Cyclone Maha - link with climate change and air pollution

A major storm, Cyclone Maha, is forecast to cross the Gujarat coast around midnight on Wednesday 6th November, with wind speeds of 100-110kph.

Scientists have found connections between cyclones and both air pollution and climate change:

- Air pollution, caused by human activities, may be strengthening cyclones in the Arabian Sea. This is because air pollution weakens the forces that can otherwise prevent cyclones from forming.
- A warmer atmosphere - the result of human greenhouse gas emissions - can hold more moisture, driving extreme rainfall during cyclones, which increases the threat of flooding.
- Sea-level rise, caused by global warming, increases storm-surge damage and flooding for coastal communities.
- Powerful post-monsoon cyclones are becoming more common in the Arabian Sea because of human-caused warming.

Context

Cyclone Maha is forecast to cause significant rainfall and local authorities are warning people in Gujarat and Saurashtra to be prepared. Teams from the National Disaster Relief Force and State Disaster Relief Force, as well as the Indian Coast Guard and Navy are ready to deal with any aftermath, according to a meeting of the National Crisis Management Committee (NCMC).

Maha comes just a week after heavy rainfall in Gujarat from Cyclone Kyarr and a near miss with Cyclone Vayu in June 2019. It is the first time since 1965 that two cyclones have existed simultaneously in the Arabian Sea.

Link with air pollution

There may be a link between Cyclone Maha and extreme air pollution like the episode that parts of India are currently experiencing. According to atmospheric scientists, air pollution, caused by human activities, may be strengthening cyclones in the Arabian Sea.

This is because air pollution weakens the forces, known as vertical wind shear, that can otherwise prevent cyclones from forming, according to a 2011 study. Human emissions of air pollutants like black carbon and sulphates have increased sixfold since the 1930s. The authors concluded that “the increasing intensity of landfalling tropical cyclones is a consequence of regional emissions of pollution aerosols”.

The 2011 study focused on the link between pre-monsoon cyclones and air pollution. But it warned that continued increases in air pollution could also lead to increased post-monsoon cyclone activity.

Links with climate change

A warmer atmosphere can hold more moisture, driving extreme rainfall during cyclones, which increases the threat of flooding. At higher temperatures, the atmosphere can hold more water, increasing heavy rainfall. 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.

Sea-level rise, caused by climate change, increases storm-surge damage and flooding for coastal communities.

Global sea levels have already increased about 23cm as a result of human greenhouse gas emissions. The rate of sea-level rise varies around the world and the North Indian Ocean has risen more quickly than other places in recent years.

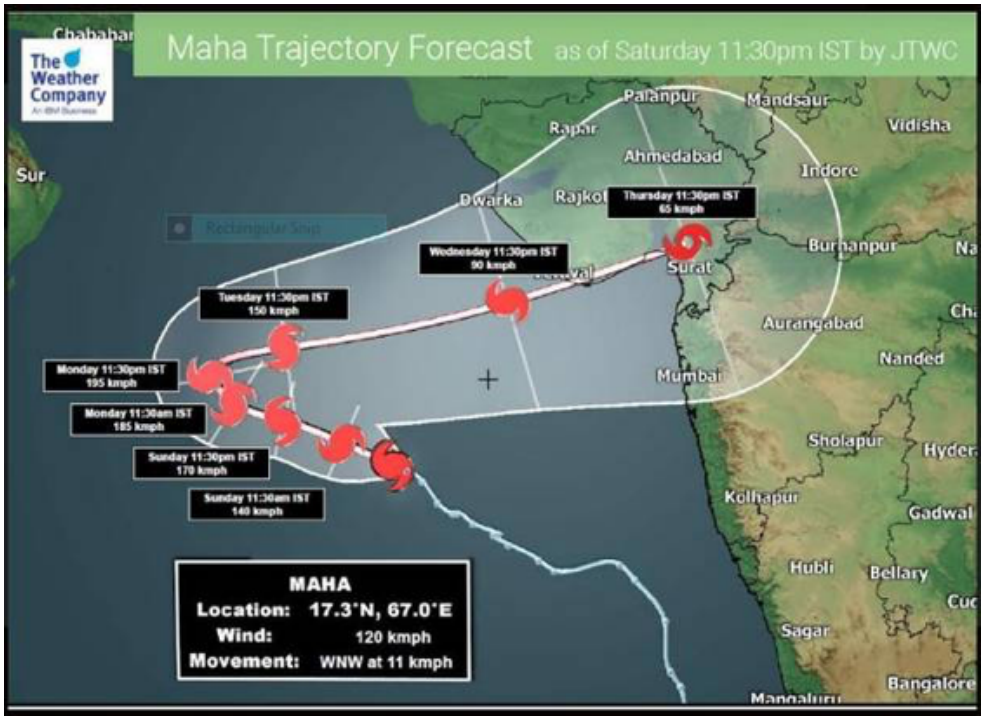
Sea-level rise increases the height of waves and storm surge, relative to the land. A small increase in sea level can lead to a very large increase in the distance inland that storm surges can reach.

Sea-level rise is a big driver for accelerated flooding along the Indian coastline. A study published last week found that 36 million people in India could be affected by 2050.

Powerful November cyclones are becoming more common in the Arabian Sea because of human activities. Post-monsoon Extremely Severe Cyclonic Storms had not been observed in modern times in the Arabian Sea before 2014; there have since been five such storms (Maha is not counted in this category, as its winds are below the threshold). This is likely the result of human-caused warming, according to a 2017 study in the journal Nature Climate Change.

One reason for this is that oceans are becoming hotter, which can make cyclones more powerful, by increasing the potential energy available to them. Global ocean temperatures have increased dramatically as a result of climate change. Global warming heats both the sea surface and the deep water, creating ideal conditions for a cyclone to become more powerful. Higher sea-surface temperatures mean that cyclone wind speeds can increase. The strongest cyclones have become more common across the world, including in the North Indian Ocean, and scientists project that climate change will continue to make the strongest cyclones more powerful.

Tropical cyclones in the Arabian Sea will become 46% more frequent this century if greenhouse gas emissions continue to rise, particularly during peak monsoon season, according to a 2012 study.



Cyclone Maha Forecast Trajectory

Spokespeople and Quotes

Dr Roxy Koll Mathew
Indian Institute of Tropical Meteorology, Pune (India)

"2017 study (Murakami et al.) and the IPCC Special Report on Ocean and Cryosphere shows that the probability of post-monsoon tropical cyclones over the Arabian Sea have increased. This, they largely link to rising ocean temperatures. Since tropical cyclones primarily draw their energy from evaporation at the ocean surface, the surface temperature and ocean heat content has a strong control on the cyclone intensity.

Cyclone Nilofar in 2014 was the first extremely severe cyclone to be recorded in the Arabian Sea in the post-monsoon season. Though the cyclone did not make landfall, it produced heavy rainfall on western Indian coasts. It also caused flash floods in northeast Oman, killing four people. 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. This year, we had Cyclone Kyarr and Cyclone Maha. In fact, Kyarr is the first super cyclone (strongest, above extremely severe cyclone) to be recorded in the Arabian Sea in the post-monsoon season.

With a rapidly warming Indian Ocean, these severe cyclones are projected to increase in number and we cannot neglect the possibility of these cyclones making landfall over the west coast of India."

Professor Amato Evan
Associate Professor
Climate, Atmospheric Science & Physical Oceanography, Scripps Institution of Oceanography
UC San Diego
Author of 2011 paper on cyclones in the Arabian Sea

“Air pollution over the region may be increasing the strength of tropical cyclones in the Arabian Sea by reducing the vertical wind shear. Our research found this to be the case for pre-monsoon storms, and we speculated that this also could be true in the post-monsoon season as well. Given the current and alarming amount of pollution the area is currently experiencing, it may be time to revisit this hypothesis."