Black Carbon and Glaciers

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Black carbon (BC) deposits produced by human activity which accelerate the pace of glacier and snow melt in the Himalayan region can be sharply reduced through new, currently feasible policies by an additional 50% from current levels, new research by World Bank (WB) specialists has said. Research report titled "Glaciers of the Himalayas, Climate Change, Black Carbon and Regional Resilience" released recently said that full implementation of current policies to mitigate BC can achieve a 23% reduction but enacting new policies and incorporating them through regional cooperation among countries can achieve enhanced benefits.

In news: Strong policies on black carbon can sharply cut glacier melt, says World Bank study
Placing it in syllabus: Environment
Dimensions

- Black carbon and its sources
- Glaciers and their significance
- Effects of Black Carbon on the environment esp. on glaciers
- Steps to reduce emission of black carbon

Content:

Black Carbon and its Sources:

- Black carbon, or soot, is part of fine particulate air pollution (PM2.5) and is a short-lived climate pollutant with a lifetime of only days to weeks after release in the atmosphere.
- It is produced both naturally and by human activities as a result of the incomplete combustion of fossil fuels, biofuels, and biomass

- Complete combustion would turn all carbon in the fuel into carbon dioxide (CO_2), but combustion is never complete and CO_2, carbon monoxide, volatile organic compounds, and organic carbon and black carbon particles are all formed in the process.
- The complex mixture of particulate matter resulting from incomplete combustion is often referred to as Black Carbon.

Sources:

- Approximately 20% of black carbon is emitted from burning biofuels, 40% from fossil fuels, and 40% from open biomass burning.
- Industry [primarily brick kilns] and residential burning of solid fuel together account for 45–66% of regional anthropogenic [man-made] BC deposition, followed by on-road diesel fuels (7–18%) and open burning (less than 3% in all seasons)

Glaciers and Their Significance:

- A glacier is a huge mass of ice that moves slowly over land.
- The main storage of fresh water is concentrated in glaciers.
- More than one tenth of the land is covered with “eternal” ice, and one fifth of the whole surface of our planet is annually coated with snow.

Glaciers fall into two groups: ***alpine glaciers*** and ***ice sheets.***

- **Alpine glaciers** form on mountainsides and move downward through valleys. Alpine glaciers are found in high mountains of every continent except Australia (although there are many in New Zealand). Alpine glaciers are also called valley glaciers or mountain glaciers.
- **Ice sheets** are not limited to mountainous areas. They

form broad domes and spread out from their centers in all directions. As ice sheets spread, they cover everything around them with a thick blanket of ice, including valleys, plains, and even entire mountains. The largest ice sheets, called continental glaciers, spread over vast areas.

Typically, glaciers exist and may even form in areas where:

- mean annual temperatures are close to the freezing point
- winter precipitation produces significant accumulations of snow
- temperatures throughout the rest of the year do not result in the complete loss of the previous winter's snow accumulation

Significance:

- Glaciers provide people with many useful resources. **Glacial till** provides fertile soil for growing crops. Deposits of sand and gravel are used to make concrete and asphalt.
- The most important resource provided by glaciers is **freshwater**. As natural water reservoirs, they represent 75% of freshwater on Earth. Many rivers are fed by the melting ice of glaciers. The Gangotri Glacier, one of the largest glaciers in the Himalayan Mountains, is the source of the River Ganga. The Ganga is the most important source of freshwater and electricity in India and Bangladesh. (Electricity is created by dams and hydroelectric power plants along the Ganges.)
- Some companies link glacial water to clean, fresh taste. Because water has been trapped in the glacier for so long, many people believe it has not been exposed to pollutants that liquid water is exposed to.
- **Glaciers dug basins** for most of the world's lakes and carved much of the Earth's most **spectacular mountain scenery.** The dramatic, diverse landscape of Yosemite

Valley, California, was sculpted entirely by glaciers during the last Ice Age.

- There are almost 55,000 glaciers in the Himalaya, Karakoram and Hindu Kush (HKHK) mountain ranges, and they store more freshwater “than any other region outside the North and South Poles”.
- The glaciers contain estimated ice reserves of 163 cubic kilometres, of which almost 80% feeds the Indus, the Ganges and the Brahmaputra

Cryosphere:

Cryosphere refers to “the part of the Earth’s crust and atmosphere subject to temperatures below 0°C for at least part of each year”. The snow, ice, and frozen ground all constitute the cryosphere, considered a source of climatic diagnosis due to its sensitivity to air temperature and precipitation changes.

Effects of Black Carbon on the Environment esp. on glaciers

Accelerating Snow Melt:

- Black carbon (BC) deposits produced by human activity which accelerate the pace of glacier and snow melt in the Himalayan region
- Deposits of BC act in two ways hastening the pace of glacier melt: by decreasing surface reflectance of sunlight and by raising air temperature
- When deposited on ice and snow, black carbon and co-emitted particles reduce surface albedo (the ability to reflect sunlight) and heat the surface.
- The Arctic and glaciated regions such as the Himalayas are particularly vulnerable to melting as a result.
- Glaciers are melting faster than the global average ice mass. The rate of retreat of HKHK glaciers is estimated to be 0.3 metres per year in the west to 1.0 metre per

year in the east.

Contributes to Global Warming:

- Black carbon is an important contributor to warming because it is very effective at absorbing light and heating its surroundings. Per unit of mass, black carbon has a warming impact on climate that is 460-1,500 times stronger than CO2.
- When suspended in the atmosphere, black carbon contributes to warming by converting incoming solar radiation to heat. It also influences cloud formation and impacts regional circulation and rainfall patterns.

Sea Level Rise:

- Melting ice sheets contribute to rising sea levels.
- As ice sheets in Antarctica and Greenland melt, they raise the level of the ocean. Tons of fresh water are added to the ocean every day.

Adds to the impact of climate change:

- Glacier melt produces flash floods, landslips, soil erosion, and glacial lake outburst floods (GLOF), and in the short run, the higher volumes of melt water could replace receding groundwater downstream.
- But in the long run, decreased water availability would aggravate water shortage.

Ecological Damages:

- Black carbon can affect the health of ecosystems in several ways: by depositing on plant leaves and increasing their temperature, dimming sunlight that reaches the earth, and modifying rainfall patterns.
- Changing rain patterns can have far-reaching consequences for both ecosystems and human livelihoods, for example by disrupting monsoons, which are critical for agriculture in large parts of Asia and Africa.

Adverse Health Impacts:

- Relative size of particulate matter Black carbon and its co-pollutants are key components of **fine particulate matter (PM2.5) air pollution**, the leading environmental cause of poor health and premature deaths.
- At 2.5 micrometres or smaller in diameter, these particles **can penetrate into the deepest regions of the lungs and facilitate the transport of toxic compounds into the bloodstream.**
- **PM2.5 has been linked to a number of health impacts** including premature death in adults with heart and lung disease, strokes, heart attacks, chronic respiratory disease such as bronchitis, aggravated asthma and other cardio-respiratory symptoms.

Steps to Reduce Emission of Black Carbon:

- Black carbon's short atmospheric lifetime, combined with its strong warming potential, means that targeted strategies to reduce emissions can provide climate and health benefits within a relatively short period of time.
- In the Himalayas, reducing black carbon emissions from cookstoves, diesel engines, and open burning would have the greatest impact and could significantly reduce radiative forcing and help to maintain a greater portion of Himalayan glacier systems.
- Regional integration and collaboration was one way to address the question of melting glaciers.

Sector Wise methods to reduce BC Emissions:

Household Energy:

- Replace traditional cooking to clean burning modern fuel cookstoves
- Replace traditional cooking and heating with clean-burning biomass stoves

- Eliminate kerosene lamps
- Replace lump coal with coal briquettes for cooking and heating
- Replace wood stove and burners with pellet stoves and boilers

Industrial Production:

- Modernize traditional brick kilns to vertical shaft brick kilns
- Modernize coke ovens to recovery ovens

Transport:

- Use diesel particulate filters for road and off-road vehicles
- Fast transition to Euro VI/6 vehicles and soot-free buses and trucks
- Eliminate high-emitting diesel vehicles

Agriculture:

- Ban open-field burning of agricultural waste

Fossil Fuels:

- Capture and improve oil flaring and gas production

Waste Management:

- Ban open burning of municipal waste

Mould your thought: Discuss the impact of Black Carbon on Himalayan Ecosystem. What can be done to preserve and prevent it?

Approach to the answer:

- Introduction
- Define black carbon and mention its sources
- Discuss its impact on Himalayan glaciers and downstream effects

- Discuss the methods to slow its impact
- Conclusion