SCIENTIFIC EVIDENCE AND POLICY BRIEF

Table of Contents

Table of Contents **2**

1 The Convention on Planetary Hydrological Security and Cryosphere Stability (CPHSCS) **4**

2 Executive Summary **5**

3 Purpose, Scope, and Policy Rationale **7**

3.1 Purpose of the Brief 7

3.2 Defining the Cryosphere and Planetary Hydrological Security 7

3.3 The Policy Question 8

4 Scientific Evidence: The Cryosphere Is Undergoing Widespread Change **9**

4.1 Overall Assessment 9

4.2 Glaciers: Declining Ice Storage and Changing Runoff 9

4.3 Ice Sheets: Global Sea-Level Implications 10

4.4 Permafrost: Thawing Ground, Infrastructure Risk, and Carbon Feedback 10

4.5 Snow Cover: Changes in Seasonal Water Storage and Surface Reflectivity 11

4.6 Scientific Synthesis 11

5 Consequences for Water Security, Ecosystems, and Human Well-Being **13**

5.1 Water Availability and Seasonal Reliability 13

5.2 Drought, Agriculture, and Food Security 13

5.3 Sea-Level Rise and Vulnerable Coastal Communities 14

5.4 Infrastructure and Community Resilience 14

5.5 Carbon Feedback and Climate-System Interactions 15

5.6 Human Security, Equity, and Intergenerational Responsibility 15

6 The Governance Challenge: Why Greater International Coordination May Be Needed **16**

6.1 Existing International Frameworks 16

6.2 Defining the Potential Gap 16

6.3 The Case for a Complementary Convention 17

6.4 Legal and Institutional Feasibility 17

7 The Scientific Basis for the 0.01% Solutions and Green Web Approach **19**

7.1 A Strategic Approach to Ecological Leverage 19

7.2 Dust, Light-Absorbing Particles, and Snow and Ice Albedo 19

7.3 Land Restoration, Vegetation, and Soil Moisture 19

7.4 Distributed Water Retention (Distributed Pond Systems) 20
7.5 The Green Web as a Proposed Research and Demonstration Corridor 20
7.6 From Demonstration to International Learning 21

8 Policy Priorities and Proposed Functions of CPHSCS 22
8.1 Scientific Observation and Assessment 22
8.2 Planetary Hydrological Risk Assessment 22
8.3 Regional and Transboundary Cooperation 22
8.4 Ecosystem Restoration and Adaptation 22
8.5 Capacity-Building and Knowledge Exchange 22
8.6 Finance and Technology 23
8.7 Proposed Institutional Architecture 23

9 Urgency, Uncertainty, and the Case for Preventive Action 24
9.1 Why Action Is Urgent 24
9.2 Avoiding Overstatement 24
9.3 The Precautionary and Preventive Approach 24
9.4 The Cost of Fragmented Responses 24

10 A Proposed Pathway for Scientific and Legal Development 25

11 Recommended Immediate Actions 27

12 Conclusion: From Scientific Evidence to Coordinated International Action ... 28

13 References and Scientific Sources 29

1 The Convention on Planetary Hydrological Security and Cryosphere Stability (CPHSCS)

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Document purpose: To establish a scientifically grounded policy rationale for developing an international framework dedicated to planetary hydrological security and cryosphere stability.

Important status clarification: CPHSCS is a proposed convention. This brief does not imply that the Convention has been adopted, that its proposed institutional bodies have been established, or that the United Nations, UNCCD COP17, or any government has formally endorsed it.

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2 Executive Summary

The cryosphere—the interconnected components of the Earth system in which water occurs in frozen form—is undergoing widespread change in response to global warming. Glaciers are retreating, ice sheets are losing mass, permafrost is thawing across many monitored regions, and spring snow cover has declined substantially across the Northern Hemisphere. These changes affect the storage, timing, distribution, and quality of freshwater; contribute to global mean sea-level rise; alter ecosystems and landscapes; and increase risks to infrastructure, food systems, livelihoods, and human security.

The Intergovernmental Panel on Climate Change (IPCC) has established that changes across the terrestrial cryosphere are widespread and that several indicators have reached states unprecedented in centuries to millennia. More recent research reinforces the urgency of this assessment. A 2026 study based on long-term observations from 156 permafrost monitoring sites found significant increases in active-layer thickness at substantial proportions of monitored Arctic, Antarctic, and mountain sites. A 2026 assessment by the International Centre for Integrated Mountain Development (ICIMOD) also reported substantial glacier losses across the Hindu Kush Himalaya, a region whose water systems support communities and ecosystems across a large part of Asia.

The policy challenge extends beyond the physical deterioration of ice and snow. The cryosphere interacts with atmospheric processes, terrestrial ecosystems, groundwater, rivers, lakes, coastal systems, and human water demand. Its changes can therefore produce cascading consequences across national borders and across sectors of governance. Yet the relevant responsibilities are distributed among climate, biodiversity, land, freshwater, disaster-risk, scientific, and development frameworks.

Existing international agreements provide essential legal foundations for addressing these challenges. The United Nations Framework Convention on Climate Change (UNFCCC), the Convention on Biological Diversity (CBD), the UNCCD, and international watercourse agreements each address important parts of the problem. Their combined contribution should be strengthened, not displaced. The policy question is whether additional coordination, explicit objectives, scientific assessment, and international cooperation focused on the relationship between cryosphere stability and planetary hydrological security would improve the effectiveness of this existing system.

This brief proposes that CPHSCS be developed as a complementary international legal framework with the following objectives:

1) Recognize the interdependence of cryosphere stability and planetary hydrological security.
2) Strengthen the observation, assessment, and sharing of cryosphere and hydrological data.
3) Improve coordination among climate, land, biodiversity, freshwater, disaster-risk, and development policies.
4) Support regional and transboundary cooperation on water-related risks and ecological change.
5) Promote scientifically evaluated restoration, adaptation, and risk-reduction measures.
6) Establish appropriate principles, institutional arrangements, financing mechanisms, and monitoring procedures through an inclusive international negotiation process.

The central policy proposition is that protecting the cryosphere and safeguarding planetary water systems should be addressed as interconnected dimensions of long-term ecological stability, human well-being, and international cooperation.

The evidence supports urgent action. The precise form, scope, and legal obligations of any new convention should nevertheless be determined through scientific review, legal analysis, consultation with affected communities, and intergovernmental negotiation.

3 Purpose, Scope, and Policy Rationale

3.1 Purpose of the Brief

This brief consolidates the scientific evidence relevant to the proposed Convention on Planetary Hydrological Security and Cryosphere Stability. It is intended for policymakers, diplomatic representatives, scientific institutions, international organizations, universities, civil-society organizations, and other stakeholders considering how international cooperation can better address the interconnected challenges of cryosphere change and water security.

The brief has three purposes.

First, it summarizes established scientific findings on changes in glaciers, ice sheets, permafrost, and snow cover, together with the principal consequences for freshwater systems, sea level, infrastructure, ecosystems, and human well-being.

Second, it identifies a potential policy and institutional gap between the scientific understanding of interconnected cryosphere–hydrological processes and the distribution of responsibilities across existing international governance frameworks.

Third, it sets out a proposed pathway for evaluating and developing CPHSCS as a complementary legal instrument.

The brief distinguishes among three categories of statements:

Established scientific findings: Observations and assessments supported by published scientific research and authoritative assessment reports.

Policy interpretations: Conclusions about the implications of scientific findings for international cooperation and governance.

Proposed measures: Objectives, programmes, and institutional arrangements that would require further assessment, consultation, and negotiation.

This distinction is essential. Scientific evidence can establish the nature and seriousness of a problem, but the design of a convention requires additional legal, institutional, economic, and political analysis.

3.2 Defining the Cryosphere and Planetary Hydrological Security

For the purposes of this initiative, the cryosphere encompasses the Earth's frozen-water components, including glaciers, ice sheets, seasonal snow, sea ice, lake and river ice, and permafrost-associated frozen ground. These components differ in their physical properties, geographical distribution, and response to warming. They should therefore be assessed individually as well as in relation to the broader Earth system.

Planetary hydrological security is proposed as a policy concept concerning the long-term integrity and functioning of the water cycle and the ability of human and natural systems to access, retain, regulate, and sustain water under changing environmental conditions. It includes water availability, seasonal variability, water quality, ecosystem functions, disaster risks, and the transboundary consequences of changes in water storage and movement.

The two concepts are related but not identical. The cryosphere stores freshwater, influences the timing of runoff, affects surface reflectivity and energy exchange, and contributes to sea-level regulation. Hydrological security also depends on precipitation, groundwater recharge, soil conditions, wetlands, vegetation, river management, infrastructure, pollution control, and water demand.

Consequently, a comprehensive approach must address the cryosphere without treating it as the sole determinant of water security.

3.3 The Policy Question

The central policy question is not whether existing international agreements are valuable. They are indispensable. The question is whether their objectives and implementation arrangements, taken together, sufficiently address the specific interdependence of cryosphere stability, water-cycle integrity, and the resulting risks to communities and ecosystems.

CPHSCS proposes to examine this question through an internationally coordinated process that identifies existing obligations, implementation gaps, opportunities for institutional cooperation, and areas in which additional legal commitments could provide demonstrable value.

4 Scientific Evidence: The Cryosphere Is Undergoing Widespread Change

4.1 Overall Assessment

The IPCC Sixth Assessment Report, Working Group I, concludes that changes across the terrestrial cryosphere are widespread, with several indicators reaching states unprecedented in centuries to millennia. It also documents long-term glacier retreat, declining Northern Hemisphere spring snow cover, and substantial Greenland Ice Sheet mass loss.

The evidence should not be interpreted as indicating that every cryosphere component is changing at the same rate or in the same direction. Sea ice, glaciers, snow cover, ice sheets, and permafrost respond differently to temperature, precipitation, ocean circulation, local geography, and other factors. The strongest scientific conclusion is that many major cryospheric components are experiencing substantial, warming-related changes with significant consequences for the Earth system.

4.2 Glaciers: Declining Ice Storage and Changing Runoff

Mountain glaciers act as natural water-storage systems. They accumulate snow and ice during periods of net accumulation and release meltwater during warmer periods. In glacier-fed catchments, this seasonal contribution can support rivers, ecosystems, agriculture, hydropower, and communities.

The IPCC has assessed widespread glacier retreat and increased rates of retreat since the 1990s. The implications vary geographically. In some catchments, increasing melt may temporarily raise runoff before declining glacier volume reduces the amount of ice available for future release. In other locations, changes in precipitation, snow accumulation, evaporation, groundwater, and water demand may be equally important.

The Hindu Kush Himalaya provides a significant example. ICIMOD reported in March 2026 that glaciers across the region lost approximately 12% of their total area between 1990 and 2020 and around 9% of their estimated ice reserves. Its assessment also indicated that glacier ice loss has accelerated since 2000. The region's mountain water systems support major Asian river basins and communities numbering in the hundreds of millions to billions, depending on the population and geographical definition used.

These findings demonstrate the importance of sustained monitoring, catchment-specific water assessments, and regional cooperation. They do not mean that every community downstream depends directly on glacier meltwater or that the effects of glacier loss will be uniform throughout the region.

For CPHSCS, the policy implication is that glacier monitoring should be linked to hydrological modelling, water-resource planning, ecosystem assessment, disaster-risk reduction, and the needs of downstream populations.

Regional evidence should also be considered alongside global assessments. Kamp, Walther, and Dashtseren’s review of Mongolia’s cryosphere synthesizes the country’s glaciers, permafrost, seasonal snow, and related landforms, while Pan et al. document glacier recession in the Mongolian Altai during 1990–2016. These studies provide a national and regional evidence base for assessing how global cryosphere trends manifest in Mongolia; their findings should be applied within the studies’ geographic and observational limits (Kamp et al., 2022; Pan et al., 2018).

4.3 Ice Sheets: Global Sea-Level Implications

The Greenland and Antarctic ice sheets contain vast quantities of land-based ice. When land ice melts or is discharged into the ocean, it contributes to global mean sea-level rise. The rate and magnitude of future contributions depend on atmospheric and oceanic warming, ice-sheet dynamics, and other interacting processes.

The IPCC has documented increasing Greenland Ice Sheet mass loss and sustained Antarctic Ice Sheet mass loss since the early 1990s. Projections of future contributions vary by emissions pathway and by the treatment of uncertain ice-sheet processes.

Research published in 2026 has also reported substantially higher estimates of Thwaites Glacier's potential contribution to sea-level rise by 2100 under particular modelling assumptions. Such findings are important for risk assessment, but they should not be presented as a single universally accepted forecast. The results depend on the model formulation, assumed grounding-zone characteristics, and climate forcing.

Sea-level rise threatens coastal settlements, infrastructure, freshwater supplies, wetlands, and low-lying islands. Its consequences are influenced not only by global mean sea level but also by local vertical land movement, ocean circulation, tides, coastal morphology, and storm conditions.

For CPHSCS, the relevance of ice-sheet stability lies in the connection between changes in the frozen-water system and risks experienced by populations far from the regions where ice loss occurs. This provides a strong rationale for cooperation between cryosphere-monitoring institutions, climate bodies, coastal adaptation programmes, and vulnerable states.

4.4 Permafrost: Thawing Ground, Infrastructure Risk, and Carbon Feedback

Permafrost is ground that remains at or below 0°C for at least two consecutive years. Its temperature, ice content, organic matter, and physical characteristics vary widely. The active layer above it thaws seasonally and refreezes under suitable conditions.

When permafrost warms and degrades, the consequences may include ground subsidence, slope instability, erosion, altered drainage, ecosystem change, and damage to buildings, roads, railways, pipelines, airports, and other infrastructure. Where previously frozen organic matter decomposes, carbon dioxide and methane may be released, contributing to additional warming. The magnitude and timing of these effects vary according to soil conditions, moisture, vegetation, temperature, and other local factors.

A peer-reviewed study published in Communications Earth & Environment on 26 August 2026 analysed long-term active-layer measurements from 156 monitoring sites with at least ten years of observations during 2000–2024. It found statistically significant active-layer thickening at approximately 55% of monitored Arctic sites and 38% of Antarctic sites. Significant increases were also observed at more than 90% of the monitored European mountain and high-elevation Asian sites included in the study. The authors identified particularly substantial changes in some mountain permafrost settings.

These findings provide direct observational evidence of widespread permafrost degradation across multiple regions. However, the percentages describe the monitored sites included in the analysis, not the proportion of the entire Arctic, Antarctic, or global permafrost area that has degraded.

The research also has particular relevance to Mongolia and the broader high-elevation Asian region, where permafrost conditions may influence slope stability, ground conditions, ecosystems, and hydrological processes. Site-specific research is necessary before translating regional findings into national infrastructure or water-management conclusions.

For CPHSCS, priorities include long-term permafrost monitoring, the integration of ground observations with remote sensing and climate data, vulnerability mapping, and the development of adaptation guidance for affected communities and infrastructure operators.

Mongolia-focused permafrost studies add important site-specific context. Research on active-layer temperatures under a forest-steppe mosaic, spatial mapping using the TTOP approach, and thermal regimes in a permafrost-underlain Mongolian forest demonstrates the value of combining field observations with spatial modelling. These sources can inform monitoring design and vulnerability assessment, but modelled distributions and local measurements should not be treated as interchangeable or as direct measures of national infrastructure risk (Dashtseren et al., 2014; Jambaljav et al., 2022; Zweigel et al., 2024).

4.5 Snow Cover: Changes in Seasonal Water Storage and Surface Reflectivity

Seasonal snow cover stores water temporarily and influences the amount of solar energy reflected by the Earth's surface. Changes in snow extent, depth, density, and duration can affect spring runoff, soil moisture, ecosystems, water availability, and the surface energy balance.

IPCC assessments identify substantial declines in Northern Hemisphere spring snow cover. NOAA's historical assessment reported that, between 1967 and 2022, Northern Hemisphere snow cover declined by approximately 1.32% per decade in April, 4.1% per decade in May, and 12.95% per decade in June. These are historical trends for the period and dataset assessed, not measurements extending through 2026. Regional and monthly patterns vary.

Snow-cover change is important not only in polar regions and high mountains but also in continental and dryland environments where seasonal snowmelt contributes to spring soil moisture, rivers, and groundwater recharge.

For CPHSCS, snow-cover observations should be integrated into seasonal forecasting, basin-scale water accounting, drought preparedness, and assessments of how changes in the timing of snowmelt affect ecosystems and water users.

4.6 Scientific Synthesis

Taken together, the evidence establishes that the cryosphere is undergoing significant changes with implications extending beyond the geographical locations of frozen water.

The main findings are:

- Glaciers are retreating and losing ice, changing the timing and, in some regions, the longer-term availability of meltwater.
- Greenland and Antarctic ice loss contributes to global mean sea-level rise.
- Permafrost degradation affects ground stability, infrastructure, ecosystems, and carbon-cycle processes.
- Declining seasonal snow cover changes water storage, runoff timing, and surface reflectivity.

- The magnitude and distribution of consequences depend on regional conditions, future warming, and human vulnerability.

The policy response should therefore combine global scientific coordination with regional assessments and locally appropriate measures.

5 Consequences for Water Security, Ecosystems, and Human Well-Being

5.1 Water Availability and Seasonal Reliability

Water security depends not only on the total volume of freshwater available but also on when, where, and in what condition that water becomes accessible. Cryosphere changes can alter the seasonal distribution of runoff, reduce long-term ice storage, affect lake and river systems, and increase uncertainty in water planning.

The effects are not uniform. Some glacier-fed catchments may experience temporarily elevated meltwater flows before declining ice reserves reduce future contributions. Other catchments may experience changes in runoff primarily because of altered precipitation, evaporation, snow accumulation, or land-use patterns.

Effective policy must therefore avoid treating glacier loss as a simple, universal predictor of water shortage. Instead, it should support integrated assessments of precipitation, snow, ice, groundwater, surface water, ecological demand, infrastructure, and human water use.

Regional policy assessments complement the scientific literature by tracing the implications of glacier change for water, energy, food systems, and development. ESCAP's analysis of Mongolia's glaciers and its regional work on Asian glacier risks highlight the need to connect cryosphere observations with sectoral planning. UNESCO's 2025 World Water Development Report on mountains and glaciers and the World Meteorological Organization's State of Global Water Resources reports provide broader assessment contexts. These institutional syntheses are useful for policy framing, while specific quantitative claims should be traced to the underlying datasets and studies wherever possible (ESCAP, 2024, 2026; UNESCO WWAP, 2025; WMO, annual series).

5.2 Drought, Agriculture, and Food Security

Cryosphere change can interact with drought and rainfall variability to intensify water stress. In many regions, however, a drought cannot be attributed to cryosphere degradation alone. Rainfall deficits, groundwater depletion, irrigation limitations, land management, temperature extremes, and demand can all contribute.

The 2025 drought in Nepal's Madhesh Province illustrates how water stress can cascade through agricultural and social systems. An ICIMOD rapid assessment reported rainfall deficits of approximately 30–50%, the drying of more than 30% of monitored groundwater boreholes, and rice transplantation reaching only 52% by late July, compared with 92% during the same period in 2024. The assessment estimated a potential rice shortfall of 400,000–450,000 metric tonnes.

This case demonstrates the importance of groundwater monitoring, drought early-warning systems, water infrastructure, and agricultural adaptation. It should be understood as an example of interacting climatic and hydrological stresses rather than proof that cryosphere loss alone caused the drought.

The wider policy literature reinforces the need to treat water, energy, food, land, and climate adaptation as connected planning issues. ESCAP's regional analyses of systemic resilience and SDG 6, the World Bank Group's Mongolia Country Climate and Development Report, and the World Bank's analysis of herder adaptation provide complementary context on climate exposure, development choices, and resilience. UNDP Mongolia's Nationally Determined Contribution stocktake and its work on rural community adaptive capacity can

help connect these regional findings to national planning and local implementation. These reports inform policy context; they do not establish that cryosphere change alone causes any particular drought or food-security outcome (ESCAP, 2025, 2026; World Bank Group, 2024; World Bank, 2024; UNDP Mongolia, 2020, 2025).

For CPHSCS, relevant measures could include:

- Linking cryosphere observations with seasonal water and drought forecasts.
- Strengthening groundwater and surface-water monitoring.
- Supporting water-efficient and climate-resilient agricultural practices.
- Protecting the water needs of vulnerable households and ecosystems.
- Improving cross-border information exchange where water systems are shared.

5.3 Sea-Level Rise and Vulnerable Coastal Communities

Sea-level rise associated with ocean warming and land-ice loss creates growing risks for low-lying coastal areas and small island states. Potential consequences include coastal flooding, erosion, saltwater intrusion into freshwater resources, ecosystem loss, and damage to housing and infrastructure.

The distribution of local impacts depends on regional ocean dynamics, land movement, coastal geography, and adaptation measures. A sound policy approach must therefore connect global cryosphere observations with local sea-level projections and community-level vulnerability assessments.

CPHSCS could provide a framework for strengthening the scientific and institutional links between ice-sheet monitoring, sea-level assessment, coastal planning, and international support for vulnerable populations.

5.4 Infrastructure and Community Resilience

Permafrost degradation and cryosphere-related hazards can damage infrastructure and disrupt essential services. Glacial lake outburst floods, unstable slopes, changing river flows, thaw settlement, and erosion may pose risks to settlements, transport networks, energy systems, and water infrastructure.

These hazards require location-specific assessments rather than generalized global risk percentages. Infrastructure exposure depends on engineering design, local ground conditions, maintenance, settlement patterns, and the availability of monitoring and emergency-response systems.

A proposed CPHSCS framework could encourage common risk-assessment methods, data exchange, technical cooperation, and adaptation planning in affected regions.

The World Bank Group's Mongolia Country Climate and Development Report and its policy analysis of natural and built capital provide additional context for evaluating climate resilience, infrastructure, and economic-development choices in Mongolia. Such development assessments can help identify where cryosphere-related risks intersect with existing national priorities, but their recommendations should be distinguished from direct measurements of glacier or permafrost change (World Bank Group, 2024; World Bank, n.d.).

5.5 Carbon Feedback and Climate-System Interactions

The thawing of permafrost can expose previously frozen organic matter to decomposition. This may release carbon dioxide and methane and contribute to further warming. The magnitude of the feedback depends on the amount and composition of carbon in the affected ground, moisture and oxygen conditions, vegetation, and the balance between emissions and carbon uptake.

Cryosphere change also interacts with surface reflectivity, atmospheric circulation, ocean processes, and ecosystems. These interactions reinforce the importance of reducing greenhouse gas emissions while improving monitoring, adaptation, and risk management.

The proposed Convention should complement, not substitute for, climate mitigation commitments under the UNFCCC and the Paris Agreement.

5.6 Human Security, Equity, and Intergenerational Responsibility

Cryosphere and hydrological changes can disproportionately affect communities with limited resources, weak infrastructure, high dependence on natural water systems, or restricted access to adaptation finance and scientific information.

Relevant policy considerations include the rights and needs of Indigenous Peoples, mountain communities, pastoralists, smallholder farmers, women, children, persons with disabilities, and populations in vulnerable coastal and dryland areas. These groups are not uniformly vulnerable; their circumstances and priorities must be established through inclusive consultation.

A scientifically credible international framework should combine physical observations with social and economic assessments. Its purpose should be to support equitable risk reduction, protect essential water functions, improve public access to relevant information, and strengthen the capacity of present and future generations to respond to environmental change.

6 The Governance Challenge: Why Greater International Coordination May Be Needed

6.1 Existing International Frameworks

The international legal system already contains important agreements relevant to cryosphere stability and planetary hydrological security. These instruments have different purposes, legal obligations, parties, and implementation arrangements.

International framework	Principal relevance	Potential area for stronger coordination
United Nations Framework Convention on Climate Change and Paris Agreement	Climate mitigation, adaptation, and international climate cooperation	Stronger integration of cryosphere observations and hydrological risk assessments into climate planning and implementation
Convention on Biological Diversity	Biodiversity conservation, sustainable use, and related ecosystem objectives	Better integration of cryosphere-dependent and freshwater ecosystem changes into biodiversity assessment and action
United Nations Convention to Combat Desertification	Land degradation, drought, and sustainable land management	Improved coordination between dryland water stress, land restoration, and upstream or regional hydrological changes
Convention on the Protection and Use of Transboundary Watercourses and International Lakes	Cooperation on transboundary watercourses and international lakes among its parties	Stronger links between river-basin governance and relevant upstream cryosphere observations
Convention on the Law of the Non-Navigational Uses of International Watercourses	Principles and rules for international watercourse cooperation	Better scientific coordination where changes in snow, ice, or permafrost affect shared watercourses
Convention on Wetlands (Ramsar Convention)	Conservation and wise use of wetlands	Better integration of changes in snowmelt, glacial runoff, permafrost, and wetland hydrology where relevant

These instruments are complementary. The table identifies potential coordination opportunities; it does not establish that any one of these agreements is legally deficient or incapable of addressing a particular cryosphere-related issue. Their actual application depends on the text of each instrument, the parties involved, and the relevant circumstances.

6.2 Defining the Potential Gap

The potential gap is best understood as a question of institutional integration rather than a complete absence of international law.

Cryosphere processes cross geographical and administrative boundaries. Their consequences can affect climate policy, water allocation, land management, biodiversity, infrastructure, disaster preparedness, and human development simultaneously. The relevant scientific information may be collected by different institutions using different methods, reporting periods, spatial scales, and data-access arrangements.

Existing frameworks can address many of these consequences. However, there may be opportunities to improve:

1) The consistency and accessibility of cryosphere and hydrological observations.
2) The assessment of cumulative and cross-border risks.
3) The coordination of policies across land, water, climate, and ecosystem objectives.
4) The sharing of scientific expertise and technical capacity.
5) The integration of long-term cryosphere change into water-security planning.
6) The identification of responsibilities for sustained monitoring and reporting.

The United Nations Environment Programme's analysis of gaps in international environmental law provides a broader precedent for examining how legal instruments and governance arrangements can be strengthened. It does not, however, establish the existence or necessity of CPHSCS specifically. That case must be demonstrated through a dedicated legal and institutional assessment.

Other international and regional policy sources can help test whether the potential coordination gap is substantive or can be addressed through existing arrangements. ESCAP's regional glacier-risk analyses, UNESCO's mountain-and-glacier water assessment, WMO's global water-resource assessments, and the 2025 Dushanbe Glaciers Declaration and relevant United Nations resolutions demonstrate that cryosphere and water issues already receive attention through several scientific and diplomatic channels. These sources should be used to map existing initiatives and identify remaining needs, not as evidence that a new convention is necessarily required. A dedicated legal and institutional comparison remains essential.

6.3 The Case for a Complementary Convention

The rationale for CPHSCS is to evaluate whether a dedicated international framework could provide additional value by making the cryosphere–hydrological relationship an explicit subject of coordinated international action.

Possible added value could include common assessment principles, structured scientific cooperation, reporting arrangements, technical assistance, capacity-building, and a regular process for reviewing emerging risks and policy responses.

Before any negotiation, a detailed gap analysis should identify which activities are already adequately covered, which require better implementation of existing obligations, and which may justify additional international commitments. A new convention should be pursued only where its expected benefits justify its institutional and financial costs.

6.4 Legal and Institutional Feasibility

The development of CPHSCS would require a careful review of international law, including its relationship with the UN Charter, international environmental law, international water law, existing treaty obligations, and the mandates of relevant international organizations.

The process should establish whether proposed provisions would create new obligations, strengthen voluntary cooperation, facilitate implementation of existing agreements, or combine these approaches.

It should also consider the legal basis and possible route for intergovernmental negotiations, the relationship between a future conference of the parties and existing institutions, and the arrangements for adoption, signature, ratification, acceptance, approval, and entry into force.

The Convention's eventual scope and obligations should be determined by participating states through the appropriate international process, not presumed in advance by this scientific brief.

7 The Scientific Basis for the 0.01% Solutions and Green Web Approach

7.1 A Strategic Approach to Ecological Leverage

The 0.01% Solutions initiative advances an approach based on identifying strategic intervention points where targeted action may produce benefits extending beyond the immediate project area.

The name should be understood as an initiative's strategic framing, not as a scientifically established percentage of investment, land area, or effort that is guaranteed to solve a global problem. The scale of any benefit must be measured and verified.

The underlying proposition is that relatively focused interventions, when appropriately designed and connected to broader systems, may improve water retention, reduce land degradation, support vegetation, limit dust emissions, and generate useful evidence for larger restoration and adaptation programmes.

Whether these interventions produce meaningful benefits depends on their location, design, water balance, ecological setting, maintenance, community participation, and long-term monitoring.

7.2 Dust, Light-Absorbing Particles, and Snow and Ice Albedo

Fresh snow and clean ice reflect a substantial proportion of incoming solar radiation. Deposited dust, black carbon, and other light-absorbing impurities can reduce reflectivity and increase the energy absorbed at the surface, thereby enhancing melting under suitable conditions.

A 2015 study of the Claridenfirn glacier in the Swiss Alps found that Saharan dust and black carbon lowered mean annual albedo by approximately 0.04–0.06 at the studied locations and increased annual melt by approximately 15–19%, depending on location. These results came from a particular glacier and a specific long-term analysis; they should not be generalized as a universal melt increase for all glaciers.

The research supports investigating the connections among dust sources, atmospheric transport, deposition on snow and ice, and cryosphere change. It does not establish that dryland restoration alone can halt glacier loss, which is strongly driven by global and regional warming.

For CPHSCS, appropriate priorities include better monitoring of dust and black carbon, improved source attribution, research on atmospheric transport, and coordinated evaluation of measures that may reduce avoidable emissions or dust exposure.

7.3 Land Restoration, Vegetation, and Soil Moisture

Vegetation cover and soil condition influence surface stability, infiltration, evaporation, and the movement of windblown dust. In suitable locations, restoring degraded land and improving soil moisture can reduce erosion, support vegetation, and improve local water retention.

However, land restoration is not automatically water-positive. Afforestation, planting, irrigation, or other interventions can increase water consumption and reduce downstream flows if poorly matched to local hydrology. Restoration design must therefore account for native vegetation, soil characteristics, rainfall, groundwater, water demand, and the ecological limits of the site.

A scientifically sound programme should establish a baseline, specify measurable objectives, evaluate water and ecological trade-offs, and monitor outcomes over multiple years.

For Mongolia, the scientific evidence base should include research on the cryosphere as a connected set of components rather than glaciers alone. The review by Kamp et al. covers Mongolia's broader cryosphere; studies of Mongolian peatlands add evidence relevant to wetland carbon, water storage, and ecosystem functions; and research on glacier-fed lakes in the Munkh-Khairkhan Mountains offers a case-specific basis for examining cryosphere–hydrosphere interactions under dryland climate stress. These sources can guide research questions and monitoring design, but each study's methods, location, and conclusions must be checked before extrapolating to the proposed corridor (Kamp et al., 2022; Wu et al., 2025; Cryosphere–Hydrosphere Interactions study, 2026).

7.4 Distributed Water Retention (Distributed Pond Systems)

The Green Web concept includes consideration of distributed water-retention measures such as ponds, small reservoirs, restored wetlands, infiltration areas, and greenbelts. Depending on site conditions, these measures may help retain seasonal runoff, support vegetation, reduce erosion, provide local water storage, and strengthen resilience to drought.

Their performance cannot be assumed in advance. In drylands, evaporation can be high, groundwater recharge may be limited, and poorly located water structures can disrupt natural flows or damage ecosystems. Construction can also affect downstream water availability, land use, and local communities.

Accordingly, every proposed intervention should be assessed against a site-specific hydrological balance and environmental safeguards. Performance indicators may include retained water volume, evaporation and seepage, groundwater response, vegetation survival, soil stability, downstream flow, biodiversity, and maintenance costs.

The aim should be to establish which combinations of measures work, where they work, under what conditions, and at what cost.

7.5 The Green Web as a Proposed Research and Demonstration Corridor

The Green Web is proposed as a landscape-scale implementation and learning framework, with an initial corridor identified around 43°–44° North latitude in Mongolia. This geographical designation is a programme proposal, not an independently validated scientific boundary for cryosphere protection.

Its potential contribution is to test the relationship between dryland restoration, distributed water retention, soil and vegetation recovery, dust dynamics, and local hydrological resilience.

A credible demonstration programme should include:

- A documented baseline of climate, hydrology, soils, vegetation, land use, and water demand.
- A clearly defined intervention area and appropriate comparison sites.
- Long-term monitoring using field observations, remote sensing, and reproducible methods.
- Independent scientific review and transparent publication of results.
- Assessment of ecological, social, economic, and downstream impacts.
- Community participation in planning, implementation, and evaluation.

- Explicit recognition of uncertainty and unsuccessful interventions.

The initial corridor should not be presented as proof that a particular restoration model can stabilize distant glaciers or reverse global cryosphere loss. Rather, it can contribute field evidence about dryland hydrology, restoration effectiveness, and the potential for regionally coordinated ecological action.

The proposed corridor should therefore be framed as a testable landscape-scale demonstration, not as a proven cryosphere-stabilization intervention. Mongolia's glacier, permafrost, and peatland literature can establish regional context and help select indicators, while global permafrost mapping and mountain-permafrost studies can inform methods for comparing observations across sites (Obu et al., 2020; Ishikawa et al., 2025; Kamp et al., 2022). The programme should separately measure local water retention, soil and vegetation outcomes, dust-related indicators where feasible, and any downstream effects. It should not infer a causal effect on distant glacier mass balance without a credible research design and direct evidence.

7.6 From Demonstration to International Learning

The proposed pathway is to generate reliable local evidence, compare results across ecological zones, publish findings, and identify which approaches may be adapted to other regions.

The value of the 0.01% Solutions approach would therefore rest on measurable performance and independent evaluation rather than the initiative's name or scale alone.

International learning should also draw on comparable assessment systems. The WMO State of Global Water Resources reports can provide context for hydrological monitoring, while UNESCO's 2025 report and ESCAP's regional glacier publications can help frame mountain-water interdependence and regional risk. The World Bank and UNDP country studies can inform the design of locally relevant adaptation indicators and community consultation. These sources serve different purposes and should not be treated as equivalent evidence: peer-reviewed studies support specific scientific claims, while institutional reports primarily synthesize evidence and inform policy and implementation.

CPHSCS could provide a broader international setting for sharing such findings, connecting regional demonstration programmes with scientific networks, and evaluating how landscape-scale restoration can complement emissions reduction, water governance, and climate adaptation.

8 Policy Priorities and Proposed Functions of CPHSCS

The following priorities are proposed for discussion during the development of CPHSCS. They are not existing treaty obligations, nor are they presented as provisions already agreed by states.

8.1 Scientific Observation and Assessment

The Convention could encourage cooperation among scientific institutions to improve the collection, quality, comparability, and accessibility of cryosphere and hydrological data.

Possible activities include glacier mass-balance monitoring, snow-cover assessment, permafrost temperature and active-layer monitoring, ice-sheet observation, hydrological modelling, and evaluation of the consequences for downstream water systems.

Existing scientific networks and data systems should be used wherever possible. New arrangements should address demonstrated gaps rather than duplicate existing programmes.

8.2 Planetary Hydrological Risk Assessment

A proposed assessment function could examine how changes in frozen-water storage interact with precipitation, groundwater, river flows, ecosystems, infrastructure, and human water demand.

Assessments should distinguish observed changes from projections and should report uncertainty transparently. Regional and basin-scale analyses are essential because global indicators alone cannot determine local water availability or vulnerability.

8.3 Regional and Transboundary Cooperation

The Convention could facilitate scientific and technical cooperation among countries that share river basins, mountain systems, ecosystems, or related cryosphere risks.

Potential activities include shared monitoring protocols, coordinated risk assessments, early-warning cooperation, joint research, and capacity-building for institutions with limited technical resources.

Such cooperation should complement existing watercourse agreements and respect applicable international law.

8.4 Ecosystem Restoration and Adaptation

CPHSCS could support the evaluation of restoration and adaptation approaches that contribute to hydrological resilience, including wetland restoration, soil conservation, sustainable rangeland management, and context-appropriate water retention.

Activities should be based on scientific evidence and subject to safeguards against ecological damage, unsustainable water abstraction, and unintended transfers of risk to downstream communities.

8.5 Capacity-Building and Knowledge Exchange

The proposed framework could facilitate training, technical cooperation, access to scientific information, and knowledge exchange among researchers, policymakers, local communities, and institutions.

Priority areas may include cryosphere monitoring, hydrological modelling, remote sensing, drought preparedness, infrastructure adaptation, and community-based environmental observation.

8.6 Finance and Technology

Any future financing mechanism should be developed only after a clear assessment of needs, existing funding channels, institutional costs, and the relationship with established climate, biodiversity, land, and development finance.

The objective should be to mobilize additional resources where justified, avoid unnecessary duplication, and ensure transparent allocation and reporting.

Technology cooperation should support appropriate monitoring and analysis while taking account of data quality, accessibility, national capacities, and the needs of affected communities.

8.7 Proposed Institutional Architecture

Subject to legal analysis and intergovernmental negotiation, a future convention could consider the following institutional functions:

Conference of the Parties: A decision-making body established by the treaty to review implementation and agree on matters within its mandate.

Secretariat: An administrative body supporting meetings, information exchange, reporting, coordination, and implementation.

Scientific and Technical Body: An independent or intergovernmental scientific advisory arrangement to assess evidence, identify research priorities, and advise on monitoring and evaluation.

Financial and Technical Cooperation Arrangements: Mechanisms, to be determined by the parties, for supporting capacity-building, research, monitoring, and implementation where appropriate.

These are possible design options. Their form, authority, composition, funding, and relationship with existing institutions should be settled only through the process that develops the legal instrument.

9 Urgency, Uncertainty, and the Case for Preventive Action

9.1 Why Action Is Urgent

The evidence demonstrates that important cryosphere changes are already occurring. Some processes, particularly the loss of long-lived ice masses and changes to permafrost systems, can persist for long periods and may not be readily reversible on human timescales.

The precise future trajectory depends on emissions, regional climate conditions, ice and ground dynamics, and other factors. Nevertheless, IPCC assessments establish that continued warming is expected to further reduce the extent or volume of most cryosphere components. Waiting for complete certainty about every regional consequence would increase the risk of delayed monitoring, inadequate preparation, and costly adaptation. Preventive action is justified where the risks are material, even when some outcomes remain uncertain.

9.2 Avoiding Overstatement

Scientific urgency should not depend on exaggerated or unsupported claims. Three distinctions are especially important.

First, cryosphere degradation is widespread, but not every component or region changes identically.

Second, cryosphere change can contribute to water insecurity and disasters, but the outcome in any particular location depends on multiple climatic, ecological, social, and economic factors.

Third, targeted restoration and water-retention measures may generate significant local or regional benefits, but they are not substitutes for greenhouse gas mitigation and cannot be assumed to reverse global ice loss.

A credible policy framework should communicate these distinctions clearly. Scientific integrity strengthens the case for action by ensuring that decisions are grounded in evidence rather than overstated certainty.

9.3 The Precautionary and Preventive Approach

A preventive approach would combine continued emissions reduction with monitoring, adaptation, risk reduction, ecosystem protection, and international scientific cooperation. The proposed Convention should apply evidence-based assessment, transparency, periodic review, and adaptive management. Measures should be revised as scientific understanding improves, and implementation should be evaluated against measurable outcomes.

9.4 The Cost of Fragmented Responses

Where observations, risk assessments, and policies remain disconnected, governments and communities may have difficulty anticipating cascading effects or coordinating action across sectors and borders. Greater cooperation could improve the use of existing data, reveal shared risks, strengthen regional preparedness, and support more consistent long-term planning. Whether a new convention is the most effective means of achieving these outcomes should be evaluated against alternatives, including stronger implementation of existing agreements and the establishment of cooperative arrangements under current institutions.

10 A Proposed Pathway for Scientific and Legal Development

The development of CPHSCS should proceed through a staged process that keeps scientific assessment, legal design, diplomatic engagement, and practical implementation distinct while allowing them to inform one another.

Stage 1. Consolidate the Scientific Evidence

Prepare a reviewed scientific synthesis of cryosphere change and planetary hydrological security, drawing on IPCC assessments, peer-reviewed research, international monitoring networks, regional studies, and relevant national observations.

The synthesis should identify established findings, emerging evidence, uncertainties, regional differences, and research priorities.

Stage 2. Conduct a Legal and Institutional Gap Analysis

Map the relevant international agreements, institutional mandates, scientific programmes, and existing cooperation mechanisms.

The analysis should determine which needs can be met through current frameworks, which require improved implementation or coordination, and which may justify new legal commitments.

Stage 3. Establish an Independent Scientific and Technical Process

Develop transparent terms of reference for scientific review, including expertise in glaciology, hydrology, permafrost, climate science, ecology, disaster risk, international water management, and social vulnerability.

The scientific process should assess the evidence impartially. It should not be required to prove the necessity of CPHSCS in advance; it should be able to confirm, refine, or challenge the proposed policy rationale.

Stage 4. Consult States, Scientific Institutions, and Affected Communities

Conduct consultations with governments, relevant international organizations, universities, research centres, civil society, Indigenous Peoples where relevant, local communities, and other affected stakeholders.

Consultations should identify priorities, concerns, potential benefits, implementation burdens, and safeguards. They should also consider the views of countries with different capacities, geographical circumstances, and development needs.

Stage 5. Develop the Legal Options

Prepare alternative legal and institutional models, including the possibility of a new convention, a framework agreement, protocols under existing arrangements, or strengthened cooperation mechanisms.

Each option should be assessed for legal feasibility, added value, cost, enforceability, institutional compatibility, and implementation requirements.

Stage 6. Pursue an Appropriate Intergovernmental Process

If the evidence and consultations establish a sufficient basis, interested states could consider an appropriate diplomatic route for developing and negotiating a legal instrument.

The process should be transparent and inclusive, with clearly defined participation, drafting, decision-making, and review arrangements. No particular negotiation timetable or outcome should be presumed before states have considered the options.

Stage 7. Link the Legal Framework to Measurable Implementation

Any future instrument should establish clear objectives, responsibilities, reporting arrangements, and periodic review.

Where pilot programmes such as the Green Web are pursued, their results should be documented independently and used to inform wider policy development. Pilot activity should remain distinct from formal treaty adoption and should not be represented as proof of global effectiveness before sufficient evidence exists.

11 Recommended Immediate Actions

The following actions are proposed for the next phase of the initiative.

1. Commission a scientific evidence review. Verify the figures, methods, geographical scope, uncertainty ranges, and publication details used in the brief. Give priority to IPCC assessments and peer-reviewed research, while clearly labelling preliminary findings.

2. Prepare a legal and institutional mapping study. Examine the mandates and implementation arrangements of relevant climate, biodiversity, land, water, disaster-risk, and development frameworks.

3. Establish an independent scientific and technical review process. Ensure transparent selection criteria, conflict-of-interest safeguards, and the ability to report findings independently of the initiative's policy preferences.

4. Develop a CPHSCS concept paper and draft framework outline. Specify the proposed objectives, scope, principles, potential obligations, institutional options, and relationship with existing international law.

5. Prepare a research and demonstration protocol for the Green Web. Define baseline conditions, measurable indicators, comparison methods, ecological safeguards, community participation, monitoring responsibilities, and publication requirements.

6. Initiate structured consultations. Engage interested governments, scientific institutions, universities, international organizations, civil society, and affected communities to evaluate the proposed framework and its alternatives.

7. Develop a transparent implementation and financing plan. Estimate the costs of scientific monitoring, institutional coordination, technical assistance, and potential pilot projects. Identify existing programmes that could be strengthened before creating new structures.

8. Establish a public evidence and progress record. Publish the scientific references, consultation outcomes, methodological limitations, and subsequent revisions of the proposal. Clearly distinguish civil-society advocacy from formal government or United Nations decisions.

12 Conclusion: From Scientific Evidence to Coordinated International Action

The scientific evidence establishes that the cryosphere is undergoing widespread change and that the consequences extend to water systems, ecosystems, infrastructure, coastal regions, and human well-being. These changes are not confined to the places where ice, snow, and permafrost occur. Their effects can propagate through river basins, agricultural systems, settlements, and global sea-level processes, creating risks that require cooperation across scientific disciplines, policy sectors, and national borders.

Existing international frameworks provide essential foundations for responding to these challenges. The next policy task is to determine whether their implementation and coordination can be strengthened sufficiently, or whether a complementary international legal instrument would provide additional and measurable value.

The Convention on Planetary Hydrological Security and Cryosphere Stability is proposed as a framework for examining and addressing that question. Its credibility will depend on the quality of its scientific foundation, the rigor of its legal analysis, the inclusiveness of its development process, and its ability to define practical objectives without duplicating existing institutions or overstating what particular interventions can achieve.

The proposed Convention should therefore proceed through evidence, consultation, legal assessment, and intergovernmental consideration. Its purpose should be to strengthen the collective capacity to observe change, anticipate risk, protect water-related ecological functions, support affected communities, and coordinate preventive action.

The central policy principle is clear: cryosphere stability and planetary hydrological security should be considered together in the development of long-term international cooperation.

Restoring Land. Restoring Hope. By Restoring Water.

13 References and Scientific Sources

The following scientific assessments, peer-reviewed research publications, institutional reports, and international legal instruments support the scientific findings and policy analysis presented in the Scientific Evidence and Policy Brief for the proposed Convention on Planetary Hydrological Security and Cryosphere Stability.

Source-use note: The additional sources listed in this section are now connected to the relevant discussions in Sections 4–7. Peer-reviewed research is used for study-specific findings; reports from ESCAP, UNESCO, WMO, the World Bank, and UNDP are used mainly for regional synthesis, policy context, and implementation considerations. General portals are discovery tools rather than substitutes for citing a specific dataset or publication. All bibliographic details, publication dates, URLs, and quantitative claims should be checked against the original source before formal circulation.

The references are organized to correspond with the numbered citations used throughout the brief. Scientific findings should be interpreted within the geographical scope, observation periods, methodologies, assumptions, and uncertainty ranges of the original sources. International legal instruments are included to establish relevant governance context and should be interpreted according to their respective legal status, scope, and applicability.

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Source-Use and Verification Note

Scientific figures in this brief are associated with specific studies, observation periods, geographical areas, datasets, methodologies, or model scenarios. They should not be detached from those qualifications. Observed changes, model projections, and policy interpretations should be clearly distinguished. Findings from an individual glacier, monitoring network, river basin, or drought-affected region should not automatically be generalized to the entire planet.

The legal status of each international instrument must also be described accurately. Treaties, resolutions, declarations, advisory opinions, scientific assessments, and institutional reports have different legal functions and effects. The relevance of each instrument to CPHSCS should be assessed in light of its text, scope, parties, and applicable provisions.

These sources provide scientific and policy context for evaluating the proposed relationship between cryosphere stability and planetary hydrological security. They support the case for rigorous scientific assessment and consideration of stronger international coordination. They do not, by themselves, establish that CPHSCS has been adopted, ratified, endorsed, or mandated by the United Nations, UNCCD COP17, any government, or any international organization.

The proposed Convention should therefore be developed through transparent scientific review, legal and institutional analysis, consultation with affected communities and relevant stakeholders, and an appropriate intergovernmental process.

THE 0.01% SOLUTIONS–GREEN WEB–CRYOSPHERE CONVENTION INITIATIVE TEAM