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Introduction

Cyclones can be the most intense storms on Earth. A cyclone is a system of winds rotating counter clockwise in the Northern Hemisphere around a low pressure centre. The swirling air rises and cools, creating clouds and precipitation. The Coriolis force that compels the surface winds to spiral towards the low-pressure system. As Coriolis force is negligible in the equatorial belt between latitudes 5 degrees north and 5 degrees south, cyclonic systems do not develop in this region.

An anticyclone is the opposite of a cyclone. An anticyclone's winds rotate clockwise in the Northern Hemisphere around a centre of high pressure. Air comes in from above and sinks to the ground. High pressure centres generally have fair weather.

The terminology associated with tropical cyclones can be confusing, because people call these dangerous storms by different names in different parts of the world. In the North Atlantic and Caribbean as well as the northeastern Pacific, they go by "hurricane." In the Northwest Pacific – the most active tropical-cyclone basin in the world – they're "typhoons," while in the Indian Ocean and South Pacific they're simply "tropical cyclones" or "cyclones." Tornadoes – much smaller and more localized than tropical cyclones, and capable of generating even higher wind speeds – are occasionally colloquially called "cyclones," though they're completely different storms.

Types of Cyclone

1. Tropical Cyclone: It occurs over tropical ocean regions. it is two types- Hurricanes and typhoons. Hurricanes are found in the Atlantic and Northeast Pacific, whereas typhoons are found in the Northwest Pacific. On the basis of intensity and wind speed, this cyclone is classified into five categories- 1, 2, 3, 4 or 5. Category 5 has a wind speed of 155 mph or above.

2. Polar Cyclone: It occurs over Polar Regions of Greenland, Siberia and Antarctica. It is strong during the winter season.

3. Mesocyclone: It is a vortex of air within a convective storm. It is the air that rises and rotates around a vertical axis, usually in the same direction as low-pressure systems in a given hemisphere. These types of cyclones are accompanied by the rotating air within the thunderstorm.

How does a cyclone form?

Cyclones are formed in the low-pressure area. The topography and the intensity as well as frequency of cyclones that could strike a coast decide the vulnerability of the place.

The temperature difference between the warm, rising and the cooler environment led to the rise of air to become buoyant and then moves to upward. Then the high-pressure area fills the air in the low-pressure area. This cycle continues as warm air rises and a low-pressure area filled with cool air. They build up over a period of time. The warm, moist air rises and cools the water in the air and forms clouds. The whole system of clouds and wind spins and grows, fed by the ocean's heat and water evaporating from the ocean surface.

There are six factors responsible for the formation of the cyclone:

(1) Sufficient warm temperature at sea surface

(2) atmospheric instability

(3) impact area of Coriolis force so that low pressure can be developed

(4) high humidity in the lower to middle levels of the troposphere

(5) a pre-existing low-level focus or disturbance

(6) low vertical wind shear.

Case study – Cyclone Fani

Extremely Severe Cyclonic Storm Fani was the strongest tropical cyclone to strike the Indian state of Odisha since the 1999 Odisha cyclone. The second named storm and the first fudge cyclonic storm of the 2019 North Indian Ocean cyclone season, Fani originated from a tropical depression that formed west of Sumatra in the Indian Ocean on 26 April. Vertical wind shear at first hindered the storm's development, but conditions became more favorable for Fani on 30 April. Fani rapidly intensified into an extremely severe cyclonic storm and reached its peak intensity on 2 May with 1-minute sustained winds equivalent to a high-end Category 4 major hurricane. Fani weakened before making its landfall, and its convective structure rapidly degraded thereafter, degenerating into a remnant low on 4 May, and dissipating on the next day.

Prior to Fani's landfall, authorities in India and Bangladesh moved at least a million people each from areas within Fani's projected path onto higher ground, and into cyclone shelters, which is thought to have reduced the resultant death toll and casualties. Fani killed at least 89 people in eastern India and Bangladesh and caused about US$8.1 billion in damages in both India and Bangladesh, mostly in Odisha, in India.

COASTAL REGULATION ZONE - CRZ

The coastal areas of seas, bays, creeks, rivers, and backwaters which get influenced by tides up to 500 m from the high tide line (HTL) and the land between the low tide line (LTL) and the high tide line have been declared as **coastal regulation zone (CRZ)** in 1991.

The coastal regulation zones have been declared by the Ministry of Environment, Forest and Climate change under the Environment Protection Act 1986.

While the CRZ Rules are made by the Union environment ministry, implementation is to be ensured by state governments through their Coastal Zone Management Authorities.

Importance of Regulation of Coastal Zones

- Protection of ecologically Sensitive Areas like mangroves, coral reefs which act as a shield against tsunami and cyclone
- Improving the lives of coastal communities like fishing communities
- Resilient measures for mitigating impacts of Climate Change and high-intensity Cyclones
- To balance development with conservation of the coastal environment

Timeline of CRZ regulations

In India, the Coastal Regulation Zone (CRZ) Rules govern human and industrial activity close to the coastline, in order to protect the fragile ecosystems near the sea.

They restrict certain kinds of activities — like large constructions, setting up of new industries, storage or disposal of hazardous material, mining, reclamation and bunding — within a certain distance from the coastline.

Coastal Regulation Zone (CRZ) notification was first issued in 1991 by Ministry of Environment, Forest and Climate Change (MoEFCC) under **Environment (Protection) Act, 1986** with the mandate to take measures to protect and conserve our coastal environment.

Shortcomings of CRZ 1991:

- Uniform regulations for the entire Indian coastline without taking into account the diversity in terms of biodiversity, demographic patterns, natural resources, etc.
- Laid no clear procedure for obtaining CRZ clearance.

- Post clearance monitoring and enforcement mechanism was not laid out.
- Measures/rules to check pollution emanating from land-based activities were not included.
- Caused hardships to traditional communities living in ecologically sensitive coastal stretches (fishermen, slum dwellers, etc.).

- Several amendments were made in the CRZ 1991 notification which was consolidated and issued in the CRZ 2011 notification. The CRZ 2011 notification took into account the issues of CRZ 1991.

Objectives of CRZ 2011:

- To conserve and protect coastal stretches;
- To ensure livelihood security to the fishing & local communities living in the coastal areas;
- To promote development in a sustainable manner based on scientific principles, taking into account natural hazards and sea-level rise.

- In December 2018, Union cabinet approved the Coastal Regulation Zone (CRZ) Notification, 2018.

Classification of Coastal Zones under CRZ Notification 2011

- **CRZ-I (ecologically sensitive areas like mangroves, coral reefs, biosphere reserves etc.).**
  - No new construction shall be permitted in CRZ-I except
    - Projects relating to the Department of Atomic Energy;

- Construction of trans-harbor sea link and roads without affecting the tidal flow of water, between LTL and HTL. Etc.

- Between Low Tide Line and High Tide Line in areas which are not ecologically sensitive, the following may be permitted;

  - Exploration and extraction of natural gas;
  - Construction of basic amenities like schools, roads, etc. for traditional inhabitants living within the biosphere reserves;
  - Salt harvesting by solar evaporation of seawater;
  - Desalination plants;
  - Storage of non-hazardous cargo such as edible oil, fertilizers within notified ports;

- **CRZ-II (Areas which are developed up to the shoreline and falling within the municipal limits; includes built-up area – villages and towns are that are already well established),**

  - Buildings are permissible on the landward side of the hazardous line.
  - Other activities such as desalination plants are also permissible.
  - Some construction is permitted only as per guidelines specified by the notification.

- **CRZ-III: Areas that are relatively undisturbed and do not fall under either in Category I or II and also include rural and urban areas that are not substantially developed.**

  - Between 0-200 metres from HTL is a No Development Zone where no construction shall be permitted.

- Only certain activities relating to agriculture, forestry, projects of Department of Atomic Energy, mining of rare minerals, salt manufacture, regasification of petroleum products, non-conventional energy sources and certain public facilities may be permitted in this zone.

- Between 200-500 metres of HTL, those permitted in 0-200 metres zone, construction of houses for local communities and tourism projects are permissible.

- **CRZ-IV: The aquatic area from low tide line up to territorial limits is classified as CRZ-IV including the area of the tidal influenced water body.**

  - There is no restriction on the traditional fishing undertaken by local communities.

  - No untreated sewage or solid waste shall be let off or dumped in these areas.

- A separate draft **Island Protection Zone** Notification has been issued for protection of the islands of Andaman & Nicobar and Lakshadweep under Environment (Protection) Act, 1986.