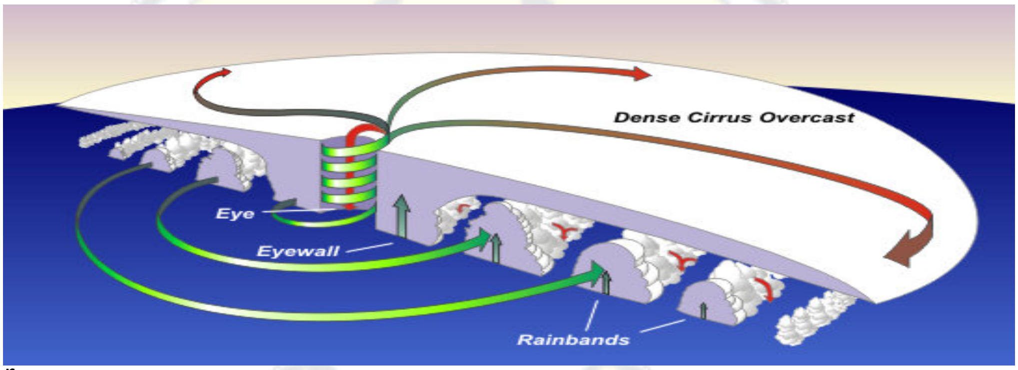
1. What is the typical structure of a tropical cyclone? Discuss. How is the structure associated with the weather pattern of an area affected by a cyclone? Discuss.

Introduction

Tropical cyclones are violent storms that originate over oceans in tropical areas and move over to the coastal areas bringing about large scale destruction caused by violent winds, very heavy rainfall and storm surges. This is one of the most devastating natural calamities. They are known as Cyclones in the Indian Ocean, Hurricanes in the Atlantic, Typhoons in the Western Pacific and South China Sea, and Willy-willies in the Western Australia.

Body

- Tropical cyclones originate and intensify over warm tropical oceans. The energy that intensifies the storm, comes from the condensation process in the towering cumulonimbus clouds, surrounding the centre of the storm.
- With continuous supply of moisture from the sea, the storm is further strengthened. On reaching the land the moisture supply is cut off and the storm dissipates.
- A



r
opical cyclone is characterised by the strong spirally circulating wind around the centre, called the eye. The diameter of the circulating system can vary between 150 and 250 km. The eye is a region of calm with subsiding air. Around the eye is the eye wall, where there is a strong spiralling ascent of air to greater height reaching the tropopause.
- The eye is surrounded by the "eye wall", the roughly circular ring of deep convection, which is the area of highest surface winds in the tropical cyclone. Eye Wall region also sees the maximum sustained winds i.e. fastest winds in a cyclone occur along the eyewall region. The eye is composed of air that is slowly sinking and the eye wall has a net upward flow as a result of many moderate – occasionally strong – updrafts and downdrafts.
- Convection in tropical cyclones is organized into long, narrow rain bands which are oriented in the same direction as the horizontal wind. Because these bands seem to spiral into the center of a tropical cyclone, they are called "spiral bands".

- Along these bands, low-level convergence is a maximum, and therefore, upper-level divergence is most pronounced above. A direct circulation develops in which warm, moist air converges at the surface, ascends through these bands, diverges aloft, and descends on both sides of the bands.

Tropical cyclones form in many parts of the world from initial convective disturbances sometimes referred to as cloud clusters. As the clusters evolve from a loosely organized state into mature, intense storms, they pass through several characteristic stages. Further, the structure is associated with the weather pattern in the following manner:

- Generally a larger scale (i.e., thousand kilometre) vortex already exists when the core develops and much of the research into tropical cyclone formation has examined the formation of the large-scale vortex in which the core forms. The distinction between core formation and large-scale vortex formation is important.
- Warm ocean waters (of at least 26.5°C) throughout the upper 50 m of the tropical ocean must be present. The heat in these warm waters is necessary to fuel the tropical cyclone.
- The atmosphere must cool fast enough with height, such that it is potentially unstable to moist convection. It is the thunderstorm activity which allows the heat stored in the ocean waters to be liberated and used for tropical cyclone development.
- The mid-troposphere (5 km altitude), must contain enough moisture to sustain the thunderstorms. Dry mid levels are not conducive to the continuing development of widespread thunderstorm activity.
- The disturbance must occur at a minimum distance of at least 500 km from the equator. For tropical cyclonic storms to occur, there is a requirement that the Coriolis force must be present. Remember that the Coriolis effect is zero near the equator and increases to the north and south of the equator. Without the Coriolis force, the low pressure of the disturbance cannot be maintained.
- There must be a pre-existing near-surface disturbance that shows convergence of moist air and is beginning to rotate. Tropical cyclones cannot be generated spontaneously. They require a weakly organized system that begins to spin and has low level inflow of moist air.
- There must be low values (less than about 10 m/s) of vertical wind shear between the surface and the upper troposphere. Vertical wind shear is the rate of change of wind velocity with altitude.

Conclusion

Tropical Cyclones thus commonly develop in areas near, but not at the equator. As they move across the oceans their paths are steered by the presence of existing low and high pressure systems, as well as the Coriolis force and disrupt the normal life of the regions they pass through causing widespread damage.

2. What are tidal waves? How is tsunami different from tides? Explain.

Introduction

A tidal wave is a regularly reoccurring shallow water wave caused by effects of the gravitational interactions between the Sun, Moon, and Earth on the ocean. It is primarily affected by the Earth's rotation
[Note - The term "tidal wave" is often used to refer to tsunamis; however, this reference is incorrect as tsunamis have nothing to do with tides.]

Body

Difference between a tsunami and a tidal wave

Although both are sea waves, a tsunami and a tidal wave are two different and unrelated phenomena. A tidal wave is a shallow water wave caused by the gravitational interactions between the Sun, Moon, and Earth.
Tsunamis is an ocean wave triggered by large earthquakes that occur near or under the ocean, volcanic eruptions, submarine landslides, or by onshore landslides in which large volumes of debris fall into the water.

- **Origin**
  - Tsunami originate in deep sea under impact of crustal movement
  - Tide originate on surface of water under impact of gravity of moon and the sun
- **Propagation**
  - Tsunami travel at high speed in deep sea
  - Tides are comparatively slower
- **Size**
  - Tsunami become gant wave on reaching the shore
  - Tides may become big but not as big as Tsunami
- **Potential**
  - Tsunami usually leads to destruction and disaster along coastline
  - Tides can be harnessed to create energy, transportation for inland ports etc
- **Frequency**
  - Tsunami are non-frequent
  - Tides are frequent and can be predicted on basis of position of moon and sun I.e spring tide and neap tide.
  - Tsunami orginates at bottom of ocean floor as a result of volcano, landslide or tectonic plate movement

Conclusion

Tsunami safeguard measure like early warning system, standardised operation protocol, capacity building for rapid deployment of navy and NDRF personnel etc have been developed in the wake of Chennai Tsunami disaster.
Besides this govt. should also implement the regulations suggested under Hyogo protocol to further reduce the loss caused by Tsunami related disaster in future.

3. With the help of suitable examples, explain the correlation between landform evolution and geophysical phenomena.

Introduction

Landform evolution is an important aspect of earth sciences and involves complicated interaction among different physical processes and environmental factors, such as underlying rock structures, tectonics, rock types, climate and climatic changes, and human activities, all occurring over a wide range of spatial and temporal scales.

Body

Correlation between landform evolution and geophysical phenomena

- One of the most commonly observed patterns of river systems is the branching pattern of dendritic drainage network (from the Greek dendrites). It ranges from the small scale of rill (formed by erosion on a newly exposed surface) to the continental scale drainages that evolved over long geological times (e.g., the Mississippi, the Amazon, the Congo, and the Yellow).
- Climatic variables play a key role in drainage form, slope form and process, and in the evolution of a drainage basin through time. Annual variations in temperature, precipitation, and seasonality of precipitation work together to influence the degree of chemical and physical weathering of slope materials, the depth of weathered materials or soils that develop, and perhaps most importantly, to determine the vegetation type and percentage of cover across a landscape.
- Vegetation covers in turn controls slope form and mass movement process and therefore the resultant drainage basin attributes.
- In temperate regions, the rates of chemical and/or physical weathering are sufficiently high to produce thicker sequences of weathered materials or soils that often bury rock outcrops in their own weathering products.
- Vegetation cover is high, protecting the surface from rain splash and the root mass is sufficient to stabilize the materials on the slope. When overland flow does occur it is often ineffective at eroding the surface because of the

protective vegetation, and infiltrating waters moving downslope as "throughflow" are prevented from eroding the soil because of the binding effects of plant roots.

- In the temperate climate landscape, downslope movement of materials to the fluvial channel occurs primarily by the slow mass movement process of either continuous or seasonal creep. Longitudinal profiles for these "creep dominated slopes" assume a smooth convex/concave form from the drainage divide downward to the stream channel.
- The wind is the main geomorphic agent in the hot deserts. The landforms which are created by erosional and depositional activities of wind are called as Aeolian Landforms.
- Volcanic eruptions result in the formation of landforms- intrusive and extrusive landforms.
- Glaciers have played an important role in the moulding of landscapes in the mid and high latitudes of alpine environments. The major depositional landforms made by glaciers are – Esker; Outwash plains; Drumlins.

Conclusion

The geophysical phenomena keep changing the landforms with varying degree.

4. What is a storm surge? How does it get formed? Discuss.

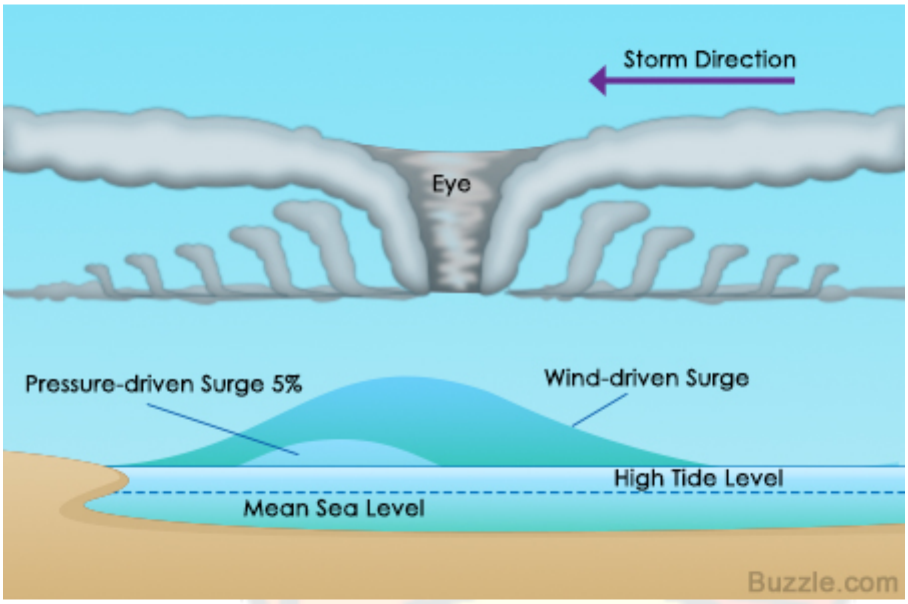
Introduction

A storm surge is a rise in sea level that occurs during tropical cyclones, intense storms also known as typhoons or hurricanes. The storms produce strong winds that push the water into shore, which can lead to flooding.

Body

Formation of storm surge:

When a hurricane is in deep ocean waters, the circulating wind pushes the ocean surface to create a vertically circulating column of water, where the surge is barely visible. However, as the storm moves closer to the shore, the water which is being pushed downwards by the wind cannot move any lower, so the water forces itself from the sides towards land, causing a storm surge wave. Although low pressure also contributes to the surge, its influence is very small, i.e., around 5%.



Whenever a hurricane moves near coastal areas, storm surges are the biggest and most common threat to life and property. This phenomenon is commonly found in low-pressure systems, and the severity of the storm surge wave depends on the tides, shallowness of the water in the area, and the angle at which the water is to the hurricane.

The various causes and factors contributing formation and propagation which are

- Strength and Size of the Storm: During a hurricane, the water level rises to form storm surges, where the strength and speed of the winds are the highest. Usually, the largest surges occur in the direction of where the wind is blowing. Due to the rotation of the earth, the surge occurs towards the right side of the hurricane in the northern hemisphere, and towards the left side in the southern hemisphere. A larger storm will also cause a larger surge.
- Atmospheric Pressure: The force exerted by the atmospheric pressure is a smaller factor in the formation of a storm surge. The atmospheric pressure is the highest at the edges of the storm, and gradually reduces as it nears the center. Due to the low pressure, the water bulges outwards, starting off a high surge.
- Bottom Conditions Near Shore: Another minor factor determining the strength of a surge is whether the coastal slope is steep or shallow, and rough or smooth. A shallow and smooth ocean floor near the coast can dramatically enhance the speed and power of the storm surge, while a steep climb with rough obstructions can slow and sometimes even stop a storm surge. A wider shore will have a higher surge than a narrower shore.
- Distance from Storm Center to Shore: For a storm surge to achieve maximum potency, the distance between the eye of the storm and the shore should neither be too close nor too far. If the distance is less, the surge cannot gather enough velocity to gain power. However, if the storm is too far, the surge will lose its gathered energy by the time it reaches the shore.

- Tides: The gravitational force of the sun and moon cause low and high tides. If the storm surge occurs during a low tide, the intensity will be significantly reduced. However, a storm surge during high tide will cause a storm tide capable of heavy destruction.
- Sea Waves: When waves break onto the beach, they may collect into pools, eventually making it easier for the surge to overcome the friction of the beach, and move even further inland.
- Freshwater: Usually, before a storm reaches land, most coastal areas receive heavy rainfall, causing water levels to rise. This is especially true in areas that have a river delta, causing bigger and stronger storm surges.
- Shape and Angle of Coast to the Storm: A shore with a convex shape will have a lower surge as compared to a concave shore. Also, if the storm is moving parallel to the shore, it will cause lower and weaker storm surges as compared to a storm moving perpendicular to the coast.

Conclusion

The loss of life is minimal with sufficient precautions. There is usually some loss of life, when a Category 2 or stronger surge hits. Combined with the force of the hurricane itself, big storms can claim thousands of lives.

Additional information: Tsunami vs Storm surge vs Storm tide

A storm surge is not to be confused with a tsunami, because although both events can lead to the formation of huge, destructive waves of water, a tsunami can only be formed by an earthquake or other seismic activity. On the other hand, a storm surge is formed primarily due to the high velocity winds of a hurricane, and to a lesser extent, low-pressure conditions. It should also not be confused with a storm tide. When a storm surge and high tide combine their forces, it forms an even stronger surge, known as a storm tide.

5. What is a solar storm? Explain. How does it affect the Earth? Discuss.

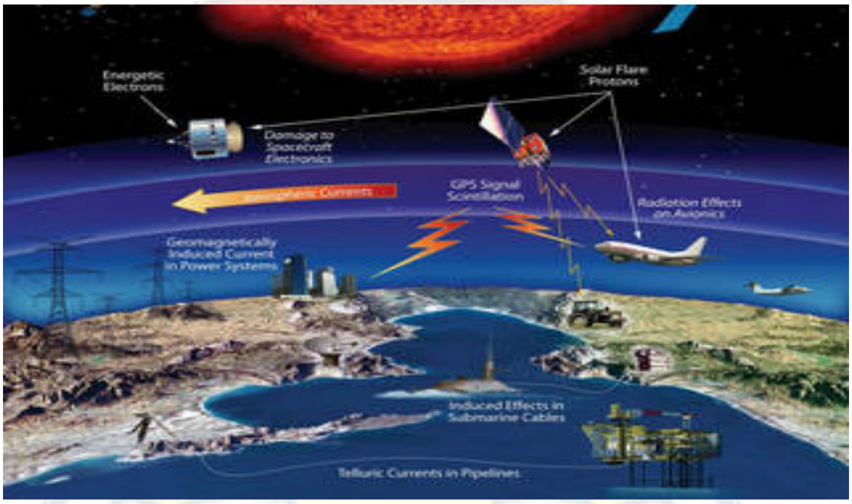
Introduction

Solar storms are a variety of eruptions of mass and energy from the solar surface. Flares, prominences, sunspots, coronal mass ejections are the common harbingers of solar activity, as are plages and other related phenomena. These kinds of space weather activities affect earth and normal functioning of humans on earth.

Body

- Solar activity associated with Space Weather can be divided into four main components: solar flares, coronal mass ejections, high-speed solar wind, and solar energetic particles.

- They all involve sudden releases of stored magnetic energy, which accelerates the hot gases near the surface or in the corona of the Sun. Sometimes these particles make it all the way to the Earth and beyond by flowing along the Sun's magnetic field into interplanetary space.
- The sun goes through periodic variations or cycles of high and low activity that repeat approximately every 11 years. Although cycles as short as 9 years and as long as 14 years have been observed. The solar or sunspot cycle is a useful way to mark the changes in the sun.



- Solar storms can last only a few minutes to several hours but the effects of geomagnetic storms can linger in the Earth’s magnetosphere and atmosphere for days to weeks.
- When the material collides with the Earth's magnetic field and trapped radiation belts, it can dump particles into our upper atmosphere to cause the Aurora.
- The same 'charged' particles can produce their own magnetic fields which can modify the Earth's magnetic field and affect compass readings. The changing magnetic fields can also 'induce' electricity in long pipelines, or produce electrical surges in our power grids leading to brownouts and black outs.
- Modern society depends on a variety of technologies susceptible to the extremes of space weather. Strong electrical currents driven along the Earth’s surface during auroral events disrupt electric power grids and contribute to the corrosion of oil and gas pipelines.
- Changes in the ionosphere during geomagnetic storms interfere with high-frequency radio communications and Global Positioning System (GPS) navigation.
- During polar cap absorption events caused by solar protons, radio communications can be compromised for commercial airliners on transpolar crossing routes.
- Exposure of spacecraft to energetic particles during solar energetic particle events and radiation belt enhancements cause temporary operational

anomalies, damage critical electronics, degrade solar arrays, and blind optical systems such as imagers and star trackers.

- Human and robotic explorers across the solar system are also affected by solar activity. Research has shown, in a worst-case scenario, astronauts exposed to solar particle radiation can reach their permissible exposure limits within hours of the onset of an event. Surface-to-orbit and surface-to-surface communications are sensitive to space weather storms.

Conclusion

As society's reliance on technological systems grows, so does our vulnerability to space weather. The ultimate goal in studying space weather is an ability to foretell events and conditions on the Sun and in near-Earth space that will produce potentially harmful societal and economic effects, and to do this adequately far in advance and with sufficient accuracy to allow preventive or mitigating actions to be taken.