Glaciers - The Pulse of earth's water system

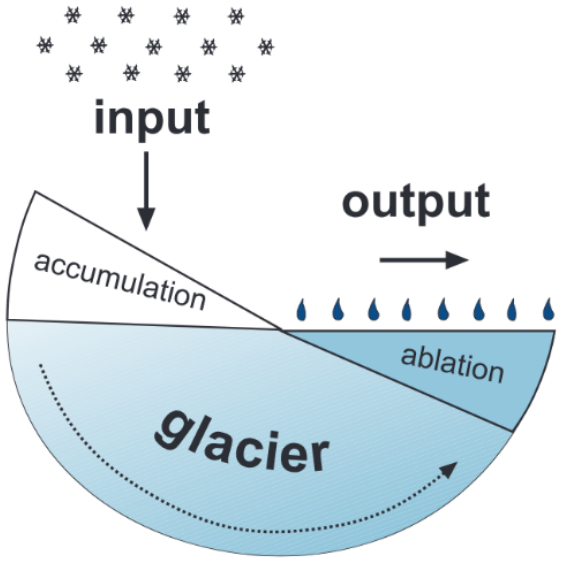
Syllabus: **GS I – Changes in Critical Geographical Features**

Why in News?

United Nations General Assembly declared 2025 as the International Year of Glaciers' Preservation and proclaimed March 21 of each year as the World Day for Glaciers, starting in 2025.

What are Glaciers?

- **Glaciers** – A glacier is an accumulation of ice and snow that slowly flows over land.
- **Formation** - At higher elevations, more snow typically falls than melts, adding to its mass.
- Eventually, the surplus of built-up ice begins to flow downhill.
- At lower elevations, there is usually a higher rate of melt or icebergs break off that removes ice mass.



- **Glacier across the globe** - The world's largest glacier complexes are located in the Polar Regions, and the ice body covering the Antarctic Peninsula (north of 70° S) is by far the largest, with an area of almost 81,000 km^2.

Continent name	Glacier complex Name	Area (km^2)
North America	Malaspina-Seward Glacier Complex	30 195
	Northern Ellesmere Icefield	19 521
	Prince of Wales Icefield	19 009
South America	Southern Patagonian Icefield	13 326
	Northern Patagonian Icefield	4018
	Cordillera Darwin Icefield	1894
Europe	Severny Island Northern Ice Cap	20 667
	Asgardfonna-Balderfonna-Olaf V Glacier Complex	8371
	Vatnajökull Ice Cap	8092
Africa	Northern Icefield Glacier Complex	1
	Kersten Glacier Complex	<1
	Stanley Glacier Complex	<1
Asia	Siachen Glacier Complex	7401
	Academy of Sciences Ice Cap	5574
	Karpinsky-University Glacier Complex	4033
Oceania	Tasman Glacier Complex	249
	Adams-Lambert Glacier Complex	43
	Lyell-Ramsay Glacier Complex	31
Antarctic	Antarctic Peninsula Ice Body[a]	80 852
	Alexander Island Glacier Complex	47 486
	Thurston Island Ice Cap	11 133

- **Icesheets** - An ice sheet is a mass of glacial ice that sits on land and extends more than 50,000 square kilometers (19,300 square miles).
- Ice sheets are constantly in motion, spreading out from broad domes.
- Ice sheets once covered much of the Northern Hemisphere during a series of Pleistocene Ice Ages.
- Currently, there are only two ice sheets on Earth: the Antarctic and Greenland Ice Sheets.
- Together, the Antarctic and Greenland Ice Sheets contain more than 99 % of the freshwater ice and 68 % of the fresh water on Earth.

What are the significances of glaciers?

- **Component of cryosphere** - Glaciers are a key component of the cryosphere, the frozen part of the Earth.

  The cryosphere encompasses all frozen parts of the Earth system, including glaciers, ice sheets, snow cover, permafrost, sea ice, lake ice, and river ice.

- **Natural water reservoir** - For centuries, glaciers have acted as natural reservoirs, storing freshwater.
- **Source of rivers** – Glaciers gradually releases water to sustain rivers that quench thirst, irrigate fields, and power hydroelectric plants.
- In regions such as the Himalayas, the Andes, and the Alps, glacier-fed rivers such as the Ganges, the Yangtze, and the Amazon form the backbone of economies and

ecosystems.

- **Biodiversity** - Many UNESCO-designated biosphere reserves depend on glacial meltwater to sustain fragile ecosystems.
- 50 UNESCO heritage sites with glaciers represent almost 10 percent of Earth's glacier area.
- **Climate change indicator** - The Glacial mass balance reflects the atmospheric conditions over a (hydrological) year and are an indicator of climate change.

Glaciologists assess the state of a glacier by measuring its annual mass balance as the combined results of snow accumulation (mass gain) and melt (mass loss) during a given year.

Status of Glacial Loss
• In 2023, glaciers experienced their greatest water loss in over 50 years, marking the second consecutive year in which all glaciated regions worldwide reported ice loss. • Switzerland, for instance, lost 10% of its total glacier mass between 2022 and 2023, according to the World Meteorological Organization (WMO). • The Intergovernmental Panel on Climate Change (IPCC) reports that glaciers have been losing approximately 273 billion tonnes of ice annually since 2000. • A UNESCO study in 2022, 'World Heritage Glaciers: Sentinels of Climate Change', warns that glaciers in one-third of these sites could disappear by 2050, underscoring the need for urgent global action.

What are the impacts of glacial loss?

- **Climate change** - Disappearance of glacial loss is accelerating sea-level rise, disrupting weather patterns, and threatening water supplies for over two billion people.
- **Reduced river flow** - Rising temperatures disrupts the water flows from mountains.
- Initially, increased glacial melt may seem beneficial — more water in rivers, more supply for cities and farms.
- Once glaciers reach a tipping point, they can no longer replenish themselves, leading to severe water shortages.

UNESCO's World Water Development Report 2025 highlights that 25 countries, home to a quarter of the world's population, already face extremely high-water stress annually, a number set to rise as glaciers disappear.

- **Droughts** - Cities such as Lima, La Paz, and Kathmandu, which depend on glacier-fed sources, are already experiencing worsening droughts and declining hydropower generation.
- **Glacial Lake Outburst Floods (GLOFs)** - As glaciers retreat, they leave behind massive lakes, precariously held back by loose, unstable rocks.
- These natural barriers are fragile, and when they collapse, they unleash sudden,

devastating floods.
- Countries such as Nepal, Bhutan and Peru are on the frontlines of this growing threat.

In October 2023, a GLOF from the South Lhonak Lake in Sikkim sent torrents of water crashing into the Teesta river, destroying infrastructure and killing dozens.

- **Biodiversity loss** - In the Hindu Kush Himalayas, glacial retreat threatens unique plant and animal species, disrupts river flows, and puts immense pressure on mountain biodiversity, destabilising ecological balance.
- **Sea level rise** - Melting ice sheets in Greenland and the Antarctic as well as ice melt from glaciers all over the world are causing sea levels to rise.
- As per the IPCC special report on "Ocean and Cryosphere in a Changing Climate", glaciers alone lost more than 9,000 billion tons of ice between 1961/62 and 2015/16, raising water levels by 27 millimetres.

What can be done?

- Glaciers are pulse of our planet's water system and Protecting them is protecting our future.
- As glaciers retreat, the need to integrate local knowledge with scientific approaches becomes even more urgent.
- Governments can strengthen policies to curb emissions, invest in climate adaptation and implement strategic initiatives for glacier protection and sustainable water management.
- Individuals can make significant change by reducing carbon footprints, advocating for climate action and supporting sustainable water management practices.
- Designation of 2025 as International Year of Glaciers' Preservation will mobilise high-level political engagement, international scientific collaboration, and education campaigns.

Reference

The Hindu | Glaciers - The pulse of earth's water system

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