

Using Thunderquakes to X-ray earth

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Why in News?

A new study has demonstrated that thunderquakes can be used to study the Earth's shallow subsurface.



- The technique combines naturally occurring seismic energy from thunderstorms with fibre-optic cables.
- **Thunderquakes** - Lightning superheats the surrounding air, producing a shock wave heard as thunder.
- When part of this energy reaches the ground, it is converted into seismic waves, called as "Thunderquakes".
- **Technology - Distributed Acoustic Sensing (DAS)** used to convert ordinary fibre-optic cables into thousands of vibration sensors.
- A laser-based **interrogator** sends light through the fibre and detects tiny changes caused by ground vibrations.
- The study used a 4+ km fibre-optic cable with more than 2,100 sensors. It recorded 458 clear thunderquakes over two years.

Thunderquakes 'X-ray' the Earth subsurface -

- Thunderquakes *generate air-coupled Rayleigh waves*.
 - These waves travel along the Earth's surface and contain information about subsurface structures.
- Through **seismic dispersion**, different frequencies travel at different speeds and depths.
 - Analysing these variations helps estimate seismic wave velocity and subsurface properties.
- The study could image the subsurface to about 100 metres depth, without drilling.
- **Applications**
 - Detecting groundwater movement
 - Identifying sinkholes and underground voids
 - Detecting fractured or weathered rocks
 - Monitoring environmental contamination
 - Assessing building sites and foundations
 - Monitoring ground subsidence
- **Significance -**
 - The study provides a low-cost and non-invasive method of subsurface mapping while using existing telecommunication fibre infrastructure.
 - It can enable continuous monitoring of urban subsurface conditions.
- Similar atmospheric shock waves may also generate useful seismic signals from *Sonic booms, Volcanic eruptions, Meteor airbursts*.

Karst Landscapes

- Karst terrain develops where soluble rocks such as limestone and dolomite are dissolved by groundwater.
 - It can form caves, fractures and sinkholes.
- Karst landscapes cover about 20% of the world's continental land area and affect nearly 25% of the global population.

Possible planetary application

- It can be applied beyond Earth. *Titan, Saturn's largest moon*, is a potential candidate because atmospheric disturbances and lightning may occur there.
- NASA's *Dragonfly mission* is expected to explore Titan.

Reference

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