Tropical Cyclones

December 4, 2018

Manifest Pedagogy

Geography usually has been considered as a stagnant subject but UPSC has been asking highly dynamic questions linking it with current affairs. The most relevant example being the JUNO Mission question in this year mains. Topics in news are being used as a trigger for static portions in Geography. Cyclones being highly in news needs a focused and holistic understanding by the aspirants to tackle any question on it.

Update

In news: Super cyclone Amphan has affected West Bengal and Odisha.

Static dimensions:

- What is a Storm surge?
- 1999 super cyclone of Odisha

Current dimensions:

- IMD classification of cyclones
- Cyclone Amphan

Content:

What is a Storm surge?

- A storm surge is a **rise in sea level that occurs during tropical cyclones.**
- It is primarily **caused by the relationship between the winds and the ocean's surface.**
- The water level rises where the winds are strongest.
- In addition, water is pushed in the direction the winds are blowing.

- Another factor contributing to storm surge is **atmospheric pressure.**
- The pressure is higher at the edges of a cyclone than it is at the centre.
- This pushes down the water in the outer parts of the storm, causing the water to bulge at the eye and eye wall where the winds have helped add to the rise in sea level.
- The **water level can reach as high as 10 meters if the storm surge happens at the same time as high tide.**
- When a cyclone hits land, the accompanying storm surge will most often **flood the surrounding coastal area.**
- Water will more easily flood a shallow coast than a steep one.
- Flooding is responsible for most deaths and economic damage associated with tropical cyclone landfalls.

1999 super cyclone of Odisha:

- The 1999 Odisha cyclone **(BOB 06)** was the **most intense recorded tropical cyclone in the North Indian Ocean** and among the most destructive in the region.
- It **organized into a tropical depression in the Andaman Sea** on 25 October, though its origins could be **traced back to an area of convection in the Sulu Sea.**
- The disturbance gradually strengthened as it took a west-north westerly path, reaching cyclonic storm gradually.
- The storm rapidly intensified, attaining **super cyclonic storm** intensity on 28 October, 1999 and peaked with **winds of 260 km/h (160 mph).**
- The storm maintained this intensity as it made landfall in Odisha on 29 October and **dissipated on 4 November over the Bay of Bengal.**
- Nearly 10,000 people died, more than 3.5 lakh houses were destroyed, several villages were completely washed

away and more than two lakh animals were killed.
- Outer fringes of the super cyclone **also impacted Myanmar and Bangladesh.**
- The storm was the most severe to strike Odisha in the 20th century.
- In the years after the devastating cyclone, **Odisha began building cyclone shelters** on a war footing.
- It also set up the **Odisha State Disaster Management Authority,** which was the **first such disaster management to be set up in India.**

IMD classification of cyclones:

Cyclones are **classified on the basis of the wind speed.**

- The lowest official classification used in the North Indian Ocean is a **Depression**, which has a 3-minute sustained **wind speeds** of between 20–31 mph **(31–50km/h).**
- **Deep Depression:** If the depression intensifies further then it will become a Deep Depression, which has speeds of between 32–38 mph **(51–62 km/h).**
- **Cyclonic storm:** If the Deep Depression develops gale force wind speeds of between 39–54 mph (**63–88 km/h)**, it is called a Cyclonic storm and the Indian Meteorological Department (**IMD) assigns a name to it.**
- **Severe Cyclonic Storm**: They have storm force wind speeds of between 55–72 mph (**89–117 km/h).**
- **Very Severe Cyclonic Storm:** They have hurricane-force winds of 73–102 mph (**118–165 km/h).**
- **Extremely Severe Cyclonic Storm**: They have hurricane-force winds of 104–137 mph (**166–220 km/h**).
- **Super Cyclonic Storm:** The highest classification used in the North Indian Ocean which have hurricane-force winds of **above 138 mph (221 km/h).**

Cyclone Amphan:

- It is the **strongest storm to have formed in the Bay of Bengal** since the Super Cyclone of 1999 of Odisha.
- Cyclone Amphan, pronounced as UM-PUN is classed as "**Super Cyclonic storm".**
- Cyclone Amphan **made landfall on India's east coast, near Sagar Island in West Bengal.**
- It then tracked north towards Kolkata, with wind speeds of up to 160 kph (100 mph).
- It has caused over US$13 billion of damage, the **costliest cyclone ever recorded in the North Indian Ocean,** surpassing the record held by Cyclone Nargis of 2008.
- Amphan **hit seven districts** of West Bengal namely South 24 Parganas, North 24 Parganas, East Medinipur, West Medinipur, Howrah, Hooghly and Kolkata, **Odisha** state, **Bangladesh and to a small extent Sri Lanka.**
- Amphan was a **massive cyclone 700 km in extent and 15 km in height** and its very rapid intensification was unusual.
- The cyclone **caused heavy to extremely heavy rainfall** over Gangetic West Bengal, north coastal Odisha, sub-Himalayan West Bengal and northeast.
- It **caused extensive damage to** thatched houses, concrete structures, uprooted communication and power poles, disrupted rail/road links at several places, damaged standing crops, plantations and orchards.
- Evacuations across the region have been complicated by the coronavirus pandemic, as authorities attempt to maintain strict social distancing rules.
- In West Bengal, about 500,000 people were temporarily housed in storm shelters, while in Bangladesh 2.4 million people have been evacuated.

Mould your thought: What is a storm surge? Explain the IMD classification of cyclones.

In news: *Tropical cyclone ‘Gaja’*

Placing in the syllabus: Geophysical Phenomenon

Static dimensions

1. What is tropical cyclone?
2. Structure, process and classification

Current dimensions

3. Climate change and tropical cyclones
4. Volcanism and cyclones
5. Cyclones of 2018

Content

What are tropical cyclones?

Tropical cyclones are one of the nature’s most violent manifestations and potentially the deadliest of all meteorological phenomena. It is a unique combination of violent wind, heavy rainfall and mountainous waves in sea.

A Tropical cyclone is a non-frontal, synoptic-scale, low-pressure system over tropical or subtropical waters with persistent, organized convection and a closed cyclonic circulation.

Tropical cyclone is a storm system characterized by a large low-pressure centre and numerous thunder storms that produce strong winds and heavy rain. Tropical cyclones feed on heat released when moist air rises, resulting in condensation of water vapour contained in the moist air.

Favourable conditions, structure, process and classification

There are several conditions which are favourable for the formation of a tropical cyclone.

1. Tropical cyclones develop in the vicinity of **inter tropical convergence zone (**ITCZ) or near equatorial trough where relative cyclonic vorticity is already present as a quasi-steady feature. This zone is found nearly 5° north or south of the equator.
2. Tropical cyclones develop in maritime air mass over sea areas where **sea surface temperature > 26.5°C** and overlying tropical atmosphere is convectively unstable.
3. Formation of a **well-marked low pressure** area or depression close to ITCZ /near equatorial trough which later on develops into a full-fledged tropical cyclone is favoured by the arrival of the low pressure wave from the east.
4. It is found that over the regions which are climatologically favourable for the development of tropical cyclones, the **vertical shear in the zonal horizontal flow is weak**. The cyclones generally do not form when the shear of the zonal flow between 950 and 200 hPa exceeds 10 m /s.
5. There should be enough moisture up to the mid atmospheric level.
6. There should be **pre-existing vortex** in the low level of the atmosphere which will support in the formation of tropical cyclones.

Along the ITCZ, when SST exceeds 26°c the convergence of the trade winds takes place. The convection of trade winds takes along the pre-existing vortex. Convection leads to release of latent of condensation which acts as a source of energy and helps in maintenance of low pressure. With the greater convection, cyclone is fully developed with cumulonimbus

clouds. A fully developed cyclone consists of Eye region of low pressure and eye wall (clouds).

Classification of cyclones

Global warming and tropical cyclones

Climate change is likely to affect tropical cyclone behaviour in two ways.

1. The formation of tropical cyclones most readily occurs **when there are very warm conditions at the ocean surface** and when the vertical temperature gradient through the atmosphere is strong. As the climate continues to warm, the difference between the temperature near the surface of the Earth and the temperature higher up in the atmosphere, is likely to decrease as the atmosphere continues to warm. As this vertical gradient weakens, it is likely that fewer tropical cyclones will form.
2. **T**he **increasing temperature of the surface ocean affects the intensity of cyclones** (along with changes in upper atmosphere conditions), both in terms of maximum wind speeds and in the intensity of rainfall that occurs in association with the cyclone. This is because the storms draw energy from the surface waters of the ocean, and as more heat (energy) is stored in these upper waters, the cyclones have a larger source of energy on which to draw. In summary, it is likely that fewer tropical cyclones will form as the climate warms, but a higher fraction of those that do will be intense, more damaging cyclones.

The most direct influence of climate change on the impacts of tropical cyclones is via **coastal flooding**. Typically the damage from tropical cyclones comes from:

1. Excessively high winds that directly damage built

infrastructure and the natural environment; and 2. Coastal flooding caused by a **surge storm**, and the heavy rainfall that often accompanies the storm.

Volcanism and tropical cyclones

When a volcano erupts, it releases **sulphate aerosols** into the atmosphere. These fine sulphate particles (or droplets of sulphate solutions) absorb and scatter solar radiation in the Earth's stratosphere. When an eruption occurs in the lower latitudes, this scattering of radiation reduces the sea surface temperature—which is one of the mechanisms that control tropical cyclone formation. This could **reduce the frequency of tropical cyclones.**

But as per some geo-physicists the active eruption of volcanoes of Barren island, Karkatoa etc. along Indonesian arc (Andaman trench, Sunda trench regions etc), is warming the waters of North Indian Ocean. This is leading to increase in SST of Bay of Bengal. This is considered to be one of the important factors for increasing frequency and intensity of tropical cyclones of Bay of Bengal (but the observation is inconclusive which needs further investigation).

Cyclones of 2018

Atlantic Ocean

Florence (cat 4 hurricane) – West Africa, Cape Verde, Bermuda, S-E USA, Canada

Michael (cat 4 hurricane) – Central America, USA,Canada, Cayman islands, Cuba

Oscar (cat 2 hurricane) –

Helene (cat 2 hurricane) – West Africa, Azores, Ireland, UK

Chris (cat 2 hurricane) – Bermuda, East coast of USA and Canada

Eastern and Central Pacific

Aletta (cat 4 hurricane)

Bud (cat 4 hurricane) – Western Mexico, California

Hector (cat 4 hurricane) – Hawaii, Jhonston Atoll

Lane (cat 5 hurricane) – Hawaii

Norman (cat 4 hurricane) – Hawaii

Olivia (cat 4 hurricane) – Hawaii

Walaka (cat 5 hurricane) – Hawaii, Alaska, British Columbia

Sergio (cat 4 hurricane) – Mexico, Western USA

Rosa (cat 4 hurricane) – Western USA and Mexico

Willa (cat 5 hurricane) – Central America, Mexico

Western Pacific typhoons

Jelawat – Caroline Islands

Prapiroon – Japan and Korean peninsula

Maria- East China, Taiwan, Japan

Jongdari- China and Japan

Shanshan – Mariana Islands, Japan

Soulik – China, Japan, Korea and Russia

Cimaron- Japan islands, Aleutian Islands

Jebi – China, Japan, Russia

Mangkhut – Philipinnes, Vietnam, China

Trami – China, Japan, Russia

Kong-rey – China,Japan, Korea, Alaska

Yutu – Philippines,south China

Usagi – Cambodia, Vietnam and Philippines

Man-yi – Caroline Islands

Indian Ocean

Mekunu – Yemen, Oman, Saudi Arabia

Luban – Yemen, Oman

Titli – East coast of India

Gaja – Sri Lanka, Andaman islands and south India

Daye – India

Test yourself: Mould your thoughts

Discussing mechanism of tropical cyclones, comment on increasing intensity of cyclones across the world.