7. Heavy Rains in Himalayas - Geography

The IMD has warned of intensified rainfall and flash floods in Himalayan states due to the interaction between the monsoon trough and a western disturbance. This is exacerbated by climate change, which is causing accelerated warming and more intense rainfall, while a rising trend of 'mini-cloudbursts' is also being observed.

Current Weather Alert - Heavy Rainfall in Himalayan States

The Warning - The India Meteorological Department (IMD) has issued an alert for intensified rainfall due to a confluence of two major weather systems.

Affected Regions - The warning is primarily for the Himalayan states of Uttarakhand, Himachal Pradesh, and Jammu & Kashmir.

Associated Risks - The heavy rainfall significantly increases the risk of flash floods, landslides, and dangerously swollen rivers in these regions.

A Noted Trend - The IMD has also stated that while there is no observable increasing trend in traditional, large-scale cloudbursts, instances of "mini-cloudbursts" are on the rise.

Meteorological Interaction Behind the Heavy Rains

Converging Weather Systems - The current event is caused by a complex interaction of multiple systems - The monsoon trough is currently running south of its normal position.

An active western disturbance is present in the form of a cyclonic circulation over north Pakistan and adjoining Punjab.Additional cyclonic circulations over Rajasthan and Madhya Pradesh are actively pulling moisture from both the Arabian Sea and the Bay of Bengal.

Combined Effect - This interaction enhances wind shifts, accelerates moisture build-up, and increases atmospheric instability, creating the perfect conditions for widespread heavy to extremely heavy rainfall, particularly in the Himalayan foothills.

Understanding the Key Weather Systems

The Monsoon Trough

Definition - It is an elongated low-pressure area that is a semi-permanent feature of the monsoon circulation, stretching from the heat low over Pakistan to the Bay of Bengal.

Geographical Orientation - Its alignment is influenced by the east–west orientation of the Himalayas and the north–south orientation of the Khasi-Jaintia Hills.

Oscillation and Impact - The trough periodically shifts its position northwards or southwards -

1. **Southward Shift -** This position leads to an active or vigorous monsoon spell over most parts of India.
2. **Northward Shift -** When the trough shifts to the Himalayan foothills, it causes "break monsoon" conditions (dry spells) over central and peninsular India but simultaneously brings heavy, concentrated rainfall to the Himalayan states, which can sometimes lead to floods in the Brahmaputra river.

Western Disturbances (WD)

Definition - WDs are low-pressure systems, also known as Extra-Tropical or Mid-Latitude Cyclones, that originate in the Mediterranean region and travel eastwards across Central Asia towards India.

Occurrence - They are most common during the winter months (November–April), with their peak frequency in January–February.

Impact on Indian Weather - They are the main source of winter rainfall in the northwestern plains (crucial for Rabi crops). They bring heavy snowfall to the higher Himalayan altitudes, which is vital for replenishing glaciers and ensuring a steady flow of water in rivers during the summer.

The Role of Climate Change in Himalayan Extreme Weather

Rising Temperatures

Accelerated Warming - The Himalayas have been warming at nearly twice the global average since the year 2000.

Increased Precipitation Intensity - Warmer air can hold approximately 7% more moisture for every 1°C rise in temperature, leading to rainfall events that are heavier, longer, and more frequent.

Glacial Retreat - The rapid melting of glaciers has led to the formation of numerous unstable glacial lakes, increasing the risk of devastating Glacial Lake Outburst Floods (GLOFs).

Changing Nature of Western Disturbances

Seasonal Shift - Once confined mainly to winter, WDs now occur throughout the year, bringing unseasonal and extreme rainfall.

Moisture Intensification - Global warming, particularly the warming of the Arabian Sea, injects additional moisture into these systems, amplifying the amount of rainfall they can produce over the Himalayan states.

Cloudbursts Explained

Definition and Nature

IMD Definition - A cloudburst is a weather event where 10 cm (100 mm) or more of rainfall occurs within one hour over a localized area of 20–30 sq. km.

Mini Cloudburst - This is a related term for an event with 5 cm (50 mm) of rainfall per hour.

Nature and Predictability - Cloudbursts are extremely localized and sudden, making them impossible to forecast accurately with current technology.

Characteristics

High-Intensity, Short-Duration Rainfall - They are defined by extremely heavy rain (over 100 mm/hour) that lasts for a very short period, from a few minutes to an hour. Examples include the 2010 Leh cloudburst and the 2021 Uttarakhand cloudburst.

Localised Impact - The destruction is confined to a small area, typically less than 20–30 sq. km, as seen in the 2022 Amarnath Yatra cloudburst.

Mountainous Terrain - They occur most frequently in hilly regions like the Himalayas due to the orographic effect (the forced upward movement of moist air by mountains).

Mechanism of a Cloudburst

1. **Moisture Inflow -** Warm, humid winds from the monsoon currents move inland.
2. **Rapid Orographic Lift -** The steep terrain of the mountains forces this moist air to rise very quickly.
3. **Rapid Condensation -** As the air ascends, it cools rapidly, causing its water vapour to condense into dense, moisture-heavy clouds.
4. **Sudden Downpour -** The cloud becomes so saturated that it can no longer hold the water, releasing a massive amount in a very short time, leading to a cloudburst.

Observed Trends and Consequences

Forecasting Limitations - While satellite imagery can detect large, dense cloud cover, it cannot predict if or when a cloudburst will occur.

Fragile Terrain - In the sensitive Himalayan ecosystem, even 2–5 cm of rainfall can trigger landslides, making these events particularly dangerous.

Risks and Consequences - The primary risks are flash floods and landslides. They cause rivers to swell suddenly, as seen with the Chenab River in Jammu, where an overflow led to landslides that killed 30 people. They frequently cause disruption to pilgrimage and tourist routes, road blockages, and severe infrastructure damage.

Source - https - //timesofindia.indiatimes.com/city/dehradun/2-system-interaction-may-trigger-heavy-rains-in-uttarakhand-himachal-and-jk/articleshow/123619234.cms