

Research to develop case studies on climate change adaptation in the Global South that can be applied to the BC context



What can we learn from experiences in climate change adaptation even when the context varies widely?

Photo by Ojha (2021)

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Disclaimer

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Executive Summary

Climate change adaptation represents a proactive endeavour by communities, governments, and organizations worldwide, demanding true collaboration. Aligning policies, resource-sharing, and knowledge coordination among states and entities make this effort possible. Yet, power imbalances persist, with Western paradigms often overshadowing traditional knowledge and marginalizing Indigenous perspectives. The disparity in resources between the Global North and South generally results in interventions not always in the best interest of the latter. Effective strategies should center on mutual respect, international partnership, and valuing both regions' intrinsic knowledge and strengths.

During the COVID-19 pandemic, Canadians demonstrated a receptiveness to varied knowledge bases, indicating potential wider acceptance of global insights, including those on climate change adaptation. This research presents nine case studies from the Global South detailing events like flooding, wildfires, droughts and food security. Highlighted are innovative adaptation strategies that include community-based practices and systemic approaches with multiple stakeholder participation. In addition to academic and grey literature, insights from key actors engaged with Global South partners are incorporated. The shared experiences underscore the importance of collaborative knowledge-building and resilience, targeting policymaker engagement and fostering accountable partnerships.

Additionally, the role of Canadian institutions is explored, focusing on their shift from providing aid to fostering decolonized and equitable ties. Knowledge transfer implications are addressed, but the central inquiry lies in our genuine eagerness to learn from others.

I. Introduction

Innovative forms of collaboration for community climate change adaptation are crucial in addressing the challenges posed by climate change and are being undertaken by academia, government agencies, and independent organizations. Interesting case studies show the transition from extractive frameworks of cooperation to a more mutual understanding, although there is still a long way to go for intercultural collaboration as proposed by some communities: a new understanding of where community members become allies and collaborators connect with respect, commitment and accountability to local values and interests (Vazquez et al., 2021). Moreover, community-academic partnerships have emerged as an innovative format for collaboration that facilitates climate action and increases transformative potential. These partnerships contribute to adaptation through collaborative and autonomous responses, which should be considered in policy recommendations (Huntington et al., 2017; RieckMann et al., 2021).

To support adaptation efforts and identify effective adaptations based on local conditions, researchers are encouraged to collaborate directly with vulnerable groups at the forefront of climate change (Pisor et al., 2023). Engaging with communities is not only practical but also ethically responsible, as researchers bear the responsibility of listening to those experiences based on traditional knowledge; therefore, climate change research and policy-making can be more participative and inclusive. Consequently, strengthening collaborative governance, building capacities, and promoting multi-stakeholder engagement are crucial steps in developing robust climate change adaptations (Miquelajauregui and Madariaga-Fregoso, 2022; Pearce et al., 2009).

Furthermore, valuing and revitalizing historic and traditional knowledge can greatly enhance climate change engagement and foster committed community-based actions. In this regard, collaborations between indigenous communities, climate scientists, and social scientists play an essential role in anticipating and responding to timing shifts associated with climate change (Bastian and Hawitt 2022; Donkers, 2021). By incorporating traditional knowledge and combining expertise from diverse fields, these collaborations can contribute significantly to effective climate change adaptation strategies. Of course, collaborators need first to recognize the cultural and socioeconomic conditions that are drivers of climate injustice before drawing into climate strategies.

Some government efforts around the world involve the establishment of community-based committees and partnerships with local organizations. In Bangladesh, for example, the Village Disaster Management Committee (VDMC) collaborates with the local government and other organizations to implement community-based flood management practices (Adhikari et al., 2018). Similarly, local governments in Australia have implemented localized adaptation strategies, focusing on community engagement, education, and various sectors such as council

operations, water consumption management, and sustainable transport (Chou, 2020). In Ghana, the government has outlined planned climate change adaptation strategies, including the introduction of improved crop varieties and the provision of irrigation facilities in communities (Teye and Nikoi, 2022).

Moreover, an innovative approach to climate change adaptation governance is Adaptive Collaborative Risk Management, which combines conventional risk management with collaboration and adaptation (May and Plummer, 2011). This approach emphasizes the vital importance of grassroots innovations and socially innovative initiatives at the community level. As Zupancic (2022) remarks, when coordinated by the government, these initiatives can be scaled up, promoting participatory forms of governance, empowering communities and enhancing their adaptive capacities in the face of climate change. However, scaling up initiatives require a deep understanding of the contexts, having clear that this process means “achieving greater numbers through adoption of the innovation” UNDP (2022).

The provincial governments of Canada have implemented various approaches to address climate change. One of these approaches is the establishment of Regional Adaptation Collaboratives (RACs), which bring together networks of actors to share information and develop adaptation responses (Bednar and Henstra, 2018). Furthermore, provinces have taken the initiative to set legislated targets for greenhouse gas emissions reduction and have increased funding for research and innovation in climate change (Newman and Perl, 2014). In the forest policy sector, Canada has integrated forest-related adaptation into provincial climate change strategies, leveraging their ownership and control of forests to implement adaptation measures (Rayner et al., 2013). The progress in climate change adaptation within Canada's protected areas sector has been limited, with organizations reporting a lack of capacity and persistent barriers to implementing adaptation strategies (Barr et al., 2020).

The coexistence of multiple institutional understandings of climate change at different scales also poses challenges to adaptation policies and strategies (Patiño and Gauthier, 2009). One of the issues is the ineffective engagement of Indigenous communities in climate change response by governments and organizations. Indigenous knowledge and cultural practices are often overlooked, leading to ineffective adaptation strategies that do not incorporate Indigenous cultures and knowledge (Kinay et al., 2023). Additionally, inadequate planning decisions, fragmented approaches, and sector-by-sector resource allocations have constrained adaptation efforts at the community and regional levels (Waldick et al., 2016). According to Gray (2017), the uncertainty and complexity of climate change impacts, coupled with the limitations of predictive models, have contributed to failures in adaptation planning and decision-making. Therefore, it is crucial to address these challenges and incorporate diverse perspectives, including Indigenous knowledge, in order to develop effective community strategies to adapt to climate change and mitigate catastrophic events in Canada.

British Columbia has been implementing some systemic and practical solutions to adapt to climate change. The Climate Preparedness and Adaptation Strategy, for instance, enhancing preparedness for climate impacts, including wildfires, flooding, and extreme heat. The strategy encompasses actions across ministries and a significant investment of \$513 million (Government of British Columbia, 2022). Furthermore, the BC Wildfire Service supports fire and fuel management besides suppression strategies to reduce the risk and impact of wildfires. Additionally, the provincial flood and resilience plan includes flood risk assessment guidelines, flood mapping guidelines, and professional practice guidelines for flood assessments (Government of British Columbia, 2023).

While community-based adaptations are being made, there is a pressing need for long-term sustainable development in collaboration with other social, economic, gender, and health considerations (Drolet, 2012). Improved data and monitoring are essential for adaptive management and ecological resilience (Holmes et al., 2013). In a similar vein, Murphy (2011) mentioned some practical local solutions to reduce vulnerability and increase preparedness for climate events. As we know, community-level development path transformations are critical for reducing greenhouse gas emissions and enhancing community resilience.

Some non-governmental organizations (NGOs) play a significant role in climate change adaptation as knowledge brokers and intermediaries in the production, communication, and uptake of climate information. They assist people in acquiring, understanding, valuing, and incorporating climate information into decision-making processes, particularly for climate-vulnerable populations (Jones et al., 2016; McGregor et al., 2018). Moreover, Canadian organizations are actively involved in policy development, advocacy, monitoring, and community engagement (Toch, 2015). C. Black (personal communication, August 8, 2023) described his experience as a member of Deetken, a Canadian-based social enterprise: “We have found multi-laterals often rely on our growing expertise, for example, in gender-lens investing, to inform the development of their own frameworks once mandated by policy-makers.”

NGOs have been influential in encouraging the government to ratify international climate change agreements such as the Kyoto Protocol. Additionally, they promote community-based adaptation strategies and bridge the gap between scientific and local knowledge (Blanco, 2006; Toch, 2015). It is worth noting that organizations in British Columbia are already incorporating adaptation strategies into their management and conducting further research on adaptations (Burch et al., 2014; Lawrence and Marzano, 2013).

When considering the contributions of local NGOs in Global South countries¹ at risk from climate change for knowledge creation and adaptation support, there are valuable insights that are often underestimated (McGregor et al., 2018). It is clear that in order to mitigate the impacts of climate change and extreme weather, families and communities must have access to not only financial contributions, but to all kinds of resources and tools that enable them to adapt (Nema and Muthupriya, 2022).

Therefore, it is essential for governments, international organizations, and other stakeholders to increase their efforts in supporting communities in Global South regions to enhance climate change adaptation and resilience. However, it is equally important to rethink traditional approaches and mechanisms for delivering aid to these communities. That means supporting effective frameworks that secure the long-term sustainability of each collaboration, frameworks that go beyond capacity building, monitoring and community consultation. This relationship requires improving our ability to listen to the communities and implies a critical engagement with culture and community life to recognize their interests (Ouma and Dimaras, 2013).

Collaboration networks have identified North America, including Canada, as one of the social core hubs for research on climate change adaptation (Benomar et al., 2022). In the context of protected areas, Parks Canada and the Canadian Parks Council Climate Change Working Group have developed a Climate Change Adaptation Framework for Parks and Protected Areas through an international collaborative process (Nelson et al., 2020). In terms of marine conservation, Canada is well-positioned to assume a leading role in climate change adaptation and has the potential to contribute to international commitments on biodiversity loss and climate change mitigation (Bryndum-Buchholz., 2022). It is important to note that the Canadian government has doubled its international climate finance commitment from \$2.65 billion to \$5.3 billion for the period of 2021-2026, still far from the amount committed by Germany, France and UK (Tomlinson, 2021). This finance is allocated to support developing countries in transitioning to low-carbon, climate-resilient, nature-positive, and inclusive sustainable development. A minimum of 40% of the funding is dedicated to climate adaptation projects, and at least 20% is allocated to projects that leverage nature-based climate solutions (Government of Canada, 2023). Since this funding is coming from the Climate-related Official Development Assistance (ODA), the specific support related to climate justice and equity is still unclear.

¹ The Global South, which comprises developing nations from Africa, Asia, Latin America, and Oceania, is characterized by geopolitical disparities and historical power dynamics in contrast to economically developed countries in the Global North (Turunen, 2020).

Moving forward, the literature does not report meaningful experiences on collaboration between the Global North and the Global South, specifically for climate change adaptation other than the official frameworks supported by national governments, and these usually go in one single direction (Barbier, 2015; Lesnikowski et al., 2016). These frameworks are usually financial, technological or related to capacity-building to support intervention programs in Indigenous communities to run ecosystem services schemes or other conservation programs (Salcido and Ramirez, 2008; Wit and Freitas, 2019). Consequently, practical strategies that can lead to systemic changes are missing due to weak collaboration and lack of documentation. The lessons learned are not disseminated properly within their regions, let alone shared with stakeholders from the north.

Canadian organizations have learned after the Covid pandemic that multistakeholder collaboration is crucial to address global issues and that there is valuable experience and knowledge from others. This renewed understanding can help Canadian actors to transit from “providing aid” to “building equitable partnerships” in the context of international cooperation (BCCIC, 2022). Therefore, Canadian actors and institutions may learn from regions in the world that have experienced and adapted to the effects of climate change for decades, for example, with tools for effective low-budget infrastructure, community-based protocols or risk management strategies (Cai et al., 2015; MacDonald and Birchall, 2019). As we learn to differentiate the processes of cooperation and collaboration, it is also possible to unlearn the traditional forms that our Canadian actors and institutions approach to the needs of our Global South partners and build alliances based on intercultural respect, inclusion, and common goals.

Our main objective in this document is to present a series of case studies from the Global South as a means to illustrate the value of knowledge from areas of the world that have long addressed the effects of human-induced climate adversities. These case studies offer insights into the experiences of communities and the systemic solutions that have had a significant impact on many regions, and through these insights, inspiration to communities of the Global North to seek out that knowledge that is grounded in the practice of communities from the Global South. It is important to note that these case studies do not necessarily involve partnerships with northern counterparts. Nonetheless, they provide interesting experiences that can inform Canadian actors (government, funding agencies, NGOs, and academia) about the challenges and successes in community practices. With the support of the UBC Sustainability Hub and the British Columbia Council for International Cooperation (BCCIC), we have gathered information from various sources and conducted in-depth interviews with key partners. Through these efforts, we aim to explore what we can learn from diverse contexts in climate change adaptation, even when the context varies widely.

1.1 Importance of international cooperation and collaboration.

International cooperation is gradually evolving with a comprehensive and inclusive approach that addresses various aspects of global challenges and promotes shared goals and values. Among many definitions, Ashkenas (2015) points out that international cooperation involves the adjustment of behaviour and policies by states or entities to align with other parties. It typically encompassed negotiations, agreements, and resource-sharing to tackle mutual concerns such as global security, climate change, or public health (Ashkenas, 2015). However, the acceleration of this transition remains challenging for organizations and institutions striving to establish effective partnerships through formal international organizations and multilateral approaches that coordinate policy, knowledge, and accountability (Schaaf, 2015; Yang, 2022).

It is important to recognize that power imbalances exist in the practice of international cooperation. The dominance of Western knowledge and peer-reviewed assumptions often overlooks traditional knowledge and marginalizes Indigenous paradigms, syncretism, and the intriguing contradictions within traditional groups (Bennett et al., 2022; Wheeler et al., 2020).

Despite these challenges and imbalances, international cooperation for development claims to should to prioritize inclusivity, equity, and mutual respect among participating nations. It should place the needs and aspirations of Global South countries at the forefront, ensuring their active involvement in decision-making processes (Munusamy and Hashim, 2021). To achieve this, it is crucial to differentiate between the historical legacies of development assistance and the impacts of humanitarian aid when dealing with so-called failed states (Chong, 2002; Young and Pakenham, 2021). A. Vadnais (personal communication, July 19, 2023) brought an example: “In our collaborations, we often encounter remnants of paternalistic aid models. While we strive to decolonize our approach and promote equitable partnerships, it remains a challenge as we sometimes engage with organizations still rooted in these traditional practices.” Furthermore, cooperation of all kinds should prioritize addressing global challenges and promoting shared goals that benefit all nations and people, recognizing that addressing local crises anywhere will have consequences that resonate globally and vice versa; global solutions impact locally.

On the other hand, international collaboration involves the active participation and joint efforts of multiple parties working together towards a specific goal or project. Collaboration prioritizes the sharing of resources, infrastructure, and expertise to achieve a common outcome or solve a problem, regardless of its dimension and location (Ashkenas, 2015). As an example, a Canadian-based multinational organization recognizes this need: “Our focus on gender (cross-sector), and clean energy requires a multi-disciplinary approach such that we include not only economists and finance professionals on our team, but also engineers and others with diverse educational backgrounds and expertise. Our team, therefore, requires significant internal collaboration to be effective.” C. Black (personal communication, August 8, 2023). In order for collaboration to be

successful, it is important for the synergy to be inclusive, interactive, and well-communicated to all stakeholders while respecting their cultural, social, and financial differences.

Each case is unique; however, the failures of collaboration efforts are often related to ineffective partner relationships and a lack of specific systems to monitor the emotional state of the network in order to address any conflicts (Ferrada and Camarinha-Matos, 2012; Zhao and Priporas, 2017). Additionally, the introduction of new technological tools, financial regulations, and organizational schemes can constitute strong barriers in various forms of resistance to true collaboration, especially when these are imposed from top-down policies.

Nicholas-Figueroa (2017) suggests that improved collaboration would integrate Western science and traditional knowledge to generate innovative and unique information that is absent when conveyed only in Western ways. Moreover, it is crucial to treat them at the same level, recognizing the existence of "Traditional or Indigenous science." An example of an emerging strategy is the South-South collaboration, which involves countries in the Global South across regions of Africa, Asia, Latin America, and Oceania. This model is seen as a global partnership for sustainable development (Clark et al., 2020). The South-South collaboration promotes research alliances, educational exchanges, joint production of vaccines, and capacity-building initiatives. Its main purpose is to address common challenges, promote development, and provide cost-effective solutions for developing countries (Heryadi et al., 2022; Sáenz et al., 2010; Were, 2019). Indeed, the South-South collaboration can be considered beyond an expression of solidarity as a more authentic mechanism to recognize that countries know each other and identify with their counterparts at the same level of privilege and/or oppression.

The implications of international collaboration and knowledge transferability can be complex. As mentioned before, there is a wealth of local knowledge not recognized by Western science, and traditional knowledge may be hidden by communities that choose not to share, which we must respect. International understanding can promote innovation and economic growth by allowing countries and regions to learn from each other's successes and failures. It can also enhance cultural understanding and cooperation between nations (Wilkesmann et al., 2009). Of course, the challenges in collaboration and knowledge adaptation are related to different cultural, social, and economic contexts, and these differences need to be clearly recognized, especially in topics like climate change adaptation.

Given this background and the multiple goals in the local and global arenas, it is highly likely that learning from experiences in climate change adaptation will involve both cooperation and collaboration. The next section will present some case studies in an interesting narrative.

1.2 Overview of the Importance of Climate Adaptation Strategies in the Global South

Before delving into specific cases of climate adaptation, it is important to note that Global North countries possess greater resources and infrastructure than the Global South to respond and adapt to climate change effectively. The Global South is frequently associated with areas marked by poverty and corruption, making it the subject of extensive research and numerous interventions aimed at addressing socioeconomic inequalities (Watson, 2015). According to the Brandt Report, an imaginary line divides the world into the Global North and the Global South based on socio-economic and political attributes (Lees, 2021).



Fig 1. The Global South. Source: Royal Geographic Society. (2023).

How do the North and South adapt to the effects of climate change? The adaptation process primarily relies on experience and resources. Developed countries, such as the United States and the United Kingdom, face heightened vulnerability due to rising sea levels, which lead to coastal erosion, flooding, and the loss of crucial ecosystems, thereby endangering both human populations and wildlife (Marengo et al., 2017; Volkov et al., 2023). Furthermore, the increased frequency and severity of extreme weather events like hurricanes, storms, heat waves, and droughts result in significant infrastructure damage, loss of lives, and economic repercussions. Recent occurrences of devastating hurricanes, floods, and wildfires in countries like the United States, Canada, and Australia highlight the urgent need for practical and systemic approaches to address climate change (Nicholls, 2019; Xue et al., 2021). Additionally, disruptions to agriculture, water supply, and energy systems further strain the economy, underscoring the necessity for sustainable and climate-resilient solutions.

Adaptation strategies in the Global North have evolved and now aim for a more holistic approach, transitioning from traditional disaster management methods to broader sustainable development pathways that tackle the root causes of climate risks. This entails integrating climate change considerations into existing systems and infrastructure, such as water

engineering and building retrofits (Boon et al., 2021). A greater emphasis on managing, conserving, and restoring ecosystems to enhance their resilience and provide ecosystem services is also evident, including measures like habitat conservation, carbon sequestration, and sustainable fisheries management (Lam et al., 2020).

In the Global North, various practical measures with differing impacts have been implemented at the community level. These include raising public awareness and understanding of climate change impacts and adaptation strategies through education campaigns, community engagement, and information dissemination (Lata and Nunn, 2011). The agricultural sector has adopted adaptive measures such as crop diversification, irrigation, adjusting planting dates, and utilizing drought-tolerant or early-maturing crop varieties (Mabe et al., 2012). Furthermore, the promotion of green infrastructure, urban forestry, and energy-efficient considerations in architectural design helps reduce greenhouse gas emissions and enhance climate resilience (Akinola et al., 2020). The fact is that, as J. Carolsfeld suggested (personal communication, July 19, 2023), “adaptation is more about practical measures. It is not about buying electric cars. It implies more actions rather than reflexive workshops”.

It is important to note that the Global North often positions itself as a technical expert and intervenes in the Global South to address climate change impacts (Praskievicz, 2022). Consequently, some proposed adaptation and mitigation solutions for the Global South prioritize market-led proposals that benefit the global North more than the Global South (O'Sullivan et al., 2022). Additionally, acknowledging the disproportionate impacts of climate change on vulnerable social groups and ecosystems in the Global North is essential for successful adaptation strategies (Lucatello and Sánchez, 2022; Vergunst and Berry, 2021).

Conversely, the impacts of climate change in the Global South reveal higher vulnerability due to limited resources, infrastructure, and marginalization. Erratic and unpredictable rainfall patterns, floods, droughts, and prolonged dry spells have adversely affected water systems used for energy supply through hydropower, leading to energy shortages (Chirambo, 2020). Moreover, insufficient funding, technological limitations, and weak governance systems pose significant challenges in implementing adaptation measures. For example, inadequate urban infrastructure in Global South cities exacerbates their vulnerability to extreme weather conditions, resulting in increased risks and fatalities (Gaum and Laubscher, 2021). Other risks include the loss of agriculture and forestry resources, water shortages, food insecurity, biodiversity loss, and health risks. These impacts exacerbate existing inequalities within regions and disproportionately affect vulnerable populations (Akanwa and Joe-Ikechebelu, 2020; Bartlett et al., 2022). However, As J. Carolsfeld clarified (personal communication, July 19, 2023) “Not all inequalities are climate-linked. There are capitalism and market-driven issues. Climate variability amplifies inequalities as Covid-19 did”.

Global South adaptation strategies range from community-based responses to institutional engagements of local groups, with top-down policies typically decided at the national level. Strategies implemented focus on the management and restoration of ecosystems to enhance their resilience and provide ecosystem services. Common local measures include habitat conservation, reforestation, and sustainable land management (Lam et al., 2020; Nalau et al., 2018). Moreover, agricultural adaptation strategies aim to enhance resilience and food security by promoting crop diversification, improving water management practices, adopting climate-resilient crop varieties, and implementing sustainable farming techniques such as agroforestry (Mabe et al., 2012). Additionally, low-budget mechanisms for climate adaptation in Global South countries can include low-cost rainwater harvesting systems, community-based early warning systems utilizing affordable technologies like mobile phones and local radio stations, and climate-resilient infrastructure with improved insulation and natural ventilation to withstand extreme weather events, minimizing damage and repair costs (UNSDG, 2022; World Bank, 2021).

Community institutions and organizations actively participate in climate change adaptation efforts by empowering decision-making processes and promoting local knowledge and traditional practices (Lata and Nunn, 2011). This community-based process empowers communities to determine their involvement in climate adaptation activities. However, their higher vulnerability and financial limitations make Global South regions more susceptible to the imposition of solutions by the Global North within pre-designed frameworks that constitute, in many cases, detrimental solutions. Institutional and policy-based solutions include implementing climate change adaptation plans, integrating climate considerations into development policies, and enhancing capacity-building efforts (Chirisa et al., 2021; Lam et al., 2020). An example of such a policy is the "Reducing Emissions from Deforestation and Forest Degradation" (REDD+)² Initiative that, on one side, promotes Learning Communities to share local knowledge between communities, and on the other side, establishes performance-based payments for community and Indigenous peasants (Alianza MREDD, 2023; Estrada, 2016).

It is common to find community groups and institutions collaborating on conservation practices for hydrological services and biodiversity stewardship to receive temporary monetary compensation (Mora-Carvajal et al., 2019). For some national governments, this exchange is a means to access climate finance mechanisms and international support for funding and implementing climate change adaptation projects. This includes leveraging funds from international climate funds, bilateral partnerships, and multilateral agreements (Estrada, 2016).

² The REDD+ Program is an example of a systemic approach from the United Nations Framework Convention on Climate Change that designs a national strategy to approach certain regions of interest.

Some concerns persist about the efficiency of these financial mechanisms and whether their benefits truly reach those who need them the most (Jayachandran, 2013).

The structural disadvantages faced by the Global South suggest they have acquired extensive experience in confronting the catastrophic effects of climate change and have thus learned multiple lessons from palliative, practical, and holistic approaches. International cooperation and collaboration, alongside local resilience, have proven somewhat effective in creating adaptation strategies that are not always supported by the privileges of the global North.

1.3 Significance of compiling practical and systemic cases

Climate change consequences impact communities around the world in different and unique ways. Therefore, adaptation strategies should be tailored to local experiences and needs. Local knowledge plays a crucial role in providing valuable insights into the specific impacts of climate change on a particular region or community, aiding in understanding its implications and identifying the most appropriate adaptation measures (Naess, 2012). How communities respond to catastrophic climate events is not solely determined by their financial or technological capacity but also reflects their way of living, thinking, and being. Understanding these changes can help identify the most suitable adaptation measures according to their cosmovision. Additionally, Naess (2012) suggests that involving local stakeholders in the decision-making process increases ownership and acceptance of adaptation strategies, leading to greater implementation and long-term sustainability.

When establishing collaboration relations, it is essential to recognize that there is no unique cosmovision or community or Indigenous ontology (Galway et al., 2019; Sesana et al., 2018). This is a frequent barrier for multinational organizations: “Another challenge has been learning to work in many different countries. For example, just to mention five countries: Mexico, Haiti, Nicaragua, Peru and Argentina, each has a very differentiated business culture” C. Black (personal communication, August 8, 2023).

While some academic and non-governmental entities may hesitate to engage in community collaboration, the complex relations and governance mechanisms of traditional communities do not imply that they are not open to beneficial changes or that they compromise their values in inequitable relations. Communities value the practical effectiveness of these approaches and understand the importance of knowledge, attitudes, and beliefs in [health] learning and behaviour change (Smylie et al., 2014). Indigenous and settler researchers can foster spaces for deep learning and knowledge co-creation with communities, even though this endeavour may be challenging and require ongoing attention to relational accountabilities (Hart et al., 2016).

Respecting pre-existing knowledge systems and embracing diverse understandings of knowledge in knowledge translation efforts among communities and organizations is crucial (Smylie et al., 2014). Indigenous knowledge is not solely acquired from books but also through engagement with Indigenous authors and community participation (Hart et al., 2016). However, it is important to consider potential challenges, such as the influence of traditional beliefs on the uptake of new knowledge (Naess, 2012). To ensure effective adaptation, it is recommended to integrate local Indigenous knowledge with scientific climate assessments in the design and implementation of strategies (Antwi-Agyei et al., 2014)

On the other hand, systemic changes span from individual behaviours to international policies, but they generally start from top-down decisions. Finding examples where community-led initiatives have shaped higher levels of governance to negotiate the imposition of national strategies is difficult, and even less so to place an agenda from community assemblies. In his book "Instituting Nature," Andrew Mathews (2011:25) identified institutions in Oaxaca, Mexico, created by Indigenous communities like Ixtlan de Juarez, as mature, inclusive, and capable of reacting to any conservation initiative. The region of Ixtlan has maintained accompanying official intervention mechanisms such as the Program for Certification of Rights to Ejido Lands (PROCEDE) when it has been convenient to their interests (Mathews, 2011:229). Another example is the City of Curitiba in Brazil, which has become a shining example of environmental stewardship for the whole country. Its success in promoting sustainability, reducing emissions, and improving the quality of life for its residents serves as a valuable inspiration for other cities seeking to adopt environmentally conscious practices (Berzons, 2020). However, there are not many examples from the bottom up that drive evidence-informed decision-making, especially for climate change policies.

Systemic changes across sectors are equally necessary as practical strategies in the local arenas. "The systemic level needs to be informed by community practices. For climate adaptation, community experiences are the ones that give sustainability to landscape interventions" A. Vadnais (personal communication, July 19, 2023). We all need to transition to renewable and efficient energy, but questions arise about who pays the costs and who receives the benefits. While recognizing the benefits of a circular economy that minimizes waste and resource consumption, the issue of power and technology distribution becomes relevant.

Promoting more sustainable agricultural practices and policies, such as agroforestry, organic farming, and reduced use of synthetic fertilizers, can help mitigate emissions, but discussions about the ownership of lands arise. A conversation on climate colonialism between the Global North and Global South highlights these disparities, with climate financial mechanisms operating in Global South countries lacking the political will to address the root causes of climate disaster. This unequal relation perpetuates procedural injustices and frames Global South countries as incompetent or unaccountable actors (Ogumbude, 2022). Projects financially supported in the Global South are often used to justify climate action without considering local impacts. For

example, "carbon offset projects purchased to claim a smaller carbon footprint without truly reducing the amount of greenhouse gas emissions produced. Reforestation projects are done in Brazil and Ecuador, and have been shown to involve land grabs from indigenous people, who are evicted from their homelands" (Edukemy, 2023:1).

In this research, we will provide illustrative examples of climate change adaptation strategies by focusing on international cooperation and community collaboration. The aim is to call on the general public to be more open to learning from others rather than assuming that they have all the resources only to provide "aid."

II. Methods

2.1 Literature Review

This short research is based on the compilation of multiple case studies. To begin, we conducted a Scoping Literature Review to clarify concepts in the literature and define gaps in knowledge. A scoping review serves the purpose of identifying the existing literature on a specific research question, as established in our study (Munn et al., 2018). According to Munn et al. (2018), scoping reviews do not aim to produce a critically appraised and synthesized result/answer to a particular question; rather, they aim to provide an overview or map of the evidence.

Scoping Reviews employ a rigorous approach, often including a protocol and conducting a systematic and fairly exhaustive search. Moreover, they can serve as the precursor to a full systematic review (Charles Sturt University, 2023).

For this study, we have identified two types of cases: systemic and practical cases. Systemic Approaches consider the vulnerability of coupled human-environment systems and comprehend the complex linkages within and between them to integrate human agency into adaptation strategies (Crane et al., 2011; Turner et al., 2003). It is important to note that vulnerability is not solely determined by exposure to hazards but also depends on the sensitivity and resilience of the system experiencing those hazards. As a result, this approach requires conceptual frameworks that account for the diverse and interconnected nature of these systems (Turner et al., 2003).

As a holistic strategy, systemic approaches consider solutions that are political, financial, or related to education and infrastructure, but they consistently involve public consultation and cooperation, given the complexities involved (Keller, 2023). Jake Keller describes a systems approach called ADAP (adaptation decision-making assessment process) as an initial assessment from the Federal Highway Administration (FHWA) to address infrastructure adaptation (Keller, 2023;1). According to Keller (2023), the ADAP approach can be utilized at any stage of responding to the effects of climate change, ranging from resiliency planning to new project development and responding to damages already incurred. We consider Keller's illustrations to cover the impact and the response from a systemic approach at a community level. Consequently, the case studies that we describe generate a visible impact in these areas and strategies that are addressed with these elements.



Fig 2. Community level impacts of Climate Change
Source: Keller (2023)

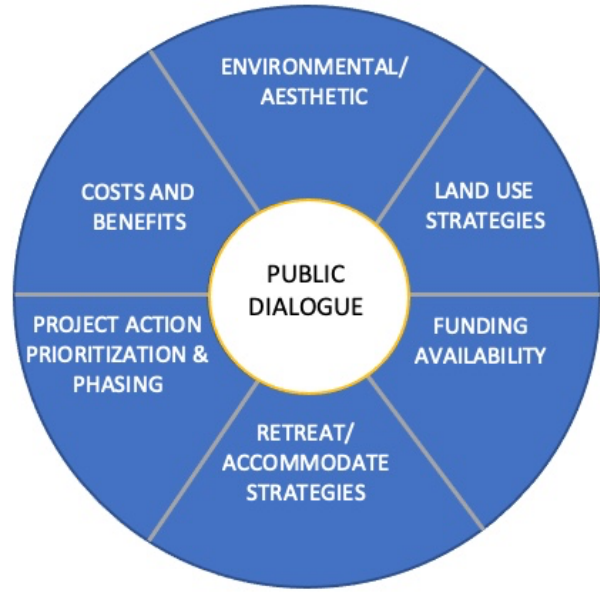


Fig. 3 Elements to address Climate Change Impacts
Source: Keller (2023)

The main issue is that systemic solutions typically originate from higher levels of authority and organizations. However, their potential benefits can be realized when local knowledge is considered, and practical solutions are valued, leading to better engagement levels (Reed et al., 2013).

On the other hand, practical strategies encompass community-led initiatives. While some authors argue that a systematic framework is generally necessary to identify barriers to adaptation and locate points of intervention, along with understanding the actors, context, and systems involved in the adaptation process (Moser and Ekstrom, 2010; Reed et al., 2013), practical strategies effectively connect practices to livelihood concerns and empower communities to engage with climate adaptation and mitigation in simple and everyday ways. Therefore, community involvement and participation enhance the effectiveness and efficiency of climate change policies and adaptation programs (Safrina et al., 2022).

Notably, “systemic and practical approaches are complementary”, a point that emerged coincidentally from the key actors interviewed for this research (J. Lamyin and J. Carolsfeld, personal communication, July 19, 2023). In another interview, P. Acosta (personal communication, July 19, 2023) expressed “Our experience seems to be more practical. Even if the funding come from a national government, our focus go to community and family practices and behaviours.” Therefore, engaging with communities helps avoid harmful top-down approaches and ensures that adaptation strategies account for the specificities of the place and the needs of local communities (Simon et al., 2019).

2.2 Key actor's interview

To provide context and contrast to this research, we aimed to reach at least five organizations affiliated with the BCCIC and their representatives. The BCCIC is a coalition of international development organizations and people working in solidarity with partners across the world working to improve their own conditions. We conducted interviews with five BCCIC members using an informal semi-structured questionnaire. Upon their acceptance to be interviewed in a Zoom meeting, we shared a list of questions and ensured they understood the study's purpose.

During the interviews, we explored the participants' experiences and perspectives. We registered their opinions and manually coded the responses for thematic analysis. It is essential to highlight that this study did not seek data saturation or triangulation due to the limited number of available organizations. The narratives and experiences of the key actors serve to illustrate the purpose of non-intensive research rather than establishing direct links to existing theories or concepts.

2.3 Analysis

The findings from the case studies in the literature review and key actors' interviews were periodically reviewed in consultation and feedback from the BCCIC staff. This study can serve as a baseline for future communications and dissemination. The research question was initially presented during the Panel "The Pulse of Climate Activism: Indigenous Feminist Movements Leading Climate Responses and Solutions | Led by British Columbia Council for International Cooperation (BCCIC)" during the Together|Ensemble at the University of British Columbia (UBC) – Advancing the SDGs in British Columbia, in June 2023. Subsequently, the main findings were presented and discussed at the "Research to Action: Advancing Urban Sustainability 2023" Conference at UBC in September 2023. BCCIC continues to draw the next steps for knowledge exchange and learning.

III. Case studies.

3.1 Flooding

BANGLADESH – Flood Early Warning System.

Bangladesh has implemented a comprehensive flood management strategy, encompassing the construction of flood shelters and the establishment of early warning systems. The country faces frequent flooding, exacerbated by climate change and other natural disasters. To tackle this challenge and enhance the resilience of flood-vulnerable communities, the Bangladesh Red Crescent Societies (BDRCS) which is a humanitarian organization in Bangladesh, has been actively implementing community-based resilience programs.

One of the significant interventions documented by Ferdous et al. (2020) is the Integrated Flood Resilience Programme (IFRP), which is currently underway in four communities of Nilphamari and Lalmonirhat Districts. Launched in March 2018 with support from the Ministry of Foreign Affairs (MoFA) of the Republic of Korea (RoK) and the Korea International Cooperation Agency (KOICA), the IFRP aims to strengthen community resilience, enabling effective responses to multi-hazards and climate-induced phenomena.

As part of the IFRP, Bangladesh Red Crescent Societies (BDRCS) collaborated with various stakeholders, including Community Disaster Response Teams (CORT), Community Disaster Management Committees (CDMC), Unit Disaster Response Teams (UDRT), Community Organizers (CO), and Upazila and District Water Development Board, to develop a Flood Early Warning System (FEWS) for the four communities. The FEWS was designed to minimize flood losses for the community, protecting their livelihoods and properties by providing timely and accurate early warnings.

A flood early warning system is critical for minimizing flood-induced hazards. Currently, various humanitarian and development organizations are actively engaged in flood forecasting and early warning systems at local, national, continental, and global scales. In a flood early warning system, real-time hydrometeorological observations play a vital role, provided by weather radar satellites and hydrometeorological station networks (Billa et al., 2006). These real-time data facilitate flood risk avoidance, timely flood warnings, and necessary preparations. Additionally, probabilistic weather forecasts contribute to providing input for hydrological models to generate warning scenarios (Burguer, 2009). The selection of an appropriate model that characterizes and simulates catchment responses is equally crucial for effective flood early warning (Thielen et al., 2015). Developing flood forecasting and warning systems is an essential element in regional and national flood preparedness strategies, ranking as a high priority in many countries. Flood early warning systems are considered an alternative to structural schemes, being more cost-effective.

Despite the high priority accorded to flood warnings in flood risk management, there is a lack of comprehensive data on the benefits and costs of such systems (Wallingford, 2006). Evaluating the benefits of early flood warning systems involves assessing potential savings in flood damage to private and public assets resulting from timely actions taken in response to warnings.

Fedous et al (2020) describe the flood early warning system for these communities as mainly consisting of four action lines:

- 1) Risk, knowledge and scoping. To assess the vulnerability of communities by collecting useful data.
- 2) Monitoring and early warning. Focus on the rainfall river level, warning decision and warning instruments by upstream communities.
- 3) Dissemination and communication. Dedicated to household warnings and early information to downstream communities.
- 4) Response, capacity and resilience. Ensure that evacuation centers and search and rescue teams have relief goods and enhance community response capabilities to build resilience.

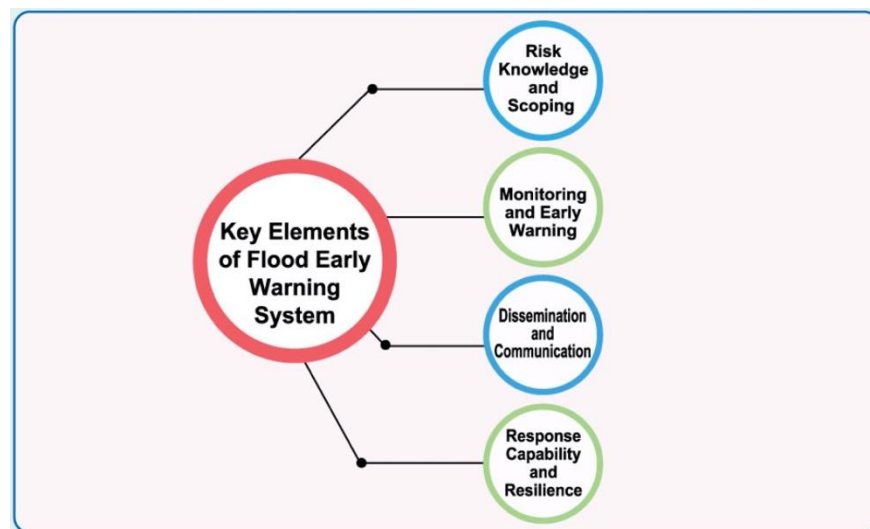


Fig 4. FEW System. Source: UNDDR 2006 as cited in Fedous et al (2020)

This study was conducted to assess the effectiveness of the developed flood early warning system during the 2019 flood at the four communities. The study aimed to evaluate the system's impact on reducing economic losses and its ability to assist communities in responding to floods.

The study found that approximately 78% of households in the four communities were inundated by the 2019 flood. The Flood Early Warning System proved to be effective in reducing the impacts on assets and income of the community people. This was attributed to the comprehensive training and orientations provided to CORT volunteers, enabling them to disseminate early warning messages and take appropriate measures before and during the flood. These volunteers received training in areas such as First Aid, search and rescue, gender sensitivity, mock drills, contingency planning, and making flood-resilient houses, among others.

The results highlighted the importance of a community-based approach, but in fact, this is a well-landed collaboration among various stakeholders interested in reducing flood vulnerability and building community resilience. The success of the Flood Early Warning System in these four communities served as an exemplary model that could be replicated in other flood-prone areas of Bangladesh, with the potential to reduce flood losses and enhance community resilience (Fedous et al., 2020)



Fig 5. Flood marker with explanatory signboard beside the river area of Lalmonirhat. Source: (Fedous et al., 2020).

PERU -Holistic Flooding Adaptation Strategy.

The residents of Huaraz, Peru, are experiencing significant changes in their environment due to the melting glaciers and are taking steps to adapt to these changes. The ongoing glacier retreat, largely due to climate change, threatens the water supply of the city, poses the risk of catastrophic floods, and exposes previously buried metal-rich rocks, which can pollute local water sources.

One of the primary ways the community is adapting is through legal action. For instance, resident Saúl Luciano Lliuya has waged a lawsuit against the German energy company RWE, arguing that

as a major contributor to greenhouse gas emissions, they should help pay for measures to prevent a catastrophic flood from the now unstable lagoon formed by the melting Palcaraju glacier (Rueda, 2023). Lliuya's lawsuit says RWE should pay for 0.5% of the costs of flood prevention programs in Huaraz, or what amounts to around \$20,000 dollars. The case is currently being reviewed by a German court. "If we put some pressure on those who emit greenhouse gasses, perhaps they will have to change their practices," he added (Rueda, 2023:1).

In terms of physical adaptations, Huaraz has made efforts to prevent catastrophic flooding from Lake Palcacocha. Officials have constructed a dike and set up large, plastic tubes to siphon water out of the lake to prevent it from overflowing. However, as Marlene Rosario of the regional government suggests, further adaptations are needed, including the construction of reservoirs and treatment plants below the lake to both control water levels and ensure the water's safety for use in the future (Rueda, 2023).



Fig 6. Community dike practices to give back space and place to the water. Source: Rueda (2023).



Fig 6. Community practices to prevent overflowing. Source: Rueda (2023).

Additionally, local farmers are developing strategies to deal with the unexpected side effects of global warming. For instance, they are working with technical help from the Mountain Institute and local Universidad Nacional Santiago Antúnez de Mayolo to create artificial wetlands that can filter out heavy metal contaminants being released downstream due to glacial melt. Certain local plant species are being employed in specific areas due to their capacity to accumulate metals, helping to mitigate the negative impacts on water and soil quality. Around 200 families are participating in this scheme, and the long-term plan is to replicate this project in other communities dealing with similar challenges (Collyns, 2023). “We want to develop the potential of the highland páramo and bofedales wetlands to work naturally as sponges and water filters, a very good strategy is to use local biodiversity, in this case, plants that have an extraordinary capacity to accumulate metals.” Plants like reed and grasses, known locally a totora, junco and cola de zorro, are some of the best to use” said Raul Loayza, an aquatic toxicologist leading the research (Collyns, 2023;1).

The UNASAM proved high effectiveness of artificial wetlands in the mining area of Mesapata, in Ancash. According to Loayza, “The technique reduced metal concentrations from lead and iron by two to three orders of magnitude and increased acidic pH from 3 to 7 (pH neutral)” (Collyns, 2023;1).



Fig 7. Bofedales System in Peru. Source: Vivas (2022)

It is important to mention that some local residents have changed place names and perceive the retreating glaciers as a threat to their livelihoods and water scarcity concerns. The catastrophic flooding in the past has taken almost 1800 people's lives, and that is something they look to avoid in the near future. Consequently, the development of adaptation strategies in Huaraz involves understanding the changing climatic conditions, emotional attachments to glaciers, and the need for improved risk management (Vuille et al., 2018).

NEPAL - Community-Based Flood Management System.

Nepal aims to enhance early flood warning capabilities, improve community resilience, and reduce the impacts of floods on vulnerable populations. These systems involve collaboration between local communities, government agencies, and other stakeholders to create a more effective and inclusive approach to flood risk mitigation. In this case, we are presenting a pluralistic approach that was taken and then a specific community case example.

1. **Pluralistic Approach:** The approach to flood management in Nepal recognizes the need for a pluralistic approach that accommodates different management styles and scales. This approach acknowledges the diverse contexts and specific approaches required for effective flood risk reduction (Dixit, 2003). Generally, the pluralistic approach includes:
 - a) **Community-Based Early Warning Systems:** Nepal has been developing community-based early warning systems to address flood risks. These systems involve the active participation of local communities in monitoring, forecasting, and disseminating flood-related information. They aim to provide timely warnings to vulnerable communities, enabling them to take appropriate actions and evacuate if necessary (smith et al., 2016).
 - b) **Flash Flood Early Warning Systems:** In addition to perennial river floods, efforts have been made to develop community-based early warning systems specifically for flash floods in Nepal. These systems focus on the rapid onset and short duration of flash floods, which pose unique challenges for early warning and response (Adhikari and Sitoula, 2018).
 - c) **Collaboration with Government Agencies:** The community-based flood management systems in Nepal work in collaboration with government agencies, such as the Department for Hydrology and Meteorology (DHM). This collaboration ensures the integration of community-based systems with the operational flood forecasting methodologies of the government (smith et al., 2016).
 - d) **Legal Framework and Policy Initiatives:** Nepal has introduced legal frameworks and policy initiatives to address disaster risk reduction, including floods and landslides [35]. These initiatives emphasize the importance of early warning systems, community participation, research activities, and awareness programs (Gaire et al., 2015).
2. **Community case:** Historic floods like this disproportionately affect rural and remote areas like the far west region of Nepal. In Badabaika, 35 households more than half of the community were displaced from their families' ancestral lands after the massive floods of 2008. In the Kanchanpur District of Nepal, an uncommon sight was found along the Banahara River: a group of women hauling long stalks of bamboo to the riverbank, building a barrier to protect their land. In a particular report, Ashmita Ojha (2021) from the Mercy Corps Organization describes their impression of this community-based initiative that called their attention as they already coordinated the Managing Risk through Economic Development (MRED) programme to build resilience to natural disasters and climate change.



Fig 8. Women in Badabaika, Nepal build bamboo spurs as protection from floods. Source: Ojha (2021).

Utilizing the MRED's strategy, Mercy Corps aided the inhabitants of Badabaika in tackling societal norms that frequently sideline women from pivotal decisions. This was achieved by fostering discussions among women and men regarding the detrimental consequences of gender barriers. Furthermore, Mercy Corps facilitated the establishment of a Community Disaster Management Committee (CDMC) in the village. This committee took the helm of the local climate resilience initiatives, and women were actively involved as its members.

In regions vulnerable to flooding, bamboo spurs have proven effective. These structures reinforce riverbanks, mitigating floodwater's impact and curtailing soil erosion. Recognizing their efficacy, Mercy Corps conducted workshops in Badabaika to endorse these bamboo spurs as economical, yet robust solutions, particularly after witnessing the devastation that displaced a significant portion of the community. Similar successful implementations were observed in places like Kailali, where the bamboo spurs were used to redirect water flow along riverbends. Such instances underscore the potential of bioengineering in disaster risk reduction.

While the bamboo spurs were beneficial and environmentally friendly due to bamboo's organic nature, they do degrade over time and necessitate annual upkeep. A notable challenge arose when the COVID-19 pandemic intensified financial strains. Many men from the village ventured out in search of employment opportunities, leaving behind the women of Badabaika. With the monsoon season approaching, women like Sukhira Rana, a dedicated CDMC member, rallied their counterparts to shoulder the responsibility of repairing and setting up the spurs. As Rana

poignantly expressed, "No matter male or female, we are equally responsible for our community risk management" (Ojha, 2021).

The commendable efforts of the women didn't stop there. Along the Banahara River, they not only refurbished and constructed bamboo spurs but also cultivated kans grass at the riverbanks. This grass, known for its long, fibrous roots, serves as an excellent natural barrier against soil erosion. Additionally, it's a sought-after crop, bringing in substantial revenue. The earnings from the kans grass sales are channeled directly into the community's emergency management fund. This fund, innovatively established by the women of Badabaika, covers expenses related to spur maintenance and provides for essentials during crises. Despite facing a constantly evolving environment, the tenacity of Badabaika's women shines brightly, with unwavering support from external entities such as Mercy Corps (Ojha, 2021).



Fig 9. Community men and women-built bamboo spurs to hold the riverbank in place and planted kans grass to prevent flooding and erosion before the year's monsoon season. Source: Ojha (2021).

3.2 Wildfires

CHILE – Wildfire Adaptation Strategy.

The country has been grappling with a megadrought since 2010, worsening vegetation flammability and escalating summer fires. An unprecedented heatwave accompanied by Puelche winds and high temperatures in the country's southern areas worsened the situation. Poor territorial planning was also blamed for the ease of wildfire spread. An estimate from the National Forest Corporation (CONAF) indicated that about 41% of the wildfires in Ñuble, Biobío, and Araucanía regions were man-made and intentional (Reliefweb, 2023).

The Chilean government declared a state of emergency in multiple regions of the country [1]. The National System for Disaster Prevention, Mitigation and Attention (SENAPRED) closely monitored the situation, reporting updates about active fires and the extent of the damage (ECHO, 2023).

Faced with the wildfires' gravity, Chile requested assistance from the Union Civil Protection Mechanism (UCPM), asking for resources like airplanes, helicopters, ground fire-fighting units, and fire behavior analysts' teams. Some countries responded to this request by offering their aid (ECHO, 2023).

Holistically, Chile has a systemic strategy to face and adapt to wildfires in various ways, as per 2023 reports:

- 1) **Planning and Coordination:** In response to wildfires, the Chilean government has activated the National Strategic Plan for the Prevention and Combating of Forest Fires of the National Forestry Corporation (CONAF), from the Ministry of Agriculture, and the Chilean Wood Corporation (CORMA) (ECHO, 2023). Additionally, response mechanisms have been activated as provided for by Law 21.364 which establishes the National System for the Prevention and Response to Disasters (SENAPRED, which is the State's technical body in charge of planning and coordinating public and private resources destined to prevent and address emergencies and disasters of natural or human-made origin) (UNCHILE, 2023).
- 2) **Immediate Response:** The government declared a state of emergency in regions most affected by the fires, such as Biobío, Ñuble, and Araucanía, which allowed for the mobilization of additional resources and personnel to combat the fires (UNCHILE, 2023).
- 3) **Reconstruction and Recovery:** After the fires, the government has been working to repair damages to infrastructures, such as the recovery of rural drinking water services damaged during the fires (UNCHILE, 2023).

- 4) Mitigation: According to Alejandro Miranda, a researcher at the Center for Climate Science and Resilience CR2, emphasis is placed on the responsibility of those who control forest monocultures in the prevention, mitigation, and combating of fires. Similarly, the duty of the State to establish safe limits for the development of this economic activity is underlined (Carrere, 2023).
- 5) Adaptation to Climate Change: In response to increasingly extreme weather conditions, Chilean authorities are seeking to adapt to new climate conditions to prevent fires from spreading with the current speed and intensity (Carrere, 2023). *And here is the problem with homogenous forests.* Homogeneous forests, specifically composed of exotic plantation species, are problematic in Chile for several reasons, according to the information provided.



Fig 10. Homogenous and native forests in Chile. Source: Lara et al. (2021)

With the support of government and timber companies, Chile created the economic and technological conditions to convert large areas of diverse native forests into more flammable tree plantations, which primarily consist of highly flammable non-native pine and eucalyptus forests (Bannister et al., 2018). These species contain oils and resins in their leaves that can easily ignite when dry. This situation can facilitate fires to spread more easily and promote larger fires in the future. Furthermore, the conversion from diverse native forests to structurally homogenous plantations happens at a time when the climate is becoming warmer and drier, exacerbating the fire risk (McWethy et al., 2018).

Homogeneous forests represent a form of forest degradation, and their predominance means that native forests have been neglected. Large areas of forest have been replaced with these plantations, contributing to a loss of biodiversity and ecosystem health. This also has generated conflicts between the Mapuche nation, forest companies and the government. The forest replacement process underscores the urgent need for a new productive model that ensures fair wealth distribution and the use of science-based sustainable forest management practices to protect native forest ecosystems throughout the country (ECHO, 2023).

The increased reliance on these homogeneous forests could undermine Chile's climate change strategies and its goal of becoming carbon neutral by 2050. Native forests can play an essential role in sequestering carbon and providing other ecosystem services such as water provisioning and climate regulation. Therefore, the conversion to plantations may compromise these ecological services and Chile's ability to achieve its climate targets (ECHO,2023).

Despite these measures, the challenge remains large due to the drought context that Chile is experiencing, combined with high temperatures that favour conditions for forest fires. The change in forest policy about homogenous forests and prevention strategies are fundamental to face and adapt to this situation.

BOLIVIA - The Monkoxi and their relation with Wildfire.

The escalation and spread of wildfires are becoming more severe, with estimates projecting a 30% surge in wildfire frequency by 2050 (UNEP, 2022). Considering this intimidating scenario, it's no wonder that environmental and land custodians might aspire to a future that involves less fire. However, changes in climate conditions and land utilization, rather than fire itself, are identified as the primary contributors to wildfires (van Montford, Hoodveld, 2022). Surprisingly, in many regions, reduced usage of fire has frequently resulted in large-scale wildfires (Pyne, 2012). As such, it's becoming evident that solutions to the wildfire issue must accept the inevitability of fire and require concerted efforts among a diverse array of stakeholders.

In some regions, Indigenous knowledge and burning methods are being employed by land managers to enhance fire management strategies. However, these interventions predominantly originate from outside sources and often occur in protected areas where Indigenous people are no longer regular residents, such as in Australia and the USA.

Rodriguez et al (2023) described a contrasting scenario in the Lomerío region in Bolivia, where Indigenous communities can also devise their own strategies for managing wildfire risks, not just to safeguard their territories from the destructive force of fire but as a part of a broader political

self-determination agenda. This process is reshaping the dialogue around the role of Indigenous knowledge in wildfire management.

The communal indigenous territory (TCO) of Lomerío has an extent of 256,000 ha in the department of Santa Cruz, (Bolivian lowlands) dominated by Chiquitano dry forest, with shrubland, savanna and inundated swamp areas. The shrubland and savanna areas are impacted by cattle grazing and more recently from the repeated impact of fire (Navarro, 1999). In the Lomerío are located around 7000 Monkoxi through 29 small communities. In 2006 the Monkoxi were granted property rights over their communal territory, and via the Union of Indigenous Communities of Lomerío (CICOL) with the responsibility to safeguard its environmental and cultural integrity. Monkoxi people have a self-consumption economy, which is largely centred on the product from the forest (Rodriguez et al., 2023).

This method emphasizes Indigenous knowledge and agency as the core of fire management strategies, with modern technical knowledge serving as a supporting element. This represents a unique instance of intercultural dialogue about fire management led by indigenous people. “Under this approach, rather than Indigenous knowledge being included, integrated or incorporated into Western-driven fire management policies, Indigenous knowledge and agency are at the centre of the fire management strategy, and modern technical knowledge serves as a complement to it” (UEA, 2023:1).



Fig 11. Communal Indigenous Territory (TCO) of Lomerio. Source: Deniau, 2022, cited in Rodriguez et al., (2023)

This case study further indicates that, due to the multiple causes of wildfires, there are no straightforward solutions to the wildfire problem. Instead, the solutions must be as diverse as the problem itself.

The Monkoxi People are concurrently devising strategies to manage, control, prevent, and monitor the use of fire. They are also actively working to safeguard community resources and engage the younger generation with their land via cultural and knowledge reinvigoration. The contributions of CICOL in maintaining the Lomerío Territory have been significant, with wildfire management strategies grounded in traditional decision-making structures and knowledge systems. In addition, they liaise with external organizations to introduce innovative techniques and technologies to counter climate, landscape, and sociocultural shifts (Rodriguez et al., 2023).

This serves as an exemplar of how Indigenous populations are currently administering wildfire in their territories in response to a progressively more combustible landscape. It also illustrates how modern wildfire risk management strategies are embraced by forest-dependent indigenous communities and adjusted to fit their needs.

In collaborative research led by Rodriguez et al (2023), they indicate that due to the introduction of novel techniques and methods, such as the burning protocol and fire control program, the Monkoxi's wildfire risk management system is in a transitional phase. It is shifting from the conventional method of fire use to one that amalgamates various knowledge systems. Moreover, it's an evolving process, with continuous deliberations about introducing new methods like controlled burning around environmentally sensitive areas and the potential modifications of the burning calendar. There are also ongoing efforts to reconnect the younger generation with their territory (UEA, 2023).

Summary of the Monkoxi strategies according to Rodriguez et al (2023):

1. Organization for Fire Management:
 - a) Governance: Although CICOL is the institution in charge of developing and monitoring the guidelines, community chiefs oversee their application at the community and communal level.

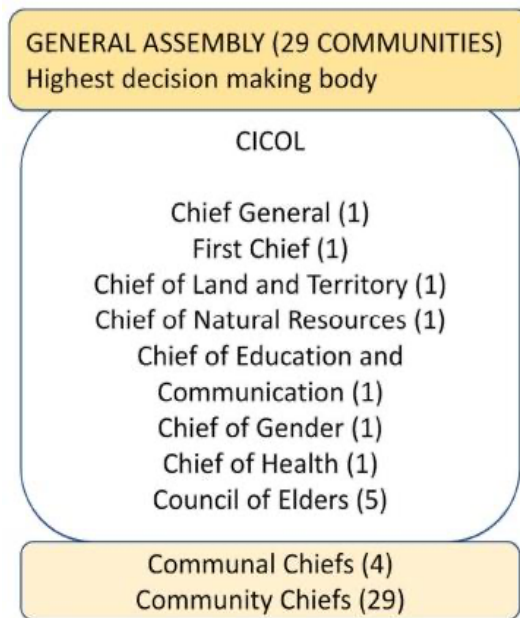


Fig 12. Governance structure at Lomerio. Source: Rodriguez et al., (2023)

- b) Goal Management: There are three key problems that need to be addressed to reduce fire risk in this activity:

Issues	Strategies
Hotter and drier conditions at this time of the year makes fires potentially more hazardous and the vegetation more flammable.	The protocol calls for making fire breaks 2.5 m away from the perimeter of the Chaco (farming unit) and carrying out burns in the early morning or evening.
Closeness between cropped areas. This increases the chances of fires escaping from one Chaco to another.	Sharing responsibility for family burns and ensuring oversight of the activity by community chiefs.
Reduced numbers of young people involved in farming activities, limiting the possibilities of successfully undertaking a controlled burn.	

“When wildfires are caused by community members, we still maintain the belief that forest fires have not been caused on purpose but through neglect. This is what we do. We practice tolerance as part of our culture...As our way of using our community justice.” (P. Jimenez, interview extract, El Puquio)., cited in (Rodriguez et al., 2023).

2. Strengthening local fire use and management norms: a new burning protocol:
 - a) Inform the chief about the intent to carry out the burn.
 - b) Agree with neighbours adjoining the area to be burned to help manage the burn and prevent its spread to other areas.
 - c) Burns should be carried out in the early hours of the day, not when the temperature is very high.
 - d) There should be no strong winds.
 - e) Clean 2.5 m around the perimeter of the area where the burn will take place, with more than five people to monitor the burn, and those in adjoining areas must also be present.
 - f) The people who participate in the burn must also have the necessary tools and equipment in the event of a fire spreading outside the area subject to burning.
 - g) Requirements for monitoring: Communal chiefs must keep a list of the community members who have *Chacos* (farming units) and a burning calendar for their community members.

- h) Community members must request permission to carry out controlled burning from highest authority in the community and they must commit to following their advice.
- i) The person carrying out the burn must be a member of one of the communities of Lomerío. The size of the chaco should not exceed 1 hectare.

As a response to a top-down fire management policy approach from the Bolivian Forest Management Agency (ABT), in 2020 CICOL started to develop a set of strategies to self-govern the management of fire risk within their communities. “As indigenous people do not have machinery to sow, it always must be through fire, to burn the Chaco, taking good care to control it. The ABT should come to the communities to engage in dialogue, to exchange ideas so that we can fairly explain our experience, both as Chiquitanos and ABT. (Juan Faldin, Interview extract, Puerto Nuevo), cited in (Rodriguez et al., 2023).

3. Documenting local knowledge of fire use and management:

CICOL wanted to conduct their own investigation to record the Monkoxi's understanding of fire and assess the implementation of newer fire prevention and control techniques at the grassroots level. The research explored the diverse applications and cultural connotations of fire, views on climate and terrain shifts, and age-old fire prevention methods. From the discussions, it emerged that, in the Monkoxi's understanding, effective fire prevention in the chacos is influenced by:

- a) Wind direction (always burn facing the wind).
- b) Wind strength (avoid burning during powerful winds).
- c) Optimal times for burning (usually midday for a quick burn due to higher temperatures).
- d) Preferred months for seasonal burns (primarily August and September).

Furthermore, the Monkoxi's spiritual beliefs dictate refraining from using fire in holy locations where Jichis reside, typically in environmentally delicate areas. However, these core principles are becoming less consistent because of the evolving climate and socio-cultural dynamics. This underscores the importance of introducing updated burning protocols and fire management techniques. Finally, the Monkoxi strategy also encompasses water basin conservation, agroforestry and a strong emphasis on knowledge revitalization and reconnection of youth with their territory.



Fig 13. Photovoice stories of the cultural significance of fire used to prepare the land as a natural means of fertilising the soil and controlling pests. Source: Stories by Jorge Andres Guizada Palachay, Johan Pedriel Rodríguez Cesarí, cited in Rodríguez et al., (2023)

Despite the increasing pressure of climate and sociocultural changes and the potential threat of fire use policy criminalization in their territory, the Monkoxi have demonstrated their ability to respond proactively. In this process, they are facilitating a more balanced dialogue with the Bolivian Forestry Agency (ABT) regarding the use of fire in Lomerío and contesting the anti-fire narrative. Policymakers should take into account two key elements of the Monkoxi fire management systems: the negative perception the Monkoxi have towards sanctions as a regulatory tool in their traditional justice systems and the priority they place on fire prevention over suppression. (Rodríguez et al., 2023). This should confirm that “Community organization and own resilience is the best call for policy-makers’ attention” J. Carolsfeld (personal communication, July 19, 2023).

MEXICO - The Ejido System.

Ejidos are communal-based land tenure systems where ejidos and indigenous communities hold about 60% of Mexico's forestlands. The Ejidos System in Mexico has played a significant role in promoting better forest management (Ordonez et al., 2023). The Ejidos System empowers local communities by granting them control over their forestlands and resources and this local control allows communities to make decisions based on their specific needs and priorities, leading to more sustainable and community-driven forest management practices (Lawrence et al., 2019).

Many ejidos have adopted community forest management (CFM) practices, which involve greater organization, investment, vertical integration, and community participation in forest management, this participation includes changes to the traditional hierarchies in Ejido communities that have shifted over the past decade, with women and young people representing a hopeful future for conservation in Mexico (Ellis et al., 2017).

The Ejidos System recognizes and values the traditional knowledge and practices of indigenous communities (Bray et al., 2003). Indigenous communities have a deep understanding of their local ecosystems and have developed sustainable forest management practices over generations. Incorporating this traditional knowledge into forest management strategies enhances the ecological and cultural sustainability of the forests.

CFM in Ejidos has been shown to reduce deforestation rates and promote forest cover maintenance and biodiversity conservation (Ellis et al., 2017). Furthermore, The Ejidos System in Mexico contributes to better forest fire management through various mechanisms:

1. Wildland Fire Use (WFU) can be implemented at broader spatial scales to increase controlled burning in forests. WFU allows for the management of lightning-ignited fires to achieve specific resource management objectives (Stephens 2008). The timing and location of the fires are based on traditional knowledge about community territories accumulated over millennia. These managed fires were an important component of their stewardship of the land.

According to Indigenous Corporate Training (2019), the cultures that used controlled burns aimed to:

- a) Manage the buildup of combustible materials, regeneration and pests.
- b) Open and maintain trails and paths.
- c) Create grazing lands for prey species (and later for horses)
- d) Rejuvenate quality and quantity of forage (new growth being higher in protein and minerals)
- e) Clear land for agriculture
- f) Stimulate productivity of berry patches
- g) Stimulate the growth of medicinal plants
- h) Produce materials for basketry
- i) Create fuel breaks around camps and villages

In Mexico, prescribed burning is a common strategy used to minimize the risk of wildfires. Tariq et al. (2021) describe it as a process that involves intentionally introducing fire under specific environmental conditions, such as controlled duration, intensity, and rate of spread. By conducting prescribed burns, fuel loads are reduced, which decreases the likelihood of severe wildfires. Additionally, Tariq et al. (2021) mentioned that prescribed burning is an essential tool

for land management in Mexico. It is used for purposes such as fuel reduction, logging restoration, forest maintenance, and biodiversity conservation. By implementing prescribed burns, land managers can achieve specific environmental protection targets and promote healthier ecosystems. Moreover, some Ejidos have access to Remote sensing techniques, such as synthetic aperture radar (SAR) imagery, that can be used to assess the effectiveness of prescribed burns. SAR data can detect changes in vegetation structure and provide insights into the impact of prescribed burns on the landscape (Tariq et al., (2021).

Climate change is altering fire regimes, making prescribed burning an even more important strategy for wildfire management. As the probability of fire risk increases, prescribed burns may be used more extensively to reduce exposure to wildfire hazards. However, it is crucial to understand how prescribed burn weather conditions may change under global warming (Virgilio et al., 2020).



Fig 14. Controlled burns in Mexican Ejidos. Source: WWF (2019).

2. Indigenous Land-use Practices: Indigenous communities, often associated with the Ejidos System, have been recognized for their role in controlling deforestation and reducing CO₂ emissions through their land-use practices, including fire management. Indigenous lands have been found to have the lowest incidence of wildfires, contributing to carbon stock maintenance and biodiversity enhancement (Mistry et al., 2016). Indigenous land-use practices vary

significantly among different ejidos, influenced by geographical, climatic, cultural, and legal factors but generally include:

- a) Traditional Agriculture
- b) Crop Rotation
- c) Conservation Agriculture
- d) Agroforestry
- e) Controlled Grazing



Fig 15. Agroforestry after fire in Mixteco community. Source: Photo by Leah Penni cited in Penniman (2015)

Additional Ejido Initiatives: Communities have a profound relationship with their forests, encompassing sustainable forestry practices and inter-community alliances that bolster wildfire response mechanisms. Developed Ejidos possess forestry management plans, official permits, and significant investment and infrastructure. Communities in Chihuahua, Durango, Michoacán, and Oaxaca stand out as prime examples of business diversification where the profits are equitably distributed among community members. These assets furnish resources and comprehensive training not only for permanent community firefighters but also for community volunteers (Mayorga, 2020). Organized Ejidos recognize their susceptibility to the effects of climate change. The confluence of drought, abundant fuel, and wind-felled weak trees poses a severe threat. Previously, their firebreaks in the forest were typically situated about 300 meters

away from the direction of the fire. Given the increasing speed of wildfires, these firebreaks now need to be at least 500 meters distant to effectively counter the flames (Mayorga, 2020).



Fig 16. Communities and Ejidos organize their own strategies for wildfires and external agencies (Army and Forest Officials) join to support. Source: CONAFOR cited in Mayorga (2020).

Finally, in a comparative study on the US-Mexico border led by Villareal and colleagues (2019), it's highlighted that many of the Sky Island forests in northern Mexico were previously owned by private haciendas until events like the Mexican Revolution from 1910 to 1920 and the introduction of the Agrarian Code in 1934. This code transferred private lands to local groups known as "ejidos" (Thoms and Betters 1998). Unlike the US, where forests were mainly under federal control, these ejidos in Mexico took on the task of managing their forests and wildfires. This meant that wildfires in northern Mexico weren't as aggressively controlled as they were in the western US. In the 1980s, Mexico's forest service, with support from the US Forest Service and USAID, initiated a more proactive fire management strategy (Rodriguez-Trejo et al. 2011). Yet, during this time, Mexico's firefighting budget was significantly smaller, investing only about one-tenth of what the US spent per acre on combating wildfires (Villarreal and Yool 2008).

The Ejidos System in Mexico offers a structure that allows local communities to engage actively in wildfire management and reap the benefits of sustainable forest management. This approach fosters better conservation results and enhances community welfare. However, it's important to recognize that this case study suggests communities possess full authority and decision-making power over their natural resources. Such legal and customary rights are absent in many countries, even those in the Global North, with advanced wildfire strategies.

3.3 Droughts and Water Management.

SRI LANKA - Tank Cascade Systems.

Village Tank Cascade Systems (VTCSs) in Sri Lanka refer to interconnected small-tank systems that have been traditionally used in the dry zone of Sri Lanka for water management.

Origins and Design: VTCSs have evolved over thousands of years, forming sustainable ecosystems due to human interventions to ensure water availability and services in the dry zone of Sri Lanka (Ratnayake et al., 2021). Originally built by the ancient kings of Sri Lanka over 2,000 years ago, these cascades were created to tackle water scarcity in the dry zone (TWB, 2023).

Functionality: These systems work as a network of small tanks storing surface water. Each cascade connects a series of reservoirs, increasing in size as one progresses down the cascade. As water is released from one tank to irrigate paddy fields, it flows to the next, effectively sharing water across the cascade and supporting multiple agricultural lands (Malaka, 2023).

Socio-Ecological Significance: The VTCSs have provided regulatory, supporting, and provisional ecosystem services, making them vital for the livelihood and food security of rural farming communities (Ratnayake et al., 2021). These systems also helped in adapting farming systems to local conditions and have been recognized as Globally Important Agricultural Heritage Systems by the U.N. Food and Agriculture Organization (Malaka, 2023).



Fig 17. Sri Lanka Village Small Tank. Source: Malaka (2023).

The following description is taken mainly from a recent report from the region of Anuradhapura, Sri Lanka by Rodrigo Malaka (2023): Acknowledged by the U.N. Food and Agriculture Organization (FAO) as a vital global agricultural heritage system, these tanks face challenges from

shifts in climate, land use, population, and agricultural amplification, despite their significance in climate adaptation.

The dry zone of Sri Lanka is home to over 14,000 ancient village tanks, many of which remain well-maintained and support around 246,000 hectares (608,000 acres) of paddy cultivation, which constitutes about 39% of the total irrigable land. However, many have become non-functional due to lack of upkeep. International Development entities have been instrumental in aiding the revival of these systems.

These systems are robust, capable of mitigating the effects of natural calamities such as floods by storing excess water, and reducing the impact of droughts by minimizing water loss from tanks due to absorption by the surrounding terrain. Additionally, the cascaded tank-village design ensures efficient water flow from one tank to the next, facilitated by a web of tanks and channels.

FIGURE 18

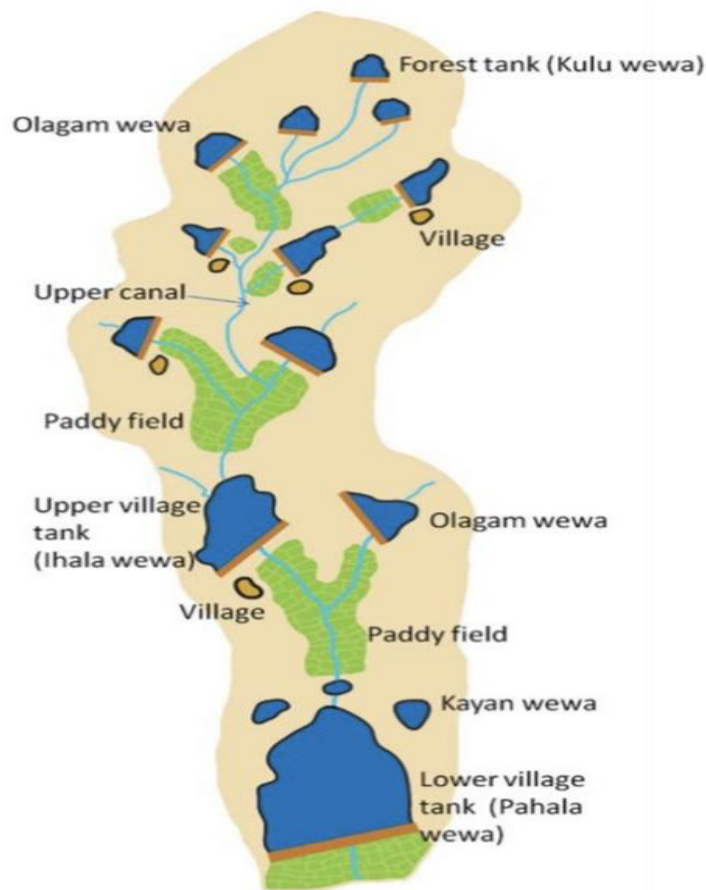


Fig 18. Graphical representation of the tank cascade system. Source: IUCN 2023 cited in Malaka (2023).

Part of this cascade includes "kulu wew" or forest tanks, often situated in the upper catchment wilderness areas surrounding villages. These tanks play a pivotal role during the rainy season by retaining surplus water. Madduma Bandara, a professor from the University of Peradeniya who pioneered the description of these tank cascade systems in 1985, noted the importance of viewing and restoring the system holistically. He emphasized that these forest tanks not only filter silt and debris but also serve as water sources for wildlife, decreasing the instances of wild animals venturing to village tanks.

Furthermore, the system boasts intriguing features, like the natural tree belt termed "gasgommana" present on either side of the topmost parts of each tank. Shamen Vidanage, IUCN's country representative, highlighted its role as a barrier against the dry wind, consequently diminishing water evaporation.

Many experts are advocating for the prompt restoration of these tanks in light of the region's climate change readiness. They stress the need for careful restoration to ensure maximal benefits for the community. Recent research has shown the crucial role of these tank environments in delivering regulatory and supporting ecosystem services (ES), along with their synergistic interactions with the provisional ES of the VTCS. This study also illuminated the intricate interplay of land, water, biodiversity, climate, and food in determining the VTCS's productivity, suggesting its integration into the ecological restoration plans for VTCS (Ratnayake et al., 2021).



Fig 19. Restoration of the tanks in a cascade system according to the hydrology of the system in Kappirigama. Source: IUCN 2023 cited in Malaka (2023).

This specific case study suggested by P. Acosta (personal communication, July 19, 2023) was found very interesting, as supported by Hope International Development Agency based in British Columbia and as a clear example of international cooperation.

CHILE - Land-based salmon farming.

Land-based salmon farming, also known as recirculating aquaculture systems (RAS), is an innovative approach to salmon farming that takes place on land rather than in traditional net pens located in oceans or open waters. This method aims to address some of the environmental concerns associated with conventional open-net salmon farming, such as disease transmission, sea lice infestations, and the release of waste and chemicals into the marine environment.

Land-based salmon farming offers several potential benefits:

1. **Safe Environment for Fish:** By utilizing Recirculating Aquaculture Systems (RAS) in land-based fish farms, it's possible to create a safe environment for the salmon, where they can school and swim naturally, akin to their wild counterparts. Such a controlled environment protects them from diseases and contaminants, thus eliminating the requirement for antibiotics and chemicals (Aquabounty, 2023).
2. **Environmentally Friendly:** Land-based fish farms, by virtue of being closer to consumer markets (restaurants, grocery stores, etc.), can dramatically reduce greenhouse gas emissions usually associated with airfreighting imported salmon. This is because they aren't confined to coastlines and can be set up almost anywhere (Aquabounty, 2023).
3. **Sustainable Source of Protein:** With the global population on the rise and many wild fisheries collapsing or reaching their peak harvests, land-based salmon farming emerges as a sustainable source of protein. It provides an alternative to sea-based open net pen farming, which has had issues related to the escape of Atlantic salmon into other waters and the spread of diseases to wild salmon populations (The Narwhal, 2023).
4. **Benefits over Sea-based Farming:**
 - a) **Proximity to Markets:** Being on land and not confined to coastlines, these farms can be set up closer to consumer centers.
 - b) **Flexible Waste Management:** Waste can be controlled and managed more effectively on land.
 - c) **Ideal Growing Conditions:** These farms can ensure conditions that are free from disease and eliminate the need for pesticides or antibiotics.
 - d) **Protection for Wild Populations and Marine Ecosystems:** By farming on land, the risks associated with escapes and consequent cross-breeding or disease transfer to wild populations are reduced (The Narwhal, 2023).
5. **Growing Interest and Investment:** The interest in land-based salmon farming has seen a surge in recent years, as indicated by the numerous onshore projects that have been launched. Although capital-intensive, this growth showcases the faith of investors in the potential of this farming method (Hoel and Howell, 2021).
6. **Technical Advancements:** There are different systems like RAS and Flow-Through Systems (FTS) for land-based farming. RAS, in particular, offers advantages such as being able to be placed anywhere, reduced water consumption, and energy savings. Even though there

are challenges like ensuring the right microbial conditions and water chemistry, technological advancements are continually addressing these issues (Hoel and Howell, 2021).

The Chilean Case:

Chilean salmon farming, especially in its early stages, greatly benefits from access to high-quality water. This water is provided by watersheds dominated by native forests and characterized by high precipitation levels in the country (León-Muñoz et al., 2023).

Chile's status as the second-largest producer and exporter of salmon worldwide is evident with its US\$5.2 billion in salmon exports the previous year (Perez, 2022). Chilean salmon exports were valued at US \$3.307 billion in the first half of 2023, marking a \$68 million rise compared to H1 2022. Despite fluctuations in exports to various countries, the overall volume and value of exports increased by 2% and 2.1% respectively, compared to the same period in the previous year. The Chilean salmon Industry exports to countries like Mexico, China, Russia, and Brazil (Appel, 2023).

Over the past 15 years, the Chilean government has backed the research and development of various aquaculture species, aiming to close their life cycles, address technological barriers, and boost production (Perez, 2022).

Recirculating aquaculture systems (RAS) have been highlighted as pivotal technology. For instance, Fundación Chile, is a leading business incubator and pioneer of salmon farming in Chile that is innovating in the following areas: production of vaccines and natural astaxanthin (Perez, 2022). Additionally, the organization is prominently involved in the Corvina project. As part of this initiative, fish are reared until they reach the juvenile stage at Fundación Chile's Aquaculture Centre. RAS technologies have enabled increased production densities while ensuring stable farming conditions, despite challenges like access limitations to new aquaculture licenses (Perez, 2022).

The growth of the salmon farming industry in Chile during its initial commercial phase was attributed to various factors, including natural resources, low labour costs, and a conducive business environment. Significantly, Fundación Chile's role was instrumental during these years. Their efforts, along with international cooperation, particularly the 'Japan-Chile Salmon Project,' resulted in the transfer of specific knowledge that significantly contributed to the industry's development in Chile (Chavez et al., 2019).



Fig 20. New Land-Based Salmon Farming in the Reloncavi Estuary of Chile. Source: Billund Aquaculture (2023).



Fig 21. New Land-Based Salmon Farming in the Reloncavi Estuary of Chile. Source: Billund Aquaculture (2023).

Challenges

The risks of land-based salmon farming due to climate change are mainly:

1. **Water Quality and Availability:** The success of land-based salmon farming, especially in places like Chile, is highly dependent on access to high-quality water. This water often comes from watersheds dominated by native forests and characterized by high precipitation levels. However, climate change and human activities are increasingly affecting these watersheds. Under a high emissions scenario (RCP 8.5), over 50% of current salmon production in Chile could be situated in high or very high-risk areas due to a combination of a drier and warmer climate, as well as ongoing deforestation and fragmentation of native forests. This could severely limit the availability and quality of water required for optimal aquaculture production (León-Muñoz et al., 2023).
2. **Temperature Sensitivity:** Salmon, including the Atlantic variety, are cold-water fish. Rising global temperatures are reducing the availability of cold water, causing significant stress to salmon. Ideally, salmon thrive in water temperatures between 8-14°C. However, when water temperatures rise above 16°C, salmon experience stress, reduced appetite, and stunted growth. In extreme cases, water temperatures above 23°C can be fatal to salmon. Even in Norway, a significant increase in ocean temperatures has been recorded, and the predictions suggest further warming, which might limit production at Norwegian fish farms (Collinz & Franz, 2022).
3. **Oxygen Levels:** Warmer water contains less oxygen, which is essential for salmon survival. Reduced oxygen levels can make it more challenging for salmon to breathe, especially as higher temperatures increase the salmon's metabolic rate, which in turn amplifies their oxygen requirements (Collinz and Franz, 2022).
4. **Infrastructure Vulnerability:** Infrastructure used in salmon aquaculture can be vulnerable to the physical risks associated with climate change. For example, the pens in which farmed salmon are kept could be destroyed due to extreme weather events, leading to the escape of salmon and potential financial losses (Zitti and Guttormsen, 2022)

Finally, the Chilean Salmon industry is finding protective solutions for climate-associated events in new Landscape configurations. This process involves creating an environment that supports the efficient and sustainable production of aquatic organisms. In the south-central region of Chile, the watershed current design needs adjustments to withstand the hydroclimatic changes (León-Muñoz et al., 2023).

3.4 Food Security

MEXICO – The Chinampas System.

Climate change poses significant threats to food security, impacting agricultural efficiency, food costs, accessibility, and the enduring viability of farming systems. It is crucial to implement effective adaptation methods, maintain sustainable land use, and formulate policies that delve into the socioeconomic aspects of food security to counter these impacts.

Delving deeper, the centrality of land issues becomes evident when considering food security amid a shifting climate. Extreme climatic disturbances, such as droughts, floods, and heat waves, have the potential to diminish crop output and quality, which then hampers food production (Vermeulen et al., 2012). The communities most affected face challenges such as:

1. Changes in agricultural productivity and crop failures can cause market instability and food price volatility, making food less affordable and accessible, especially for vulnerable populations (Vermeulen et al., 2012).
2. Agricultural Yields: Climate change can affect agricultural yields by changing temperature and precipitation patterns, which in turn affect crop growth, development, and productivity (Lobell and Gourdjji, 2012).
3. Land Degradation and Soil Quality: Climate change can worsen soil degradation, erosion, and nutrient depletion, which in turn affect agricultural productivity and food security (Challinor et al., 2014).
4. Changes in temperature and precipitation patterns can impact soil moisture levels, nutrient availability, and soil fertility, resulting in reduced crop yields (Challinor et al., 2014).
5. Water Availability: Climate change can alter water availability for agriculture, affecting irrigation systems and crop water requirements. Changes in precipitation patterns and increased evapotranspiration rates can lead to water scarcity, which in turn affects crop growth and food production (Vermeulen et al., 2012).

Consequently, the adoption of adaptation measures like modifying crop types, recalibrating planting schedules, refining water management tactics, and embracing climate-resilient techniques is essential to safeguard food security (Challinor et al., 2014).

Taking a look at traditional practices, the Chinampa system in Mexico stands out. It is an age-old method that involves farming on man-made islands or floating gardens in shallow aquatic environments. In their research on food security in the Global South, Lerner and Eakin (2010) noted that "chinampa" is a term from the Nahuatl language, spoken by the Aztecs and several other native Mexican groups. Primarily associated with the southern parts of Mexico City, these

Chinampas are created by layering mud, plant life, and organic materials over mats, anchored by wooden stakes in the lakebed. Such floating gardens are extremely fruitful, supporting the cultivation of diverse crops like maize, beans, squash, and various vegetables. The lake's nutrient-dense sediment, coupled with its water, naturally nourishes and irrigates these crops (Lerner and Eakin, 2010). The Chinampa system boasts multiple advantages. It harnesses otherwise neglected lake and wetland areas for farming, maximizing land efficiency. The floating gardens also act as biological filters, enhancing biodiversity and refining water quality. Furthermore, Chinampas support household economies by blending subsistence vegetable farming with produce meant for nearby urban markets (Lerner and Eakin, 2010).



Fig 22. Chinampas System in the semi-urban area of Mexico City. Source: MXCity in FAO (2018).

In the regions of Xochimilco, Tláhuac, and Milpa Alta, the chinampas span over two thousand hectares. Approximately 12 thousand individuals work in these fields, predominantly cultivating crops like vegetables, corn, beans, pumpkin, amaranth, and a variety of flowers. The area is home to 51 types of domesticated agricultural plants and 131 kinds of ornamental plants. Notably, these chinampas showcase vast biodiversity, boasting 2% of global biodiversity and 11% of national biodiversity. This includes a myriad of species: 139 vertebrates, 21 fish, six amphibians,

10 reptiles, 79 birds, and 23 mammals. Given their productivity, chinampas play a crucial role in feeding one of the world's most densely populated cities, yielding an impressive 40 thousand tons of agricultural produce annually (FAO, 2018).

In an interview with a BCC Reporter, Lucio Usobiaga described chinampas as "giant sponges." He emphasized that "you don't need to water them, yet they remain productive throughout the year" (Gayatri, 2022:1). The consistent fertility of the soil can be attributed to the fine lake sediments, decaying plant matter, and animal waste. Furthermore, the presence of Ahuejote fences (*Salix Bonplandiana*) around each chinampa provides multiple benefits. They combat erosion, shield the chinampas from wind and pests, and even function as natural support structures for vine crops (Gayatri, 2022).



Fig 23. Chinampas are protected by Ahuejote Trees in the semi-urban area of Mexico City. Source: Gayatri (2022).

The Chinampa system represents an innovative and sustainable approach to agriculture, integrating traditional knowledge, ecological principles, and local resource management. It showcases the resilience and adaptability of indigenous communities in utilizing their natural surroundings for food production and livelihoods. When confronted with climate-related challenges like frost or inconsistent rainfall patterns, chinampa farming stands out. It serves as a testament to how agroecological amplification can harmoniously exist alongside urban progression and cultural heritage preservation. This harmony is achieved by fostering social connections that introduce innovative technological solutions and encourage community unity and mutual support (FAO, 2017).

IV. Discussions and conclusion.

4.1 Considerations for transferability

When we began gathering experiences from the Global South, our primary aim was to present a digestible narrative that showcased both remarkable examples and seemingly rare, potentially non-transferable ideas, especially in North American contexts. Additionally, we sought to challenge prevailing beliefs that positioned us as the pinnacle of scientific, technological, and financial prowess in the realm of climate change adaptation.

We discovered that just because an event or strategy isn't documented doesn't mean it's non-existent. Much of the Global South's climate adaptation data can be found in what some researchers term “Grey Literature” or non-peer-reviewed publications. This doesn't devalue the grey literature; rather, the data might originate from hard-to-reach sources or underfunded projects. Traditional or Indigenous knowledge, which most of the time is intentionally preserved, falls under this category. Indeed, grey literature is validated by communities and valued by community-based researchers. Therefore, communities become one of the biggest producers of grey literature or “Gold Knowledge” (Bannister, 2005). For instance, even though many countries in the Global South are in high-heat regions, locating documented adaptations to heat waves in academic journals, proved to be challenging. We did find innovative strategies in places like Taiwan, although it's not part of the Global South.

Scholars specializing in climate change from areas most impacted by climate change face challenges getting their work published. Researchers from the Carbon Brief website looked into about 1300 authors of the top 100 climate change papers cited between 2016 and 2020. They discovered that 90% of these researchers hailed from the Global North, reflecting their specific interests, expertise, and training. This lack of representation results in essential viewpoints being overlooked (McGrath, 2021).

When we locate potential case studies, two primary aspects are essential: Firstly, the case study's translation, which goes beyond language and includes compiling all relevant data in a clear, analytical manner. Secondly, understanding that contexts differ makes it crucial to consider several factors for knowledge adaptability:

1. **Adaptation Implementation Rates Vary:** It's essential to understand that while adaptation planning and implementation activities could be implemented, their prevalence can differ substantially between regions. It's crucial to gauge the readiness and maturity level of the adaptation initiatives of the region in question before transferring knowledge. For example, we are starting to experience high levels of drought in some regions of British Columbia and interconnected lakes could potentially play a role in alleviating water

scarcity. However, there are several factors to consider before determining the feasibility and effectiveness of such a solution: hydrological conditions, environmental impact, infrastructure and engineering, regulatory considerations, social resistance and long-term sustainability.

2. **Beware of Historical Climate Assumptions:** One obstacle to successful adaptation has been the assumption that future climate conditions will mirror the past. This is not accurate given the rapid changes we're experiencing. Hence, incorporating current and projected climate data into design guidelines, standards, policies, and practices is critical to reducing risk and adverse impacts (Lempert et al., 2018). Besides, we have to consider that in Canada, regulations are stricter and more diversified than many other places.
3. **Adaptation is an Ongoing Process:** Transferring knowledge isn't about offering a single solution. Adaptation is a continuous risk management process without a definitive end point. It requires individuals and organizations to regularly assess risks and vulnerabilities from various drivers, including climate, economic, environmental, and societal factors. After assessment, they need to take action to reduce those risks and continuously learn and iterate over time (Lempert et al., 2018). According to J. Carolsfeld (personal communication, July 19, 2023) "Project funding agencies typically allocate resources between one or three years after an application is submitted and once the participative consultation is done with communities. When the resources become available, many stakeholders are not engaged anymore with the initiative". Therefore, it is important to remain connected in the learning process regardless of financial barriers and be willing to update collaborations to the current community needs.
4. **Economic and Operational challenges:** Proactive adaptation initiatives offer benefits that surpass their costs, both in the short and long term. These benefits span multiple sectors, such as equity, justice, cultural heritage, the environment and health conditions. However, their implementation might be costly and slow (Lempert et al., 2018). For instance, transitioning from ocean-based salmon farms to land-based operations in places like British Columbia might come with its set of challenges, including environmental, investment, regulatory, and social challenges. Significant investments and timeframes (estimated at between \$1.8 billion to \$2.2 billion and at least 10 years respectively in BC) are needed to make such a transition, and even then, the feasibility and profitability of land-based salmon farming are not guaranteed (Dowson, 2023).
5. **Regional Specificity:** The information provided by Ouranos, a Canadian consortium, underscores the importance of regional climate-change knowledge transfer. They have focused on climate indices and vulnerability indicators tailored to specific regions, emphasizing that knowledge transfer tools need to be localized for maximum efficacy

(Vescovi et al 2009). We might be able to mimic the flood prevention strategy described in this document for river banks in Nepal, but we need to use local species of trees, shrubs and grass that can be sustainable.

Before introducing any major modifications to our systems, thorough research, modelling, stakeholder collaboration, and assessments are crucial. This ensures that the selected solutions are sustainable, environmentally sound, and cater to all concerned parties.

4.2 The role of Canadian actors in international collaboration for development and their approaches to the Global South

Canada strengthens its collaborative relationships with other nations through detailed policies, research initiatives, and bilateral agreements. In areas like development cooperation, innovation, and policy discussions, Canada prioritizes inclusiveness, alignment with its foundational values, and joint growth.

Canada's official development cooperation is focused on eradicating poverty and fostering a peaceful, inclusive, and thriving world. Notably, Canada supports gender equality and women and girls' empowerment as the primary method to reach these goals, guided by its Feminist International Assistance Policy (OECD, 2023). The Official Development Assistance (ODA) is tailored to support poverty alleviation, consider the views of the impoverished, uphold human rights, and reflect Canadian ideals, foreign policy, sustainable growth, and democracy and international human rights standards. Another policy instrument is the Multilateral Development Strategy, designed to boost global cooperation and tackle mutual issues within a collaborative, just, and standardized global framework (OECD, 2023).

Regarding research and innovation, Canada offers numerous funding channels to back international research and partnerships. Collaboration in research between Canada and the EU, active since 1996, is a testament to this commitment. Together, they operate the Horizon 2020 (H2020) program, covering diverse sectors like health, bioeconomy, and Arctic research, among others (European Commission, 2023).

Canadian entities actively work on the Sustainable Goals Development Agenda, specifically Climate Action, by advocating reporting, engagement, sustainable development education, collaboration, and monitoring progress through various organizations and educational establishments.

The approach of Canadian actors to Global South countries claims sustainable development, addressing global challenges, and promoting mutual learning. Partnerships have been established with nations such as China, India, and Brazil, among others (Aleixandre-Benavent et

al., 2017). The objective of these collaborations is to tackle global issues like climate change and foster knowledge sharing, usually from the Global North. Recently, Canada teams up with the Global South to boost capabilities in areas like disease transmission and public health (Yassi et al., 2016), benefiting both Northern and Southern participants. In spite of that, all collaboration efforts need careful management. As C. Black (personal communication, July 19, 2023) recognized “One key challenge we have come across is the sense among our local partners those international standards or requirements feel imposed and that they do not necessarily account for local expectations and objectives.” There are also good experiences where, according to P. Acosta (personal communication, July 19, 2023) project partners and funders have the opportunity to follow up on the sustainability of results through a framework template that communicates the results of projects carried out in places like Sri Lanka or Congo.

It's essential that partnerships are built on mutual benefit and collective learning. The significance of learning from the global South and countering dominant knowledge production is highlighted. Nonetheless, we must critically assess efforts to decolonize our cooperative approaches (Ouma and Dimaras, 2013). Decolonization requires grasping historical contexts and aspiring for more balanced relationships. Emphasizing participatory research and addressing inequalities can curtail Western knowledge dominance (Gosh et al 2021). As J. Carolsfeld suggested (personal communication, July 19, 2023) “Working in Brazil and Bolivia in collaboration on fisheries management, it is all about people, not really fish. Any development idea has to come from the community, then we take their ideas and try to match them with Canadian expertise. The Key is to collaborate with local organizations that already have the connections for collaboration.”

The Global South, with its rich diversity, goes beyond mere geographical definitions. Acknowledging their varied beliefs and recognizing the implications for various sectors is vital in the decolonization journey (Roberts, 2018). The future of decolonization requires adopting a human rights approach and cultivating relationships rooted in mutual respect and equity (Gosh et al., 2021). This transformation calls for including Global South voices in leadership capacities across multiple areas, such as climate change adaptation studies (Lasgo, 2022).

Moreover, it is recognized that knowledge creation is influenced by power relations, and the influence of research partnerships on Canadian society is undeniable (Toukan 2021). The Global South is actively redefining its part in knowledge generation. Over recent years, there's been increasing critique of global knowledge disparities and a move towards equitable models (White, 2019). J. Carolsfeld (personal communication, July 19, 2023) pointed out “For Canadians is difficult to value the expertise from some countries, basically because of different contexts but also because we need people who translate this knowledge in a way that Canadians are able to understand. Usually having a North American author or institution supporting any publication on this could be an advantage.”

Canadians see scientific collaboration as important, with 52% believing that being a world leader in scientific achievements is very important (Pew Research Center, 2020). This could indicate an appreciation for global collaboration and receptiveness to knowledge globally, including from the Global South. Particularly during the Covid-19 crisis, Canadians' openness to varied information sources, even non-English ones, was evident (Theivendrampillai et al., 2023). Such openness can be translated to other knowledge domains, including climate change adaptation.

4.3 Conclusions

Climate change adaptation requires innovative, multi-faceted, and collaborative efforts from all global stakeholders. From the intricate tapestry of case studies and literature presented, it is evident that academia, governments, independent organizations, and NGOs play pivotal roles in bolstering community resilience against climate adversities. There has been a significant evolution in collaborative frameworks, transitioning from mere extractive cooperation to deeper mutual understanding and partnerships. While community-academic partnerships, participatory governance, traditional knowledge incorporation, and grassroots innovations are laudable strides in the right direction, significant challenges remain, including gaps in intercultural collaboration and the adequate integration of indigenous insights.

Case studies from various countries and regions highlight the importance of localized and context-specific solutions. The experience of countries like Bangladesh, Bolivia, and Nepal underscores the merit of a practical community-centred approach. In contrast, Canada offers insights into the significance of policy, funding, and multi-stakeholder collaboration as examples of systemic approaches. However, the underlying barriers, particularly in Canada's protected areas and the broader lack of interregional collaborative experiences, are striking. As delineated in Section 1.3, the criterion for discerning whether a case study leans more towards being systemic or practical fundamentally relies on identifying the origin of the initiative. Take, for instance, the community in Nepal that constructs bamboo spurs to safeguard their riverbanks. This instance illustrates how grassroots efforts can garner the attention and support of external organizations, which may ultimately influence policymakers.

NGOs, particularly local ones, have emerged as crucial knowledge brokers, intermediaries, and connectors, bridging the often-wide chasm between scientific research and community application. The role of Canadian organizations, especially post-Covid, has transformed, emphasizing not just aid provision but equitable, intercultural, and inclusive partnerships.

Given the overarching goal of learning from global south case studies, it becomes imperative to stress that true resilience against climate challenges isn't just about adopting best practices but also about mutual learning, knowledge exchange, and leveraging shared experiences across diverse contexts. Adaptation isn't just a reactive process but a proactive, collective journey of

communities, governments, and organizations across the globe. As we pivot towards a future rife with climate uncertainties, a united, collaborative front becomes our most potent tool, ensuring not just survival but a sustainable, inclusive thrive.

International cooperation and collaboration are essential mechanisms for addressing global challenges like climate change, public health, and global security. Such cooperation involves aligning policies, sharing resources, and coordinating knowledge among different states or entities. However, inherent challenges exist, including power imbalances where Western paradigms often overshadow traditional knowledge, marginalizing Indigenous perspectives. For effective international cooperation, there's a need for inclusivity, equity, and mutual respect, prioritizing the needs of developing nations.

Barriers to effective collaboration often stem from ineffective interfirm relationships and external factors like new technologies or top-down policies. The potential for collaboration is evident in models like the South-South collaboration, which fosters sustainable development through research alliances, educational exchanges, and joint projects. Recognizing and integrating both Western and traditional knowledge can lead to richer innovations. Overall, both cooperation and collaboration are pivotal for learning and advancing in areas like climate change adaptation.

The Global North, characterized by its superior resources and infrastructure, is grappling with the challenges of climate change, such as rising sea levels, extreme weather events, and associated economic repercussions. Their adaptive strategies are shifting towards a more holistic and sustainable approach that integrates climate considerations across various sectors. Conversely, the Global South faces higher climate vulnerabilities due to their limited resources, infrastructure, and historical marginalization. Despite these challenges, the Global South is participating in both community-based responses and top-down policies to mitigate the adverse effects of climate change, even with financial and technological constraints. It is evident that the Global North often takes an interventionist approach, sometimes imposing solutions that might not necessarily prioritize the best interests of the Global South. Effective adaptation strategies must be rooted in mutual respect, international collaboration, and recognizing the inherent strengths and knowledge of both the Global North and South.

Climate change impacts vary significantly across communities, emphasizing the need for tailored adaptation strategies rooted in local experiences. Local knowledge, encompassing both traditional insights and practical experience, is essential in shaping these strategies and ensuring their effectiveness. While communities' responses to climate change aren't solely based on their resources, their unique ways of living and thinking influence their adaptive measures. Engaging with local stakeholders in the decision-making process fosters ownership and the sustainability of these strategies. The importance of respecting and integrating indigenous knowledge with scientific assessments is paramount, although challenges arise from traditional beliefs' influence

on adopting new knowledge. However, systemic changes often originate from top-down decisions, potentially marginalizing community-driven initiatives. Issues of climate colonialism, power imbalances, and the misuse of carbon offset projects in the Global South underscore the need for a more equitable approach to addressing climate change, ensuring that strategies don't perpetuate injustices or exploit vulnerable populations.

Finally, Canada is dedicated to forging strong collaborations with both the Global North and the Global South, prioritizing inclusiveness, alignment with its values, and shared growth to advance global research partnerships. Canada's commitment to the Global South needs to expand not only for sustainable development and mutual learning but also to focus on decolonization, inclusivity, equitable relationships that include the recognition that we (Canadians) can gain from learning from others. While Canadians hold scientific achievements in high regard, their openness to diverse knowledge sources, evidenced during the Covid-19 pandemic, signifies a potential broader acceptance and recognition of global perspectives, underscoring the importance of embracing knowledge from the Global South.

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VI. Appendix I. Questionnaire for Interviews.

1. Since we are looking into topics of international cooperation or collaboration, or solidarity, what do these terms mean to you and in your practice?
2. In your work, do you see a connection with climate change or climate justice? Do you see a difference between “change” and “justice” when we speak of justice? Locally in Canada? At a local level in the countries of partnerships that you have?
3. Any thoughts on how a small-scale collaboration or partnership can influence policy changes at a higher level? (From bottom-up instead of Top-down policies). If you don’t know what to convey at this time, are there questions you would like to ask BCCIC about climate justice?
4. How should we ensure that climate change adaptation efforts in your collaboration projects address the unequal burdens faced by different groups in the Global South?
5. What are the key challenges when collaborating with global South partners on climate change adaptation? How would you address these challenges?
6. What is your opinion and experience on practical and systemic approaches to climate change adaptation?
7. How do you engage with policymakers and advocate for policy changes that support climate change adaptation and climate justice?
8. Can you share any examples of successful partnerships or collaborations that have influenced policy changes related to climate change adaptation in the Global South? Anything relevant that Canadian actors can learn from (especially as we in BC are only now starting to realize the dramatic impacts of climate change in person)?
9. Are there any people in the Global South that you suggest we should talk with about these issues?