RISING BLACK CARBON HEATING HIMALAYAN SNOW - ENVIRONEMNT

NEWS: A study by **Climate Trends** shows **rising black carbon (BC) levels** in the Himalayas are **accelerating snow surface heating**, with serious implications for **glacier melt and downstream water security**.

- The Himalayas, often termed the **"Third Pole"**, are crucial for **water security, glacial stability, and climate balance across South Asia.**

WHAT'S IN THE NEWS?

Warming Snow Surfaces

- **Rising Snow Surface Temperatures**:
    - Between **2000 and 2009**, the average snow surface temperature in the Himalayas was around **-11.27°C**.
    - This temperature increased significantly to **-7.13°C** between **2020 and 2023**, indicating clear **warming trends** on snow-covered regions.
    - This warming is mainly due to **climate change**, which affects high-altitude and snow-covered areas more rapidly than lowlands.
- **Geographical Variations in Snow Warming**:
    - The **Eastern Himalayas** experienced the **highest increase** in snow surface temperatures.
    - The **Central Himalayas** followed, and the **Western Himalayas** were relatively cooler.
    - These variations may be influenced by **differences in altitude, exposure to moisture-laden winds, solar radiation, and anthropogenic emissions**.

Glacier and Water Security Impact

- **Threat to Glaciers**:
    - The accelerated **melting of glaciers** is a direct consequence of rising snow surface temperatures.
    - This melt leads to a **reduction in glacier volume**, threatening the long-term existence of many Himalayan glaciers.
- **Impact on Downstream Populations**:

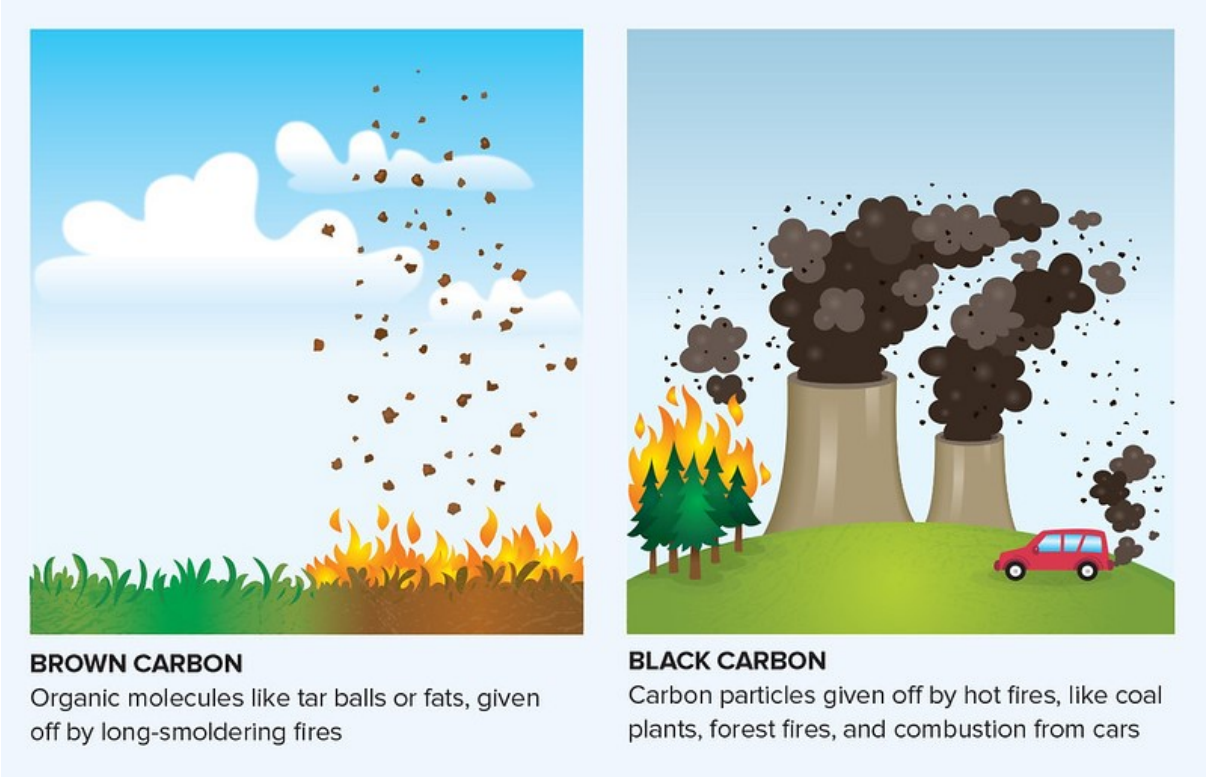
    - **Nearly 2 billion people** who live downstream in **South and Southeast Asia** depend on the **Himalayan glaciers for freshwater**.
    - These glaciers feed major river systems like the **Ganges, Brahmaputra, and Indus**, which are vital for **drinking water, irrigation, hydropower, and ecosystem balance**.
- **Shortening of Snow Season**:
    - The **onset of snowmelt is occurring earlier** each year.
    - The **duration of snow cover** is reducing, affecting **water availability during the dry season**, especially for agriculture.
- **Broad Impacts**:
    - This altered snow and melt pattern affects **river flows**, disrupts **agriculture calendars**, and endangers **ecosystems and biodiversity** that rely on predictable seasonal changes.

Snow Depth Paradox

- **Increase in Snow Depth**:
    - Despite overall warming, the **average snow depth** rose from **0.059 meters (2000–2009)** to **0.117 meters (2020–2023)**.
    - This paradox challenges the usual expectation that rising temperatures reduce snow cover.
- **Reasons for Increased Snow Depth**:
    - **Increased Snowfall**: Warmer air holds more moisture, which can lead to **more intense snowfall**, especially during specific cold spells.
    - **Shift in Seasonal Precipitation**: Changes in the **timing and type of precipitation** (more snow instead of rain in colder months) can contribute to thicker snow layers.
    - **Wind Redistribution**: Strong winds can **blow and pile up snow** unevenly across the landscape, leading to deeper accumulations in some regions.
- **Regional Observation**:
    - The **Western Himalayas** exhibited the **greatest snow depths**.
    - This is because the region is **higher in elevation**, and is more **frequently exposed to Western Disturbances**—weather systems that bring **intense winter precipitation** in the form of snow.

Black Carbon as Catalyst to Global Warming

- **Nature of Black Carbon (BC)**:
    - Black Carbon is a **short-lived but highly potent climate pollutant**.
    - It is produced through **incomplete combustion** of biomass and fossil fuels, including **wood, coal, diesel, and agricultural waste**.
- **Effect on Climate and Snow**:
    - Unlike other aerosols (e.g., sulfate aerosols) that **reflect sunlight and cool the atmosphere**, BC **absorbs solar radiation**.
    - When BC settles on snow and ice, it **reduces albedo** (reflectivity), meaning snow **absorbs more heat**, accelerating **melting**.
    - This contributes to **surface warming** and alters the **hydrological cycle**, leading to **unpredictable water availability and flooding risks**.



Sources of Black Carbon

- **Geographic Hotspot**:
    - The **Indo-Gangetic Plain**, stretching across **northern India, Pakistan, Nepal, and Bangladesh**, is one of the **world's most polluted regions** and a major **BC hotspot**.
    - This region lies just **south of the Himalayas**, making it particularly influential in **transporting pollutants to glacier zones**.

- **Major BC Sources**:
    - **Biomass Burning**: Includes burning of firewood, cow dung, crop residues, and forest biomass for heating and cooking.
    - **Fossil Fuel Combustion**: Emissions from **vehicles**, **industries**, and **coal-based power plants** contribute significantly to BC.
    - **Forest and Agricultural Fires**: Seasonal **stubble burning** and **wildfires** release large quantities of BC into the atmosphere.
    - **Biofuels**: Use of traditional cooking fuels like **kerosene, wood, and dung cakes** in rural areas is a major BC source.
- **India's BC Emission Profile**:
    - It is estimated that **biofuel use alone contributes around 42%** of **India's total black carbon emissions**.
    - This highlights the urgent need for **clean cooking energy transitions** to reduce BC levels and mitigate climate impacts.

Source: https://www.thehindu.com/sci-tech/energy-and-environment/rising-black-carbon-heating-himalayan-snow-study/article69638446.ece