Beyond distribution: environmental justice challenges of Indigenous communities across the Circumpolar North

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Abstract The Circumpolar North is warming at an unprecedented pace, accelerating entrenched environmental injustices against Indigenous peoples. Although the disproportionate distribution of these harms is paramount, in this review, we contend that an exclusive emphasis on distribution is analytically inadequate. An inclusive multidimensional framework of environmental justice has been introduced that rigorously analyzes procedural, recognitional, and restorative injustices that systematically generate and perpetuate these unequal outcomes. By synthesizing findings, this review chronicles how climate impacts, ranging from sea-ice melting to permafrost thawing, are inextricably entangled with governance failure, sidelining of Indigenous knowledge, and unaddressed past legacies. The discussion also probes the structural design of these injustices, founded on colonial continuums and prevailing political economies, such as 'green colonialism'. Finally, the review maps evidence-based directions forward, highlighting the urgency of Indigenous-led governance, epistemic justice in the form of knowledge co-production, and legal reforms responding to the legal determinants of health. Placing Indigenous sovereignty and self-determination at the center is not simply a question of equity but an essential condition for successful and sustainable climate adaptation and justice in the Circumpolar North.

Keywords environmental justice; Arctic; Circumpolar North; climate justice; Indigenous;

1. Introduction: Expanding the Justice Framework in the Circumpolar North

The Circumpolar North includes the Arctic and the northernmost areas, which constitute an enormous and ecologically vulnerable area marked by harsh climates and special ecosystems.

The area is inhabited by Indigenous Peoples who have preserved varied cultural and social habits for thousands of years and constructed a close and complementary relationship with their environment. Nonetheless, the Circumpolar North is a key location for studying environmental justice because it involves intersecting environmental, political, and social vulnerabilities, which are enhanced by its location at the center of global climate change. Accelerated Arctic warming and related environmental alterations disproportionately affect Indigenous livelihoods, cultural practices, and well-being.

One of the key elements of environmental injustice is distributional injustice, which describes the unequal allocation of environmental burdens and benefits (Grove et al., 2024; Mueller and Brooks, 2020; Smollin and Lubitow, 2019). In the Circumpolar North, Indigenous peoples tend to have a disproportionate share of environmental damage, for example, from resource extraction activities, yet tend to reap fewer benefits from the same development activities carried out on their traditional lands. For example, research on wind energy development illustrates how the infrastructure burden can be disproportionately distributed on social and spatial scales, generating localized resistance despite general public acceptance (Mueller and Brooks, 2020). Likewise, research on coastal systems shows how socio-ecological shifts change who gains from and controls resources and who has rights upheld, directly affecting the perception of environmental justice within communities (Lau et al., 2021).

However, without attention to distributional injustices alone, the full picture of the systemic problems that Indigenous peoples in the Circumpolar North are suffering is not captured. The deepest injustices are typically lodged in the systems and processes that generate and reproduce these inequitable outcomes. This requires a more nuanced model that encompasses procedural, recognitional, and restorative justice. Procedural justice relates to the reasonableness and inclusiveness of decision-making procedures, focusing on whether affected communities enjoy substantial participation and influence (Savaresi et al., 2024; Taylor et al., 2023; Park et al., 2024). For instance, in offshore wind farm locations, disputes frequently occur as a result of problems with consultation with local fishing villages; thus, there is a need for equitable decision-making procedures (Park et al., 2024). Exclusion from decision-making has also been recognized as a factor leading to procedural injustice in humanitarian settings, including refugee camps (Rafa et al., 2024). The successful management of forest resources and greenhouse gas mitigation initiatives is based on guaranteeing public and political acceptability,

which is often ensured through the involvement of Indigenous Peoples in participatory workshops to assess possible strategies (Peterson St-Laurent et al., 2018).

Recognitional injustice arises from the structural neglect of Indigenous worldviews, cultural values, and sovereignty rights, usually positioning them as peripheral to scientific, policy-making, and governance policies. This highlights the importance of recognizing and incorporating the needs, values, worldviews, rights, and knowledge of marginalized groups (Rastegar and Ruhanen, 2022). For example, in agrivoltaics, recognition justice asks how current and future farming activities, including customary ones, should be acknowledged (Taylor et al., 2023). Likewise, climate justice debates often emphasize the need to recognize the specific knowledge and experiences of those affected and of particular groups (Savaresi et al., 2024). The historical context of colonialist policy and institutional racism further highlight the difficulties in attaining population health equity for Indigenous groups, leading to environmental injustice (Brown et al., 2024).

Finally, restorative injustice captures the inability to rectify prior harms, renew disrupted cultural systems, and restore community well-being. This entails the acknowledgment and repair of harm, which can vary from proactive intervention to identify possible harmful effects to institutionalized procedures for redress (Rastegar and Ruhanen, 2022). In energy justice, restorative justice seeks to rectify historical injustices and restore equilibrium, such as by repairing harm inflicted by private developers and paying compensation to affected communities (Park et al., 2024). The interrelatedness of these dimensions of justice (viz. distributional, procedural, recognitional, and restorative) highlights that environmental injustice in the Circumpolar North is not only a result of the unequal distribution of harm but also of deeply rooted systemic injustices.

This holistic approach to justice is important for building effective and just responses to the challenges facing the Circumpolar North. It goes beyond merely quantifying unequal exposure to environmental hazards and critically assessing decision-making, whose expertise matters, and how historical injustices can be redressed. Emerging work on climate justice, which has been escalating in prominence since 1997, also reinforces this holistic approach, taking into account multiple scales, dimensions, and intersections of justice, such as inter-generational justice and the effect on ecosystems (Parsons et al., 2024). It is important to understand these subtleties to ensure a just transition to low-carbon societies, which demand changes in laws

and systems to fix social and economic justice (Savaresi et al., 2024). The transition calls for inclusive climate policies that consider the interests and needs of all groups in society, particularly the most vulnerable, and provide inclusive decision-making processes (Looze et al., 2024).

2. Theoretical-Methodological Foundation: An Integrated Justice Framework

Environmental justice issues confronting Indigenous peoples of the Circumpolar North run far deeper than simple distributional injustices, which are symptoms rather than causes of injustice (Mueller and Brooks, 2020). A thorough understanding necessitates an integrated justice framework that closely examines procedural, recognitional, and restorative dimensions, in conjunction with distributional dimensions (Table 1), to encapsulate the intricacies of Indigenous experiences in this fragile region (Savaresi et al., 2024; Parsons et al., 2024; Rastegar and Ruhanen, 2022). This method recognizes that uneven distributions of environmental burdens, such as pollution or degradation of natural resources, are frequently signs of more fundamental failures of governance, recognition, and historical responsibility (Nsude et al., 2024; Mueller and Brooks, 2020).

Procedural justice underpins the resolution of these structural imbalances by emphasizing equity and participation in decision making (Savaresi et al., 2024; Taylor et al., 2023; Park et al., 2024; Rastegar and Ruhanen, 2022). For Indigenous peoples of the Circumpolar North, this axis underscores the vital significance of Free, Prior, and Informed Consent (FPIC), fair participation, and self-governance within decision-making frameworks that affect their territories and means of livelihood (Park et al., 2024; York and Yazar, 2022). Failure to meaningfully consult and engage Indigenous communities on environmental and developmental schemes, such as offshore wind farm placement or energy policy development, results in profound conflict and injustice (Looze et al., 2024; Park et al., 2024; Rafa et al., 2024). The omission of impacted communities from decisions regarding environmental disamenities is an absence of procedural justice (Grove et al., 2024). The combination of different rights, principles, and concepts and the conscious handling of power disparities are essential for promoting procedural fairness in decision making (Rastegar and Ruhanen, 2022). Research has shown that participatory processes in which Indigenous Peoples are involved in assessing climate change mitigation plans play a crucial role in enhancing public and political acceptability (Park et al., 2024).

Recognitional justice involves the legitimacy and respect of Indigenous knowledge systems, cultural practices, languages, and land-based identities, which are sometimes marginalized or ignored within dominant environmental policies and scientific thinking (Savaresi et al., 2024; Taylor et al., 2023; Parsons et al., 2024). This highlights the institutional neglect of Indigenous knowledge and modes of being, which frequently results in their marginalization from processes that directly impact their customary lands and resources (Rafa et al., 2024; Rastegar and Ruhanen, 2022). For instance, under agrivoltaics, recognition justice requires acknowledgement of current and future farming operations, including traditional farming (Taylor et al., 2023). Similarly, holistic climate justice frameworks prioritize acknowledging the specific knowledge and experience of affected groups and individuals (Parsons et al., 2024). Institutional racism and historical colonialist policies have significantly contributed to creating obstacles to population health equity among Indigenous communities, irrevocably intertwining recognition injustice with environmental consequences (Grove et al., 2024).

Restorative justice is therefore essential in addressing the long-lasting historical legacies and ongoing harms inflicted upon Indigenous peoples, calling for reparative actions, land-back programs and cultural renewal (Savaresi et al., 2024; Rastegar and Ruhanen, 2022). This aspect goes beyond simply compensating for harm to actually correcting historical injustices and correcting the balance, including actions such as remediating contaminated sites, paying offending communities and implementing programs for the replenishment of natural resources and cultural continuity (Park et al., 2024; Rastegar and Ruhanen, 2022). Pinpointing harm, both anticipatory through preventative measures and through institutionalized practices for redress, is at the heart of restorative justice (Rastegar and Ruhanen, 2022). The term “just transition litigation”, for instance, analyzes how courts can enable justice claims in the transition to low-carbon societies with restitution elements for those who are disproportionately impacted (Savaresi et al., 2024).

In addition, the Legal Determinants of Health (LDOH) offer a structural perspective in which legislation and policy can be connected to all facets of environmental justice, especially in the Circumpolar North. LDOH examines how legal and regulatory systems, or their absence, drive health outcomes and sustain or reduce inequities between groups of people (Lau et al., 2021). This lens assists in understanding that laws and policies made sometimes without proper Indigenous involvement or concern can unintentionally (or purposefully) increase

distributional harms, erode procedural rights, invalidate Indigenous knowledge, and not offer spaces for restorative action. Bringing LDOH into the justice system emphasizes the structural character of such challenges and identifies legal and policy reform as a key leverage point for obtaining environmental justice for Indigenous peoples in the Circumpolar North. This integrated approach, including procedural, recognitional, and restorative justice and an understanding of legal determinants, goes beyond a simplistic emphasis on distributed harms to critically examine the deeply embedded processes and systems that create and sustain environmental injustice in the Circumpolar North.

Table 1. Framework for analyzing arctic indigenous environmental justice

Justice Dimension	**Definition & Relevance**	**Manifestations in Arctic Indigenous Contexts**	**Rights & Principles Affected**
Distributional Justice	Concerns the unequal allocation of environmental benefits and burdens, and the assistance to respond to them (Ford et al., 2021).	• Disproportionate Climate Impacts: Rapid warming threatens health, livelihoods, and well-being, despite minimal contributions to greenhouse gas emissions (Ford et al., 2021). • Loss of Cultural Heritage: Coastal erosion and thawing permafrost are destroying archaeologically and culturally significant sites, such as an Ipiutak cemetery in Alaska and key Inuvialuit sites in Canada (Ford et al., 2021). • Food Sovereignty Threats: Climate change impedes safe travel and access for hunters and fishers, disrupting subsistence harvests in Alaska, Greenland, Siberia, and Canada (Ford et al., 2021).	• Right to lands, territories, and resources. • Right to sustain cultural and spiritual relationships with the land. • Right to physical and mental health and well-being.
Procedural Justice	Demands equitable processes,	• Inadequate Consultation: While governments often consult, practices are insufficient and fail to equitably include	• Right to participate fully

	ensuring all stakeholders have influence over decisions that affect them and can participate in fair decision-making (Ford et al., 2021).	Indigenous worldviews or secure Free, Prior, and Informed Consent (FPIC) (Ford et al., 2021). • Exclusion from Governance: Socio-political institutions often undermine Indigenous agency by failing to include them as partners or leaders. An example is the exclusion of Inuit from woodland caribou management decisions in Nunatsiavut, Canada (Ford et al., 2021). • Disadvantageous Power Dynamics: Complex power imbalances often marginalize Indigenous voices in negotiations and decision-making forums (Ford et al., 2021).	and effectively in decision-making. • Right to self-determination. • The principle of Free, Prior, and Informed Consent (FPIC).
Recognitional Justice	Addresses the social structures and institutional practices that prevent the respectful recognition of cultural identities, knowledge systems, and worldviews (Ford et al., 2021).	• Historical Legacies: Underlying vulnerabilities are rooted in colonial histories of marginalization, forced sedentarization, and land dispossession (Ford et al., 2021). • Non-Recognition of Indigenous Knowledge (IK): Indigenous Knowledge systems and their methodologies are often not equitably included in research, land-management, and policy (Yua et al., 2022). • Cultural Misrecognition: Failure to recognize the spiritual and cultural value of land and species in decision-making processes (Ford et al., 2021).	• Right to be free from discrimination. • Right to maintain cultural traditions and knowledge systems. • Right to self-determination and identity.
Restorative Justice	Focuses on addressing historical and	• Addressing Historical Trauma: Acknowledging and remedying the persistent effects of colonization, such as	• Right to redress and compensation for

	contemporary harms through reparative measures, healing, and the revitalization of cultural practices and rights.	land theft and cultural suppression, is argued to be essential for addressing climate injustice (Ford et al., 2021). • Land Back and Cultural Revitalization: Supporting initiatives that restore Indigenous relationships to land and water and strengthen intergenerational knowledge transfer. • Legal and Policy Action: Indigenous agency is demonstrated through resistance, education, and legal actions that seek to defend rights and secure remedial outcomes (Ford et al., 2021).	taken or degraded lands and resources. • Right to self-determination and cultural integrity.
Capabilities Justice	Examines how impacts affect the freedom and ability of individuals and communities to "function" and live as they choose (Ford et al., 2021).	• Undermined Health and Well-being: Climate change affects the ability to live as chosen, linked to mental health stresses among Saami and ecological grief among Inuit, who mourn physical changes to the land and lost traditional activities (Ford et al., 2021). • Constraints on Functioning: High rates of food and water insecurity, alongside unique health vulnerabilities, constrain the ability to manage climate change and live according to cultural preferences (Ford et al., 2021).	• Right to self-determination. • Right to physical and mental health and well-being. • Right to maintain customs and cultural traditions.

3. Manifestations of Injustice: Evidence from a Changing Climate

Climate change is redrawing the Circumpolar North, precipitating a cascade of physical effects that realize multidimensional injustices for Indigenous peoples. These injustices move far beyond the unequal distribution of environmental burdens to reveal governance failure, disrespect for Indigenous knowledge, and profound cultural and spiritual loss.

Sea ice loss, a leading effect of Arctic warming, illustrates these cumulative injustices in the Arctic. Distributionally, Indigenous peoples are disproportionately impacted because their established hunting pathways, transportation corridors, and access to marine resources become tenuous or lost (Ogunbode et al., 2024). This has immediate effects on food security and economic wellbeing. Procedural shortcomings occur in adaptation planning, which tends to neglect Indigenous self-determination and local knowledge of the problem. Decisions regarding resource management and climate adaptation measures are often made without the Free, Prior, and Informed Consent (FPIC) of Indigenous peoples, resulting in ineffective or culturally unsuitable measures (Parsons et al., 2024). The deep ecological knowledge gained over centuries about sea ice processes is devalued in science and policy communities, disempowering Indigenous peoples' jurisdiction and adaptive potential (Parsons et al., 2024). The social and spiritual losses are vast, as sea ice forms a part of Indigenous identity, ceremonies, and languages, generating restorative needs that go beyond the recovery of material benefits to encompass the renewal of related cultural practices based on the ice environment (Parsons et al., 2024).

Permafrost thawing is another key manifestation of injustice. Thawing permafrost destabilizes infrastructure, including homes, roads, and community buildings, disproportionately affecting Indigenous settlements often situated on vulnerable terrains (Ogunbode et al., 2024). It also releases greenhouse gases and alters hydrological regimes, further impacting traditional land and livelihoods. Procedural injustices arise when external agencies implement mitigation or adaptation measures without genuine collaboration or equitable participation by Indigenous communities. The emphasis is usually on technical fixes instead of enabling local self-government in the provision of their evolving landscapes (Parsons et al., 2024). Extensive Indigenous knowledge of permafrost stability, traditional land management practices, and knowledge of changes in the landscape are normally excluded in favor of Western scientific reports. This disrespect for Indigenous knowledge perpetuates a cycle of imposing external solutions, often unsuccessfully, further undermining Indigenous sovereignty and cultural practices (Parsons et al., 2024). Restorative requirements are immense, extending beyond the repair of physical infrastructure to the re-establishment of traditional land-use activities and spiritual relationships with the land, which are disrupted by permafrost degradation (Parsons et al., 2024).

Biodiversity shifts, such as shifts in species distribution, abundance, and phenology, also reflect these systemic inequalities. Distributionally, Indigenous people, whose culture and livelihood are intrinsically linked to local animals and plants, are confronted with direct threats to food security and customary harvesting when focal species migrate or are reduced (Ogunbode et al., 2024). These effects are not equal but are borne mostly by those who are most dependent on the system. Procedural failures occur when conservation or resource management plans are made without the equal involvement of Indigenous communities. Such plans have tended to limit Indigenous peoples' access to traditional lands or resources, maintaining colonial power dynamics instead of self-determination (Parsons et al., 2024). The rich ecological understanding of Indigenous people regarding species interaction, seasonal patterns, and ecosystem vitality is devalued or taken and not given due credit. This not only demeans Indigenous intellectual property but also results in less effective and culturally insensitive management strategies (Parsons et al., 2024). Restorative justice requires strategies that promote the resurgence of ancient ecological knowledge, guarantee Indigenous rights to land management, and enable cultural processes that conserve biodiversity, thus restoring the spiritual and cultural connections severed by environmental transformation (Parsons et al., 2024). The overall climate justice framework prioritizes comprehending different scales, dimensions, and intersections of justice, such as inter-generational justice, and the effects on more-than-human beings, such as ecosystems, which is important for dealing with biodiversity changes (Parsons et al., 2024).

4. Case Studies in Systemic Injustice: Moving Beyond Isolated Harms

Systemic injustice case studies of environmental justice issues, especially those extending beyond single distributive frameworks into the examination of the multidimensional injustices experienced by Indigenous peoples, are a contemporary emphasis in scholarly research (Table 2). These are particularly significant in polar northern spaces, covering elements of distributive, procedural, recognition, and restorative justice (Savaresi et al., 2024; Taylor et al., 2023; Park et al., 2024; Haque et al., 2024; Heffron et al., 2024; Liu et al., 2024; Parsons et al., 2024; Wilke, 2023; Carvalho and Spataru, 2023) (Dhiaulhaq et al., 2024; Brousseau et al., 2024; Mahmood et al., 2023; Harding et al., 2020; Heydon, 2018; Kaswan, 2020).

4.1 Multidimensional Injustices in Mining Operations

Mining operations tend to represent systemic injustices. Consider Indigenous people in the Global North, for example: the location and operation of mining operations tend to expose them to disproportionate environmental contamination (distributive injustice), such as elevated toxic emissions in air, water, and soil (Cannon and Cannon, 2024; Grabowski et al., 2022; Wang et al., 2021). These communities are often excluded from decision-making, with their participation being limited and decision-making processes being unclear, reducing their rights to information and participation (procedural injustice) (Figueroa and Ulibarri, 2024; Park et al., 2024; Wilke, 2023; Heydon, 2018). Indigenous communities, for example, have experienced procedural environmental injustice in the negotiations of Canada's oil sands projects, with their concerns poorly represented (Heydon, 2018). In addition, mining practices can violate Indigenous peoples' customary rights to sacred places and cultural identity without considering their distinctive cultural values and deep land ties (Dhiaulhaq et al., 2024; Grabowski et al., 2022; Hernandez, 2019; Suiseeya, 2014). This cumulative injustice signifies the limitation of viewing solely the distribution of pollution, ignoring existing governance failures, and the lack of respect for Indigenous cultures and rights. When mining operations result in ecological harm, the lack of restorative justice adds to injustice by not allowing affected communities to gain sufficient compensation and environmental restoration (Park et al., 2024; Giovannettone et al., 2024; Dhiaulhaq et al., 2024).

4.2 Energy Injustice in the Energy Transition

In a world moving towards a low-carbon society, developments in energy infrastructure may also lead to disparities (Savaresi et al., 2024; Hearn et al., 2021). Consider agrivoltaics, for instance: even as they seek to deliver net-zero emissions and significant investment, they can perpetuate new forms of inequity if not oriented toward a sense of fairness (Taylor et al., 2023). For example, distributive injustice occurs when the economic and environmental rewards of agrivoltaics do not equitably reach smallholder farmers and rural communities but instead mostly accrue to large energy companies or wealthy landowners, leading to a disproportionate benefit distribution (Taylor et al., 2023; Park et al., 2024). Procedural injustice occurs in the form of absent transparent, substantive participation mechanisms for farmers and local communities in project planning and approval processes. Top-down decisions are made, neglecting to fully consider their opinions and customary practices (Taylor et al., 2023; Park et al., 2024). Perceiving injustice means noting the inability to respect and incorporate local farmers' customary farming knowledge and practices, leading to the overlooking of their

exclusive cultural identities and livelihood strategies (Taylor et al., 2023; Park et al., 2024). For example, in siting conflicts for offshore wind farms in South Korea, the cultural values and traditional fisheries knowledge of fishing communities are usually insufficiently acknowledged, increasing tensions (Park et al., 2024). The Minamata Convention also suffers from the same problem of controlling and constraining mercury emissions. Its need for global coordination is to ensure that the costs and benefits of mercury emissions reduction are equitably borne across the world so as not to transfer the burden to poor countries or communities (Simone et al., 2022).

4.3 Injustice in Climate Adaptation and Conservation

Climate adaptation measures and the creation of protected areas can also create injustice among Indigenous people. For example, in the Nakuru-Zambezi Transfrontier Conservation Area (KAZA TFCA), Indigenous peoples were forcibly displaced through the establishment of protected areas and lost their customary rights to land use, exemplifying distributive injustice (Vehrs and Zickel, 2023). They were denied participation in management and decision-making for conservation areas and did not attain significant participation (procedural injustice) (Wilke, 2023; Dhiaulhaq et al., 2024; Brousseau et al., 2024). The lack of respect for Indigenous traditional ecological knowledge and land use practices and the inability to acknowledge their status as land stewards represent serious recognition injustice (Dhiaulhaq et al., 2024; Grabowski et al., 2022; Hernandez, 2019). The allocation of climate aid money could also be unfair. Although climate vulnerability largely impacts distributive justice, whether the distribution of funds will truly consider the vulnerabilities and needs of the affected population remains to be properly analyzed (Liu et al., 2024). Studies have shown disparities in access to urban ecosystem services for low-income and minority groups. These groups have limited access to environmental amenities such as parks, clean water, and air (distributional injustice) (Haque et al., 2024; Grove et al., 2024).

4.4 Water Insecurity and Systemic Vulnerability

Water insecurity significantly mirrors systemic disparities, particularly among low-income families and vulnerable groups. For example, in U.S.-Mexico border colonies (colonias), neighborhoods without piped water and sewage infrastructure experience high levels of household water insecurity (Tippin, 2021). This insecurity extends beyond unequal access to

clean water. It is further intrinsically connected to the denial of these communities' interests in decision-making (procedural injustice) and neglect of their specific lived experiences and vulnerabilities (recognition injustice) (Tippin, 2021; Canfield et al., 2023). Environmental justice research on water is mainly concerned with drinking water, but environmental injustice related to non-potable water (e.g., surface water) is also important and is usually linked to distributive, procedural, and recognition injustices (Canfield et al., 2023).

4.5 Evolution and Application of Cross-Dimensional Justice Concepts

In the past, policymaking has traditionally experienced dynamic evolution in the notion of justice (Looze et al., 2024). The meaning of justice in Dutch energy policy changed from "resource availability management for economic growth" to "climate policy inclusive in nature" between 1974 and 2022, with greater emphasis on economic distribution, ecological effects, inclusiveness, transparency, and recognition (Looze et al., 2024). This suggests that scholars and policymakers increasingly accept that resolving environmental and energy problems involves transcending the individual distributional dimension to blend multidimensional justice (Parsons et al., 2024; Haque et al., 2024; Liu et al., 2024; Looze et al., 2024). Finally, these case studies emphasize that resolving environmental justice issues in Indigenous communities must go beyond straightforward analyses of distributive injustice.

This involves engaging with procedural failures in governance frameworks, poor identification of culture and rights, and past injustices (Savaresi et al., 2024; Amorim-Maia and Olazabal, 2024; Liu et al., 2024) (Parsons et al., 2024; Wilke, 2023; Dhiaulhaq et al., 2024; Brousseau et al., 2024; Grabowski et al., 2022; Hernandez, 2019; Suiseeya, 2014). Only by fully incorporating distribution, process, recognition, and restorative justice can systemic injustices be credibly confronted and meaningful equitable change promoted (Savaresi et al., 2024; Taylor et al., 2023; Park et al., 2024; Heffron et al., 2024; Giovannettone et al., 2024; Dhiaulhaq et al., 2024; Heyen, 2022; Schmid et al., 2024).

Table 2. Environmental Justice Cases in Arctic Indigenous Contexts.

Category	Representative Cases	Justice Dimensions Affected	Impacts	Policy
Resource Extraction & Contamination	• Fossil fuel & metal mining projects across the Arctic overlapping Indigenous territories (Hanaček et al., 2022). • Transport infrastructure supporting extractive industries (Hanaček et al., 2022).	Distributional: Uneven burden of pollution and habitat destruction (Ford et al., 2021). Procedural: Lack of Free, Prior, and Informed Consent (FPIC) and meaningful consultation (Ford et al., 2021). Recognitional: Dismissal of spiritual and cultural connections to land (Vickery & Hunter, 2016).	• Loss of traditional knowledge and practices, significantly higher in Indigenous territories with high bio-cultural values (Hanaček et al., 2022). • Documented negative socio-environmental impacts on Indigenous groups, fishers, and pastoralists (Hanaček et al., 2022). • Repression against activists is more likely in Arctic countries with a low rule of law and without preventive mobilization (Hanaček et al., 2022).	Projects often proceed despite historical treaty violations and ongoing land dispossession (Ford et al., 2021). Legal frameworks frequently fail to protect subsistence lifestyles (Ford et al., 2021; Vickery & Hunter, 2016).
Climate Change	• Coastal erosion	Distributional: Disproportionate	• Food insecurity from diminished	Except in North

Impacts & Adaptation Inequities	threatening Ipiutak cemetery in Alaska and Inuvialuit archaeological sites in Canada (Ford et al., 2021). • Unsafe ice conditions impeding hunting and travel in Alaska, Greenland, Siberia, and Canada (Ford et al., 2021).	suffering from impacts despite minimal GHG contributions (Ford et al., 2021). Capabilities: Undermines rights to health, wellbeing, and ability to live as chosen (Ford et al., 2021).	ability to engage in subsistence hunting and fishing (Ford et al., 2021). • Mental health impacts, including "ecological grief," "eco-anxiety," and identity loss linked to environmental change and cultural dislocation (Ford et al., 2021). • Physical health risks from changing disease vectors and water insecurity (Ford et al., 2021).	America, there is little prioritization of Indigenous Peoples in adaptation policy development, despite high susceptibility (Ford et al., 2021).
Knowledge & Data Governance	• Research extraction without community benefit or data sovereignty (Rathwell et al., 2015). • Use of Indigenous knowledge in environmental monitoring (e.g., Inuit sea	Procedural & Recognitional: Exclusion from wildlife and land management decisions; Indigenous knowledge and worldviews marginalized in official processes (Ford et al., 2021;	• Loss of epistemic justice: Indigenous narratives and forms of expression (oral history, art) are delegitimized (Rathwell et al., 2015). • Complementary understanding: When included, Indigenous knowledge	Socio-political institutions often fail to include Indigenous groups as partners or acknowledge their leadership, undermining self-determination.

	ice observations) without equitable partnership (Rathwell et al., 2015).	Rathwell et al., 2015).	provides critical place-based data, challenges scientific causal framings, and increases policy legitimacy (Rathwell et al., 2015).	
Policy & Legal Frameworks for Justice	• International human rights law: Using the right to property (interpreted as collective spiritual resource) to hold states accountable. • Domestic policy: Finland's Sámi Climate Council to incorporate Sámi knowledge into national climate policy.	Restorative & Procedural: Addresses historical injustices and creates structural pathways for equitable participation and self-determination.	• Legal determinants of health (LDOH): Laws and policies can structure social determinants to either advance health equity or entrench discrimination. • Successful advocacy: Legal and policy actions, such as the establishment of the Sámi Climate Council, demonstrate strengthened Indigenous agency (Ford et al., 2021).	UNDRIP provides a rights-based framework. Leveraging LDOH is a key strategy to implement these rights and protect Indigenous livelihoods from climate impacts.

5. Structural Architecture of Injustice: Legacies, Laws, and Power

The structural injustices experienced by Indigenous peoples in the Circumpolar North are firmly entrenched in colonial histories, political-economic institutions, and governance systems that collectively heighten climatic vulnerability (Table 3). These foundational institutions impose inequities that are far more than distributional disproportions and require a multi-dimensional conceptualization of justice that includes procedural, recognition, and restorative justice to understand and respond to them effectively (Taylor et al., 2023).

Colonial continuums are strong agents of modern climate vulnerability among Indigenous peoples. Historical policies, including land dispossession and forced assimilation, have systematically undermined Indigenous land tenure, traditional ecological knowledge systems, and self-governance capacity (Grabowski et al., 2022; Hernandez, 2019). For example, the creation of conservation zones, seemingly for nature conservation purposes, has in the past caused the displacement of Indigenous peoples and the loss of their customary use rights over land, resulting in distributional injustice in terms of lost access to goods (Grabowski et al., 2022). The exclusion of Indigenous stewardship heritage and expertise from resource management is a deep recognition of injustice (Grabowski et al., 2022). These long-standing processes have disproportionately exposed Indigenous societies to the effects of climate change by undermining their adaptive capabilities and severing their inherent link to the land and its resources.

Barriers to governance and participation add to this vulnerability. Studies often find that Indigenous peoples tend to be left out of decision-making regarding resource extraction, land use, and climate adaptation plans, even when such decisions have a direct effect on their lands and livelihoods (Heydon, 2018). The principle of Free, Prior, and Informed Consent (FPIC), although a standard international norm, also encounters major implementation hurdles, resulting in procedural injustices (Heydon, 2018). For instance, in the Canadian Oil Sands, First Nations consultation processes have illustrated procedural environmental injustice, where Indigenous concerns and voices were not sufficiently incorporated into project design and regulatory systems (Heydon, 2018). Such exclusion from governance systems not only denies communities agency but also ignores their rich traditional ecological knowledge, which can provide strong, locally adapted climate solutions (Grabowski et al., 2022).

Policy and resource analysis highlights the continuation of such injustices through case studies of land rights litigation and governance structures. The Nagoya Protocol, for example, was

targeted at redressing injustices caused by the international demand for genetic resources, such as the exploitation of traditional knowledge and rights expropriation (Suiseeya, 2014). However, such international compacts, while necessary, must be backed by strong national implementation and acknowledgment of Indigenous customary laws and land claims to bear fruit in concrete justice results. The continuing battle for land rights by Indigenous peoples in the Circumpolar North provides evidence of the inadequacies of current legal systems to safeguard their ancestral territories and involve them in resource management. Where environmental policies are legislated insensitively to histories and local contexts, they can inadvertently deepen entrenched injustices, specifically around the destruction of self-organizing ecological systems and colonization of Indigenous governance (Grabowski et al., 2022).

The political economy of the global demand for resources, or so-called "green colonialism", fuels injustices that cannot be sufficiently addressed by simply redistributing resources (Taylor et al., 2023). Although necessary, the worldwide shift toward net-zero economies requires substantial investment in clean and new energy infrastructure (Heffron et al., 2024). However, unless these investments are fairly arranged, they can mimic colonial resource extraction and exploitation patterns (Taylor et al., 2023). For instance, the growth in agrivoltaics, estimated globally at USD $3.6 billion in 2021 and set to grow to USD $9.3 billion by 2031, offers a new possibility of renewed injustices if its gains are not shared equitably and if Indigenous rights to land and traditional farming practices are not established and incorporated into its development (Taylor et al., 2023). Likewise, the advantages and disadvantages of climate mitigation measures, including the Minamata Convention on Mercury, should be addressed internationally to ensure fair distribution and avoid the disproportionate burdening of less-resourced countries or Indigenous peoples (Simone et al., 2022). The development of justice ideas in policy, such as Dutch energy policy between 1974 and 2022, demonstrates a slow transformation from predominantly economic distribution issues to a broader conception that involves ecological effects, inclusiveness, openness, and acknowledgment, reflecting an increasing, though slow, recognition of such multi-faceted justice issues (Looze et al., 2024).

Table 3. Structural Drivers: Colonial Legacies and Legal-Political Barriers to Justice

Category	Specific Form(s)	Implications & Consequences

Historical Colonial Legacies	• Forced Assimilation & Cultural Disruption: Historical policies included forced sedentarization, land dispossession, and the residential school system, which sought to erase Indigenous cultures and governance. In Canada's Arctic, by 1964, 75% of Inuit school-age children were attending residential schools, forcibly removed from their families and knowledge systems. • Direct Attacks on Reproductive Justice: The imposition of measures intended to prevent Indigenous births, including forced sterilizations. In Arctic Canada, data from 1970-1973 revealed 180 Indigenous people were sterilized across 33 settlements, often through coercion or without informed consent.	• Intergenerational Trauma & Undermined Resilience: These policies created underlying socio-economic inequities that heighten vulnerability and reduce capacity for climate adaptation (Ford et al. 2021). • Erosion of Cultural Continuity: The severing of intergenerational knowledge transfer directly impacts the ability to maintain land-based practices and Indigenous knowledge, which is critical for environmental stewardship and adaptation (Ford et al. 2021).
Contemporary Legal & Governance Barriers	• Marginalization in Environmental Governance: Indigenous representatives are often granted participation without power. In the Arctic Council, the six Indigenous Permanent Participant organizations are denied a vote, as all decisions require the consensus of the eight Arctic states. • Limited Mandate of Key Institutions: The Arctic Council lacks a binding legal personality and its mandate is restricted to environmental protection and sustainable development, limiting its	• Procedural Injustice: Systemic exclusion from meaningful decision-making over lands, resources, and environmental policies (Ford et al. 2021). • Recognitional Injustice: The non-recognition of Indigenous sovereignty and self-determination in legal and political forums (Ford et al. 2021). • Imposed Vulnerabilities: Policies and decisions made without Indigenous input often

	ability to enforce human or Indigenous rights. • Lack of Free, Prior, and Informed Consent (FPIC): While consultation is common, socio-political institutions often fail to include Indigenous worldviews or secure genuine FPIC. Governments undertake developments without consensus on issues with competing interests (Ford et al. 2021).	increase climate vulnerability, such as excluding Inuit from wildlife management decisions for culturally critical species like the woodland caribou (Ford et al. 2021).
Political Economy & "Green Colonialism"	• Sovereign Control Over Resources: The central governments of Arctic states, often located thousands of miles from the Arctic, control resources and prioritize national economic and security interests over Indigenous well-being. • Offshoring Environmental Harm: Even governments committed to climate action may support oil and gas development in the Arctic, such as Russia's project to produce 25 million tons of oil per year, which has devastating local environmental consequences.	• Distributional Injustice: Indigenous peoples bear the environmental burdens of resource extraction and pollution while being excluded from the benefits (Ford et al. 2021). • Capabilities Injustice: The ability of communities to "function" and live according to their cultural choices is undermined by large-scale industrial projects that damage the ecological integrity of their territories (Ford et al. 2021).

6. Knowledge Systems and Epistemic Justice: Challenging the Status Quo

The incorporation of Indigenous knowledge systems (IKS) into environmental management and climate adaptation planning provides an important avenue to disrupt prevailing epistemic injustices and heighten effective decision-making, especially in the Circumpolar North (Table 4). To this end, a stringent, fact-based process that goes beyond theoretical prognosis and proves the value, methods, and outputs of these co-production approaches is required.

Indigenous knowledge, usually built up over several generations, is a rich source of tried-and-tested environmental observations and adaptation measures. Indigenous knowledge systems create rich descriptions of local ecosystem processes, weather patterns, and resource supply, often exceeding the spatial and temporal scales of traditional scientific observations (Hernandez, 2019). For instance, Indigenous peoples have a rich understanding of animal migration routes, ice cover, and vegetation changes, which are essential for navigation and adaptation to changing Arctic ecosystems (Hernandez, 2019). Recording these observations, frequently using qualitative approaches such as oral history and community-based monitoring, constitutes rich evidence of the effects of climate change and local adaptation measures (Hernandez, 2019). This affirmation of IKS as valid evidence is central to attaining epistemic justice, acknowledging multiple forms of knowledge and historical marginalization.

Effective co-production approaches in environmental research and governance share equal partnerships and transparent governance structures that value Indigenous self-determination. Such collaborative frameworks entail the participation of Indigenous peoples and researchers in collaboration from project conception to data gathering, analysis, and sharing, such that research questions are suited to the cultures and benefit the communities (Heydon, 2018; Hernandez, 2019). For example, “Two-Eyed Seeing”, a framework that emerged from Mi’kmaw Elder Albert Marshall, is an example of an integrative knowledge system that openly blends the strengths of Indigenous knowledge with Western scientific methodologies. Case studies illustrating this concept in environmental management document enhanced results, including more successful conservation practices and sustainable use of resources, through the integration of local ecological knowledge with wider scientific analysis (Hernandez, 2019). These models empower Indigenous peoples by ensuring their involvement in decision-making and encouraging a better holistic understanding of complicated environmental problems.

Significant obstacles prevent the complete integration of IKS. Institutional challenges include strict bureaucratic systems and Western-centric research frameworks that tend to debase or misapprehend Indigenous knowledge (Hernandez, 2019). Epistemological challenges stem from varying worldviews and processes of knowledge validation, with Western science potentially finding it difficult to recognize the legitimacy of non-quantifiable or experiential knowledge (Hernandez, 2019). Funding mechanisms often favor mainstream scientific investigations, discouraging Indigenous-led or co-produced research from receiving proper

provisions (Hernandez, 2019). These barriers reinforce procedural injustice because Indigenous voices and ways of knowledge are routinely excluded from powerful forums (Heydon, 2018). Overcoming these barriers requires changes to research policy systems, funding agendas, and academic education to create meaningful respect and collaboration.

To counter these challenges, Indigenous communities are increasingly asserting data sovereignty and taking back control of their data and research processes. This entails developing Indigenous-led research protocols, ethical standards, and data governance systems that resonate with their cultural values and aspirations (Suiseeya, 2014). The drive for data sovereignty is an affirmation of communities reclaiming self-determination and ensuring that research serves them directly, not being taken away and utilized without their benefit or consent (Suiseeya, 2014). For instance, the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization, despite challenges with its implementation, constitutes a concerted worldwide effort to mitigate the unfair effects of the worldwide demand for genetic resources on Indigenous communities, such as the exploitation of traditional knowledge and the removal of rights (Suiseeya, 2014). This legal framework aims to ensure that the benefits of the utilization of traditional knowledge are shared equitably, providing a mechanism for Indigenous communities to exercise control over their intellectual property and knowledge (Suiseeya, 2014). This movement is crucial for dismantling colonial legacies in research and empowering Indigenous communities to shape their climate adaptation and environmental management futures.

Table 4. Considerations for a just transition and ethical knowledge co-production

Category	Concept & Application	Evidence & Outcomes	Implementation
Foundations of a Just Transition	People-Centered Pathways: • Prioritize human well-being, social equity, and decent work in all climate actions. • Use inclusive social dialogue and participatory	• South Africa's Presidential Climate Commission (PCC) exemplifies a multi-stakeholder approach, holding workshops in coal communities to address health impacts	• Engage a wide range of stakeholders from the outset, ensuring processes are accessible through clear language and

	decision-making to define transition pathways.	and clarify renewable energy benefits. • Just Transition Work Programme (JTWP) emphasizes social safety nets, unemployment support, and local community engagement in development agendas to minimize risks.	communication methods. • Develop transition plans that are nationally determined but locally driven, allowing for context-specific solutions.
Governance & Equity in Transition	Addressing Global Inequity: • Ensure climate actions do not repeat or exacerbate oppressive global systems, structural inequalities, and trade protectionism that disadvantage vulnerable nations and communities. • Adopt a human rights-based approach, respecting land rights and Free, Prior, and Informed Consent (FPIC), especially in renewable energy development.	• The EU Carbon Border Adjustment Mechanism (CBAM) was found to potentially reduce African exports and diminish the continent's GDP, highlighting how well-intentioned policies can have unjust outcomes. • EU's Corporate Sustainability Due Diligence Directive (CSDDD) makes a just transition a compliance issue by requiring companies to conduct human rights and environmental due diligence in their value chains.	• Channel unconditional support (finance, technology, capacity building) from developed to developing nations, avoiding financial instruments that deepen debt. • For businesses, integrate human rights due diligence into climate transition strategies, considering impacts on workers and local communities from asset decommissioning or repurposing.
Ethical Knowledge	Relational and Contextual Process:	• The "Wheel of Knowledge Co-	• Begin with the "Relate Phase":

Co-Production	• An interactive process where diverse actors (e.g., scientists, Indigenous knowledge holders) collectively generate and apply knowledge (Satterthwaite et al. 2024). • Rooted in trust, humility, and long-term engagement, acknowledging diverse epistemologies like Traditional Knowledge (Satterthwaite et al. 2024).	Production" framework outlines iterative phases like "Relate" and "Assess" to build trust and evaluate the appropriateness of the approach, emphasizing flexibility and integrity (Satterthwaite et al. 2024). • Research shows co-production leads to better quality research, strengthened public trust, more equitable knowledge generation, and greater success of sustainability initiatives (Satterthwaite et al. 2024).	invest time in building relationships and shared goals before defining research questions (Satterthwaite et al. 2024). • In the "Assess Phase," reflect on power dynamics, pre-existing relationships, and social norms to ensure the process is contextually appropriate (Satterthwaite et al. 2024).
Ethical Frameworks for Co-Production	Applying Explicit Ethical Values: • Move beyond ad hoc ethics; use established principles to guide collaborations, ensuring they are equitable and beneficial (Page, 2022). • Key principles include Justice (equity, fair distribution of outcomes), Respect for Autonomy (rights, beliefs, values),	• The Australian Consensus Framework for Ethical Collaboration highlights procedural principles like honesty, transparency, and shared understanding, which are critical for managing collaborations (Page, 2022). • Case studies reveal that ethical issues like ownership of intellectual	• Use ethical principles a priori to decide if co-production is suitable by weighing the expected net benefits for all parties against the costs (Page, 2022). • Negotiate and document agreements on data ownership,

	Beneficence (producing benefit), and Solidarity (collective commitment to sharing costs and benefits) (Page, 2022).	property and power imbalances are common. Principles of justice and respect are paramount in resolving these conflicts (Page, 2022).	responsibilities, and credit at the project's outset, and update them as contributions change (Page, 2022).
Navigating Power & Ensuring Equity	Power Sharing and Inclusivity: • Actively identify and work to rebalance power imbalances between researchers, policymakers, and Indigenous communities (Page, 2022; Satterthwaite et al. 2024). • Prioritize the needs of the most vulnerable, ensuring the process does not perpetuate historical marginalization.	• The Coalition for Research to Improve Aboriginal Health (CRIAH), an Aboriginal-led co-production model, identifies trust, respect, and sharing of power and leadership as key ethical issues for achieving health equity (Page, 2022). • A core finding is that "co-production should be approached as a practice governed by a set of values, rather than an exact science or process" (Page, 2022).	• It is incumbent upon the more powerful party in a collaboration to prioritize the principles of beneficence and justice (Page, 2022). • Ensure the process is characterized by inclusivity and flexibility, creating space for all forms of knowledge and adapting to community timelines and priorities (Satterthwaite et al. 2024).

7. Health and Wellbeing: The Human Dimension of Environmental Justice

Indigenous peoples throughout the Circumpolar North are subject to disproportionate health impacts due to environmental change (Table 5), which is acutely mediated by environmental justice and the Legal Determinants of Health (LDOH) (Hill et al., 2024; Brubacher et al., 2024; Warner and Abate, 2014). These effects are realized through epidemiological data, mental

health, and ecological emotions, and require community-based resilience strategies (Venhof et al., 2024; Oré et al., 2024; Lebel et al., 2022). Climate change, loss of biodiversity, and resource extraction heavily impact the health and well-being of Indigenous Peoples, who frequently preserve and manage much of the planet's biodiversity owing to their native connections to local ecosystems and traditional ecological knowledge (Hill et al., 2024; Brubacher et al., 2024). This unequal burden places these communities in the category of environmental justice communities (Warner and Abate, 2014).

Epidemiological data repeatedly show that climate-driven environmental changes are responsible for specific health burdens in Circumpolar Indigenous peoples. For example, variations in cryospheric conditions that involve thawing permafrost and erratic ice directly enhance the risk of injury for those undertaking traditional hunting and fishing, which are part of subsistence and cultural practices (Brubacher et al., 2024). These ecological changes also interfere with traditional food sources, causing nutritional deficits and a higher dependence on shop-purchased, usually less healthy, foods. This transition can intensify existing health inequalities and lead to chronic illnesses (Brubacher et al., 2024; Willox et al., 2014). In addition, the increasing climate warming in the Circumpolar North allows for the development and transmission of infectious diseases, such as vector-borne and zoonotic diseases, posing new public health threats that disproportionately impact these communities (Parkinson, 2013). Studies have confirmed that Arctic Indigenous groups are subjected to greater quantities of environmental contaminants than other populations, although the specific contribution of these exposures to negative health effects is still under investigation (Singh et al., 2014). Furthermore, the interaction of environmental factors with multiple social determinants of health, including employment, education, income, and housing, magnifies these health hazards (Hayes et al., 2019).

The extensive psychological health effects of environmental transition in the Circumpolar North are highly evident, spreading beyond overall well-being to include climate worry, ecological sorrow, and the effects of cultural loss (Venhof et al., 2024; Lebel et al., 2022). Indigenous communities' strong cultural and spiritual ties to their homeland and traditional ways of life result in environmental damage and climate-related changes in ecosystems, causing a distinct type of distress (Hill et al., 2024; Willox et al., 2014). For instance, denial of access to customary hunting grounds or culturally valued species may cause intense grief, erosion of identity, and added psychological burden (Venhof et al., 2024). Research has

emphasized that environmental shifts destabilize not only physical states but also social atmospheres, significantly impacting everyday life, health, and well-being (Ulturgasheva et al., 2014). This multifaceted interaction typically leads to higher rates of mental health disorders, such as anxiety and depression, and in certain environments, elevated rates of suicidal thoughts as a result of the synergistic stressors of environmental, social, and cultural disruption (Pharr and Batra, 2024; Lebel et al., 2022). The social–ecological model highlights that the well-being of an individual is shaped by larger societal contexts, such as community and societal levels, in which changes in the environment have meaningful effects (Pharr and Batra, 2024).

The Legal Determinants of Health (LDOH) offer an important framework for viewing the ways in which particular pieces of legislation and policy have direct impacts on Indigenous peoples' health outcomes in issues of environmental justice (Fung and Dong, 2024). Historically, institutional racism and colonial policies have established systemic weaknesses, resulting in a disproportionate health burden on Indigenous peoples (Brown et al., 2024). For instance, legal mechanisms regulating land use, resource mining, and environmental protection frequently ignore Indigenous peoples' rights and traditional ecological knowledge, resulting in environmental deterioration that directly affects community well-being (Warner and Abate, 2014; Hoover et al., 2012). The subjectively perceived unavailability of justice, a key element of LDOH, can adversely affect physical health, psychological status, and social and environmental conditions (Fung and Dong, 2024). When communities perceive that they cannot turn to the justice system to rectify environmental damage, it can result in ongoing degradation and amplify health issues (Fung and Dong, 2024). Alternatively, Indigenous rights recognized through the law, self-determination in health, and co-management of resources can support community resilience and create channels for reducing health inequities (Pollock and Cunsolo, 2019; Peterson St-Laurent et al., 2018; Oré et al., 2024). "Just transition litigation" frameworks are appearing to confront how legal proceedings can dispute the distribution of climate action burdens and benefits, procedural justice in decision-making, and the acceptance of affected communities' interests and experiences (Savaresi et al., 2024).

Community-based resilience projects are important for Circumpolar Indigenous protection and adaptation to health, providing evidence-based responses that maximize Indigenous knowledge and local governance (Hill et al., 2024; Kipp et al., 2019). Projects typically use place-based solutions that meet the specific priorities and needs of the local community, thus relating global adaptation to local contexts (Amorim-Maia and Olazabal, 2024). These include community-

based monitoring schemes that utilize indigenous knowledge and technology for the identification and management of climate change effects, improvement of food preservation methods, and retention of traditional hunting techniques in the context of environmental change (Kipp et al., 2019). The involvement of Indigenous people in decision-making regarding environmental management and resource development is crucial to ensure that health issues are properly addressed and that interventions are culturally acceptable (Peterson St-Laurent et al., 2018; Lawlor et al., 2013). This collaborative strategy, which aligns local ecological knowledge with scientific examination, is critical for developing capacity and creating long-term partnerships that yield population health equity (Brown et al., 2024; Peterson St-Laurent et al., 2018). Regenerative practices, extending beyond the maintenance of the status quo to positively support change and ecosystem healing, also encompass indicators of healthy, resilient, and connected communities, highlighting the physical and mental health of residents and the establishment and maintenance of cultural identity (Oyefusi et al., 2024). These efforts highlight self-organization, local institutions, and shared knowledge within communities as critical for improving adaptive capacity and minimizing climate change vulnerability (Tohidimoghadam et al., 2023).

Table 5. Health Impacts of Climate Injustice on Arctic Indigenous Communities

Category	**Effects & Climate Stressors**	**Affected sections**	**Evidence**
Mental Health & Psychosocial Wellbeing	• Ecological grief and anxiety from witnessing environmental degradation and loss of land. • Mental trauma and stress from dangerous travel conditions and fear of injury. • Impacts on cultural identity from displacement and loss of sacred sites (e.g.,	Canadian Inuit, Saami in Europe and Russia, Alaska Natives (White et al., 2023)	• Qualitative studies identify land connection as central to wellbeing; climate change disrupts this through restricted mobility and livelihoods. • Identity loss is linked to a diminished ability to engage in traditional activities that contribute to food security and culture.

	coastal erosion of Ipiutak cemetery in Alaska).		
Food Security & Nutritional Health	• Food insecurity and malnutrition from disrupted subsistence hunting, fishing, and herding. • Increased risk of chronic diseases (e.g., obesity, diabetes) from a shift to expensive, processed store-bought foods (Lohmann et al., 2023). • Foodborne illness from thawing permafrost causing traditional ice cellar storage failures.	Inuit in Nunavik, Indigenous communities across Arctic (Lohmann et al., 2023)	• Contaminant dilemma: Marine mammals essential for diet are often highly contaminated with POPs and mercury, creating a choice between cultural practices and health (Lohmann et al., 2023). • Thawing permafrost is posing direct threats to food security and safety, with documented food spoilage in ice cellars.
Infectious & Vector-Borne Diseases	• Increased risk of waterborne disease (e.g., gastrointestinal outbreaks) from extreme weather events affecting water quality and sanitation infrastructure. • Potential exposure to ancient pathogens (e.g., anthrax) from thawing permafrost (Lohmann et al., 2023). • Expansion of vectors for diseases like tularemia and tick-borne encephalitis (Lohmann et al., 2023).	Arctic populations in permafrost regions, Northern Russia (Lohmann et al., 2023)	• Climate change creates newly hospitable environments for encroaching pathogens and vectors (Lohmann et al., 2023). • The 2016 anthrax outbreak in Siberia linked to thawing permafrost and reindeer exposure is a documented case (Lohmann et al., 2023).

Exposure to Environmental Contaminants	• Neurodevelopmental deficits in children from prenatal and postnatal exposure to methylmercury (MeHg) in traditional seafood diets (Lohmann et al., 2023). • Immune system suppression and reduced vaccine response in children exposed to PFAS and PCBs (Miller, 2023). • Negative impacts on fetal growth, cardiovascular, and endocrine systems (Lohmann et al., 2023; Miller, 2023).	Indigenous populations across circumpolar Arctic, Faroese and Nunavik children (Lohmann et al., 2023; Miller, 2023)	• Epidemiological cohort studies show prenatal MeHg exposure associates with lower IQ, attention problems, and poorer memory functions in children (Lohmann et al., 2023). • A complex interaction exists where marine food omega-3 fatty acids can diminish some adverse effects of mercury, highlighting the nutritional-contaminant dilemma (Lohmann et al., 2023).
Physical Safety & Infrastructure	• Accidental injury and death from unpredictable ice and weather conditions while traveling/hunting. • Health risks from damaged infrastructure (e.g., housing instability from thawing permafrost, compromised water and sanitation systems) (Lohmann et al., 2023).	Inuit in Canada, Alaska Native communities (Lohmann et al., 2023)	• Unstable ice conditions directly inhibit safe hunting and travel, increasing risks of injury and death. • Thawing permafrost destabilizes ground, affecting buildings and critical infrastructure like water and sanitation systems, which can lead to health risks (Lohmann et al., 2023).

8. Pathways to Justice: Policy, Governance, and Community-Led Solutions

Indigenous peoples in the Circumpolar North experience serious environmental justice issues (Table 6); thus, an examination of policy, governance, and community-based solutions from a

strong intervention and implementation gap perspective is required. These groups are negatively impacted disproportionately by environmental modification such as climate change and biodiversity decline while, at the same time, having critical traditional ecological knowledge (ITEK) for planetary health and climate resilience (Brubacher et al., 2024; Hill et al., 2024). Reducing these gaps demands a multi-scalar solution, from global policy to local Indigenous-governed initiatives, critically assessing their effectiveness and determining obstacles to effective implementation.

An analysis of policy implementation reveals differing levels of achievement and substantial gaps in implementing environmental, health, and Indigenous rights policies across the Circumpolar North. Even with increased acknowledgment of Indigenous Peoples' distinct vulnerabilities and knowledge, successful policy transfer into concrete results remains an ongoing issue (Hill et al., 2024; Lebel et al., 2022). Most policies are made at the national or global levels without adequate attention to the local context, cultural contexts, or direct engagement with Indigenous communities, resulting in implementation deficits (McGetrick et al., 2015). For example, climate change mitigation or biodiversity conservation policies tend not to incorporate ITEK properly, despite its established utility in adaptation and mitigation practices (Hill et al., 2024). The current legal systems of land use and resource extraction have previously dispossessed Indigenous Peoples and remain a major obstacle to their self-determination in environmental governance (Hill et al., 2024). This tends to lead to environmental degradation, which has a direct effect on the well-being and health of Indigenous peoples, making it pertinent that policy mechanisms are robust to guarantee that Indigenous knowledge and rights are at the heart of environmental governance (Hill et al., 2024).

Indigenous governance frameworks provide evidence of self-determination in environmental management and offer essential avenues for environmental justice. These frameworks prioritize local control, cultural suitability, and ITEK integration, often resulting in more equitable and sustainable environmental impacts (Hill et al., 2024). For example, stakeholder and Indigenous Peoples' participatory workshops in British Columbia have proven effective in bringing together differing views to assess forest carbon mitigation measures, including biophysical, social, economic, and procedural factors (Peterson St-Laurent et al., 2018). Some of the main goals of these models are to enhance adaptation to climate change and forest resilience, preserve ecosystem services, maximize the potential for climate change mitigation, and achieve social licensing and political feasibility (Peterson St-Laurent et al., 2018). The

models aim to enhance economic opportunities for Indigenous Peoples and respect their rights and title to forest areas, which are the cornerstones of equitable environmental management (Peterson St-Laurent et al., 2018). The success of these programs highlights that Indigenous communities are more capable of creating and applying effective environmental protection practices that work for both their communities and the wider ecosystem when they have control over their territories and resources (Hill et al., 2024; Peterson St-Laurent et al., 2018).

Legal empowerment tactics, such as rights-based initiatives and litigation, are becoming increasingly important for Indigenous communities to exercise their rights and gain environmental justice. The affirmation of Indigenous peoples' rights to land, resources, and self-determination creates a legal basis for contesting environmentally harmful projects and promoting culturally appropriate policies (Hill et al., 2024). Although litigation is frequently protracted and labor-intensive, its results can achieve legal precedence that defends Indigenous lands and lifeways, forcing governments and industries to maintain environmental norms and observe treaty commitments (Hill et al., 2024). Nonetheless, the perceived unavailability of justice may have a detrimental effect on the physical health, mental well-being, and social and environmental conditions of Indigenous communities, further reaffirming the necessity of strong legal aid and assistance (Hill et al., 2024). Progress in legal systems that facilitate Indigenous self-determination and co-management of natural resources, such as laws that enshrine the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP), is essential for enabling people to act on environmental injustices and defend their well-being (Hill et al., 2024).

Climate finance and resource distribution are vital sectors in which inequalities continue to perpetuate environmental injustice within the Circumpolar North. There is usually a large disparity between the magnitude of the environmental problems confronted by Indigenous groups and the monetary investments that go towards financing their adaptation and mitigation actions (Hill et al., 2024). Financing frameworks often cannot directly go to communities or accompany severe conditions that do not reflect Indigenous agendas or traditional governance arrangements (Hill et al., 2024). This requires building community-led resource models that enable Indigenous Peoples to decide how climate finance is spent so that investments serve locally determined priorities and Indigenous-driven solutions (Hill et al., 2024). These models would make climate action more effective by promoting self-determination and local capacity building instead of imposing top-down solutions that are not culturally appropriate or

sustainable (Hill et al., 2024). In addition, equal resource distribution is not just a question of finance, but also equitable access to information and technological resources necessary for tracking environmental transformations and formulating adaptive responses (McGetrick et al., 2015). Closing the implementation gaps and ensuring true environmental justice for the Indigenous peoples of the Circumpolar North requires addressing these finance and resource distribution differences.

Table 6. Pathways to Justice: Analyzing Governance and Legal Mechanisms

Mechanism Type(s)	**Features & Operationalization**	**Outcomes**	**Gaps & Challenges**
Rights-Based National/Sub-National Policies • Sámi Climate Council (Finland) • Land Claims Agreements & Co-Management Boards (e.g., James Bay and Northern Quebec Agreement, Inuvialuit Final Agreement)	• Recognitional Justice: Formal inclusion of Indigenous knowledge in national climate policy. • Procedural Justice: Structures for "joint" management of land, water, and wildlife between Indigenous and state governments. • Legal Empowerment: Creates legally mandated platforms for Indigenous participation.	• The Sámi Climate Council is an independent expert body tasked with bringing Sámi perspectives into Finnish climate policy. • Co-management boards act as mechanisms for knowledge co-production, synthesizing Indigenous and Western approaches and fostering social learning for adaptive governance.	• Power Imbalance: Co-management can be complex, with concerns about the "Balkanization of decision-making" and potential for state dominance in "joint" structures. • Limited Mandate: Advisory bodies may lack binding authority, and their influence depends on the government's willingness to heed advice.
International Legal	• Restorative & Distributive Justice: UNDRIP affirms rights to	• UNDRIP provides a foundational framework for	• Enforcement Challenges: UNDRIP is a non-

Instruments & Petitions • UNDRIP (UN Declaration on the Rights of Indigenous Peoples) • Inter-American Court of Human Rights (IACHR) Jurisprudence • International Tribunal for the Law of the Sea (ITLOS)	lands, territories, resources, and cultural traditions. • Legal Personhood for Nature: IACHR recognizes collective Indigenous property, viewing land as a spiritual resource, not just an economic one. • Human Rights at Sea: ITLOS jurisprudence links law of the sea to human rights, protecting traditional fishing.	defining Indigenous rights in the context of climate change, including the right to self-determination and FPIC. • IACHR has innovatively interpreted the right to property to include the collective, spiritual, and cultural dimensions essential to Indigenous livelihoods.	binding declaration; implementation relies on state adoption and political will. • Limited Jurisdiction: International courts like IACHR and ITLOS can only hear specific types of cases and their rulings can be difficult to enforce domestically.
Indigenous-Led Advocacy & Knowledge Systems • Indigenous Environmental Declarations (McGregor et al. 2020) • Legal and Policy Action (e.g., litigation, protests)	• Relational & Epistemic Justice: Grounded in Indigenous philosophies that question the legitimacy of state and international governance systems that "fail all life" (McGregor et al. 2020). • Agency & Resistance: Strengthened through education, demonstrations, and legal strategies to defend rights.	• Indigenous declarations present a "distinct diagnosis of the planetary ecological crisis," offering alternative frameworks based on relationality with the natural world (McGregor et al. 2020). • Advocacy and resistance are documented responses to decisions that violate rights, seeking to	• Political Resistance: Indigenous values and knowledges often face significant political resistance when introduced into mainstream policymaking (Jones et al., 2024). • Resource Disparity: Communities often face well-resourced corporate and state opponents in legal and political battles.

		secure just processes and outcomes.	
Evaluative & Accountability Tools • Indigenous Climate Justice Policy Analysis Tool	• Multi-dimensional Assessment: A qualitative tool assessing policies across 13 criteria and five justice dimensions: relational, procedural, distributive, recognitional, and restorative (Jones et al., 2024). • Empowerment: Designed to help Indigenous communities hold governments accountable and guide non-Indigenous policymakers.	• The tool helps identify gaps in policy, such as the failure to recognize kinship relationships (whakapapa) with the natural world, a concept central to Indigenous conceptions of justice (Jones et al., 2024). • It grades policies from "Unacceptable" to "Climate Justice," with the highest standard requiring justice beyond current colonial frameworks (Jones et al., 2024).	• Systemic Limitations: The tool acknowledges that "true" justice is likely unattainable within dominant colonial, capitalist systems (Jones et al., 2024). • Resource Intensity: Its comprehensive nature makes it resource-intensive to apply, requiring specific capabilities and expertise (Jones et al., 2024).

9. Evidence-Based Recommendations for Transformative Change

Transformative change to respond to environmental justice issues confronting Indigenous peoples in the Circumpolar North requires evidence-driven recommendations for multiple actors and levels of government, emphasizing authentic Free, Prior, and Informed Consent (FPIC), equitable co-production of knowledge, whole-of-government health-environment approaches, transformed climate finance, and strong monitoring and accountability systems. These propositions aim to fill gaps in implementation and create structural reforms that

empower Indigenous peoples and uphold their rights (McGetrick et al., 2015; Hill et al., 2024; Lebel et al., 2022; Oré et al., 2024).

Restructuring governance must prioritize certain policy mechanisms to entrench true FPIC and ensure authentic power-sharing with Indigenous peoples. This means transcending consultation to ensure that Indigenous Peoples have the right to self-determination over resources and land, especially in relation to development projects and conservation efforts (McGetrick et al., 2015; Warner and Abate, 2014). Legal structures must be overhauled at the national and global levels to officially acknowledge and protect Indigenous legal conventions and governmental systems to facilitate co-management agreements that equally share authority and responsibility (Warner and Abate, 2014). For instance, research emphasizes the importance of acknowledging Indigenous rights and claims to forest lands as central to fair environmental management, which requires particular changes in legislation that empower Indigenous decision-making institutions (Warner and Abate, 2014). This means reforming institutions to provide Indigenous representation and decision-making opportunities in environmental governance institutions beyond tokenistic inclusion to substantive authority to respond to historical injustices and systemic vulnerability (Oré et al., 2024).

Equitable ITEK and Western science co-production demands applied protocols for incorporating ITEK into Western science, such that ITEK is honored, conserved, and used ethically in environmental management and policy (Hill et al., 2024). This means formulating Indigenous-person-centered, culturally suitable methodologies for collaborative research that honors Indigenous intellectual property rights (Hill et al., 2024). These protocols must have inbuilt mechanisms for the collaborative collection, analysis, and interpretation of data to ensure that both knowledge systems equally contribute to the understanding of environmental changes and adaptive approaches in countering them. Evidence indicates that ITEK provides valuable insights into resilience to climate change and planetary health and, therefore, necessitates systematic incorporation into adaptation and mitigation programs (Hill et al., 2024). It takes the next step beyond merely "consulting" Indigenous peoples to directly involve them as equal actors in knowledge construction and utilization and to develop culturally appropriate and sustainable solutions (Ulturgasheva et al., 2014).

Specific strategies for addressing the Legal Determinants of Health (LDOH) and the impact of climate health are necessary in the health-environment nexus. Policies must clearly associate

environmental conservation with health outcomes, acknowledging that environmental degradation directly contributes to health inequities among Indigenous groups (Lebel et al., 2022; Brubacher et al., 2024). This involves creating health impact assessments of Indigenous-initiated environmental initiatives that integrate local health measures and traditional healing systems. In addition, legal reforms must provide Indigenous peoples with greater access to civil justice, tackling the reported unavailability of justice that has a negative effect on physical health, psychological well-being, and social and environmental factors (Fung and Dong, 2024). It is important to enhance healthcare systems in the Circumpolar North to incorporate traditional medicine and culturally appropriate mental health services, as climate change has a disproportionate effect on Indigenous mental health, causing climate anxiety, grief and cultural loss (Lebel et al., 2022; Rückle et al., 2025; Hayes et al., 2019). This encompasses policy actions to address the social determinants of health, including employment, education, income, and housing, which are typically heightened by climate change (Oré et al., 2024; Hayes et al., 2019).

Climate finance reform should include specific provisions for direct Indigenous access to climate resources, bypassing standard funding mechanisms that often do not reach communities or impose onerous conditions (Hill et al., 2024). This calls for the establishment of specialized Indigenous climate funds or direct disbursement mechanisms through which Indigenous Peoples can decide how to prioritize and administer climate adaptation and mitigation projects based on their priorities and customary governance mechanisms (Hill et al., 2024). These processes must be configured to enhance Indigenous-driven solutions, local capacity, and self-determination in climate action, instead of introducing top-down processes that are not culturally appropriate or sustainable (Hill et al., 2024). Equitable resource distribution should embrace equal access to technological and informational resources, which are essential for tracking environmental changes and formulating adaptive strategies (McGetrick et al., 2015).

Finally, strong monitoring and accountability systems are needed to track progress toward environmental justice. This includes creating evidence-based indicators that capture Indigenous values of justice, well-being, and environmental health and go beyond traditional measures, which frequently neglect Indigenous values (Oré et al., 2024). These indicators would be co-developed with Indigenous peoples and include environmental quality, cultural vitality, self-determination, and health outcomes (Oré et al., 2024). Independent watchdog

agencies, potentially Indigenous-led, must be created to inspect compliance with environmental protection policies and Indigenous rights and to provide redress and enforcement mechanisms (Warner and Abate, 2014). Mandatory regular and transparent reporting on these indicators at all levels of governance must be ensured to guarantee that policy implementation is aligned with the expressed targets and that Indigenous voices are the focus of the assessment of environmental justice advancement (McGetrick et al., 2015).

10. Conclusion: Integrating Evidence for a Just Circumpolar Future

Rigorous evidence from studies throughout the Circumpolar North conclusively proves that environmental injustice for Indigenous peoples far surpasses the discernible disproportionate allocation of climate change effects (Ogunbode et al., 2024; Rafa et al., 2024). Rather, they are the result of systemic procedural breakdowns, the ongoing neglect of Indigenous knowledge (recognitional injustice), and unresolved historical grievances (restorative injustice) (Parsons et al., 2024; Savaresi et al., 2024; Taylor et al., 2023; Rafa et al., 2024). This analysis emphasizes that severe sea ice decline, extensive permafrost thaw, and extreme biodiversity changes are not simply environmental processes but are indissolubly connected to intricate justice aspects, requiring a paradigmatic approach to conceptualizing and confronting environmental issues in the region (Ogunbode et al., 2024).

The principal findings emphasize the fundamental link between physical climate effects and multifaceted injustices. For example, the melting of sea ice, which is at the heart of Indigenous transportation, hunting, and culture, has direct distributional effects on food security and economic stability (Ogunbode et al., 2024). This effect is heightened by procedural injustices, where adaptation planning automatically excludes Indigenous self-determination and local ecological knowledge (Ogunbode et al., 2024). Similarly, thawing permafrost, which destroys vital infrastructure in Indigenous communities, exposes recognitional injustices in the exclusion of Indigenous knowledge regarding landscape stability and customary land management practices (Ogunbode et al., 2024). Biodiversity changes similarly exemplify these systemic problems, with patterns of species distribution and abundance posing direct threats to Indigenous subsistence and cultural traditions, typically exacerbated by conservation measures devised without equal Indigenous input (Ogunbode et al., 2024). This wide-angle perspective, grounded in research from the local to the global level, affirms that environmental injustice

776 within the Circumpolar North is a result of deeply rooted systemic injustices and no single
777 instances of harm (Parsons et al., 2024).
778
779 Such challenges require structural changes that extend beyond incremental responses. A
780 transformative turn requires transitions beyond traditional models of governance to completely
781 embed Free, Prior, and Informed Consent (FPIC), fair participation, and Indigenous self-
782 governance in every environmental decision-making process, ranging from resource planning
783 to climate change adaptation planning (Ogunbode et al., 2024; Savaresi et al., 2024; Berglund
784 et al., 2023). Existing policy and project-making processes without actual cooperation or
785 meaningful participation of Indigenous voices commit injustice and generate ineffective results
786 (Rafa et al., 2024). Structural change also necessitates a radical reconsideration of knowledge
787 hierarchies, affirming and prioritizing Indigenous knowledge systems, cultural practices, and
788 land-based identities as critical for effective and equitable climate change action (Ogunbode et
789 al., 2024; Taylor et al., 2023). This is further applied to law and policy changes, acknowledging
790 the "Legal Determinants of Health" (LDOH) as a structural prism to view how laws and
791 regulations, or their absence, influence health outcomes and perpetuate or reduce inequities in
792 all aspects of justice (Rafa et al., 2024; Uwayezu et al., 2018).
793
794 There are still important gaps in research that call for top priority to move forward with justice
795 in the Circumpolar North. There is a pressing need for additional studies that quantitatively and
796 qualitatively evaluate the long-term, intergenerational effects of climate change on Indigenous
797 cultural and spiritual health, beyond mere material impacts (Parsons et al., 2024). Research is
798 also needed on how to develop and test Indigenous-led adaptation and mitigation plans,
799 measure their effectiveness, and the conditions under which they might be scaled and sustained
800 (Ogunbode et al., 2024). In addition, a deeper study of the mechanisms by which legal and
801 policy environments enable or hinder procedural, recognitional, and restorative justice is
802 needed (Savaresi et al., 2024; Rafa et al., 2024). This research must be designed to provide
803 actionable evidence for policy reforms that institutionalize Indigenous rights and knowledge in
804 environmental governance.
805
806 Ultimately, Indigenous leadership is necessary for a fair circumpolar future. Placing Indigenous
807 knowledge, forms of governance, and worldviews at the center as core solutions is not just an
808 issue of equity but a practical requirement for creating effective, sustainable, and culturally
809 suitable measures to counter climate change (Ogunbode et al., 2024; Parsons et al., 2024). The

integral connection between Indigenous Peoples and their land and surroundings holds precious lessons on ecological resilience and adaptive potential (Lau et al., 2021). Restorative justice, such as land-back efforts and cultural revitalization, must be prioritized to restore old wrongs and empower Indigenous peoples to take charge of co-creating a more equitable and sustainable future in the Circumpolar North (Savaresi et al., 2024). This holistic approach guarantees that striving for environmental justice is not merely about minimizing effects but essentially about decolonizing environmental governance and respecting Indigenous sovereignty.

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