Rising Avalanche Risks

For Prelims: **Avalanche**, **Earthquake, Himalayas**, **Avalanche Monitoring Radar.**

For Mains: Causes of avalanches and ways to mitigate its risks.

Source: HT

Why in News?

A massive **avalanche** occurred in Uttarakhand's Chamoli district, burying people and properties under **snow and debris.**

- **Warmer temperatures**, **more rain, and less snowfall** are altering snow conditions, increasing avalanches in the Himalayas.

What is an Avalanche?

- **About:** An **avalanche** is the rapid flow of **snow, ice, and debris** down a mountain slope. It often carries **earth, rocks, and rubble**, causing destruction.
    - Avalanche risk peaks from **December to April** due to heavy **winter snowfall (snow accumulation)** and **spring thaw** (weakening snow layers).

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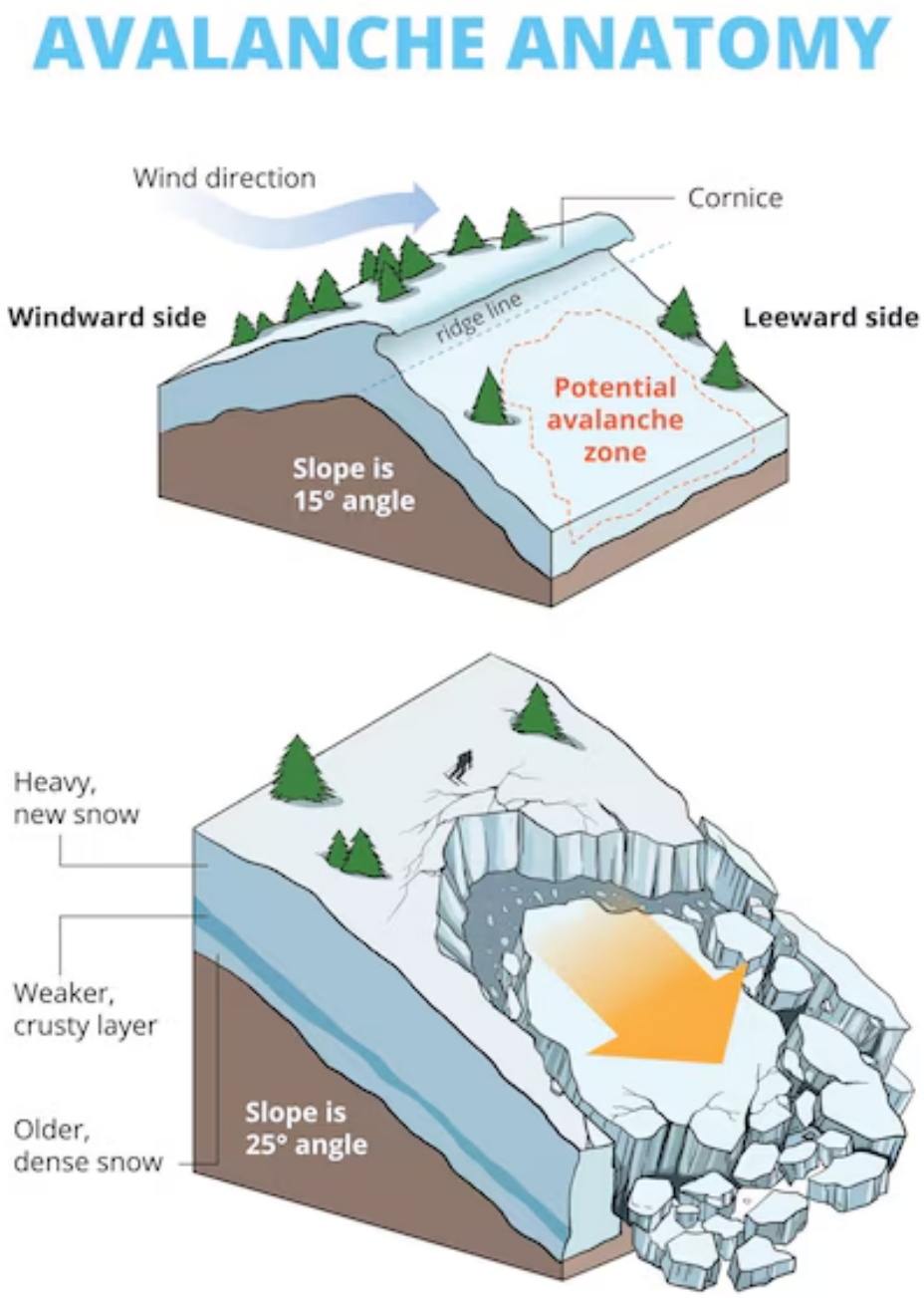

- **Types:**
  - **Loose Snow Avalanche:** It starts from a **single point** where snow is **not well bonded,** spreads in an **inverted V-shape** as snow particles fall, and is **less dangerous** due to lower volume and speed.
  - **Slab Avalanche:** It occurs when a **cohesive snow slab breaks away** from underlying layers, often reaching speeds of **50–100 km/h** and causing significant destruction.
  - **Gliding Avalanche:** The snowpack **slides down a smooth surface, like grass or rock slabs**, leaving a broad fracture line separating it from stationary snow.
  - **Wet-Snow Avalanche:** A wet-snow avalanche is naturally triggered by **rising temperatures or rain,** as meltwater weakens the snow layer bonds.

What are the Causes of Avalanche?

Natural

- **Snow Accumulation:** Continuous or excessive **snowfall increases the weigh**t of the snowpack, leading to instability. E.g., **Himachal Pradesh avalanche (January 2020).**
    - **Windy conditions** on fresh snow slopes can enhance instability.
- **Weak Snow Layers:** Temperature changes weaken the snowpack, e.g., **fresh snow over a weak base** may lead to an avalanche.
    - **Sudden warming** weakens the snowpack, leading to **wet-snow avalanches.**
- **Earthquakes:** **Seismic activity** can destabilize snow layers. E.g., **Nepal earthquake 2015** triggered avalanches in the **Langtang Valley, Nepal.**

Human-Induced

- **Deforestation:** Tree roots stabilize slopes, but **deforestation**, like in Himalayan road projects, **raises avalanche** and landslide risks.
- **Adventure Tourism:** Skiing, snowboarding, and mountaineering can trigger avalanches by **disturbing the snowpack**. E.g., In February 2024, skiers in **Gulmarg** triggered an avalanche by skiing in a **non-ski zone.**
- **Global Warming:** Rising global temperatures cause **frequent freeze-thaw cycles**, increasing avalanche risks.

How Avalanche Differ from Landslides?

Basis	Avalanche	Landslide
Definition	A type of landslide that occurs in **snowy regions**, involving the movement of snow and air.	A form of mass wasting where a **large area of land** moves under the force of **gravity.**
Causes	Heavy snowfall, Unstable snowpack, **ice** pellets, Strong winds depositing snow on slopes, **Temperature fluctuations**	Earthquakes, **Volcanic eruptions, Heavy rains and floods**, Deforestation, Wildfires
Flowing Matter	Composed of **snow and air.**	Consists of **soil, rocks, or mud.**
Occurrence	Occurs in snowy regions where snowpacks are **weakly held by snow layers.**	Happens on land with **steep slopes.**
Speed of Movement	**Very fast** (up to 250 miles per hour in extreme cases)	Can be **fast** like avalanches or **slow-moving** over time

Why are Himalayas More Prone to Avalanches?

- **Rising Temperatures:** The **Himalayas** are **warming faster than average**, causing glacier melt and **retreating snow lines**.
    - Avalanches in the western Himalayas have increased significantly since the **1970s.**
- **Wetter Snow:** Warmer temperatures cause **rain instead of snow**, making the snowpack **wetter and unstable.**
    - Rainwater percolating into the snowpack weakens its structure, **reducing friction** between snow layers and increasing avalanche risks.
- **Permafrost Melting:** The **melting of** permafrost causes **water accumulation** at their base, making ice layers **more prone to sliding.**
- **Increased Wind Speeds:** Rising temperatures are causing **higher wind speeds**, which increase snow transport and make fresh snow layers more unstable.
- **Steep Slopes:** The **steep and rugged terrain** of the Himalayas makes it **easier for snow to slide down** due to gravity.
- **Earthquakes:** The Himalayas lie in a **seismically active zone**, and **earthquakes** can trigger avalanches by shaking the unstable snow layers.

Karakoram Anomaly

- The **Karakoram Anomaly** refers to the **unusual behavior** of glaciers in the **Karakoram Range**, where they have either remained **stable or experienced slight mass gains, contrary** to the widespread trend of **glacier retreat** observed globally due to climate change.
    - **Karakoram Range** is a mountainous region spanning **Pakistan, India, Afghanistan, Tajikistan, and China.**

How to Mitigate Avalanche Risk?

- **Early Warning Systems (EWS):** EWS can reduce avalanche risk by monitoring snow conditions (using **sensors and satellites**), issuing **alerts** (weak snow layers), and aiding **rescue efforts** (timely preventive action).
    - E.g., In **2022**, India's **first avalanche monitoring radar** was installed in **Sikkim** that can detect avalanches within **3 seconds of trigger.**
- **Snow Test:** Snow tests can be conducted regularly to **assess the stability of the snowpack** and predict avalanche risks.
- **Defensive Structures: Snow sheds** can be constructed over **transportation routes** to shield vehicles from falling snow.
    - **Wall reinforcement** and **splitting wedge** can help strengthen structures and **deflect avalanches** away from buildings.
- **Dual-Purpose Infrastructure:** Build dams to **protect against flooding and debris flows** after snowmelt, ensuring **year-round disaster mitigation**.
- **Artificial Avalanche Triggering:** Controlled explosions trigger **small avalanches** to **prevent larger ones,** protecting roads, settlements, and ski slopes.
- **Afforestation:** Encouraging forest growth can help in **natural avalanche control** over time.

Conclusion

Global warming and **climate change** are intensifying avalanches in the Himalayas by **altering snowpack stability, increasing rainfall,** and **accelerating glacier melt**. With the region's **steep terrain and seismic activity**, proactive measures such as early warning systems, protective infrastructure, and controlled avalanche triggering are essential to mitigate risks and safeguard communities.

Drishti Mains Question:

Discuss how climate change is increasing avalanche risks in the Himalayas and suggest mitigation strategies.

UPSC Civil Services Examination, Previous Year Question (PYQ)

Mains

Q. Bring out the relationship between the shrinking Himalayan glaciers and the symptoms of climate change in the Indian subcontinent. (2014)