5. State of the Cryosphere 2025 Report – Reports & Indices

The State of the Cryosphere 2025 Report by the International Cryosphere Climate Initiative (ICCI) warns that global ice loss is accelerating at an alarming rate, threatening catastrophic sea-level rise and water crises in Himalayan regions. The report coincides with COP30 (Belém, Brazil, 2025).

About Cryosphere - The cryosphere includes ice sheets, glaciers, snow, sea ice, and permafrost that store most of Earth's freshwater. It spans 52% of land and 5% of oceans, making it highly vulnerable to climate change. It supports 670 million people directly and billions more via freshwater supply.

Key Features - Acts as a global thermostat by reflecting sunlight and regulating temperature. Stabilizes ocean circulation through formation of cold, dense water masses at the poles. Maintains river flows for billions through glacier- and snow-fed systems.

Key Highlights of State of the Cryosphere 2025 Report

Ice Sheets - Losses from the Greenland and Antarctic ice sheets have quadrupled since the 1990s, bringing them close to irreversible thresholds. Impact - Several meters of sea-level rise over coming centuries are now likely inevitable. High emissions (warming ≥2°C) lock in >10 meters of unstoppable sea-level rise, threatening global coastal infrastructure, farmland, homes, and livelihoods.

Polar Oceans - Rising greenhouse gases are severely damaging polar ocean functions like heat/carbon absorption, marine food webs, and global ocean circulation. Antarctic Overturning Circulation (AOC) - Deep-ocean "engine" formed around Antarctica that drives the global ocean conveyor belt; now slowed substantially due to freshwater melt and warming, increasing risk of long-term, potentially irreversible disruption. Atlantic Meridional Overturning Circulation (AMOC) - Major North Atlantic current system transporting heat and regulating global climate; slowing significantly, likely from Greenland melt and warming seas, raising risk of abrupt climate shifts affecting weather, rainfall, and food systems worldwide. Ocean acidification already reaches potentially lethal levels for shelled marine life at >430 ppm CO_2. Impact - Both AOC and AMOC have slowed substantially due to freshwater melt and warm surface waters. At 2°C (≈500+ ppm CO_2), risk of irreversible circulation collapse and global species loss sharply increases, threatening food security.

Mountain Glaciers and Snow - Global glacier ice loss is increasing exponentially (273 gigatons per year from 2000–2023) with a 36% increase in the latter half. Snowpack thickness and duration are declining globally. Impact - Water supply, agriculture, economies, and political stability at risk for billions. Even at 1.5°C warming, High Mountain Asia could lose 60% of its ice; at 3°C, only 15% remains.

Sea Ice - Extent and thickness at both poles have declined 40–60% since 1979. Record lows occurred in 2023–2025. Multi-year Arctic ice (4–7 years old) has nearly vanished. Impact - Accelerates ice-sheet melt, destabilizes weather patterns and ocean circulation, and threatens ice-dependent species. At ≥2°C warming, Arctic becomes ice-free every summer.

Permafrost - Over 210,000 km² of permafrost has thawed per decade for a century, accelerating since the 1990s. Impact - Releases 0.3–0.6 Gt CO_2-eq/yr, equal to a top-10 emitter. Under 1.5°C - emissions reach ~India's level (~2.5 Gt/yr). At 3–4°C - emissions match US/China (~5+ Gt/yr) for centuries; causes infrastructure failure across Arctic.

Factors Contributing to Cryosphere Melting

Rising Greenhouse Gas Concentrations - CO_2, methane, and other gases trap more heat; the cryosphere is extremely sensitive to even 1°C–2°C warming.

Accelerated Atmospheric Warming (Arctic Amplification) - Loss of reflective ice exposes darker surfaces, absorbing more heat.

Ocean Warming & Freshwater Influx - Warm water melts ice shelves from below. Freshwater dilutes ocean surface, weakens AMOC and AOC.

Thinning of Protective Ice Shelves - Ice shelves act as "barriers"; their thinning speeds glacier flow into oceans, causing irreversible ice loss.

Marine Heatwaves-Melt Sea ice rapidly and destabilize ecosystems.

Black Carbon & Soot Deposition - From vehicles, crop burning, industry, wildfires. Reduces albedo, accelerates melt — especially in Himalayas.

Snowfall & Precipitation Changes - Less snow, more rain; reduced snowpack increases melt duration.
Human Land Use in Mountains - Tourism, roads, deforestation increase dust, warming, and glacier retreat.

Impact of Cryosphere Melting on the Ecosystem

Permafrost Thaw Releases Methane & CO_2 - Methane is 80× more potent than CO_2 (20-year scale). Leads to feedback loops and ecosystem shifts.
Loss of Sea Ice Disrupts Marine Food Webs - Sea-ice algae loss affects krill, fish, birds, penguins, seals, whales.
Rising Sea Levels Flood Coastal Ecosystems - Submerges islands, mangroves, reefs, wetlands. Threat to nations like Kiribati, Maldives, Tuvalu.
Changes in Ocean Salinity - Freshening near poles; rising salinity near tropics → ecosystem disruption.
Decrease in Albedo - More heat absorption → faster melt → further warming.
Dormant Diseases Emerging - Permafrost thaw can release ancient microbes (e.g., 2016 Siberian anthrax).
Habitat Loss for Ice-Dependent Species - Polar bears, walruses, penguins, seals face food scarcity & reproduction decline.
Disrupted Ocean Circulation - Weakening AMOC and AOC collapse fisheries and oxygen zones.
Impact on Human Livelihoods - Fishing collapse, water shortages, reduced agriculture productivity. Indigenous Arctic communities lose hunting grounds.
Loss of Snow Cover - Disrupts plant cycles, migration, and camouflage for snow-dependent species.

India's Cryosphere Crisis Cuts Two Ways

Long-Term - Sea-level rise threatens cities like Mumbai, Kochi, Kolkata, and Sundarbans.
Near-Term - Himalayan melt causes floods, water scarcity, hydrological instability.

Impact of Cryosphere Melting on India

Sea-Level Rise Risks - Coastal cities vulnerable to meter-scale rise committed by current warming.
Hydrological Whiplash - Rain-on-snow floods, GLOFs, dry-season water shortages.
Glacier Retention Projections - Western Himalaya, Karakoram, Hindu Kush - ~85% remains at 1.5°C; ~30% at 3°C
Central/Eastern Himalaya - ~40% remains at 1.5°C; ~15% at 3°C
Passing "Peak Water" - Meltwater flows will now decline permanently. Himalayan river-basin settlements may become unviable.
Extreme Events Rising - GLOFs, landslides, infrastructure failures in Himalayan states.
Black Carbon – India's Quick Lever - Cutting black carbon reduces melt within years.

Socio-Economic Risks

1. Reduced irrigation in Indo-Gangetic plains.
2. Hydropower instability.
3. Urban water stress.
4. Ecosystem and cultural loss.

Indian Government Initiatives for Cryosphere Preservation

NMSHE (Under NAPCC) - Studies climate impacts, conservation, resilience.
Centre for Cryosphere & Climate Change Studies - Research on glaciers, glacial lakes, permafrost.
ISRO Remote Sensing - Tracks glacier area, mass, movement; GLOF early warnings.
NDMA GLOF Mapping - Risk zoning, early warning systems in high-altitude areas.
Research Institutions - NCPOR, NIH Roorkee, Wadia Institute, GB Pant Institute.

Organisations Involved in Glacial Monitoring and Preservation

WMO - Global climate/glacier monitoring; Third Pole Climate Centre.
WGMS - Tracks glacier mass balance.
NCPOR - Polar & Himalayan research.
ICIMOD - HKH region cooperation.

Arctic Council - India is an observer.

Global Initiatives for Cryosphere Preservation

International Year of Glaciers' Preservation – 2025 - UN initiative to promote glacier awareness.
Decade of Action for Cryospheric Sciences (2025–2034) - Proposed UN scientific decade.
World Day for Glaciers – March 21, 2025 - Part of International Year observance.
Paris Agreement & NDCs - Global commitment to limit warming to protect cryosphere.
Cryosphere Monitoring Programmes - WGMS, NASA IceBridge, ESA CryoSat.
ICIMOD - Cross-border glacier research and resilience.
Arctic Council - Addresses Arctic glacial and sea-ice concerns.

Measures to Tackle Cryosphere Melting

Accelerate Global Climate Action - Limiting warming to 1.5°C could preserve ~50% glacier mass.
Achieve Net-Zero - Net-zero CO_2 by ~2045; net-zero GHGs by 2060s.
Fossil Fuel Phaseout - Coal → 2040s; Gas → 2050s; Oil → 2060s.
Scale Up GLOF Early Warning Systems - Expand to all Himalayan risky lakes.
Reduce Methane & Black Carbon - Cuts warming and slows glacier retreat.
Renewable Energy Expansion - Tripling by 2030, 6× by 2035, 15× by 2050.
Scale Up Carbon Dioxide Removal - Afforestation + technological CDR.
Strengthen Adaptation - Coastal defenses, water storage, permafrost protection.
Enhance Himalayan Cooperation - Data sharing, risk mapping, regional diplomacy.
Climate Finance & Tech Transfer - Support developing nations; CBDR-RC.
Eco-Sensitive Development - Regulate construction, tourism in fragile glacial areas.

Conclusion

Cryosphere preservation is now a global survival imperative. Only deep, urgent, and sustained emission cuts can prevent irreversible planetary-scale damage.

Source - https - //www.thehindu.com/news/cities/mumbai/from-himalayas-to-poles-ice-is-vanishing-cryosphere-report-warns/article70264140.ece