1. What makes the Northeast region highly prone to earthquakes? Analyse.

Approach

A simple and straightforward question where in the candidate needs to analyse what makes the Northeast region highly prone to earthquakes.

Introduction

According to the Bureau of Indian Standards (BIS), our country falls in four seismic zones. The entire Northeast of our country falls in Zone V, with the highest risk, and the region has a turbulent history of 18 devastating earthquakes in the past century. In fact, Northeast India is one of the six most seismically active regions on earth along with California, Japan, Mexico, Taiwan, and Turkey.

Body

- Seismicity is a term which expresses the frequency of occurrence of earthquake in a region in the past as well as probable occurrence in the future. Some region experience higher magnitude of earthquake, whereas some experience lower magnitude.
- Depending on magnitude and frequency, we generally define a place as a region of high seismicity and low seismicity. Seismicity of a particular region depends on the tectonic condition pertaining to number and type of movement of faults in that region.
- Earthquake is a natural phenomenon which is responsible for continuous geological formations and modifications of Earth. Therefore assessing earthquake is necessary in terms of location, frequency, magnitude to evaluate the extent of devastation and threat that it possesses.
- In India, one of the most seismic hazard zones is North east part of India. This region has witnessed several major earthquakes causing large scale devastation. The main cause of this high seismicity in North East India is its unique placement of tectonic plates and their interactions.
- This region consists of eastern and north-eastern Himalayas to the north, Indo-Burma ranges to the east, Bangladesh to the south and the Andaman-Sumatra region to the southeast.
- This region comprising of Shillong Plateau, Mikir hills, Assam valley, Tripura fold belt and the Bengal basin (Bangladesh) is jawed in 3-ways between the three tectonic arcs. The interaction of these three uniquely placed tectonic arcs makes North East India an interlocked region of high seismicity.
- Moreover, the Eastern Himalayan Syntaxes is a complex triple junction that joins the Indian and Eurasian plates with the northern end of the Burma plate where the Himalayan arc takes a sharp turn of about 900 and meets the Indo-Burma ranges.
- The tremors of some recent earthquakes have been attributed to the Kopili fault zone closer to Himalayan Frontal Thrust. This is a seismically active area

falling in the highest Seismic Hazard Zone V. It is associated with collisional tectonics because of the Indian Plate sub-ducting beneath the Eurasian Plate. Subduction is a geological process in which one crustal plate is forced below the edge of another.

- The high seismicity in this region can also be attributed to the collision tectonics between the Indian Plate and the Eurasian Plate in the north and subduction tectonics along with the Indo-Myanmar range (IMR) in the east
- Deaths and destruction during an earthquake mostly occurs due to the collapse of the buildings. North-east India has seen a significant increase in population density and also witnessed a growth of unplanned urbanization. This has caused human population and different structures to be vulnerable.

Conclusion

The enormous investment outlays for strengthening the road network, rail network and air transport network for the North Eastern region proposed will have to be designed with special attention to the earthquake risk and vulnerability in the region. Simultaneously, there is a greater need to strengthen the medical preparedness and mass casualty management facilities in the region. The public awareness on earthquake risk and vulnerability will become the foundation for an enlightened multi-stakeholder initiative to launch a concerted attempt to usher in a culture of preparedness, mitigation and improved emergency response in the North Eastern Region.

2. Discuss the phenomena of landslides as an ecological hazard.

Approach

Candidates are expected to write about landslide and then simply discuss the phenomena of landslide as an ecological hazard.

Introduction

A landslide is defined as the movement of a mass of rock, debris, or earth down a slope. They are a type of mass wasting, which denotes any downward movement of soil and rock under the direct influence of gravity. The term landslide encompasses five modes of slope movement: falls, topples, slides, spreads, and flows.

Body

Causes of landslide:
Slope movement occurs when forces acting downward (mainly due to gravity) exceed the strength of the earth materials that compose the slope.
Landslides are caused due to three major factors: geology, morphology, and human activity.

- Geology refers to characteristics of the material. The earth or rock might be weak or fractured, or different layers may have different strengths and stiffness.
- Morphology refers to the structure of the land. For example, slopes that lose their vegetation to fire or drought are more vulnerable to landslides. Vegetation holds soil in place, and without the root systems of trees, bushes, and other plants, the land is more likely to slide away.
- Human activity which includes agriculture and construction increase the risk of a landslide. The research said human-triggered fatal landslides are increasing at the highest rate in India, where 28% construction-triggered landslide events occurred during the period.

Landslide as ecological hazard:

- Every year, landslides in the region kill dozens of people and cause widespread damage to several villages such that they have now become almost unfit for habitation.
- They create blockades in the road network and river system, which in turn, cause floods.
- The terraced farm fields have been destroyed that cannot be easily renovated or made productive again.
- The road network remains closed for long periods causing indescribable hardship to the villagers who get their basic supplies and provisions from the neighbouring areas.
- Water sources are disrupted and chocked by debris from landslides.
- The river sediment load is increased considerably, causing irregular courses and frequent breaching of the banks- resulting into unexpected floods.
- The water channels are also affected due to disruption in previous channels, this leads to disturbance in water supply to dependent villagers for irrigation purposes. This then adversely affects agriculture production in the affected region.
- In India, this hazard affects at least 15% of the land area of the country (approx 0.49 million square Km.) It is very frequent in geodynamical active domains in the Himalayan and Arakan- Yoma belt of the North-eastern parts of the country as well as in the relatively stable domains of the Meghalaya Plateau, Western Ghats, and Nilgiri Hills.

Way Forward: Preparedness and Mitigation:

- The National Landslide Susceptibility Mapping (NLSM) programme of the Geological Survey of India could help assess the vulnerability of the districts and this could allow the concerned states to plan accordingly.
- Installing early warning systems based on the monitoring of ground conditions like slope displacement, strain in soil and rocks, groundwater levels can help warn the residents and authorities of the risks.
- The district and state disaster management apparatus should be ready for intervention at a short notice.

Conclusion

Landslides and their consequences are still a great problem for many countries, particularly in India due to rapidly increasing populations. The most recent example being that of Kerala. For this reason, landslide hazard zonation mapping serves as one of the many components in an integrated disaster management planning.

3. Discuss the landforms associated with volcanic activity in India.

Approach- Question is straight forward. Student can define the volcano and landforms associated with it. Examples of volcanic landforms in India can be mentioned while defining the particular landform.

Introduction

Volcano refers to a place from where gases, ashes and lave escapes out. Volcanic landforms are created by cooling of magma or lava. Due to very high temperature, some rocks slowly melt and turn into a thick flowing matter known as magma. Since it is lighter than the solid rock around it, the magma rises and gets collected in magma chambers which eventually pushes through fissures and vents in the earth's surface.

Body

Volcanic landforms

- Volcanic landforms are divided into extrusive and intrusive landforms based on weather magma cools within the crust or above the crust.

Intrusive landforms

- The lava that is discharged during volcanic eruptions on cooling develops into igneous rocks.
- The cooling may take place either on arriving on the surface or also while the lava is still in the crustal portion.
- According to the location of the cooling of the lava, igneous rocks are categorized as plutonic rocks and volcanic rocks.
- The lava that cools inside the crustal portions takes diverse forms. These forms are called intrusive forms.

Examples of intrusive landforms

- **Batholiths**- Batholiths are the cooled portion of magma chambers. It is a large body of magmatic material that cools in the deeper depth of the crust moulds in the form of large domes. They appear on the surface only after the denudation processes eliminate the overlying materials.
- **Laccoliths**- These are large dome-shaped intrusive bodies with a level base and linked by a pipe-like channel from below. It bears a similarity to the surface volcanic domes of the composite volcano, only these are located at deeper depths. In India the **Karnataka plateau** is patterned with dome hills of granite rocks.

- **Lopolith-** When the lava moves upwards, a part of the same tends to move in a horizontal direction wherever it finds a weak plane. It can get rested in various forms. If it develops into a saucer shape, concave to the sky body, it is called lopolith.
- **Phacolith**- A wavy mass of intrusive rocks, at times, is found at the base of synclines or the top of the anticline in folded igneous strata.
- Such wavy materials have a definite conduit to source beneath in the form of magma chambers (subsequently developed as batholiths). These are called the Phacoliths.
- **Sills-** The near horizontal bodies of the intrusive igneous rocks are called sill. The thinner ones are called sheets.
- **Dykes-** When the lava makes its way through cracks and the fissures developed in the land, it solidifies almost perpendicular to the ground. These are the most commonly found intrusive forms in the **western Maharashtra** area. These are considered the feeders for the eruptions that led to the development of the **Deccan traps.**

Extrusive volcanic landforms

- Extrusive landforms are formed from material thrown out to the surface during volcanic activity. The materials thrown out include lava flows, pyroclastic debris, volcanic bombs, ash, dust and gases such as nitrogen compounds, sulphur compounds and minor amounts of chlorine, hydrogen and argon.
- **Crater Lake** A Crater Lake, in general, could be of volcanic origin (volcanic crater lake, volcanic caldera lake) or due to a meteorite impact (meteor crater or impact crater), or in the crater left by an artificial explosion caused by humans. Lonar Lake, also known **as Lonar crater** (Lonar, Buldhana district, Maharashtra) was created by a meteor impact during the Pleistocene Epoch.

Conclusion

Volcanic activities have a profound influence on the earth's landforms. In India deccan traps, Karnataka plateau are some of the examples associated with the volcanic landforms as they have influences the India's physiography and its environment.

4. How do temperate cyclones affect the local weather conditions? Illustrate.

Approach

Since the question is asking you to illustrate you have to demonstrate knowledge of the subject of the question and to further explain or clarify your answer with several examples.

Introduction

Temperate cyclones, also called as extra tropical cyclones or wave cyclones or simply depressions are atmospheric disturbances having low pressure in the centre and increasing pressure outward. The convergence of the cold front and the warm front in the temperate latitude cyclones conducive for the development of mid-latitude cyclone. The development and strengthening of mid-latitude ware cyclone id known as cyclogenesis. They move counter clockwise in the Northern hemisphere and clockwise in the southern hemisphere. The temperate cyclonic motion is generated by the pressure gradient force, the Coriolis force, and the surface friction force.

Body

THE TEMPERATE CYCLONES AFFECT THE LOCAL WEATHER CONDITIONS IN THE FOLLOWING WAYS:

- Temperate cyclone is associated with the instability phenomenon called as western disturbance. In Himalayan region of India, the monsoon current progress east to west but western disturbance, move across north from west to east bringing moderate to heavy rain in low-lying area & heavy snow to mountain.
- Temperate cyclones are cold cored, and winds increase with height. They tend to have more moderate rainfall, although in extreme cases still enough to cause destructive flooding.
- Temperate cyclones have their strongest winds at the top of the troposphere in the core of cyclones have their strongest winds at the top of the troposphere in the core of the jet stream.
- A light drizzle follows temperate cyclone which turns into a heavy downpour. These conditions change with the arrival of the warm front which halts the fall in mercury level and the rising temperature.
- Rainfall stops and clear weather prevails until the cold front of an anticyclonic character arrives which causes a fall in temperature, brings cloudiness and rainfall with thunder. After this, once again clear weather is established.
- The temperate cyclones experience more rainfall when there is slower movement and a marked difference in rainfall and temperature between the front and rear of the cyclone. These cyclones are generally accompanied by anticyclones.

Conclusion

The temperate cyclone develops in region between 30° & 60° north and south latitude in both hemisphere and is responsible for much of the highly variable & Cloudy weather in temperate zone. It is in these latitude zones that the polar and tropical air masses meet and form polar fronts.

5. Discuss the origin and propagation of tropical cyclones. How are tropical cyclones named?

Approach:

Question is straight forward in its approach, it has two parts each part needs to be addressed equally also it is important to substantiate points properly with appropriate use of examples.

Introduction:

Tropical cyclones (TCs) plague coastal communities around the world, threatening millions of people and causing many billions of dollars in damage to infrastructure—impacts that are only increasing as coastal development continues worldwide. These impacts result in severe consequences in all ocean basins frequented by TCs, for example recent Hurricanes Harvey, Irma, and Maria (2017) and Florence and Michael (2018) in the Atlantic basin, Typhoons Hato and Damrey (2017), Tropical Storm Son-Tinh (2018) and Typhoons Mangkhut, Jebi, Soulik, and Yutu (2018) in the western North Pacific, Cyclone Debbie (2017) in the East Australian region, and Cyclone Mekunu (2018) in the northern Indian Ocean.

Body:

Origin and propagation-

- More than two-thirds of observed tropical cyclones originate in the Northern Hemisphere. The North Pacific has more than one-third of all such storms, while the southeast Pacific and South Atlantic are normally devoid of them. Most Northern Hemispheric tropical cyclones occur between May and November, with peak periods in August and September. The majority of Southern Hemispheric cyclones occur between December and April, with peaks in January and February.
- The formation of tropical cyclones is strongly influenced by the temperature of the underlying ocean or, more specifically, by the thermal energy available in the upper 60 metres (about 200 feet) of ocean waters.
- Typically, the underlying ocean should have a temperature in excess of 26 °C (about 79 °F) in this layer. This temperature requirement, however, is only one of five that need to be met for a tropical cyclone to form and develop. The other preconditions relate to the state of the tropical atmosphere between the sea surface and a height of 16 km (about 10 miles), the boundary of the tropical troposphere.
- All these conditions may be met but still not lead to cyclone formation. It is thought that the most important factor is the presence of a large-scale cyclonic circulation in the lower troposphere. The above conditions occur for a period of 5 to 15 days and are followed by less-favourable conditions for duration of 10 to 20 days.
- Once a tropical cyclone has formed, it usually follows certain distinct stages during its lifetime. In its formative stage the winds are below hurricane force,

and the central pressure is about 1,000 millibars, or 750 mm (29.53 inches) of mercury. The formative period is extremely variable in length, ranging from 12 hours to a few days. This stage is followed by a period of intensification, when the central pressure drops rapidly below 1,000 millibars.

- The winds increase rapidly, and they may achieve hurricane force within a radius of 30 to 50 km (19 to 31 miles) of the storm centre. At this stage the cloud and rainfall patterns become well organized into narrow bands that spiral inward toward the centre. In the mature phase the central pressure stops falling and, as a consequence, the winds no longer increase. The region of hurricane-force winds, however, expands to occupy a radius of 300 km (186 miles) or more.
- A tropical cyclone may regenerate in higher latitudes as an extratropical depression, but it loses its identity as a tropical storm in the process. The typical lifetime of a tropical cyclone from its birth to death is about six days.

Naming of tropical cyclones-

- Cyclones were usually not named. The tradition started with hurricanes in the Atlantic Ocean, where tropical storms that reach sustained wind speeds of 39 miles per hour were given names.
- The practice of naming storms started in order to help in the quick identification of storms in warning messages because names are presumed to be far easier to remember than numbers and technical terms.
- Experience shows that the use of short, distinctive given names in written as well as spoken communications is quicker and less subject to error than the older more cumbersome latitude-longitude identification methods.
- The 13 names in the recent list that have been suggested by India include: Gati, Tej, Murasu, Aag, Vyom, Jhar (pronounced Jhor), Probaho, Neer, Prabhanjan, Ghurni, Ambud, Jaladhi and Vega.
- Next, India's choice, Gati, will be chosen, and so on. Subsequent cyclones are being named sequentially, column-wise, with each cyclone given the name immediately below that of the previous cyclone.

Conclusion:

Cyclones can have an economic and emotional effect on people and property directly affected. Thousands of people have died or been displaced by them. Hundreds of homes could be destroyed causing millions of dollars' worth of damage. Having a better understanding of cyclones can help you better prepare and perhaps minimise or prevent cyclone damage.