Climate change - A silent crises threatening the Indian coast and fisheries

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Abstract

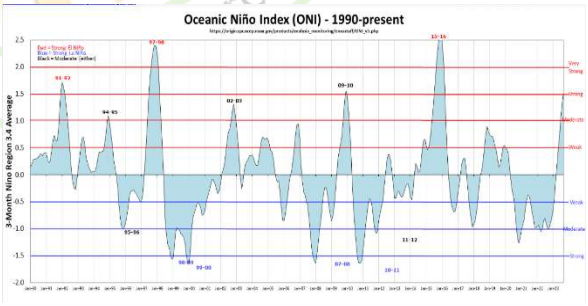
Climate change in 2023 and the years to come are expected to get worse. The worst projection for climate change in 2023, is that the chance for the average global temperature to rise above 1.5°C has increased to almost 50% for the next five year period between 2022 and 2026. Summer of 2023 was Earth's hottest since global records began in 1880, according to scientists at NASA's Goddard Institute of Space Studies (GISS) in New York. Production from marine capture fisheries has been stagnant during the past 10 years because of overfishing, unregulated fishing, habitat destruction and pollution; climate change may exacerbate this situation. The diet quality of fish across large parts of the world's oceans could decline by up to 10 per cent as climate change impacts an integral part of marine food chains.

Effects of climate change on Indian monsoon

Extreme weather phenomenon:

The El Nino (El Nino southern oscillation - ENSO) and La Nina represent opposing extremes. Climate change has caused the ENSO cycle to vary from year to year in terms of the equatorial Pacific Ocean's sea surface temperature, rainfall, surface air pressure, and atmospheric circulation. The Oceanic Nino Index (ONI) has become the de-facto standard that NOAA uses for classifying El Niño (warm) and La Niña (cool) events in the eastern tropical Pacific. It is the running 3-month mean SST anomaly for the Niño 3.4 region (i.e., 5ºN-5ºS, 120º-170ºW). Events are defined as 5 consecutive overlapping 3-month periods at or above the +0.5º anomaly for warm (El Niño) events and at or below the -0.5 anomaly for cool (La Niña) events. The threshold is further broken down into Weak (with a 0.5 to 0.9 SST anomaly), Moderate (1.0 to 1.4), Strong (1.5 to 1.9) and Very Strong (≥ 2.0) events. For the purpose of this report for an event to be categorized as weak, moderate, strong or very strong it must have equaled or exceeded the threshold of the highest category for at least 3 consecutive overlapping 3-month periods.

El Niño - 27				La Niña - 25		
Weak - 11	Moderate - 8	Strong - 5	Very Strong - 3	Weak - 12	Moderate - 6	Strong - 7
1952-53	1951-52	1957-58	1982-83	1954-55	1955-56	1973-74
1953-54	1963-64	1965-66	1997-98	1964-65	1970-71	1975-76
1958-59	1968-69	1972-73	2015-16	1971-72	1995-96	1988-89
1969-70	1986-87	1987-88		1974-75	2011-12	1998-99
1976-77	1994-95	1991-92		1983-84	2020-21	1999-00
1977-78	2002-03			1984-85	2021-22	2007-08
1979-80	2009-10			2000-01		2010-11
2004-05	2023-24			2005-06		
2006-07				2008-09		
2014-15				2016-17		
2018-19				2017-18		
				2022-23		



El Niño and La Niña Years and Intensities-Source: Golden gate weather service, 2023

Effect of global warming on Indian coast and fisheries:

Temperature rise:

The annual mean global near-surface temperature for each year between 2023 and 2027 is predicted to be between 1.1°C and 1.8°C higher than the 1850-1900 averageTemperature rise has a direct impact on physiological processes like growth, reproduction, spawning and it influences the fishes to migrate to colder water. Temperature-dependent sex determination has been discovered in all marine turtles and several marine fish. Spatial and temporal analyses of the dataset revealed that the average SST was 26.7°C, and that the warming rate from 1982 to 2020 reached up to 0.59°C/decade. The team has predicted that the annual average SST in the Indian seas would increase by 2.0 degree Celsius along to 3.5 degree Celsius along by 2099. These small pelagics, especially the oil sardine, have been known for restricted distribution – between latitude 8° N and 14° N and longitude 75° E and 77° E (Malabar upwelling zone along the southwest coast of India) where the annual average SST ranges from 27 to 29° C. The higher the SST, the better the oil sardine catch. The surface waters of the Indian seas are warming by 0.04° C per decade. Since the waters in latitudes north of 14° N are warming, the oil sardine are moving to northern latitudes. the mackerel has been extending deeper and downward as well. Shifts in the spawning season of fish are now evident in the Indian seas. The threadfin breams *Nemipterus japonicus and N. mesoprion* are distributed along the entire Indian coast at depths ranging from 10 to 100 m. However, a shift in the spawning season from warmer to relatively cooler months (from AprilSeptember to October-March) was discernible. False Trevally populations decline in the Gulf of Mannar. The species is generally seen at depths ranging from 15 to 90 metres. But over the past few years, there has been a steady decline in the catch of this fish – both because of human disturbance and changes in ocean temperatures

Ocean acidification:

Ocean acidification means a significant reduction in the pH level of the ocean over an extended course of time, caused principally by the uptake of carbon dioxide (CO_2) from the atmosphere. The pH refers to the potential or power of hydrogen. CO_2 in the atmosphere has increased from 278 ppm in pre-industrial times to 390 ppm today. During this time, the amount of CO_2 dissolved in the ocean has risen by more than 30%, decreasing the pH of the ocean by 0.11 units.

CO_2 dissolves in water to form carbonic acid. (It is worth noting that carbonic acid is what eats out limestone caves from our mountains.) In the oceans, carbonic acid releases hydrogen ions (H+), reducing pH, and bicarbonate ions (HCO_3^-).

$CO_2 + H_2O \Rightarrow H^+ + HCO_3^-$ (1)

The additional hydrogen ions released by carbonic acid bind to carbonate ions (CO_3^{2-}), forming additional HCO_3^-.

$H^+ + CO_3^{2-} \Rightarrow HCO_3^-$ (2)

This reduces the concentration of CO_3^{2-}, making it harder for marine creatures to take up CO_3^{2-} to form the calcium carbonate needed to build their exoskeletons.

$Ca^{2+} + CO_3^{2-} \Rightarrow CaCO_3$ (3)

The two main forms of calcium carbonate used by marine creatures are calcite and aragonite. Decreasing the amount of carbonate ions in the water makes conditions more difficult for both calcite users (phytoplankton, foraminifera and coccolithophore algae), and aragonite users (corals, shellfish, pteropods and heteropods). Many marine fish and invertebrates have complex life cycles. They spend their early lives as larvae while they develop and disperse to distant areas via ocean currents

for example, sea urchin and oyster larvae will not develop properly when acidity is increased. In another example, fish larvae lose their ability to smell and avoid predators. The vulnerability of larvae means that while organisms may be able to reproduce, their offspring may not reach adulthood.

In recent years, 75% of the world's tropical coral reefs have experienced bleaching due to increased heat stress. Scientists estimate that 70–90% of the reefs will be lost with a 1.5 °C global warming while almost all of them would be bleached out if the temperatures increase beyond 2 °C. Coral bleaching has been discovered at record depths, over 90 metres below the surface of the Indian Ocean. In Andaman group of islands, a massive coral bleaching up to 83.6% was recorded.

Sea level rise in the Indian seas:

Satellite observations have revealed that the rate of sea level rise is increasing and it rose by 0.11 inches from 2021 to 2022. It has increased from 0.08 inches per year in 1993 to 0.17 inches in 2022. The current analysis estimates that the projected rate of sea level rise will hit 0.26 inches by 2050. Greenhouse gas causes the Arabian sea in the Indianan to witness a substantial rise of about 0.76 m in the sea level, surpassing the global average increase of 0.75 meters. This will accelerate the erosion and increase the risk of flooding.

Coastal erosion is the displacement or loss of land caused due to rise in sea level, resulting in strong waves and coastal flooding" and is accelerated by both anthropogenic or natural causes. The rise in sea level poses a larger risk to some Indian states that have had rapid coastal erosion, including Gujarat, Tamil Nadu, and West Bengal. According to a National Centre for Coastal Research (NCCR) research from 2018, the West Bengal coast alone lost almost 99 sq. km of land between 1990 and 2016. More than 40% of erosion is noticed in four states: West Bengal (63%); Pondicherry (57%); Kerala (45%) and Tamil Nadu (41%)

As sea levels rise, saline water can intrude into freshwater sources, including rivers and groundwater aquifers. This intrusion compromises the quality and availability of freshwater resources. It can impact agriculture, drinking water supplies, and ecosystems.

Conclusion:

Earth is likely to cross a critical threshold for global warming within the next decade, and nations will need to make an immediate and drastic shift away from fossil fuels to prevent the planet from overheating dangerously beyond that level, Climatic resilience of the marine sector could be attained and the adaptation and mitigation options explored are feasible for time bound implementation. However, more research support could bring these strategies to village level. Climate smart coastal villages could directly contribute towards food and nutritional security of millions and the research interventions in this direction could bring significant improvements. Technology development and empowerment of fishing communities could bring significant changes in the livelihoods as well as national contributions of fisheries sector

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