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Policy Report

Sea Level Rise: The Silent Disaster

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ABOUT THE ORGANISATION:

LexQuest Foundation (LQF) is an independent, non-profit, research and action organisation, established in 2014, in New Delhi. We are striving to create, advocate and implement effective solutions for a diverse range of development issues.

To endorse participative governance, we engage with a broad spectrum of stakeholders, from various sections of the society, to ensure that policy-making remains a democratic process. We utilize pragmatic and futuristic research to disseminate actionable knowledge to decision-makers, experts and the general public.

Our key activities include capacity and skill-building workshops, policy advisory programs, public outreach, and stakeholder consultations. We collaborate with the government, other organizations and individuals for impactful policy formulation and execution.

By employing sustainable and equitable solutions through our multidisciplinary, intersectional initiatives and programs, we are constantly working towards creating empowered communities.



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Introducing the Issue:

By 2050, over [800 million people](#) around the world are projected to face the brunt of rising sea levels in the form of annual flooding and other associated disasters.

Climate change is now recognized as one of the most pressing global issues of our planet. It can be described as the alteration in regional or global climate patterns especially due to greenhouse gas emissions from the mid to late 20th century (onwards). The effects of climate change range from intense heat waves to changes in rainfall patterns. Rising seas is one of those climate change effects. Since 1880, average sea levels have risen by almost 23 cm with about 8 cm gained in the last 25 years. Over the past decade, sea levels have risen at twice the rate of the preceding century. Every year, the sea rises by another 3.2 mm. The [Intergovernmental Panel on Climate Change Fourth Assessment Report](#) (IPCC, 2007) indicates a sea-level rise between the range of 0.18-0.79 m, which includes the potential for a rapid loss of ice sheets due to sliding action over the bedrock, between 1980-2000 and 2090-2100. A report compiled by the [Science Advisory Group of the UN Climate Action Summit 2019](#) states that ocean acidity has increased by 26% since the industrial era due to more absorption of CO₂ in seawater.

Sea-level rise is one of the major challenges identified in the recent Intergovernmental Panel on Climate Change's Special Report '[Global Warming of 1.5°C](#)'. It is almost certain that we will experience at least one meter of sea-level rise, with some models estimating this will happen within the next 80 years, inducing serious implications in the form of damage to infrastructure, loss of land and displacement of communities. Even if we succeed in limiting the temperature increase to 1.5 degrees, sea levels will continue to rise for centuries to come, owing to the emissions we have already locked in. While living on the coast has always come with a certain level of flooding and erosion risks, climate change will alter our coastlines and we must prepare for this new reality.

There are regional and local variations in the rate of sea-level rise. Regional or local factors can be natural, such as the land rebounding upward after continental ice sheets melted at the end of the last ice age, or they may be due to human activities, such as groundwater pumping, oil and gas extraction, sediment compaction, and land management practices, among others.



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Factors Responsible for the Sea-Level Rise:

→ Thermal Expansions

Oceans have absorbed 93% of the heat trapped by the anthropogenic greenhouse gas emissions. If this absorbed heat is released into the atmosphere, Earth's temperature would increase by more than 60 degrees. The absorption by the oceans has slowed the warming of the atmosphere but has had an unprecedented adverse effect on our oceans.

In 2018, the top 6500 feet of the ocean surface was warmer than ever before. This warming expands the water and it occupies more space, thus raising the level of the oceans (and the seas). Water has a high heating capacity, that is, it takes more time to heat up as well as to cool down. Even if we somehow curb our greenhouse gas emissions right now, oceans will continue getting warmer for centuries and it would take even more time for them to cool down.

→ Melting Glaciers and Ice Sheets

When glaciers and ice sheets melt, the meltwater contributes to a rise in sea level. According to a recent study, Greenland's ice sheet - the second largest ice sheet after Antarctica - is losing sevenfold more ice now than in the 1990s. The average ice sheet loss in Greenland has increased from nearly 33 billion tons annually in the 1990s to 254 billion tons per year now. Greenland has shredded almost 4 trillion tons of ice into the oceans since 1992.

At least a third of the huge ice fields in Asia's towering mountain chain are doomed to melt due to climate change, according to a landmark report, with serious consequences for almost 2 billion people. The glaciers are a critical water store for the 250 million people who live in the Hindu Kush-Himalaya (HKH) region, and 1.65 billion people rely on the great rivers that flow from the peaks into India, Pakistan, China and other nations. "This is the climate crisis you haven't heard of," said Philippus Wester of the International Centre for Integrated Mountain Development (Icimod), who led the report. "In the best of possible worlds, if we get really ambitious [in tackling climate change],



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even then we will lose one-third of the glaciers and be in trouble. That for us was the shocking finding.”

→ Land Subsidence

Sea levels can also rise due to the sinking of coastal land. Groundwater and hydrocarbon extraction, as well as microbial oxidation and soil compaction related to agriculture, are human contributions to subsidence. Tectonic forces, including post-glacial rebound, are among the natural causes.

Using [precise measurements of subsidence](#) around the San Francisco Bay Area between 2007 and 2011 using state-of-the-art satellite-based synthetic aperture radar (InSAR), Scientists from the University of California, Berkeley, and Arizona State University mapped out the waterfront areas that will be impacted by various estimates of sea-level rise by the end of the century. They found that depending on how fast seas rise, the areas at risk of inundation could be twice what had been estimated from sea level rise only.

Since [no long-term data on land subsidence](#) or emergence are available for locations in India, the rate of increase of sea level due to climate change cannot be attributed with certainty. However, a high rate of sea level increase at [Diamond Harbour](#) can be traced to the land subsidence happening there. Other examples in India are Kandla, Haldia and Port Blair.



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Major Impacts of Sea Level Rise:

→ Storms and Flooding

With the rise in sea level along the coasts, storms and flooding will happen more frequently. Oceans provide impetus to storms and floods. As the sea reaches inland, it becomes easier for floods to tear down human habitats.

By 2050, extreme storms that previously used to occur once every century could hit the coastal cities once every year. These storms will be capable of wrecking the lives of more than one billion people who are projected to live in the low lying coastal areas by that time.

The intensity of storm surges is also likely to increase due to sea-level rise. The pulse of seawater delivered onto the coast by strong winds is called a storm surge. As a consequence of sea-level rise, storm surges occurring today are eight inches higher than they would've been in 1900.

→ Destruction of Beaches and Mangroves

The beaches around the world are shrinking due to a rise in sea level and unchecked coastal development. The waves that used to break harmlessly are washing up farther inland because of the destruction of dunes for erecting buildings. Sea walls - built to protect the coastal region from flooding and storms - are helping in eroding the beach by accentuating the waves' scouring behavior. According to Florida International University researchers, 'Without expensive remedial actions, each centimeter of sea-level rise will be accompanied by a loss of about a meter of beach'.

Rising sea levels are the greatest threat faced by mangrove ecosystems. Mangroves are considered to be very resilient trees, but the rising sea levels laced with droughts and hurricanes have resulted in receding of the mangroves. From 1954 to 2014, the four most vulnerable islands of Sundarbans - Jambudwip, Butchery, Dalhousie, and Bhangaduni - have lost about 10009 hectares of land at the rate of 164 hectares per year. This trend is seen around the world. In Australia, around 7000 hectares or 9% of the



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mangroves were destroyed in one month, according to researchers at James Cook University.

→ Salinization

As sea levels are rising, low lying coastal areas around the world are being inundated by saltwater, contaminating the soil. Rainfall washes away these salts but climate change has increased the frequency of droughts and heatwaves. This leads to more use of groundwater for drinking and irrigation, thus allowing more salt to leach into the soil. Sea level rise and land subsidence have already affected farming in low lying coastal areas. Salt contamination is affecting 20% of cultivated land and 33% of irrigated agricultural land worldwide.

→ Habitat Loss

Rising sea level and the potential for stronger storms pose an increasing threat to coastal communities, infrastructure, beaches, and ecosystems.

Not only humans but other animals that rely on low-lying habitats will be impacted by sea-level rise. Many birds use coasts and coastal ecosystems for breeding, laying eggs, finding food, or simply as a place to live. Sea turtles lay their eggs on beaches, returning to the same location every year. When beaches erode or are covered by rising seas their options become more and more limited. Physical barriers that humans are considering to curb the rising seas, like sea walls, completely impede the turtles from coming ashore to build nests and lay eggs.

Species that are only found on islands are especially vulnerable, as their range is limited and they tend to already be defenseless in the face of extinction. With sea-level rise animals like seabirds may not be able to react quickly enough to changes and their only homes may be inundated.

Around 36 million Indians are projected to get affected by severe storms and inundation due to rising sea levels. India is one of the few countries taking initiatives to meet the Paris Agreement targets and we are set to achieve two



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out of the three Paris Agreement goals before the 2030 deadline. While this seems like a good start, we need to build a comprehensive policy to tackle sea-level rise.

The Government of India formulated a national plan on water, renewable energy, energy efficiency, agriculture, bundled with additional ones, into a set of eight missions under the National Action Plan on Climate Change. The Action Plan was released on 30th June, 2008, to address the future policies and programs for climate mitigation and adaptation. A comprehensive scheme for sea-level rise is missing from the plans.

In a country that's majorly surrounded by water and is home to almost 14% of Coastal Districts Population, it becomes imperative to plan inclusive mitigation and adaptation strategies to protect not only the coastlines but also the environment of our coasts from the rising seas.



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Strategies for Mitigation:

→ Reducing Carbon Emissions

India is the fourth-largest emitter of CO₂ in the world, with 2.4 gigatons of CO₂ being emitted annually. The onus of reducing the carbon footprint lies on us, as much as it lies on the government and other stakeholders. Even if we stop with the carbon emissions at this moment, the oceans are going to be affected by it for centuries and sea levels will continue to rise, but the more carbon we dump into the atmosphere, the faster will be the rise of the sea level, leading to extreme consequences.

The introduction of a domestic emissions trading scheme (ETS) in India, as adopted by the European Union (EU) can help in curtailing carbon emissions. The ETS is a cost-effective, market-based approach that works by establishing an overall cap on carbon emissions in a particular sector and the industries in that sector have to collectively achieve the allotted cap emission. This scheme is similar to Perform, Achieve, Trade (PAT) scheme already established in India that focuses on enhancing industrial energy efficiency. In order to increase the effectiveness of an ETS, complementary policies will be needed. In EU-ETS, the complementary policies focus on renewable energy deployment, energy efficiency improvement, energy prices for fuel switching, and emissions reduction.

→ Shifting Communities

This is one of the costliest methods to mitigate the effects of sea-level rise as this includes shifting coastal communities from their home to other low-risk places. Rising sea levels are bound to inundate most of India's coast and increase the risk of extreme storms occurring frequently. Some coastal regions may not be equipped to protect themselves from each storm. For such communities, relocating might be the best option.

Although abandonment or the strategic retreat from a place is a politically difficult position to take, with many potential distributional and social justice consequences, the question of if and when to retreat needs to be at the forefront of the dialogue on adaptation policies. This is true for decisions



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regarding coastal habitat restoration in the face of sea-level rise, habitat protections, and development in highly vulnerable locations such as barrier islands.

→ Green Grey Infrastructure

Natural coastal barriers, such as mangroves, wetlands, and sandbars, lower costs for grey infrastructure, such as seawalls and sea dikes. These barriers can reduce wave energy and the height of a storm surge, which potentially lowers the cost and/or improves the resilience of the built solution.

Vietnam is adopting a combined green-grey approach for coastal protection that consists of a mangrove belt outside the sea dike to serve as the first line of defense, followed by sea dikes, and then a more extensive mangrove belt inland of the sea dike. This will scale down the cost of maintaining and upgrading sea dike construction time and again. The natural barriers, mangroves, in this case, restore on their own after a certain time, further reducing the cost.

→ Coastal Zone Protection

A coastal area is a transition zone between the marine and territorial zones. It is a fragile ecosystem that can be easily disturbed or destroyed. To protect this zone, the Coastal Regulation Zone (CRZ) Notification was issued in 1991 to regulate activities in coastal areas of India.

An amendment was made to the CRZ Notification in 2018 to enhance activities in the coastal region thereby promoting economic growth. But this amendment will put the coastal ecology at risk and make the communities vulnerable to sea-level rise. The No Development Zone (NDZ) was shrunk from 200m to 50m for areas having population density more than 2161 sq km under the updated notification. This is going to hurt not just the coastal ecosystem but also the communities residing along the coast. The disturbance due to tourism activities and infrastructure development will damage the ecologically sensitive areas like mangroves, coral reefs, and intertidal zones.

A Coastal Zone Protection Act should be drafted to protect the coast from extreme weather events by limiting infrastructure development along the



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coastline. It should be planned with the contribution of coastal communities at most risk and other stakeholders.

→ Migration

According to a report by the World Bank, 143 million people will be forced to move within their countries due to climate change by 2050. This estimate focuses on three regions - Sub-Saharan Africa, South Asia, and Latin America.

In addition to internal migration within the country, India also has to deal with climate migrants from Bangladesh as well as other countries. In order to tackle this problem, India has to work on policies for both rural and urban areas.

In rural areas, this would involve supporting the livelihoods of people and strengthening social support systems, particularly for women, children and Scheduled Caste and Scheduled Tribe populations. The already existing social security measures like PDS, NREGA, and ICDS if strengthened and implemented properly, can help rural people cope with climate shock.

At the urban end, creating policies that make cities more resilient to cater to the needs of climate migrants is required. This can lead to higher urbanization which can help in boosting the economy as well.

→ Saltwater Intrusion Mitigation

The fragile water table along the coast of Chennai is going to be severely affected by saltwater intrusion due to rising sea levels in the coming decades. The rising sea levels will move the interface between seawater and freshwater upwards and towards the ground, making it harder to obtain fresh water from the aquifers. Overexploitation of groundwater for the past three decades for industrial and commercial use is rapidly depleting the groundwater leading to severe saltwater intrusion.

Saltwater intrusion can be prevented by adopting a technique like artificially recharging aquifers through recharge basins and injection wells. Aquifer storage and recovery (ASR) is another technique in which water is injected



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into the aquifer during high supply seasons (such as winter and monsoon) and pumped to the surface during low supply season (such as summer). This strategy has been successfully adopted in the United States.



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Conclusion:

Sea level rise will increase persistently for centuries and along with it cause substantial destruction of the coasts and the surrounding ecosystem. The dire consequences of sea-level rise are largely going to be faced by the coastal habitats. According to the United Nations, 2.4 billion people or 40% of the world's population lives on or within 100 km of a seashore. If sea level rises by even one centimeter, 6 million people around the planet face seasonal, annual floods.

There is no overnight solution to this problem. The governments around the world will have to develop extensive policies in conjunction with the vulnerable communities. We need to cultivate policies based on solid groundwork, to endure the impending climate change.



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References:

- ❑ [Mitigation Instruments for Achieving India's Climate and Development Goals](#), Working Group on Mitigation Instruments, Council on Energy, Environment and Water (CEEW) and Environmental Defense Fund (EDF)
- ❑ [Rebuilt Wetlands Can Protect Shorelines Better Than Walls](#), Rowan Jacobsen
- ❑ [Integrating Green and Gray : Creating Next Generation Infrastructure](#), World Bank Group-Open Knowledge Repository
- ❑ [Sea Level](#), NASA Global Climate Change-Vital Signs of the Planet
- ❑ [Staying Afloat: The Urban Response to Sea Level Rise](#), C40 Cities
- ❑ [Climate Change 2007: Impacts, Adaptation and Vulnerability](#), Working Group II Contribution to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change
- ❑ [Global Warming of 1.5°C](#), Special Report, IPCC
- ❑ [2018 was the ocean's hottest year. We'll feel it a long time.](#), Alejandra Borunda
- ❑ [Greenland's ice losses have septupled and are now in line with its highest sea-level scenario, scientists say](#), Chris Mooney
- ❑ [Ocean Factsheet](#), The Ocean Conference, United Nations
- ❑ [Sinking land will exacerbate flooding from sea level rise in Bay Area](#), ScienceDaily
- ❑ [The Storm of the Century Could Soon Happen Every Year](#), Linda Poon
- ❑ [Storm Surge](#), U.S. Climate Resilience Toolkit
- ❑ [Sea-Level Rise Exacerbates Coastal Erosion](#), Physics Today
- ❑ [Climate change leads to worst mangrove destruction in Australia](#), Down to Earth Staff
- ❑ [Soil salinity: A serious environmental issue and plant growth promoting bacteria as one of the tools for its alleviation](#), Pooja Shrivastava and Rajesh Kumar
- ❑ [India Set to Achieve 2 of 3 Paris Agreement Goals: Draft Government Report](#), Nitin Sethi
- ❑ [Why India's CO₂ emissions grew strongly in 2017](#), Robbie Andrew
- ❑ [Draft Coastal Regulation Zone Notification, 2018](#), Ministry of Environment
- ❑ [Groundswell : Preparing for Internal Climate Migration](#), Kanta Kumari Rigaud, Alexander M. De Sherbinin, Bryan Jones, Jonas Bergmann, Viviane Clement, Kayly Ober, Jacob Schewe, Susana Beatriz Adamo, Brent McCusker, Silke Heuser, Amelia Midgley