

## Challenges in cyclone forecasting

### Why in news?

Though meteorologists had forecast a historic hurricane season for 2024 based on the expectation that a strong La Niña would emerge this winter, 2024 has evolved to be a year with a summer with no major hurricanes.

### What was the 2024 hurricane projection?

- **2023 Hurricane season** - It was history's fourth-most active despite the strong El Niño that year.
- **2024 Hurricane Forecast** - Meteorologists had forecast a historic hurricane season for 2024 based on the expectation that a strong La Niña would emerge this winter.

Usually, subdued hurricane season emerge during an [El Niño](#) and an earnest one during a La Niña.

- **Failure of projection** - 2024 has evolved to be a year with a summer with no major hurricanes.
- **Truant La Nina** - One important reason for the failure of forecast was the weakness of La Niña.

- **Cyclone** - As per National Disaster Management Authority (NDMA), cyclones result from atmospheric disturbances surrounding a low-pressure area characterized by rapid and often destructive air circulation.
  - **Air circulation**- The air circulates inward in an anticlockwise direction in the Northern Hemisphere and clockwise in the Southern Hemisphere.
  - **Occurrence**- Cyclonic winds move across nearly all regions of the Earth except the equatorial belt.
  - **Warm ocean waters** - Cyclones require sea surface temperatures of at least 26.5°C to form.
  - **Low-pressure system** - As warm, moist air rises from the ocean, it creates a low-pressure area.
    - The rising air cools and condenses, forming clouds and thunderstorms.
  - **Coriolis Effect** - The rotation of the Earth causes the air to spiral, contributing to the cyclone's circular motion.
    - Cyclones rotate counterclockwise in the Northern Hemisphere, and they rotate clockwise in the Southern Hemisphere.
  - **Intensification of cyclone** - As the storm gathers strength, it draws more warm air from the ocean.
    - The **cyclone's eye** forms at the center, surrounded by a ring of thunderstorms called the eyewall, which houses the strongest winds.
- To know more about cyclones, click [here](#).

### What are the components of forecasting cyclones?

- **Satellites** - By monitoring sea surface temperatures, cloud formations and wind patterns to detect the early formation of cyclones.
- **Doppler radar** - It provides detailed information about wind speeds and precipitation patterns.
- **Weather buoys** - These floating devices gives real-time data of atmospheric pressure and sea surface temperatures.
- **Climate models** - They estimate the likelihood and intensity of cyclonic activity by using broader atmospheric and oceanic metrics.
- **Numerical weather prediction model** - Post-processing techniques to improve forecasts of tropical cyclone track, intensity, and wind structure.
- Statistical and machine learning methods for predicting tropical cyclone intensity change.

### What are the challenges in cyclone forecasting?

- **Limitation of climate models** - They forecast cyclones not explicitly but indirectly, based on metrics that indicate cyclonic activity and its potential intensity
- **Global warming** - Rising Ocean temperatures are increasing the frequency of stronger cyclones, making it harder for traditional forecasting methods to keep pace.
- **Link between hurricanes and ENSO** - Climate change is starting to affect the traditional relationship between ENSO and hurricane intensity.
- **Rapid intensification** - Warming of upper oceans in all cyclone-producing regions of the planet led to many instances of rapid intensification that affects cyclone forecast.

*Rapid intensification is when the maximum cyclone wind speed increases*

*by 55 km/hr or more within a 24-hour period.*

- **Post landfall behavior** - Predicting the storm's behavior after landfall, such as rainfall, flooding, and wind damage, is also complex.
  - The terrain, local weather patterns, and storm structure can significantly influence the cyclone's impact after it hits land.
- **Impacting preparedness** - These challenges are critical, as it directly affects how governments and communities prepare for and respond to cyclones

### **What are factors influencing cyclone in Indian ocean?**

- **Ocean stretch** - The typical stretch of ocean limits cyclone intensification, over both the Arabian Sea and the Bay of Bengal, thus limiting the size and strength of the cyclones.
- **Movement of cyclone** - Most cyclones over the Arabian Sea tend to be steered northwestward, away from India.
- **Chronic stressors** - India is vulnerable to chronic stressors such as ocean warming, rising sea levels, and the increasing incidence of rainfall extremes and dry spells.
- **Acute stressors** - These acute stressors exacerbate the chronic ones, leading to more damaging events like heavy rainfall events, flooding, and flash drought.
- **Combination of acute and chronic stressor** - Cyclone induced flooding worsens as sea levels rise or heatwaves during droughts devastate crops and reduce water availability.
- **Monsoon Change** - Warming in the Indian Ocean, especially the Bay of Bengal, has been extending the southwest monsoon into the northeast monsoon and delivering both excess and extreme rainfall.

### **What are the needs of effective forecasting?**

- **Disaster management** - Accurate forecasting is essential to plan for cyclone mitigation and adaptation measures.
- **Resource management** - India remains an economically developing country, and any increments in its ability to manage its financial and human resources will be critical for the foreseeable future.
- **Sustainability** - India's dream of sustained economic development need the resilience of entire subcontinent.
- **Security** - India's vulnerabilities to chronic and acute climate stressors aren't only India's socio-economic vulnerabilities, but also India's national security issues.

### **What India needs to do?**

- **Hyperlocal risk projections** - India must focus on local predictions for cyclones that will help allocate resources more efficiently and enhance disaster preparedness.
- **Infrastructure enhancement** - Infrastructure upgradation is required in the installation of ocean observation systems and in high-resolution earth observation satellites.
- **Developing India-specific weather models** - That are able to understand and

simulate Indian conditions more accurately.

- **Mitigation and adaptation** - By investing in renewable energy, weather forecasting, early warning systems, and disaster management.
- **Regional cooperation** - Establishing subcontinent-wide weather and climate networks and improving forecasts and projections for all parts of India's wider neighbourhood.
- **Gathering more weather data** - To make accurate forecasts of cyclones and generate useful early warnings in a particular region.

## Reference

[The Hindu| The challenge of forecasting cyclones](#)

