

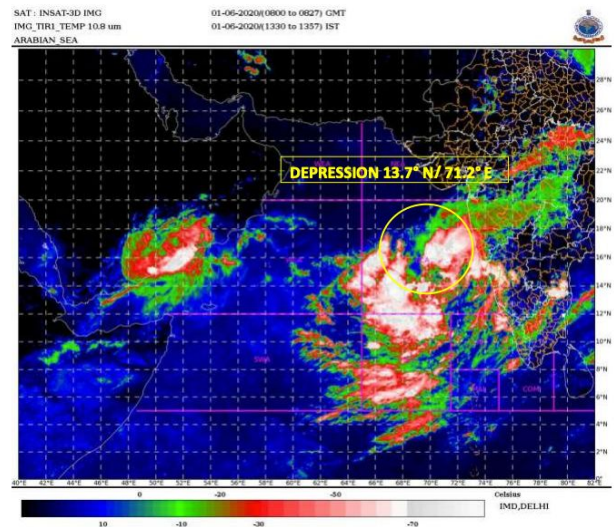
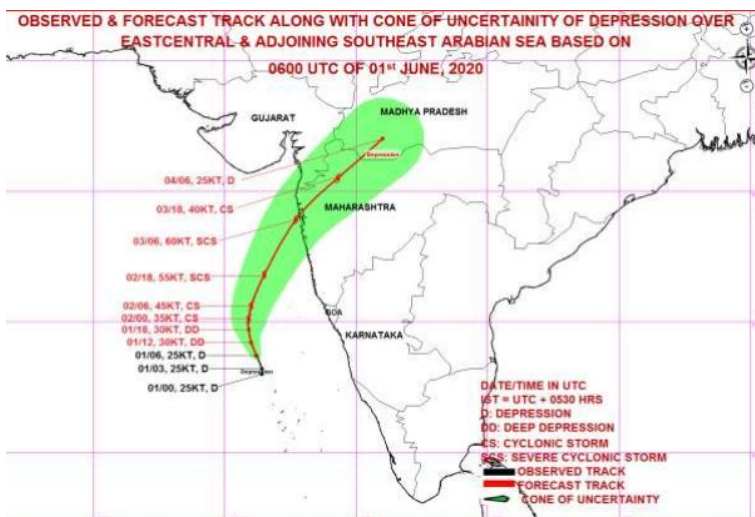
Cyclone Nisarga: link with climate change

Less than two weeks after Cyclone Amphan made landfall, a second cyclone is expected to hit the coasts of India. The Indian Meteorological Department (IMD) [said](#) that Cyclone Nisarga is expected to intensify further into a Cyclonic Storm over East Central Arabian Sea and is likely to move nearly northwards initially till June 2nd morning and expected to re-curve north-north eastwards before making landfall near north Maharashtra and south Gujarat coasts on June 3rd morning.

Cyclone Nisarga is expected to become a “severe cyclonic storm” as forecast by the IMD. The states of Gujarat and Maharashtra are on pre-cyclone alert as “very heavy” to “extremely heavy” rainfall is expected in parts of the states over the next 2 days.

Scientists have observed an increasing trend of post-monsoon tropical cyclones over the Arabian Sea. The current events are, however, pointing towards a detectable increase in cyclonic trends in pre-monsoon season as well. (see more in quote by Dr Roxy Mathew Koll below)

Source: [IMD](#)



How climate change influences cyclones

Coming on the heels of the record-breaking storm, Cyclone Amphan, which battered coastal West Bengal, Odisha and Bangladesh on May 20, climate scientists say with a rapidly warming Indian Ocean, these severe cyclones are projected to increase in number on both the east and the west coast of India.

Climate change is increasing the damage that cyclones like Nisarga and Amphan cause in several ways, including:

- Increasing sea surface temperatures which can make cyclones more powerful

- Increasing the rainfall that drops during the storm,
- Raising sea levels, which increases the distance inland that storm surges reach,
- Causing storms to gain strength more quickly.

The strongest cyclones have [become more common](#) across the world and scientists project that climate change will continue to make the strongest cyclones more powerful. The strength of cyclones affecting the countries bordering the North Indian Ocean has been increasing as the planet has warmed, according to [multiple studies](#).

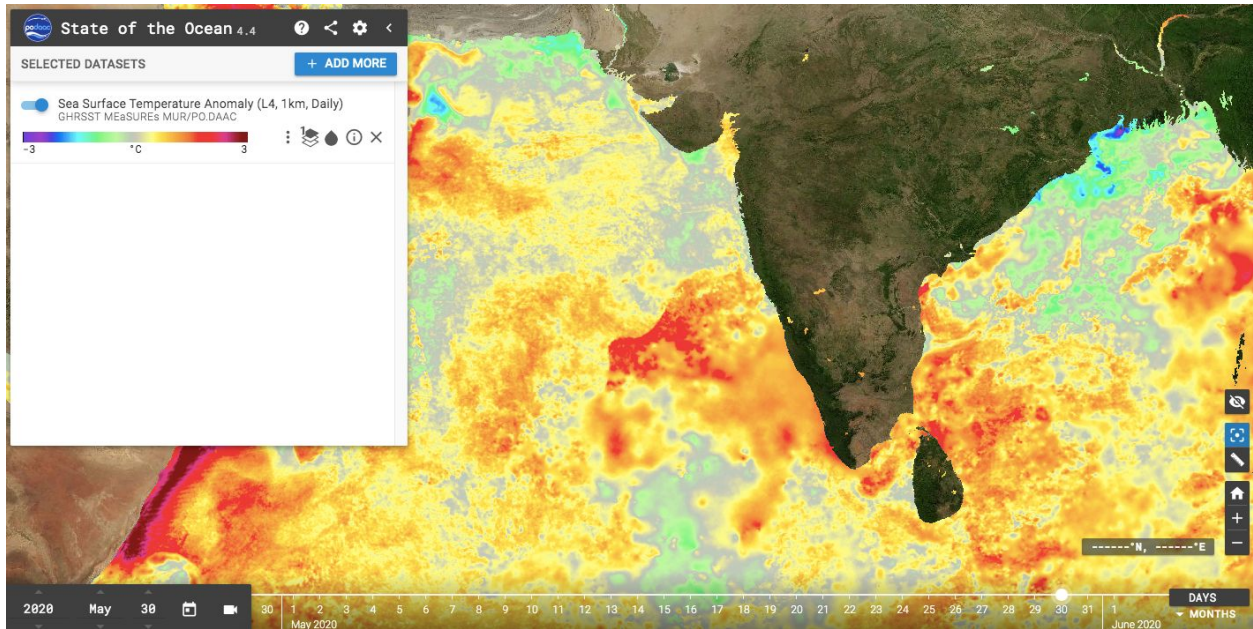
Climate change is increasing the danger from cyclones in several ways:

Temperature and storm strength

Cyclones are fueled by available heat. Warming seas can [make cyclones more powerful](#), by increasing the potential energy available to them, effectively [increasing their power](#) ceiling or speed limit. Higher sea-surface temperatures mean that cyclone [wind speeds can increase](#). Globally, ocean temperatures have increased as a result of climate change - and there has been a global increase in the observed intensity of the strongest storms over recent decades. A [study](#) published the same week as Cyclone Amphan confirmed this trend, finding that the proportion of the strongest storms is increasing about 8% a decade.

Water in the Arabian Sea has is increasing in temperature, driven by climate change (see quote by Dr Roxy Mathew Koll, below). These higher sea-surface temperatures increase the energy available to the storm:

Sea surface temperatures in the Arabian Sea; colours show difference between long-term average temperatures and temperatures on 30 May, as Cyclone Nisarga developed (see image above for location of Amphan on that date). Source: [NASA](#)



How the warming Indian Ocean is affecting both the Eastern and Western Coasts of India

Climate change is [projected to exacerbate](#) intensity of tropical cyclonic storms in selected ocean basins with the rise in sea surface temperatures. Almost all of the tropical cyclonic storms are concentrated in East Asia, North America, and the Central American regions. The North Indian Ocean—the Bay of Bengal and the Arabian Sea, generates only 7% of the world’s cyclones, however their impact is comparatively high and devastating. About one third of the global population lives around the Indian Ocean, many in small islands, developing states and least developed countries that are especially vulnerable to climate impacts.

- The region is particularly vulnerable to cyclones because of its large coastal population
- [Multiple studies](#) of the Arabian Sea and Bay of Bengal found that cyclones in the region have been getting stronger over recent decades, and warned that continued greenhouse gas emissions will lead to a further increase in the strongest storms.

More intense rainfall

The planet’s atmosphere is warming as a result of carbon emissions. A warmer atmosphere [can hold more water](#), driving extreme rainfall during cyclones, which increases the threat of flooding. Scientists have [directly linked](#) the increase in atmospheric moisture with human-caused climate change. The number of record-breaking rainfall events globally has significantly increased in recent decades, [as a result of global warming](#), and scientists [predict](#) that rainfall from cyclones will increase with continued climate change.

Scientists have linked particular cyclones and periods of heavy rainfall with climate change, using [attribution studies](#). For example:

- Heavy pre-monsoon rain in Bangladesh in March 2017, which led to flooding, was made [twice as likely](#) by climate change.
- Hurricane Harvey, a major storm that caused catastrophic flooding in Texas in 2017, [could not have produced](#) as much rain as it did without human-caused climate change.
- The amount of rainfall in three major US hurricanes, Katrina, Irma and Maria, [was increased](#) as a result of human-caused climate change.
- The strong 2015 cyclone season in the Western North Pacific was mainly caused by high sea surface temperatures in the eastern and central Pacific, which was made [“substantially” more likely](#) by human-caused climate change.

Increased storm surges

The potential storm surge from storms like Nisarga may be among the most dangerous threats from the storm. Increases in storm surge related to climate change can be due to rising sea levels, increasing size, and [increasing storm wind speeds](#). Global sea levels have already increased [about 23cm](#) as a result of human carbon emissions - dramatically increasing the distance that storm surges can reach. Sea levels in the North Indian Ocean have [risen more quickly](#) than other places in recent years.

Rapid intensification

A growing proportion of tropical cyclones are developing quickly, known as rapid intensification, according to [multiple studies](#) - these changes are linked with climate change. Warm ocean waters are one factor driving rapid intensification so higher ocean temperatures, caused by human greenhouse gas emissions, making it more likely.

Rapid intensification of a storm occurs if maximum sustained wind speed increases by 30 kts (approx 55kmh) in 24 hours. Cyclone Amphan intensified at more than [twice this rate](#) - between 1800 UTC 16/5/20 and 1800 UTC 17/5/20, intensity increased from 45 kts to 115kts (70 kts increase). Rapid intensification is a threat because it makes it harder to forecast how a storm will behave and so to prepare before it makes landfall.

Rapid intensification is expected to continue to become [much more frequent](#) this century with continued climate change. One [study](#) found that intensification rates that happen once a century now could happen every 5-10 years by 2100.

Threats to Coastal Cities

As climate change triggered tropical cyclones are on the rise in coastal India, the unplanned development adds to the vulnerability of these cities. The devastation in West Bengal in the wake of cyclone Amphan cost \$13 billion in damage to the state. As Nisarga is expected to hit the western coast, megapolis like Mumbai are under severe threat. [Multiple studies](#) claim that India's largest coastal cities, like Mumbai and Kolkata, are facing the severest threats from climate-induced flooding. Planned and unplanned development in most ecologically sensitive

zones in these cities fail to address the risks of climate-change-related flooding owing to tendencies to sidestep questions of politics, power and the distributional conflicts that shape urban development. Mumbai has observed an unprecedented growth (see map) in the last few decades, methodically constructing on its mangrove forests. Mangroves are swamp forests which provide many ecosystem services to coastal communities. The density of the trees, together with the variety of tree species, attenuate the inflow of water and create a sort of buffer zone against floods and storm surges.



Experts quotes

Dr Roxy Mathew Koll, Scientist, Indian Institute of Tropical Meteorology, Lead Author, IPCC Oceans and Cryosphere

“In the case of both the recent cyclones — Amphan and now Nisarga, the anomalously warm ocean temperatures are proving to give them a major boost. While temperatures in the Bay of Bengal were between 30-33°C prior to Amphan, surface temperatures over the Arabian Sea recorded 30-32°C prior to the depression which is now evolving as cyclone Nisarga. Such high temperatures aid rapid intensification of these cyclonic systems, which many weather models fail to capture.

We already see a detectable increase in post-monsoon tropical cyclones over the Arabian Sea. Are we moving towards such a trend during the pre-monsoon also? During the recent years we have seen a surge in Arabian Sea cyclones occurring close to the monsoon onset but we are yet to understand if there is a climate change element to it. Regardless, the IPCC reports indicate an increase in Arabian Sea cyclones during the pre- and post-monsoon seasons as a response to the rapid ocean warming trends.

Cyclone Nilofar in 2014 was the first extremely severe cyclone to be recorded in the Arabian Sea in the post-monsoon season. In the following year, two more storms of the same category — Cyclone Chapala and Cyclone Megh — were observed back-to-back in the same season. In 2019, we had Cyclone Kyarr and Cyclone Maha. In fact, Kyarr was the first super cyclone to be recorded in the Arabian Sea in the post-monsoon season.”

Dr Anjal Prakash, Research Director and Adjunct Associate Professor, Bharti Institute of Public Policy, Indian School of Business. Lead Author, IPCC’s AR6 and Coordinating Lead Author, IPCC Oceans and Cryosphere report

“India Meteorological Department (IMD) has confirmed via news reports that the weather system in the Arabian Sea would intensify into a tropical cyclone called Nisarga which will affect the west coast of India. Some of the areas which would be affected are South Gujarat and north Konkan, including large megapolis like Mumbai. These cyclones, as per IPCC Scientists, are due to ocean heat waves and warming up of oceans. The recent IPCC’s special report on Ocean and Cryosphere in a changing climate made very important revelations about the changing characteristics of the sea. The impact of the warming of the ocean means that there would be an increase in the incidences of tropical cyclone winds and rainfall, and increases in extreme waves, combined with relative sea level rise, exacerbate extreme sea level events and coastal hazards. One of the most affected cities, as per the reports, is Mumbai.

I sincerely hope that the officials have learnt their lesson post the 2005 deluge and taken care of the recommendation of the Madhav Chitale committee that was set up by the Government of Maharashtra after the floods. The committee reiterated the reasons of the flooding which was known earlier - inadequate drainage system, rapid developments and loss of ponds that used to hold water, encroachment by the slums on and over the existing drainage systems and reduction in the coastal mangrove areas. These are the adaptation measures which Mumbai must focus on. The Mithi River which is the major drainage point in the north has been reduced to an open drain due to severe encroachments and discharge of industrial effluents into the river. Occurrence of cyclones are becoming a new normal and therefore unprecedented moves are needed in times which are increasingly uncertain. COVID-19 and cyclones are double whammy! Most of the poor in Mumbai live in slums which are, sometimes also the low lying areas with very poor drainage and sanitation facilities. The combination of the pandemic and the disaster could be dangerous specially for people living in these locations. Special provisions could be made for these people who could be in a difficult situation, if the cyclone is as severe as it is being reported so far.”

Dr Jayaraman Srinivasan, Distinguished Scientist, Divecha Centre for Climate Change, Indian Institute of Science

“This year both Arabian Sea and Bay of Bengal were about 1 degree warmer than normal (in early May) and hence the conditions were conducive to increasing the strength of the cyclones. A warmer ocean does not automatically mean there will be more cyclones but if the cyclones are born they will become stronger on account of a warmer sea. The number of cyclones in a given ocean depends on the existence of circulation

patterns that are not related to climate change.”

Dr Jagdish Krishnaswamy, Senior Fellow, Ashoka Trust for Research in Ecology and Environment (ATREE) and Coordinating Lead Author, IPCC Special Report on Climate Change and Land Use

“We always had very good reasons to restrict certain types of land use in coastal zones in order to safeguard ecosystem functions and ecosystem services including highly productive fisheries. Implementation of coastal zone regulations in consultation with local communities are an important part of this approach.

Now with direct evidence of extreme events and cyclones impacting both eastern and western coastal areas of India, a phenomena likely to increase with climate warming, retaining and expanding safer and less vulnerable landuse and landcover in coastal zones and coastal cities and towns is need of the hour. Each landuse needs to be evaluated in terms of ability to absorb shocks from extreme events and whether it will reduce or enhance risks to communities downstream or around.”