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Frozen, Fragmented and Forgotten: Cryosphere Governance and the Mitigation Paradigm in International and Indian Environmental Law

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Abstract

From towering ice sheets to fragile snow cover, the cryosphere forms the backbone on which the Earth's ecological system rests as it postulates a profound control over the global climate dynamics. Although the cryosphere has profound ecological importance, its governance is still disjointed due to the absence of a global legal instrument. This paper analyses the current legal framework which regulates the cryosphere only incidentally and in a sectoral manner which leads to regulatory lacunae. Even though India is a direct stakeholder because of its reliance on Himalayan glaciers, its legal involvement is largely based on policy and not legislation. The intent is reflected in instruments like the Indian Arctic Policy, 2022 however the same lacks binding environmental obligations. The domestic environmental statutes are mainly concerned with post damage control, as opposed to the proactive protection of the cryospheric resources. This paper argues that this is a reactive approach that compromises long term climate resilience and that there is a need to shift towards resource centric protection. Despite the fact that the cryospheric crisis reflects irreversible damage, stakeholders at both international and national level have taken a mitigating approach to this crisis whereas the need is for a coordinated global action and concrete legislative intent at both these levels.

Keywords: Cryosphere, Climate Resilience, Mitigation and Climate Governance

Introduction

The cryosphere which includes glaciers, sea ice, ice sheets cover, and permafrost, essentially all the frozen parts of the earth, is one of the most critical and vulnerable regulatory ecosystem. Not only does it govern the global temperature, it also maintains sea levels, sustains freshwater supply, traps vast quantities of carbons and supports flora and fauna. Despite this crucial role that cryosphere plays in maintaining climatic equilibrium it remains on the sidelines of the international and national environmental law. Existing frameworks are rooted in the mitigation paradigm and treat cryosphere as an incidental or collateral beneficiary of climate preservation.

The cryosphere, which is a critical aspect of our planet's ecosystem, has been stuck between the ever-growing ambitions of exploring the unknown and the environmental damage sustained by it. By 2050, it is estimated that the damage to the Arctic cover could be around $182 billion to $276 billion[1] with the Arctic projected to have a summer without ice for the first time prior

[1] Dmitry A Streletskiy et al., *The costs of Arctic Infrastructure Damages due to Permafrost Degradation*, 18 ENVIRON. RES. LETT., 1 (2023).

to 2030[2]. Apart from the damage sustained due to exploration, the cryosphere also faces the threat from rising global temperatures which not only results in decline of snow cover but also critically affects the sea levels. The Himalayan region is the source of most important rivers that flow in Asia through more than 54,000 glaciers present in the region and impact the lives of billions of people.[3] Despite the critical role that the cryosphere plays in the ecosystem, there is no comprehensive regulation in the form of a global legal framework which leaves room for institutional as well as incidental lapses in the governance of the cryosphere.

International Framework Governing Cryosphere

The current unambitious commitments of maintaining 2 degrees celsius has been found to be inadequate to maintain the current ice covers in most of the ice regions with the need for temperature maintained at least 1 degree Celsius or lower to stabilize the cryosphere[4]. The Paris Agreement addresses this issue of rising temperature levels but the first Paris Agreement Global Stockade has revealed the gap between the goals and the current actions. While the Paris Agreement incidentally governs the cryosphere protection, it fails to provide any binding provisions specifically aimed at the permafrost or the glacier systems. There is a weak enforcement of the current Nationally Determined Contributions which remain self-determined and without any penalties. Other international frameworks such as the Kyoto and Montreal Protocol also address the rising temperature levels while only incidentally but also lack the strong implementation framework.

The Antarctic Treaty which was later strengthened by the Protocol on Environmental Protection to the Antarctic Treaty, governs the exploration of the Antarctic region. This exploration of mineral resources ban which is in place, protects the region from human exploration but fails to address the global climate dynamics such as rising sea levels which when addressed in the light of the cryosphere present in the region, could raise sea levels dramatically. It also fails to provide any mechanism for ice sheet stability and the role of permafrost in the cryosphere.

In November, 2025, at the COP30 which was convened in Belem, Brazil, there was only a partial acknowledgment of the thresholds governing the cryosphere which once again highlighted the gap between the reality of global climate systems and the international commitments towards conserving the cryosphere. It has been observed that the Greenland and West Antarctic ice sheets have been melting at accelerating rates[5]. Despite this, there is yet to be any integration of the physical impact on the cryosphere on the global carbon budgets as the sea level rise remains outside of the scope.

[2] Celine Heuzé & Alexandra Jahn, *The First Ice-Free Day in the Arctic Ocean Could Occur Before 2030*, 15 NAT.COMMUN., 1 (2024).
[3] SAMJWAL RATNA BAJRACHARYA & BASANTA SHRESTHA, THE STATUS OF GLACIERS IN THE HIND KUSH-HIMALAYAN REGION 122 (ICIMOD 2011).
[4] INTERNATIONAL CRYOSPHERE CLIMATE INITIATIVE, https://iccinet.org/statecryo25/ (last visited May 21, 2026).
[5] Romain Hugonnet et al., *Accelerated global glacier mass loss in the early twenty-first century*, 592 NATURE 726, 726–731 (2021).

The Mitigation Paradigm

No international covenant treats cryosphere as a separate and distinct subject requiring protection. The regulation of Cryosphere is only incidental, like in the Paris Climate Agreement and the consequent Nationally Determined Goals which focus on reduction of global temperature. The dominant assumption underlying all the international treaties and national policies and law is the linear relationship between carbon emissions and melting of glaciers. It assumes that once carbon emissions are reduced the natural consequence is going to be reduction in the ablation of glaciers. Thus, all cryosphere governance today both at the national and international level is only mitigation-centric.

This mitigation paradigm is hit by three most common natural phenomenon that are specific to cryosphere science and negate the assumption of linear relationship that most governance tools focus on. The first is the Albedo feedback loop. Albedo stems from the word 'Albus' which means white.[6] The property of a surface to reflect back radiation is what is meant by Albedo effect. It is not just an indicator of reflection, but also gravely affects climate change. Ice covers have a better albedo effect than water surfaces. In fact, water surfaces trap sunlight to further increase global temperature and cause more melting.[7] Thus, the linear relationship envisaged is in reality a feedback loop wherein even when the ideal global temperature is reached, and no more melting occurs, the heat trapped in the already melted glacial water will in turn, lead to more melting.

The second is called Permafrost Methane. When the permafrost thaws, it results in the release of greenhouse gases, especially carbon dioxide and methane. It is estimated that the permafrost locks in at least 2.5 times more carbon than is present in the atmosphere.[8] Thawing of permafrost is a result of the global temperature rise; at the same time, thawing will accelerate climate change, which in reality is the cause of it. This operates as a feedback loop. It is estimated that approximately around 110-231 billion tonnes of carbon dioxide and other greenhouse gas will be emitted by 2040 as a result of permafrost thawing. If the contributions determined as under the Paris Agreement are met this number can come down to 53 billion tonne.[9]

The third phenomenon is called the Tipping Point, which is one of the biggest hits at the simple linear relationship assumed between glacier melting and temperature rise. As defined by the Intergovernmental Panel on Climate Change, Tipping Points can be understood as those critical stages of climate change that, once reached, cannot possibly be reversed.[10] The combined

[6] Pia Gottschalk et al, *Reflecting on Surface Albedo and Climate*, 96 IR CLIM. RES., 2 (2026).

[7] Stephanie Safdie, What is The Albedo Effect And How Does it Impact Global Warming?, LEAF BY GREENLY (May 21, 2026, 10:40 PM), https://greenly.earth/en-gb/blog/ecology-news/what-is-the-albedo-effect-and-how-does-it-impact-global-warming.

[8] NATIONAL SNOW AND ICE DATA CENTER, https://nsidc.org/learn/parts-cryosphere/frozen-ground-permafrost/why-frozen-ground-matters (last visited May 21, 2026).

[9] WWF ARCTIC,https://www.arcticwwf.org/the-circle/stories/thawing-permafrost/ (last visited May 21, 2026).

[10] EUROPEAN SPACE AGENCY, https://www.esa.int/Applications/Observing_the_Earth/FutureEO/Space_for_our_climate/Understanding_climate_tipping_points (last visited May 21, 2026).

effects of continued greenhouse gas emissions can ultimately tip a natural ecosystem, like cryosphere and change its material state totally. Once this tipping point is reached, the feedback loop may start. The melting of glaciers in such a situation becomes automatic and irreversible to the extent that even in the absence of rise in global temperature glaciers would continue to melt and cause catastrophic impacts.[11]

Thus, first the melting of glaciers exposes more sea cover with trapped heat and low albedo effect. This accelerates global warming disproportionately. Further, rising temperatures cause permafrost to thaw which in itself is unstable. This thawing releases greenhouse gases, especially methane which is far more potent than any other greenhouse gas. Third, the glaciers and ice caps are prone to reaching tipping points, which may lead to a sudden, abrupt and almost irreversible collapse. This mismatch between the climate governance and reality highlights some grave concerns.

The environmental law predicts and seeks to mitigate an incremental change; however, the Crypsopheric science indicates and warns us of abrupt and non-linear transitions. It is pertinent that the cryosphere is recognised as an ecosystem demanding protection itself and not just as a secondary beneficiary of the mitigation regime that environmental law activists seek to achieve. The climate governance is mitigation centric and the complex realities of Cryospheric science highlight the failure of this mitigation approach.

India's Approach Towards Cryosphere Governance

India, being one of the nations, which is dependent on the Himalayan ecosystem, also known as the Third Pole, will be affected by damage in the cryosphere with an estimated 1.3 billion people being affected in Asia due to disturbances in the Himalayan Ecosystem. The scientific proof regarding the accelerating rate at which Himalayan glaciers are losing mass is unambiguous. The Chamoli district disaster of 2021[12] which led to more than 200 people losing their lives was attributed to a glacial detachment event. Yet this system of vital importance is governed, in India, through a framework of aspirational policies and generic statutes which were neither designed for nor are sufficient for cryosphere governance. The mitigation paradigm as discussed earlier is also reflected in the legal policy governing cryosphere governance in India as well.

National Mission for Sustaining the Himalayan Ecosystem (NMSHE) is part of the country's Action Plan for Climate Change which is introduced as a plan to provide better understanding of the fragile ecosystem and work towards the sustainable development of the region. The mission also addresses the major components required for cryosphere conservation. National Environment Policy, 2006 also addresses the threat to the ecosystem of the mountains encouraging sustainable tourism and appropriate planning for land use. The Centre for

[11] Courtney Lindwall, *Climate Tipping Points Are Closer Than Once Thought*, NRDC (May 22, 2026, 5:30 PM),
https://www.nrdc.org/stories/climate-tipping-points-are-closer-once-thought.
[12] Jonathan Amos, *Chamoli Disaster: 'It Hit the Valley Floor Like 15 Atomic Bombs'*, BBC NEWS (June 14, 2021) https://www.bbc.com/news/science-environment-57446224.

Cryosphere and Climate Change Studies, under the Ministry of Jal Shakti is focused on monitoring the glaciers as well as the levels of the glacier melt runoffs. Monitoring of glaciers forms an important component of cryosphere conservation since glaciers cover approximately 33,000 km^2 of area in the Himalayas and hence, is an essential as well as substantial part of the Himalayan ecosystem. Polar Science and Cryosphere Research (PACER), under the Ministry of Earth Sciences, is an initiative to monitor the cryosphere of the Himalayas, Antarctic and the Arctic. Despite specific policies and centres that are focused on cryosphere governance, India's response falls short because of the lack of enforcement in the absence of a strict penal framework.

It can be observed that India's cryosphere governance is more tilted towards scientific research and international cooperation with India adopting the Arctic Policy, 2022[13] which primarily focused on monitoring and research for international collaborative efforts. As both an Observer State in the Arctic Council and a Consultative Party to the Antarctic Treaty System, India contributes through its research stations, Himadri in the Arctic and Bharati in Antarctica in the scientific research component of cryosphere governance. Further, India has shown its support towards global initiatives for instance 2025, the International Year of Glacier's Preservation and the 2025- 2034 UN Decade of Action for Cryospheric Sciences[14].

This distinction between a policy and law holds integral importance when the discourse is regarding cryosphere governance since it reflects the operational failure of legal tools. With the impact on the cryosphere so high and irreversible, governance resting entirely on policy rather than law reflects the absence of legal recourse that the affected communities can seek. Despite environmental laws present, the cryosphere in the Indian legal system, finds itself in an anomalous position with the forests protected by the Forest Conservation Act, 1980, the coastal ecosystems regulated by Coastal Regulation Zone notification and wildlife habitats protected under the Wildlife Protection Act, 1972. Each of these ecosystems has a defined parameter, enforcement mechanism and legal status yet the cryosphere has none of these. In absence of a definition for the same, glaciers can fall under the category of landforms for state jurisdiction and ecological system for national protection. It is legally invisible with not a single statute clearly defining a glacier or classifies cryospheric resources as protected ecological assets.

Mitigation First Logic In India's Approach

The Environment (Protection) Act, 1986 is India's primary legislation to address the environmental concerns. It is essentially an instrument to control the pollution levels and regulate the discharge of pollutants in the environment. On its own, it does not recognize glaciers as ecological assets or have provisions for ecosystem specific regulation which can cover the cryospheric resources. It is made further more effective in the landscape of

[13] MINISTRY OF EARTH SCIENCES, GOVERNMENT OF INDIA, INDIA AND THE ARCTIC: BUILDING A PARTNERSHIP FOR SUSTAINABLE DEVELOPMENT (2022).
[14] MINISTRY OF ENVIRONMENT, FOREST AND CLIMATE CHANGE, https://www.pib.gov.in/PressReleasePage.aspx?PRID=2132964&reg=3&lang=2 (last visited May 24, 2026).

environmental protection through the Environmental Impact Assessment Notification, 2006 which governs the assessment of the infrastructure projects. Environmental Impact Assessment, which was introduced in the 1960s[15] and it was formally adopted by the United Nations in 1972[16]. Infrastructure projects in the glaciated zones are regulated through this mechanism as well which applies to non-glaciated zones as well with no separate component of cryosphere assessment. The scientific variables such as glacial mass balance trends, GLOF risk, black carbon deposition impact among others are oftentimes not even a part of regulatory EIA process. The EIA process, oftentimes, suffers from its own challenges which along with not including cryospheric provisions becomes insufficient for cryosphere protection. Thereby, it can be said that cryosphere governance is a byproduct of climate change mitigation, not a legislative objective of its own right.

The primary target of the environmental hazards due to degradation to the cryosphere are the communities which are living close to the mountains which are almost 10 percent of the global population or coasts which are approximately 29 percent of the global population. The severe impact of the changes in cryosphere or the water levels can be experienced by the marginalised members of the adjoining communities making them vulnerable to climate hazards and risks.[17] Any calamity due to the degradation of the polar, is mostly addressed in the form disaster relief rather than mitigation strategy.

Indian Judiciary's Response To Crisis

The judiciary has played a crucial role in the development of environmental governance in the country. In fact, judicial activism has been at the root of climatic governance in India. From adapting and implementing universally recognised environmental law principles like the Polluter Pays Principle, the Precautionary Principle, etc., to evolving principles like absolute liability, the Indian courts have always ruled with responsibility in the face of crisis. Cryosphere protection has also been focused upon by the Indian courts by invoking an interesting and unique jurisprudence of 'rights of nature'.

The Uttarakhand High Court in two judgments in 2017, namely Mohd. Salim vs State of Uttarakhand[18] and Lalit Miglani vs State of Uttarakhand[19] adopted a foresighted approach to address the subject of cryosphere protection. Mohd. Salim vs State of Uttarakhand laid the foundation for the well deserved recognition of glaciers like Yamunotri and Gangotri later in the Lalit Miglani judgement. Both these judgements highlight the application of the spirit of the law and not just the black letter. Based on the rights of nature approach, the Uttarakhand

[15] 2 CHRISTOPHER WOOD, ENVIRONMENTAL IMPACT ASSESSMENT: A COMPARATIVE REVIEW (Prentice Hall 2002).
[16] U.N. Conference on the Human Environment, *Report of the United Nations Conference on the Human Environment*, U.N. Doc. A/CONF.48/14/Rev.1 (June, 1972).
[17] DMITRY, *supra* note 2.
[18] Mohd. Salim vs State of Uttarakhand, 2017 SCC OnLine Utt 367.
[19] Lalit Miglani vs State of Uttarakhand, 2017 SCC OnLine Utt 392.

High Court delivered two visionary verdicts in the same year, only later to be overturned by the Supreme Court.

While dealing with a Public Interest Litigation, the Uttarakhand High Court in Mohd. Salim vs State of Uttarakhand in exercise of its parens patriae jurisdiction, granted the status of legal persons to the rivers Yamuna and Ganga, along with their tributaries and streams, having corresponding rights and duties. A legal person also known as a juristic person is an artificial creation of law where an entity is recognised to exist in law which in reality does not exist. It is out of necessity that this artificial creation of law is recognised across global jurisdictions. A legal person is accorded the same status as that of a natural person with similar rights and obligations, acting through a designated person.[20]

Recognising the spiritual and physical sustenance offered by rivers Yamuna and Ganga to communities spreading from mountains to sea, not only did the High Court recognise them as legal persons requiring protection but also ordered the constitution of a Ganga Management Board. The State's Chief Secretary along with Director of the NMAMI Range and the State's Advocate General were all appointed as the designated persons responsible to uphold the rights and maintain the obligations of the two rivers. The Court recognised the urgency to protect and preserve the living ecosystems that these two rivers form and elevated them to rights bearing personalities.

In the same year, in Lalit Miglani vs State of Uttarakhand, the Uttarakhand High Court while dealing with another Public Interest Litigation extended this 'rights of nature' approach to glaciers including Yamunotri and Gangotri glaciers by declaring them as legal person having corresponding rights and obligations just as a natural person. The High Court further remarked that constitutional rights must be bestowed on these glaciers, rivers, streams which sustain ecosystems in themselves. The Court also suggested the creation of a Nature's Rights Commission which consists of scientists and citizens whose integrity is far above any political agenda.

Citing the grave threats that the environment is under, the Uttarakhand High Court urged the application of the new environmental jurisprudence to bestow nature with legal rights. The combined effect of these two judgements was simply that these glaciers and rivers have an inherent right to exist, to be maintained without pollution and to regenerate. Cases of pollution could be taken to be injury to these legal persons and hence a right against the polluter would arise. At the same time, it established a duty, a legal duty of citizens to care towards the rights of these legal persons.

In July 2017, the Supreme Court stayed both the Salim and Lalit Miglani judgments in an appeal preferred by the Government against the Miglani judgment. While the Apex Court did not reject the grant of legal personhood to these entities on merit, however, the judgment was stayed on various procedural grounds. Few of the concerns cited by the government in its appeal included jurisdictional concerns where these rivers flow over and beyond the territory of Uttarakhand, liability of these legal persons if any damage is caused to any property or life

[20] Shiromani Gurudwara Prabandhak Committee Amritsar v. Shri Som Nath Dass and Ors, AIR 2000 SC 1421.

during flooding, enforcement mechanisms, conflict of interest that arises as a result of the appointment of state officials as designated persons, separation if power etc.[21] The judgement remains pending even today, while the legal personhood status is in abeyance.[22]

The environmental jurisprudence of the hills reveals a very interesting paradox. On one hand, the geographical landscape has never been more vulnerable, while on the other the environmental law jurisprudence and the remedies have never been richer. This paradigm shift of granting legal personhood is transformative and visionary; however, without the necessary legal backing, it cannot accrue rights and liabilities effectively.

Comparative Models: Argentina, Kyrgyzstan And Chile

Argentina's Ley de Glaciares (Law No. 26,639, enacted 2010) is perhaps the most comprehensive and vital glacier protection statute in the current time. Article 1[23] the statute defines glaciers as strategic public freshwater reserves of the nation which places them under the doctrine of public trust, making their preservation a state obligation. While there is establishment of a National Glacier Inventory, there is a provision as well which imposes a strict ban on mining, hydrocarbon extraction as well as other industrial activities within glacial zones. Failure to comply with the same leads to strict criminal penalties. But a new bill passed in 2026[24] has weakened this strict regulatory protection provided to Cryosphere with the new amendment transferring power to the provincial authorities to classify glaciers as protected and open for development. This new amendment will transfer the power of decision making into the hands of authorities which will open the gates for industrial activities in the protected glacial zones.

Kyrgyzstan's Law on Glaciers is not a standalone piece of legislation for cryosphere protection but rather a part of the Water Protection legislation. The Water Code classifies glaciers as strategic water reserves while expressly having a provision which prohibits any activity which may affect the glaciers and its integrity. The issue of reduction in glacier cover[25] continues to be a central issue for the environmental governance of the nation. Further, any damage to the glaciers is a violation of the Water Code with penalties imposed depending on the amount of damage inflicted. But through the 2017 amendment to the Code, the industrial activity ban was lifted from Davydov and Bald glaciers leading to a loophole in the cryosphere governance. Initially, it was the 1998 Kumtor gold mine incident which gave rise to the spirit of protection of the cryosphere from mining activities. Kumtor gold mine is a prominent gold mine for the world and the waste generated from this mine continues to be dumped into glaciers leading to

[21] Suji Cheriyan, S*acred Waters, Legal Rights: Reconceptualizing Personhood for Indian Rivers in the Anthropocene*, 8 IJLMH 1701, 1708 (2025).
[22] Zahid Maniyar, *Himalayan Courts: New turns in Environmental Jurisprudence***,** CJP (May 24, 2026, 2:45 PM), https://cjp.org.in/himalayan-courts-new-turns-in-environmental-jurisprudence/.
[23] Law No. 26639, art. 1 (Arg.)
[24] Rachel Flynn, *Argentina passes bill loosening protection of its glaciers*, BBC (Apr. 9, 2026), https://www.bbc.com/news/articles/c5y72e6x554o
[25] UNDP, https://www.undp.org/kyrgyzstan/blog/glaciers-kyrgyzstan-how-they-are-disappearing (last visited May 26, 2026)

reduction in glacier cover. Therefore, despite having provisions for cryosphere protection, mining activities continue to be a leading challenge for Kyrgyzstan.

Lastly, Chile presents a cautionary tale with multiple attempts to introduce a comprehensive glacier legislation, being defeated[26] primarily to continue the mineral extraction activities due to political backlash. The amendments proposed to introduce glacial and periglacial areas as protected zones and place a ban on mining activities in these zones. Although mining continues to be the main source of disturbance in the glacier cover in the Chilean Andes[27], mines continue to operate in the glacial zones. Protection of the cryosphere in Chile remains dependent on EIA which in itself is a discretionary mechanism.

This comparative analysis indicates that the effectiveness of cryosphere governance is not solely dependent on the existence of legal protections but their effective implementation even in the face of economic and political backlash. One of the major challenges that is not being addressed by any legislation is that usually the provisions focus on prevention of glacier melting, which is one of the primary concerns but glaciers with low thermal conductivity are usually not part of the discourse, which do not melt at a fast pace but there can be changes in the characteristics of the water[28] and glacier. Hence, there lies a need to address the concerns of cryosphere governance beyond melting of glaciers. Collectively, these nations highlight a recurring pattern where mining interests frequently undermine cryosphere governance. Therefore, it can be said that the cryosphere governance requires a right based legal framework rather than a discretionary one.

Conclusion And Suggestions

The cryosphere is not a casualty or a secondary victim of climate change, rather it is the very backbone of ecological stability. It is one of the most consequential parts of the ecological system of the planet, yet it remains to be the least protected. This paper has highlighted how international law furthers the mitigation approach as envisaged by the Paris Agreement which is inherently flawed as it fails to accord and recognise the cryosphere as a legal entity deserving specific protection and not just incidental protection. This results in an international environmental protection structure that is fragmented and inadequate to deal with the growing threats posed by the cryosphere.

While the UNFCCC and Paris Agreement focus on reducing global temperature and incidentally deal with cryosphere protection, the Antarctic Treaty System and Arctic Council focus on the protection of the polar regions. The Antarctic Treaty System is limited in terms of its territorial application and lacks any strong enforcement mechanism. The Arctic Council

[26] Cecilia Jamasmie, *Chile's Glacier Protection Bill Faces Fresh Delays*, MINING.COM (Oct 15, 2020, 9:19 AM), https://www.mining.com/chiles-glacier-protection-bill-faces-fresh-delays/

[27] Andreas Brenning, *The Impact of Mining on Rock Glaciers and Glaciers: Examples from Central Chile*, in DARKENING PEAKS: GLACIER RETREAT, SCIENCE AND SOCIETY (Ben Orlove, Ellen Wiegandt & Brian Luckman eds. 2008).

[28] Jakub Kronenberg, *Linking Ecological Economics and Political Ecology to Study Mining, Glaciers and Global Warming*, 23 ENV'T POL'Y & GOVERNANCE 75 (2013).

again operates without any binding obligation. The Himalayan Ecosystem remains invisible in the eyes of International Environmental law. Thus, the cryosphere continues to remain unprotected and specifically not governed through fragmented, overlapping and disconnected international regimes.

At both the national and international levels, environmental law is largely mitigation oriented. The conceptual failure that lower global temperature will automatically lower the rate of melting of glaciers is highlighted through the albedo effect, permafrost thawing and tipping points. In India, particularly the absence of any specific legislation to deal with glacier protection throws light on the underlying assumption of an incremental change in cryosphere crisis which is far from reality. The Indian judiciary has taken a proactive approach but without effective legislative support, the change is far-fetched. The judiciary can only guide but it is the legislature that builds these institutions of change and breathes life into it.

To deal with this cryosphere crisis, the most significant and impactful change can be brought through a dedicated Cryosphere Treaty having binding obligations internationally. Such a treaty must bind members to limit such activities that lead to glacial retreat and also mandate environmental impact assessment before taking up any activity in the cryospheric zones. This treaty must not just be limited to the polar regions but should also cover the Alpine, Andean and the Himalayan Cryosphere too.

Further, Article 14 under the Paris Agreement which talks about the Global Stocktake Mechanism should be amended to include cryosphere-related assessments too. Glacial states must have cryosphere-specific commitments. The UNFCCC framework must also beyond emissions recognise the intricacies of cryospheric science like the albedo effect, permafrost thawing and tipping points. Further, the Himalayan Cryosphere must be at the centre of negotiations between India, China, Bangladesh, Bhutan, Pakistan and Nepal. The Alpine Convention can serve as a model for the same. This Himalayan Cryosphere Treaty must entail shared data obligations, systematic and coordinated monitoring, early warning systems for transboundary glacial outburst and freshwater allocation.

India needs a specific legislation to protect the Himalayan Cryosphere. This Himalayan Glacier Protection Act should establish a regulatory body, mandate glacial environmental impact assessment in this ecologically sensitive zone and further assign legal personhood as envisaged by the Uttarakhand High Court with all procedural safeguards. Further, it must prompt the triggering of an emergency response mechanism like stricter emissions regulation, stricter liability and finance transfer upon a particular amount of glacial retreat or permafrost thawing. This is only possible if cryospheric science is recognised beyond the mitigation centric framework upon which environmental law is based.

These measures are complementary and require action at all levels. International and regional cooperation, national intent and judicial activism is required to address this crisis. It is needed that the reactive approach be discarded and measures be taken in anticipation as the cryosphere crisis once tipped will be almost impossible to reverse. The law must act with a faster pace than the melting of glaciers.