



Indian Ocean Warming Accelerates

For Prelims: [Global warming](#), [Indian Ocean](#), [Heatwave state](#), [Coral bleaching](#), [Seagrass](#), [Kelp forests](#), [Fisheries sector](#), [Indian Ocean Dipole \(IOD\)](#)

For Mains: [Reasons for Ocean Warming](#), [Heatwaves and Effects](#), [Sea Level Rise](#)

Source: TH

Why in News?

Recently, an **Indian Institute of Tropical Meteorology (IITM)**, Pune indicates a tenfold increase in [marine heatwaves](#), potentially intensifying [cyclones](#), with a rise from 20 days to 220–250 days per year.

What are the Key Findings of the Report?

- **Increase in Ocean Temperature:**
 - **Rapid Warming:** The [Indian Ocean's](#) temperature has risen by 1.2°C from 1950 to 2020 and is projected to increase further by 1.7°C to 3.8°C from 2020 to 2100.
 - **Marine Heatwaves:** Predictions indicate an **increase in** [marine heatwave](#) days from an average of 20 days per year to 220–250 days per year.
 - These heatwaves are linked to **quicker** [cyclone](#) formation and can lead to a nearly permanent heatwave state in the [tropical Indian Ocean](#).
 - The frequent and intense heat waves are likely to accelerate [coral bleaching](#), destruction of [seagrass](#), and loss of [kelp forests](#), which are crucial to the fisheries sector.
- **Changes in Heat Content of the Ocean:**
 - **Deep Ocean Warming:** The increase in temperature extends beyond the surface down to depths of 2,000 meters, escalating the overall heat content of the ocean.
 - The heat content of the Indian Ocean is currently increasing at a rate of 4.5 zetta-joules per decade and is expected to grow at a rate of 16–22 zetta-joules per decade in the future.
 - **Energy Comparison:** The projected increase in **heat content** is likened to the energy released by **one Hiroshima atomic bomb detonation every second, continuously for ten years**.
- **Sea-Level Rise and Thermal Expansion:**
 - Increasing heat content leads to sea-level rise primarily through thermal expansion, which accounts for over **half of the** [sea-level rise](#) in the Indian Ocean, surpassing the effects of glacier and sea-ice melting.
- **Changes in Indian Ocean Dipole (IOD) and Monsoon Patterns:**
 - **IOD Alterations:** Due to the rise in the ocean's heat content [Indian Ocean Dipole](#), a significant factor in determining monsoon strength, is likely to experience a 66% increase in **extreme events** and a 52% decrease in moderate events by the end of the 21st century.

- **Implications for Monsoons:** These changes are critical as positive phases of the dipole, characterized by warmer temperatures in the western half, are favourable for the [summer monsoon](#).
- **Future Outlook:**
 - Despite ongoing heatwaves, an "above-normal" monsoon is expected for June-September 2024 partially due to a positive phase of the IOD.

Difference Between Land Heatwave and Marine Heatwave

Feature	Land Heatwave	Marine Heatwave
Medium	Air temperature	Ocean surface water
Duration	Days or weeks	Weeks or months
Identification	Exceeds high-temperature threshold	Abnormally high sea surface temperatures
Impacts	Heat stress, dehydration, wildfires, power outages	Disrupted marine ecosystems, harm to marine life, influences weather patterns (potentially intensifying cyclones)

How do Rising Sea Levels Impact India?

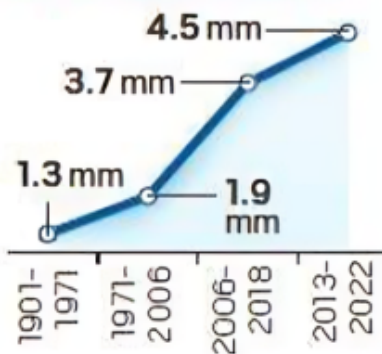
- **Rate of Sea Level Rise:**
 - According to the [Ministry of Earth Sciences](#), on average, the sea level along the Indian coast was observed to be **rising at a rate of about 1.7 mm/year** during the last century (1900-2000).
 - **A 3 cm sea level rise could cause** the sea to intrude inland by about 17 meters.
- **India is more Susceptible:**
 - India is most vulnerable to the compounding impacts of sea level rise.
 - In the Indian Ocean half of the sea level rise is due to the volume of water expanding since the ocean is warming up rapidly. The contribution from [glacier melt](#) is not as high.
 - The Indian Ocean is the **fastest-warming ocean** in terms of surface warming.
- **Implications:**
 - India is facing compound [extreme events](#) along our coastline. **Cyclones** are intensifying rapidly due to **more moisture** and heat from **ocean warming**.
 - The amount of flooding also increases because storm surges are compounding sea level rise decade by decade.
 - Cyclones are bringing more rain than earlier.
 - [Super Cyclone Amphan \(2020\)](#) caused large-scale flooding and inundated tens of km inland with saline water intruding.
 - Over time, the [Indus](#), [Ganga](#), and [Brahmaputra](#) rivers may shrink, and rising sea levels combined with a deep intrusion of saltwater will make large parts of their huge deltas simply uninhabitable.

RISE IN SEA-LEVEL OVER THE YEARS

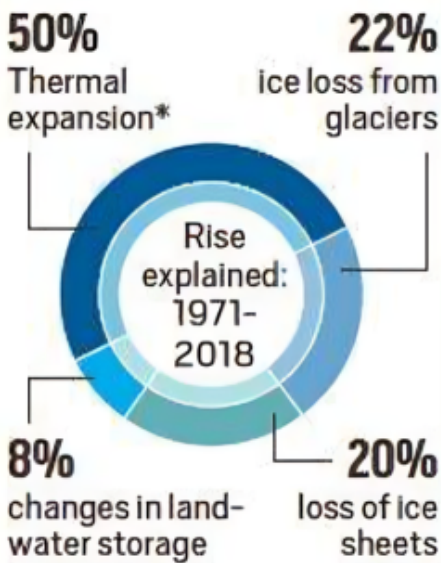
WHAT

0.20 METRES Global mean sea-level rise from 1901 to 2018

AVERAGE RATE OF RISE ANNUALLY



WHY



*when water gets warmer, it causes volume of water to increase

HOW

"There is a risk of a much higher sea-level rise due to potential intrusion of sea water under the Antarctic glaciers, as NASA has demonstrated in its recent published scientific studies.... Human influence was very likely the main driver of these increases (in sea level) since at least 1971."

NOW

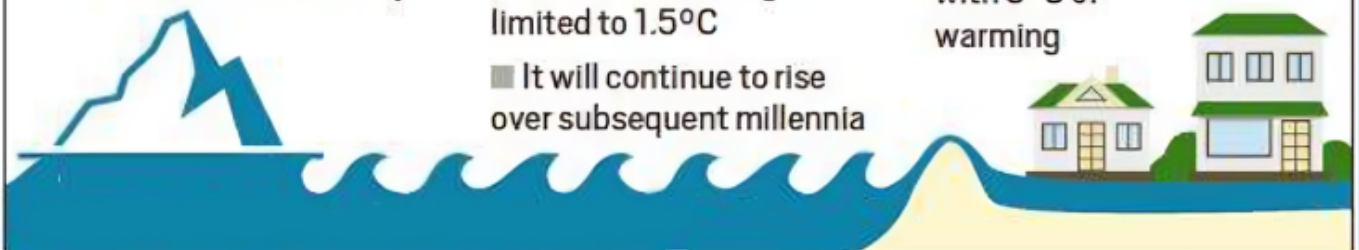
■ WMO finds it is virtually certain that global mean sea-level will continue to rise over the 21st century

■ Over the next 2,000 years, global mean sea-level will rise by about 2 to 3 metres if warming is limited to 1.5°C

■ It will continue to rise over subsequent millennia

■ Will rise 2 to 6 metres if limited to 2°C

■ Rise 19 to 22 metres with 5°C of warming



Steps Taken by India

- **Monitoring and Research:**
 - [Indian National Centre for Ocean Information Services \(INCOIS\)](#)
- **Cyclone Preparedness:**
 - [National Disaster Management Authority \(NDMA\)](#)
 - [IMD Cyclone Warnings](#)
- **Additional Measures:**
 - [National Missions on Climate Change](#)
 - [Coalition for Disaster Resilient Infrastructure](#)
 - [Renewable Energy Target](#)
 - [National Hydrogen Mission](#)
 - [Amrit Dharohar Scheme](#)

What are the Ways to Tackle the Threat of Marine Heatwaves and Intensifying Cyclones?

▪ Mitigation Strategies:

- **Emission Reduction Strategies:** Adopt and advocate for policies similar to the **European Union's Emissions Trading System (ETS)**.
 - The ETS is a cap-and-trade scheme that incentivises industries to reduce [greenhouse gas emissions](#), combating the root cause of marine heat waves.
- **Renewable Energy Integration:** Invest in and promote renewable energy sources like Germany's transition towards solar and wind power.
 - This reduces dependence on fossil fuels and lessens the long-term impact on ocean temperatures.

▪ Early Warning Systems and Preparedness:

- **Advanced Monitoring:** Emulate programs like Australia's **Integrated Marine Observing System (IMOS)**.
 - IMOS utilises a network of buoys, ships, and satellites to collect real-time oceanographic data, providing crucial insights into marine heat waves and cyclone development.
- **Predictive Modeling:** Leverage advancements like the **National Oceanic and Atmospheric Administration's (NOAA)** hurricane seasonal outlooks.
 - By statistically analysing atmospheric and oceanic data, NOAA provides forecasts for cyclone activity, allowing for better preparedness.

▪ Coastal Resilience Measures:

- **Mangrove Restoration:** Implement initiatives like **Bangladesh's efforts** to restore mangrove forests.
 - Mangroves act as [natural barriers](#), mitigating storm surges and protecting coastal communities from cyclones.
- **Infrastructure Improvements:** Strive for advancements akin to the Netherlands' **robust seawall network**.
 - Well-maintained seawalls and levees can significantly reduce cyclone damage to coastal infrastructure and settlements.

▪ International Collaboration:

- **Data Sharing and Research:** Foster open exchange of scientific data, similar to the **Global Ocean Observing System (GOOS)**.
 - GOOS facilitates international collaboration in ocean observations, leading to a better understanding of marine heatwaves and cyclone development.
- **Capacity Building:** Provide **technical and financial assistance** to developing countries, akin to the [World Meteorological Organization's \(WMO\)](#) Tropical Cyclone Programme.
 - This program equips vulnerable nations with resources and expertise to prepare for and respond to cyclones.

Drishti Mains Question:

Q. Discuss the implications of the projected increase in marine heatwaves in the Indian Ocean on cyclone formation and intensity. How can such projections inform climate change mitigation and adaptation strategies in the Indian Ocean region? (250 words)

UPSC Civil Services Examination, Previous Year Question (PYQ)

Prelims:

Q. Stiglitz Commission established by the President of the United Nations General Assembly was in the international news. The commission was supposed to deal with (2010)

(a) The challenges posed by the impending global climate change and prepare a road map

(b) The workings of the global financial systems and to explore ways and means to secure a more sustainable global order

(c) Global terrorism and prepare a global action plan for the mitigation of terrorism

(d) Expansion of the United Nations Security Council in the present global scenario

Ans: (b)

Mains:

Q. 'Climate change' is a global problem. How India will be affected by climate change? How Himalayan and coastal states of India will be affected by climate change? **(2017)**

PDF Refernece URL: <https://www.drishtiias.com/printpdf/indian-ocean-warming-accelerates>

