-from-1971-to-2015-study/story-ScRbLtCJ3X6r7fIHfZKqwI.html. Accessed on May 30, 2018.
4.. Chloe Farand, "Carbon Dioxide Levels in Earth's Atmosphere Reach 'Highest Level in 800,000 Years," *Independent,* May 5, 2018,https://www.independent.co.uk/environment/carbon-dioxide-concentration-atmosphere-highest-level-800000-years-mauna-loa-observatory-hawaii-a8337921.html. Accessed on May 31, 2018.
5. This graph shows the presence of carbon dioxide (CO_2) in the atmosphere (parts per million) based on the comparison of atmospheric samples contained in ice cores and more recent direct measurements, and provides evidence that atmospheric CO_2 has increased since the Industrial Revolution.

The exceptional ability of carbon dioxide and other greenhouse gases keeps our planet warm enough to make it habitable for life in the form that we know. The very same ability, but in increased amounts, is creating problems for the very same life that it supports. Increase in temperature is the first visible adverse effect of an increased amount of atmospheric carbon and also an inducing factor for a wide variety of problems. Before the 1950s, the largest influential factor in the global temperature fluctuations was the level of solar irradiance.[6] However, in the later decades of the 19th century, this dependent course of the global temperature with solar output had deviated into a much more spontaneous and calamitous one, owing to the increasing carbon dioxide levels in the atmosphere and the increased influence of human activity such as deforestation, seismic blasting, etc. on the planet's ecosystem.

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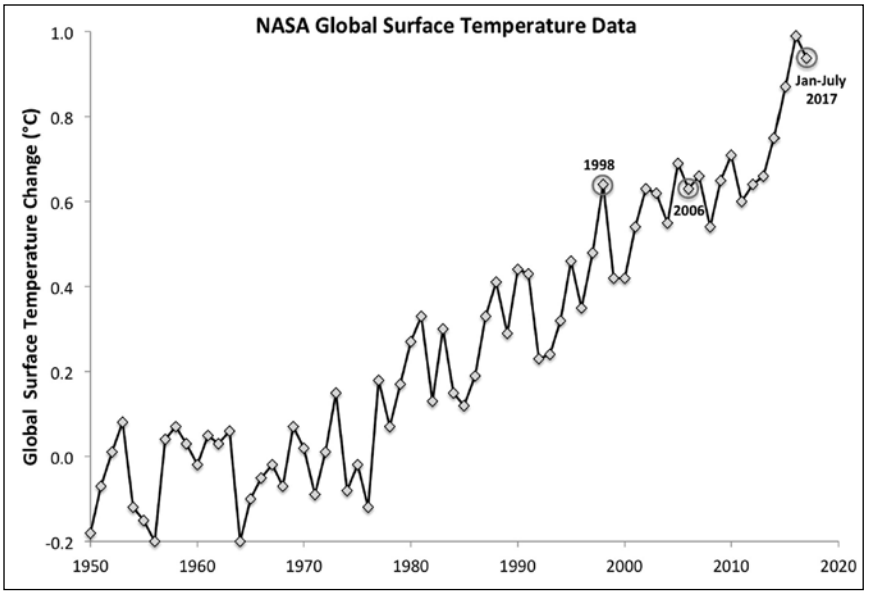
Ever since the beginning of the industrial age when humanity started to depend heavily on burning fossil fuels such as coal, oil, etc. The trend in temperature patterns started to defy the natural laws of the planet. Though the level of solar irradiance is falling to a level that is predicted to be equivalent to the creation of a mini ice age in the planet by 2030, the average temperature on the planet is on a rise, due to a warming period.[7] The 20th century temperature patterns (refer Fig. 3) reveal the history of the coal fuelled industry of the 19th century. The 20th century showed an increase of 0.8°C in average global temperature, with a per decade increase rate of 0.07°C until 1970, and 0.17°C since 1970.[8]

6. Zeke Hausfather, "Solar Influences on Climate Change," *Yale Climate Connections,* May 27, 2008, https://www.yaleclimateconnections.org/2008/05/common-climate-misconceptions-solar-influences-on-global-temperature/. Accessed on June 1, 2018.
7. Habibullo I Abdussamatov, **"**Grand Minimum of the Total Solar Irradiance Leads to the Little Ice Age," *Journal of Geology and Geophysics* , April 28, 2013, https://www.omicsonline.org/open-access/grand-minimum-of-the-total-solar-irradiance-leads-to-the-little-ice-age-2329-6755.1000113.php?aid=12810. Accessed on June 4, 2018.
8. National Oceanic and Atmospheric Administration, "Global Climate Report - Annual 2016", June 18, 2018, https://www.ncdc.noaa.gov/sotc/global/201613. Accessed on June 5, 2018.

Fig 3: Graph Showing the Global Temperature Anomaly during 1950-2017



Source: Dana Nuccitelli, "2017 is so far the Second-Hottest Year on Record Thanks to Global Warming," *The Guardian*, July 31, 2017, https://www.theguardian.com/environment/climate-consensus-97-per-cent/2017/jul/31/2017-is-so-far-the-second-hottest-year-on-record-thanks-to-global-warming . Accessed on June 5, 2018.

The year 2016 was the hottest year in recorded history, with the average global temperature rising up to a rate of 14.8, showing an increase of 1.10°C over the 20th century average temperature of 13.7°C. In fact, 16 out of the hottest 17 years in recorded history have occurred since 2001, foreshadowing the sweltering future of the 21st century.

Liquefaction of Solid Forms of Water

Liquefaction of the polar ice caps and glaciers is the major concern among the direct effects of the rising global temperature. Most scientists agree that the meltdown of the polar ice caps and glaciers of the mountain ranges such as the Alps is contributing substantially to the rising sea level, which is a major cause of concern for many island nations and coastal countries. The gravest

concern is that the meltdown of ice sheets is not only feeding the rising sea levels but also adding to the rising temperature. Ice caps, which are forming above the ocean, prevent the oceans from absorbing atmospheric heat and have the ability to reflect back the solar radiations into the outer atmosphere. With the loss of ice sheets, the planet is losing a natural mirror that reflects back the sunlight and keeps the planet habitable. Moreover, the melting ice dumps a lot of fresh water that can affect the saline composition of the oceans and shift, or even reverse, the course of water currents which have the capability to change the global climate. This would, in turn, abruptly disturb the climate and may cause serious problems like altered weather patterns and spontaneous outbreaks of calamities like cyclones, hurricanes, storms, storm surges, floods, droughts, etc with the resultant destruction of life, infrastructure, and the environment.

The Arctic is warming at twice the rate of the rest of the world. Every year, the Arctic recedes a few thousand square kilometres more than the previous year.

In fact, the adverse effects are already visible in the Arctic region which is a semi-enclosed ocean, almost completely surrounded by land. As a result, the sea ice that forms in the Arctic is not as mobile as the sea ice in the Antarctic. Although sea ice moves around the Arctic basin, it tends to stay in the cold Arctic waters. So this geographical barrier prevents the Arctic ice from melting and creating further problems for the structure of the planet. However, the rise in temperature and seismic blasting operations for the process of exploration for oil, minerals and new sea lanes, are cited as the main reasons of the loss of the Arctic ice caps. According to the National Oceanic and Atmospheric Administration's (NOAA's) latest annual Arctic Report Card, the Arctic is warming at twice the rate of the rest of the world. Every year, the Arctic recedes a few thousand square kilometres more than the previous year. The extent of Arctic sea ice for April 2018 averaged 13.71 million sq km. This was 0.98 million sq km below the 1981 to 2010 average, and only 20,000 sq km (7,700 square miles) above the record low April extent set in 2016.[9]. The polar

9. National Snow & Ice Data Centre, "Arctic Sea Ice News & Analysis", http://nsidc.org/arcticseaicenews/2018/05/. Accessed on June 5, 2018.

ice caps hold approximately 24 million cubic km of water of the total water in the ocean which is approximately 1.35 billion cubic km.

Unlike in the Arctic, in Antarctica, the ice sheets are neither confined to an ocean nor floating ones; instead, the ice sheets of Antarctica are forged on the foundations of landmasses fragmented at the South Pole. Antarctica is a landmass surrounded by an ocean. The open ocean allows the forming sea ice to move more freely, resulting in higher drift speeds. A large chunk of the ice sheets breaks away every year, and floats further northwards to the warmer oceans where this melts down at an increased rate. Also, the underwater erosion of ice sheets is a major problem that contributes additional ice loss to the breakaway of a large chunk of ice. It is estimated that the base of the ice around the South Pole shrank by 1,463 sq km between 2010 and 2016.[10] This underground erosion is actually caused by the increasing temperature of ocean waters which makes the ice sheets thinner and more prone to future breakdowns. On the whole, Antarctica sheds 125 giga tonnes of ice per year which can cause a 0.35 mm rise globally in the sea level per year.[11] Glaciers all over the world are on a retreating trend in a fast mode. Most mountain glaciers, except some in the Himalayan mountain range of Karakoram, are showing a fast pace in meltdown. The glaciers of Karakoram get excluded from the list only because of another adverse effect of climate change, i.e excessive rainfall in the form of snowfall at high altitudes which reinforces the increased rate of meltdown and slows down the retreating process of the glaciers. However, the glaciers of the Alps and Alaska are all showing increased meltdown. For instance, the glaciers of Mt. Hunter in Alaska shows a much greater rate of meltdown which even scales up to 60 times greater than it was pre-1850.[12] This excessive meltdown and frequent untimely snowfall is making most of these mountain ranges more prone to avalanches

10. Jonathan Watts, "Underwater Melting of Antarctic Ice Far Greater than Thought, Study Finds," *The Guardian,* April 2, 2017, https://www.theguardian.com/environment/2018/apr/02/underwater-melting-of-antarctic-ice-far-greater-than-thought-study-finds. Accessed on June 5,2018
11. NASA Scientific Visualisation Studio, "Hyperwall", https://svs.gsfc.nasa.gov/30880. Accessed on June 5, 2018.
12. John Abraham, "Glacier Loss is Accelerating Because of Global Warming," *The Guardian,* April 18, 2018, https://www.theguardian.com/environment/climate-consensus-97-per-cent/2018/apr/18/glacier-loss-is-accelerating-because-of-global-warming. Accessed on June 5, 2018.

and other snow eroding phenomena which cause serious damage to life, infrastructure, etc.

WHAT CHANGES WILL IT CAUSE TO THE PLANET?

Sea level rise is the most important adverse environmental challenge that concerns the whole world. The factors that are contributing to the rise of the sea level are being debated by different streams of scholars. While the environmentalists emphasise environmental deterioration, the economists are concerned about the economic liabilities that accompany such a calamitous situation. However, everybody agrees that sea level rise is an issue of great concern, causing problems to the population, infrastructure etc. According to most scientists, the sea level is rising mainly due to three reasons: thermal expansion of the ocean; mountain glacier melting; and discharge of water from ice sheets as a result of global warming. The total sea level rise projected for every 1^{o}C rise in global temperature is 2.3 metres(m),[13] but the rise in sea level is not necessarily in step with the rising global temperature—it can happen over a much longer span of time: sea level rise due to a decade-long temperature rise can occur only over a period of a century. On the other hand, even though the temperature rise may be halted by some means and efforts, there is a possibility for the trend of sea level rise to remain in its inertial status. This creates a difficulty in predicting how long the trend in sea level rise will last.

Global sea level trends and relative trends are on a different scale as the rise in sea level is not uniform throughout the Earth. Sea level rise at specific locations can be more or less than the global average due to many factors that influence it on a local scale such as subsidence, upstream flood control, erosion, regional ocean currents, variations in land height, etc.[14] For instance, there are places in the Pacific Ocean that face a rate of sea level rise of up to 10 mm per year.[15] According to the European Space Agency's study about the ocean heights, there

13. Erik Kirschbaum, "Seas May Rise 2.3 Meters Per Degree of Global Warming: Report", July 15, 2013, https://www.reuters.com/article/us-climate-ice-study-idUSBRE96E0GQ20130715. Accessed on June 5,2018.
14. NASA Global Climate Change, "Vital Signs of the Planet", https://climate.nasa.gov/news/16/rising-waters-new-map-pinpoints-areas-of-sea-level-increase/. Accessed on June 6, 2018.
15. Ibid.

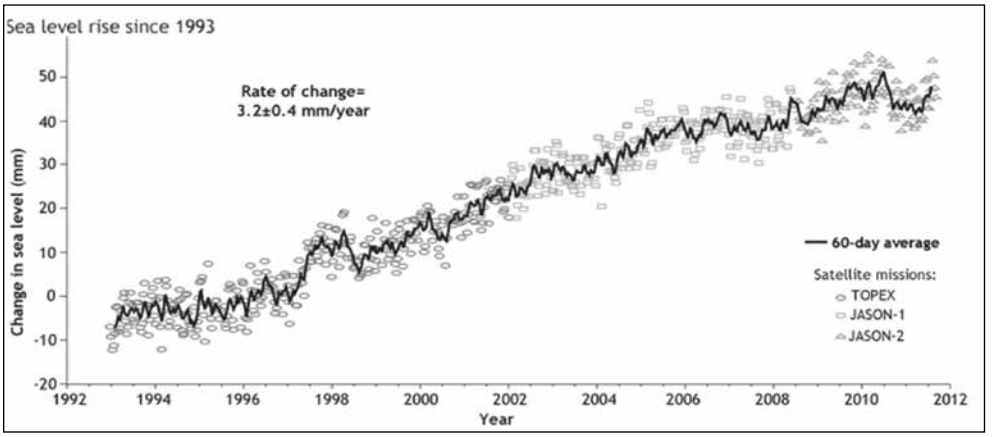
Data proves that our planet is deviating from the course of climatic conditions that it was heading in due to human activities such as deforestation, carbon emission, etc. The rise in global sea level that our planet is witnessing is the highest it has been in the last 6,000 years.

are differences of up to 3 m in ocean heights which are maintained by wind and pressure variations. Any major change in temperature can alter these patterns and the ocean currents which are driven by the ocean height differences.[16]

After the last ice age which ended approximately 26,000 years ago, the sea level rose at a very high rate, but post climate stabilisation, the sea level rise slowed down some 7,000 years ago.[17] Since then, the sea level was on hold at a stable level until it started showing a considerable increase around the 1900s. Between 1900 and 2000, global sea level rose between 0.05 inches (1.2 mm) and 0.07 inches (1.7 mm) per year, on average.[18] In the 1990s, that rate jumped to around 3.2 mm per year. In 2016, the rate was estimated to be 3.4 mm per year, and it is expected to jump higher by the end of the century.[19] Today, global sea level is 5-8 inches (13-20 cm) higher, on average, than it was in 1900. This data proves that our planet is deviating from the course of climatic conditions that it was heading in due to human activities such as deforestation, carbon emission, etc. The rise in global sea level that our planet is witnessing is the highest it has been in the last 6,000 years.[20] Data collected through several satellite missions have helped calculate that the average rate of global sea level rise is 3.2 mm, per year, give or take 0.4 mm.[21]

16. Smithsonian Institution, "Ocean Find Your Blue", https://ocean.si.edu/through-time/ancient-seas/sea-level-rise. Accessed on June 6, 2018.
17. Ibid.
18. Ibid.
19. Ibid.
20. Ibid.
21. NOAA, "Climate.gov", https://www.climate.gov/news-features/understanding-climate/state-climate-2011-global-sea-level. Accessed on June 6, 2018.

Fig 4



Source: NOAA, "Climate.gov", https://www.climate.gov/news-features/understanding-climate/state-climate-2011-global-sea-level. Accessed on June 6, 2018.

Many research organisations like NASA and NOAA are preparing several models and projections of the increasing global temperature and the accompanying rise in the sea level that varies from 1 m to 6 m. These simulations are based on the average 1-2°C rise in average global temperature which the global community is trying to adhere to. Since the global effort is becoming ineffective in restricting the rise in global temperature, these simulations can escalate even further to an unpredicted scale. Several millions of people will be affected by the sea level rise of even 1 m and that number may climb up to a billion in the worst case scenario of a 6 m rise. Other physical changes that our planet experiences due to the increased temperature are the shifts of air and ocean currents, which are all inter-related and dependent on wind and pressure differences. The frequency in the occurrence of calamitous weather conditions will be an increasing trend as the weather will start to behave in a more unpredictable manner.

ADVERSE IMPACT ON TERRITORIAL SECURITY OF INDIA

India, with its geographical location, is in a vulnerable situation when it comes to environmental degradation, climate change and sea level rise. It is estimated that an average of 1m rise in sea level will hit South Asia

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adversely, even submerging some of its island nations such as Maldives completely. India, with a coastline over 7,500 km, will also face the gravity of the situation. Several low lying areas of the Indian mainland and the strategically important island groups of Lakshadweep, and Andaman and Nicobar, would be badly affected due to sea level rise and coastal erosion.

India, with a mainland coastline of 5,422.6 km and island coastline 2,094 km, is at the forefront of coastal erosion. The Indian Ocean which is considered to be one of the roughest oceans in the world, with increased oceanic activity, cyclones, earthquakes and tsunamis, is a vulnerable region for increased coastal erosion. According to a study, "Coastal Erosion along the Indian Coast on 1:25,000 scale Using Satellite Data of 1989–1991 and 2004–2006 Timeframes", jointly conducted by the Indian Space Research Organisation (ISRO) and Central Water Commission (CWC), India lost 250.211 km^2 of land territory due to coastal erosion, while it gained 177.15 km^2 land territory due to coastal accretion. During this 15-year period, India ended up with a net shrinkage of 73.061 km^2 of land territory, including a considerable land loss of over 93 km^2 in the Nicobar Islands alone.[22] More importantly, the 2004 tsunami which triggered a spontaneous loss of land actually brought the issue of land loss into the limelight. Coastal erosion can be caused by both the slow and long-term processes, because of oceanic waves and sudden spontaneous events such as tsunamis, cyclones, storms, storm surges, etc. The pace of future

22. A. S. Rajawat et. al., "Assessment of Coastal Erosion Along the Indian Coast on 1 : 25,000 Scale Using Satellite Data of 1989–1991 and 2004–2006 Timeframes, "*Current Science*, vol. 109, no. 2, July 25, 2015, pp.347-353, http://cwc.gov.in/CPDAC-Website/Paper_Research_Work/Assessment%20of%20coastal%20erosion%20along%20the%20Indian%20coast.pdf. Accessed on June 6, 2018.

coastal erosion is witnessing an increased intensity because of the possible shift in oceanic currents, which can alter the patterns of oceanic activity.

As mentioned earlier, sea level rise in the coming century is expected to vary between 1-6 m, depending on factors such as an increase in temperature and the melting of ice sheets, sea ice, glaciers, etc. At a very limited rate of temperature rise of 1°C, the expected sea level rise would be 1-2 m. However, if the temperature rise is in excess of up to 2° C by the end of the century, it can trigger a sea level rise that would scale up to 6 m. Therefore, according to a study prepared by a group of ecologists led by Dr M Zafar-ul Islam, which presents an overview of the potential consequences of 1 m and 6 m sea level rise for coastal conservation areas on the Indian subcontinent, the total area loss due to marine intrusion into the coastal areas of the Indian subcontinent is estimated at approximately 13,973 sq. km under a 1 m rise in sea level, and around 60,497 sq km under a 6 m rise, which will be equal to 1.84 percent of the total land area of India.[23] This will result in direct shrinkage of territory, with loss of thousands of miles of coastlines as well as complete submergence of island territories. To understand this phenomenon in action in the Indian context, it is imperative to observe the track record of the island territories of the country and study the impact they have sustained over the years.

The loss of islands is an important adverse effect due to sea level rise and coastal erosion. The union territory of Lakshadweep is a tropical archipelago of 36 atolls and coral reefs in the Laccadive Sea, off the coast of the state of Kerala, India. This group of coral atolls, situated in the heart of the Arabian Sea, is allowing India to enjoy a significant strategic vantage point over the sea, especially in protecting the mainland from maritime threats and fighting the piracy activities that disrupt the global trade routes along the Indian Ocean. The Lakshadweep Islands, with a 132-km-long coastline are subjected to coastal erosion to a great extent. According to a recent study, Parali 1, of the Bangaram atoll in the Lakshadweep Islands has got eroded away, foretelling

23. Press Trust of India, "14,000 sq.km. Land at Risk with Rising Sea Level: Report," *The Hindu Business Line*, June 18, 2013, https://www.thehindubusinessline.com/news/14000-sqkm-land-at-risk-with-rising-sea-level-report/article23105650.ece. Accessed on June 6, 2018.

Several Indian naval detachments are situated in the Lakshadweep Islands, which will face the rising sea levels and may become inoperational within this century: this can become a strategic disadvantage for India as a major chunk of global trade passes through this area.

the fate of the rest of these islands. According to Dr. Hidayathulla,[24] Parali I Island, part of Bangaram atoll, which had an area of 0.032 sq.km in 1968, has been completely eroded, resulting in its inundation. Apart from Parali 1, several other atolls of Lakshadweep are facing an increased amount of net erosion such as Parali II (80 per cent), Thinnakara (14.38 per cent), Parali III (11.42 per cent) and Bangaram (9.968 per cent), etc.[25] "Since the absence of this island (Parali I) is noticed in both observations carried out in 2003 and 2007, it is assumed that the island has been subjected to complete erosion during the 1968-2003 period and an assessment of the exact year of its inundation requires data analysis for a span of 35 years extending from 1968".[26] The data obtained over this period was processed using Remote Sensing (RS) and Geographic Information System (GIS) software.[27]

In a similar case, the Maldives Islands, which have coral foundations, are facing problems due to the sea level rise. Lakshadweep Islands, with a similar coral foundation, will also face a similar fate, as they are exposed to the same part of the Indian Ocean. Several Indian naval detachments are situated in the Lakshadweep Islands, which will face the rising sea levels and may become inoperational within this century: this can become a strategic disadvantage for India as a major chunk of global trade passes through this area.

It is worth noting that on December 24, 2004, nature unleashed its fury in the form of a tsunami in the Indian Ocean. The Andaman and Nicobar

24. A native of Androth Island in Lakshadweep, who was awarded a doctoral degree in July, 2017 by Calicut University in Kerala for his work entitled "Studies on Coastal Erosion in Selected Uninhabited Islands of Lakshadweep Archipelago"
25. Press Trust of India, "Lakshadweep Island Parali 1 has Vanished," *The Hindu*, September 07, 2017, http://www.thehindu.com/todays-paper/tp-life/lakshadweep-island-parali-i-has-vanished/article19633348.ece. Accessed on June 6, 2018.
26. Ibid.
27. Ibid.

Islands, the sentinel outpost of the Republic of India in the Indian Ocean, comprised one of the areas which was devastated by the killer waves. The Car Nicobar Air Force Station, which was situated in the Car Nicobar Islands, was devastated during the tsunami and it took about three months to rebuild it to operational status. The Car Nicobar Air Force Station, with its 2-m elevation, could face problems in the future, not only from natural calamities such as tsunamis, cyclones, storm surges, etc. but also from the rise of sea levels and heavy coastal erosion. .

INS *Dweeparakshak*, situated on the island of Kavaratti, which has an average elevation of zero metres, is an example of how even a minimal level rise can affect these military installations. Similarly, the Agatti aerodrome, situated in the Lakshadweep Island of Agatti, with an elevation of 4 m, and the Car Nicobar Island Air Force Station are all examples of military stations vulnerable to natural hazards.

In fact, there is considerable threat to strategic places situated in these islands as well as in the coastal locations of the country's mainland too. It is believed that the Indian naval and air force facilities in the island groups of Lakshadweep, and Andaman and Nicobar are under threat of partial or complete destruction from the rising sea level in the near future itself. The INS *Dweeparakshak*, situated on the island of Kavaratti, which has an average elevation of zero metres, is an example of how even a minimal level rise can affect these military installations. Similarly, the Agatti aerodrome, situated in the Lakshadweep Island of Agatti, with an elevation of 4 m, and the Car Nicobar Island Air Force Station are examples of military stations vulnerable to natural hazards. Other coastal naval facilities that are stationed at cities such as Porbandar, Karwar, Kavaratti, Minicoy, Andrott, Bitra, Kochi, Chilka, Chennai, Uchipuli, Thoothukudi, Paradip, etc have an elevation under 6 m and may also face similar problems with increasing sea levels and coastal erosion. They are also at a high level risk from a natural calamity such as a tsunami, cyclone, etc, accompanied by long-term environmental challenges. Table 1 shows some of the coastal

military facilities that may face a threat from the climate change phenomenon in terms of existence, operational efficiency and operational cost.

Table 1

Name of the Facility	Name of the City	Approximate Elevation (in metres)
INS Dwarka	Okha	5
INS Sardar Patel	Porbandar	1
NAE Porbandar	Porbandar	1
INS Kadamba	Karwar	6
INHS Patanjali	Karwar	6
INS Vajrakosh	Karwar	6
INS Dweeprakshak	Kavaratti	1
INS Minicoy	Minicoy	2
INS Androth	Androth	1
INS Bitra	Bitra	2
INS Garuda	Kochi	1
INHS Sanjivani	Kochi	1
INS Venduruthy	Kochi	1
INS Dronacharya	Kochi	1
NAE Kochi	Kochi	1
INS Chilka	Chilka	2
INHS Nirvani	Chilka	2
INS Parundu	Uchipuli	5
INS Tuticorin	Paradip	1
Campbell Bay NAS	Great Nicobar	5
Car Nicobar AFS	Car Nicobar	2
Port Blair AFS	Port Blair	5

Source: Compiled by author.

Apart from damaging the existing territorial space and the infrastructure, sea level variations, climate change and other environmental disruptions can also cause territorial crises between states. A classic example in the Indian

context would be the case of New Moore Island. Formation of new islands by the deposition of sand due to oceanic activity is happening all over the world, but the location of such formed islands in a contested area can create problems. The loss of one island territory in the Lakshadweep sector denotes that the coral atolls can easily be washed away, in a situation of rising sea level, even without any calamitous environmental event. This phenomenon of loss of islands can reduce the marine territory of our country, as the two groups of islands are contributing significantly to India's territorial waters and Exclusive Economic Zone (EEZ). Similarly, islands can also be formed from accretion due to oceanic activity and shifts in oceanic currents and shifts in tectonic activities. New Moore (South Talpatti), an offshore sandbar island in the Bay of Bengal, off the coast of the Ganges-Brahmaputra delta region, was formed in the aftermath of the Bhola cyclone in 1970. The formation of this island created more complexities in the delineation process of the maritime territory between India and Bangladesh.Both countries contested sovereignty over the newly formed island which was about 3.5 km long and 3 km wide, because it was speculated to have reserves of oil and gas. Bangladesh referred to the island as South Talpatti. There were no permanent structures on New Moore Island but India sent some paramilitary soldiers to its rocky shores in 1981 to hoist its national flag.[28] This forced Bangladesh to resort to the option of approaching the Permanent Court of Arbitration (PCA)[29] to resolve the territorial dispute that had emerged between Bangladesh and its giant neighbour.

However, in March 2010, Sugata Hazra of the School of Oceanographic Studies at Jadavpur University, Kolkata, India, reported that the island had disappeared and that the sea level rise caused by climate change was

28. Associated Press, "Disputed Isle in Bay of Bengal Disappears," *The Hindu,* March 24, 2010, http://www.thehindu.com/news/international/Disputed-isle-in-Bay-of-Bengal-disappears/article16611142.ece. Accessed on June 15, 2018.
29. The Permanent Court of Arbitration, established by treaty in 1899, is an inter-governmental organisation providing a variety of dispute resolution services to the international community. Source: Permanent Court of Arbitration, https://pca-cpa.org/en/home/. Accessed on June 15, 2018.

responsible for it.[30] He further stated that sea level rise, changes in monsoonal rain patterns which altered river flows, and land subsidence were all contributing to the inundation of land in the northern Bay of Bengal, and there were other similar cases of loss of islands in the region such as the loss of Lohachara, Ghoramara.[31] Even after the submergence of the island, the contestation for the maritime region continued until 2014, when the PCA gave its verdict in favour of Bangladesh, awarding it 19,467 km^2 out of the 25,000 km^2 disputed territory, including the submerged New Moore Island region.[32]

In incidents such as mentioned above, islands are naturally claimed by the nation having control of the nearest land territory or the nation that has the capability to hold that territory by instituting infrastructure, population or by employing hard power. Formation of such islands in a neighbouring country's marine territory can further extend its EEZ. If a hostile country is acquiring this sort of island, then it can extend its capability in monitoring our coastal areas, as well as extend its claim closer to our waters. This phenomenon can give rise to situations of extension of a country's existing EEZ overlapping with the EEZ of another country and can lead to a number of territorial conflicts. There is a possibility for further escalation of the dispute into an armed conflict and instability if both nations are not willing to negotiate because of the area's strategic and economic value.

Moreover, many other security threats can arise due to environmentally challenged territorial crises between states, such as given below:

Human Security Threats: The 21st century, predicted to witness the dawn of a new age of climate induced refugees, is about to see a new category of "permanent refugees", due to loss of homeland caused by environmental hazards. This term is way out of the official UN definition of a refugee. The loss of land due to sea level rise would make people stateless and unable to

30. Associated Press, "Island Claimed by India and Bangladesh Sinks Below Waves," *The Guardian,* March 24, 2010, https://www.theguardian.com/world/cif-green/2010/mar/24/india-bangladesh-sea-levels. Accessed on June 8, 2018.
31. Ibid.
32. Rajeev Sharma, "UN Tribunal Puts an End to 40-year-old India-Bangladesh Maritime Dispute," *Russia Today,* July 16, 2014, https://www.rt.com/op-ed/172960-un-india-bangladesh-dispute-end/. Accessed on June 15, 2018.

return to their homeland forever. The South Asian island country, Maldives, is believed to face a similar fate. Bangladesh faces a loss of a significant area of its coastal land, which will trigger displacement of people and can cause a massive exodus of refugee population into neighbouring countries, including India. According to a recent news report, many fishing villages of the Bangladeshi islands in the Bay of Bengal have simply been eroded away into the sea.[33] UN scientists predict that some of the worst impacts of climate change will occur in Southeast Asia, and that more than 25 million people in Bangladesh will be at risk from sea level rise by 2050.[34]

The domestic population of Lakshadweep Islands and Andaman and Nicobar Islands, collectively numbering about 400,000 people, would face an existential threat from the sea level rise and coastal erosion due to increased ocean activity. These threats comprise a slow process of destruction which these island groups are heading towards. The 65,000 people living in the coral atolls of Lakshadweep would be the first in line.

Economic Security Threats: The territorial issue evolving due to the environmental crisis can cause problems for the economic well-being of our country—it can disrupt economic activities through loss and damage of infrastructure, loss of revenue generating land, resources, etc. The loss in infrastructure will be on a greater scale as most of India's iconic cities like Mumbai, Chennai, Kochi, etc are coastal ones and comprise important economic hubs. The military infrastructure that has developed over the course of decades of defence development in the coastal regions, in which a large share of defence expenditure is invested, is also under threat from rising sea levels. Any threat to these facilities will force the authorities to relocate and the economic liability that this would impose upon the defence budget will be high, besides creating strategic vulnerabilities.

Loss of territory can cause significant damage towards the operational status of many seaports as many of them would become inaccessible, non-

33. Karen McVeigh, "On the Climate Change Frontline: The Disappearing Fishing Villages of Bangladesh," *The Guardian,* January 20, 2017, https://www.theguardian.com/global-development/2017/jan/20/climate-change-frontline-disappearing-fishing-villages-bangladesh. Accessed on June 15, 2018.
34. Ibid.

One of the upcoming environmental threats will be the loss of low lying coastal farmlands of the country, which can cause a serious decline in India's agricultural productivity and food security.

economical or submerged. The ports, which are considered to be the boosting portals of our economy, are vital to our economic growth and development. These port areas are generally hotspots of investment and development, and any damage to their quality and existence will be a great blow to our economy as they entail huge investments and can affect future economic growth.

Submersion of coastal areas would cause a serious blow, as most of these threatened coastal areas comprise densely populated cities like Mumbai, Chennai, Kochi, etc, which are the main centres of economic activity in the country. Territorial crises can also cause disruption to the trade routes that the country is relying on, by means of over-extension of the marine territory of a hostile country in the case of new island formations.

Agricultural Security Threats: One of the upcoming environmental threats will be the loss of low lying coastal farmlands of the country, which can cause a serious decline in India's agricultural productivity and food security. For example, the Kuttanad Below Sea-level Farming System (KBSFS)[35] practised in Kuttanad, Kerala, is an example of low level cultivation which is going to be affected by the rising sea level. Cultivation of such farmlands and many others may be affected because of the sea level rise and would cause a serious decline in food production. And, any sort of decline in food security can alter the stability of the country's growth pattern.

35. The Kuttanad Below Sea-level Farming System (KBSFS) is unique, as it is the only system in India that practices rice cultvation below sea level. The major land use structure of KBSFS is flat stretches of rice fields in about 50,000 ha of mostly reclaimed delta swamps. The rice fields, which are popularly known as *"Puncha Vayals"* exist in three landscape elements: Karapadam (upland rice fields), Kayal (wetland rice fields) and Kari (land buried with black coal-like materials) Source: Food and Agriculture Organisation of the United Nations, http://www.fao.org/family-farming/detail/en/c/283069/. Accessed on June 15, 2018.

WHAT CAN BE DONE?

The whole world is on a collision course with environmental crises, in which everyone will be affected, directly or indirectly, by the environmental changes and their after-effects. Humanity needs to be aware of this impending challenge, and prepare for it. Humanity is well set on this collision course and it is now beyond the human capability to avert the situation. The only thing that the global community can do is reduce the intensity of this collision by reducing the carbon emissions, by planting more trees, etc.

India, being the largest and an important country in the most affected South Asian region, needs to act responsibly. To be prepared is the only responsible thing that we can do to face the territorial crisis that might occur due to these environmental changes. We need to prepare contingency plans for all strategic infrastructure such as airstrips, early warning systems, nuclear and thermal power plants, space exploration facilities, etc in case any one or some of them become inoperational due to the impact of the calamitous environmental changes. There is an economic burden involved in such an effort and it will be possible only in a several phased course of action. "Act Fast" is a common strategy that can be used in tackling the further intensification of these multiple environmental disasters. India can contribute to the efforts of the world to reduce the presence of carbon in the atmosphere through a rigorous forestation process. Reduction of carbon emission is the best possible way to minimise the rate of climate change. Being a country with low per capita carbon emission rate and a large population, India can effectively make a change in its global share by initiating individualistic reduction methods such as using highly efficient and low energy consuming gadgets and encouraging people to walk when the distance is short instead of using a form of transport.

Each and every person has to share the responsibility in the evolving crisis as both the causers and the recipients are the same. Each extra watt of electricity used could be causing the breaking away, and melting of, a large chunk of ice sheet from the main ice sheet. A debate is on between different schools of thought on whether humanity will survive these changes as it

survived the last ice age and warming period, but a major dilemma is that the human population has increased from a few millions to billions, and the timescale of that inflation is very short. Thus, the human population, with its bigger numbers, will definitely survive, but will suffer from the combined intensification of environmental issues. Conservation of energy in all its forms, and reduction of pollution everywhere are the best ways to save the planet and ourselves.