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Number 05

# Le Climat *ascope*



**HIGHLIGHTS OF  
SCIENTIFIC ADVANCES  
ON CLIMATE CHANGE**

**CLIMATOSCOPE.CA**

## *In this issue*

**SPECIAL ISSUE ON ADAPTATION  
TO CLIMATE CHANGE**

**BIODIVERSITÉ QUÉBEC: A WEB  
PLATFORM FOR KNOWLEDGE  
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**CARBON BORDER ADJUSTMENT  
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**NATURE-BASED SOLUTIONS  
FOR COASTAL PROTECTION**

**REMEMBERING PAST FLOODS**

# 05



## About *Le Climatoscope*

*Le Climatoscope* is a French-language popular scientific journal on climate change, published annually and aimed at an informed, but not expert, readership. Gathering articles produced by researchers from all disciplines, *Le Climatoscope* introduces readers to a portrait of the scientific advances in climate change and the latest initiatives and innovations in this field.

Founded by a team of professors from the Université de Sherbrooke in Quebec, Canada, the journal promotes the dissemination of knowledge on climate change, thus contributing to awareness, capacity building and reflection on the challenges we face and potential solutions.

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## Introduction

# ADAPTATION IS ALSO AN EMERGENCY

The United Nations reports that July 2023 was the hottest month on record for the entire planet. Here are two examples among many: On August 2, 2023, the government of Iran, on the recommendation of its ministry of health, decreed two public holidays throughout the country to protect the health of its population. At the time, the country had been experiencing a heat wave for several weeks, and hospitals were faced with numerous admissions for heatstroke. Closer to home, in Canada, the country suffered record forest fires this summer, as well as flooding that was quite unusual for this time of year.

These increasingly frequent and prolonged extreme weather events are, unfortunately, entirely in line with the forecasts made since 1990 in the numerous reports by the Intergovernmental Panel on Climate Change (IPCC) on the possibility of a rise in global temperature linked to greenhouse gases (GHGs). In its *State of the Climate* report in 2021, the World Meteorological Organization indicated that the average global temperature had already risen 1.1°C since preindustrial times (1850–1900), and that the GHG emissions measured that year would lead to a warming by the end of the century well above that defined by the Paris Agreement (1.5 to 2°C above preindustrial levels).

This information confirms that it is more urgent than ever to reduce GHG emissions if we are to limit climate change and its consequences. However, it also tells us that a new climate reality has already set in, and that in addition to fighting against its amplification, we now need to adapt to these new conditions. It's a question of "survival," according to the IPCC.

As part of the Adaptation Futures 2023 conference being held this autumn in Montréal (see Editorial), we wanted to focus this fifth issue of *Climatoscope* on adaptation

to climate change, a truly global emergency. The IPCC defines adaptation to climate change as "the process of adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities" (IPCC, 2022). In this issue, you'll find texts identifying as "adaptation" covering a wide spectrum of issues and research disciplines. If we consider the increased risk of shoreline erosion due to climate change, adaptation can be achieved, for example, through nature-based solutions, such as a better association and use of the breakwater capacities of coastal vegetation (see article by Markov et al.). It can also be achieved by better integrating climate risks into decision-making when new developments and infrastructure investments have to be made (see article by Boyer-Villemare). At the international level, it would be desirable for the question of *responsibility* for climate change to be clarified at last, so that progress can be made on the question of *how to* help the countries and populations most vulnerable to the new climatic realities (see article by Wallimann-Helmer). The creation of a financial fund for loss and damage at the last COP27 in Egypt shows a notable advance on these issues within the international community (see article by Simard et al.).

While it's not yet past H-hour to meet the commitments of the Paris Agreement, a new climate context is already in place, and the first consequences are already being felt. Solutions will emerge from work and advances in all scientific disciplines, in consultation with public authorities and citizens to ensure their implementation. We hope this new issue of *Climatoscope* will facilitate this networking and the taking of appropriate action.

### The *Climatoscope* team

# ADAPTATION FUTURES 2023: THE OPPORTUNITY TO RETHINK CLIMATE CHANGE ADAPTATION TOGETHER

**Alain Bourque**

Managing Director, Ouranos

Co-Chairman of the Adaptation Futures 2023 Advisory Committee

Once viewed as a remote, distant, and abstract environmental issue because it was too global, climate change has become a continuously topical issue and is described as a global emergency with increasingly present and worrisome economic and human consequences. The latest reports from the Intergovernmental Panel on Climate Change (IPCC) and news reports from around the world make it clear that the impacts are being felt on all continents, as well as at the country, regional, local, and even individual levels—with people now regularly affected by major or minor flooding, increasingly unbearable heatwaves, destructive forest fires, and record droughts, to name only a few of the meteorological extremes aggravated by these anthropogenic climate changes. Aside from the coverage of these high-profile impacts, science has long been aware (and society, more recently), that gradual changes are contributing to a subtle but significant degradation of our natural and built environments, which are not optimized for our new climatic reality, contributing to increased collective and individual vulnerability.

Despite these alarming facts, the twofold solution to climate change is fortunately well known: 1) reduce greenhouse gas (GHG) emissions to achieve carbon neutrality as soon as possible, and 2) learn to live with residual climate change, i.e., adapt. In addition to being well known, these two solution categories have the advantage of requiring implementation planet-wide, offering a fantastic opportunity for collaboration on a global scale, so that we can share our experiences and innovate in the most effective way possible. In this context, it becomes crucial that, at regular intervals, we take stock of our scientific and practical knowledge, exchange views on our experiences and their applicability, and improve our ways of doing things in order to increase the scope and speed of the fight against climate change.



## The Conference Series That Brings Together the Global Community of Adaptation Science and Practice

In the field of climate change adaptation, the Adaptation Futures conference series, managed by the World Adaptation Science Program (WASP), under the aegis of the United Nations Environment Program, is the international conference that brings together the global adaptation science and practice community. Since its first edition, held in Australia, this conference, which has been held every two years since 2010 (Figure 1), has gathered major adaptation projects and networks to discuss their activities, results, outputs, and impacts. It has also facilitated communication of the best available scientific data, best practices, and lessons learned, and it has provided an opportunity for key parties, including decision-makers at the local, regional, and global levels—both public and private—to meet, exchange ideas, and establish collaborations and partnerships.

At each event, a special effort is made to build the capacities of participants starting their career, particularly those from developing countries, who, as we know, are most at risk from climate change while having contributed very little to the problem. Both the event's steering and scientific committees also seek to prioritize emerging themes, to help accelerate progress in developing effective adaptation strategies.

## From October 2 to 6, 2023, Canada Hosts the 7<sup>th</sup> Edition in Montréal

As early as 2017, and then on the sidelines of the Adaptation Futures 2018 conference in Cape Town, Ouranos and the Government of Canada discussed submitting Canada's candidacy to host the edition then scheduled

for 2022. As part of an international competitive process, Ouranos submitted its bid in early 2019, and learned at the end of the same year that this bid, strongly supported by the Government of Canada, was the winning proposal, and that the announcement would be made at the close of the next Adaptation Futures conference, scheduled to take place in New Delhi, India in April 2020.

The India conference ended up being rescheduled to October 2021 and taking place only virtually and at a smaller scale than in the past. For the Canadian organizers, the pandemic prompted a review of several aspects, including the format. Indeed, the sudden and massive emergence of telecommuting, as well as the development of technological tools enabling virtual gatherings, offered the opportunity to address the issue of thousands of people travelling to the conference and emitting tons of GHGs—what some have called climate hypocrisy. As direct human contact remains crucial in some cases, particularly for young people looking for mentors to start their career in the field, it was quickly decided that Canada's Adaptation Futures edition, now rescheduled to October 2023, would be a hybrid event, targeting around 1,500 people onsite and the highest number of participants online. This approach will enable us to develop a more equitable, inclusive, and sustainable conference, using the most effective tools and approaches developed worldwide during the pandemic, to ensure impactful sessions despite the combination of onsite and virtual participants.

International-calibre advisory and scientific committees, meeting a variety of diversity criteria and including at least one Indigenous representative, have enabled the development of a program that will accelerate the global momentum in favour of adaptation. To this end, the committees also agreed that it was preferable to prioritize certain aspects, i.e., issues that will ramp up significantly in the short term and solution elements that urgently need to take off in order to reduce climate change impact risks. As a result, four specific cross-cutting objectives quickly emerged:

1. Learn from **Indigenous** and local knowledge and perspectives on climate change adaptation research, policy, practice, and action;

2. Encourage faster adoption of **transformative adaptation** to ensure long-term resilience;
3. Bring marginalized voices to the fore, particularly those from the South, as part of an approach based on **justice, equity, diversity, and inclusion** in the face of climate change;
4. **Accelerate progress** on the Global Goal on Adaptation and the Global Stocktake, and step up action to implement effective adaptation.

Acknowledging these objectives, and conscious of our community's responsibility to "walk the talk," the committees and organizers will seek to pursue these goals by developing a conference that uses more equitable, inclusive, and low-carbon means.

In addition, the committees felt that a number of specific themes were an absolute priority for the future of adaptation. Based in particular on the latest report from IPCC Working Group 2, the conference's scientific committee circulated (notably via social networks) a list of potential priority themes, ahead of the call for contributions, which was to take place in fall 2022. This collaborative and inclusive approach enabled feedback from the global adaptation community on the themes for the abstracts/sessions. Eight priority themes emerged.

## Eight Themes Identified as Priorities for the Future of Adaptation

**T**he eight priority themes are not sector-based, thereby recognizing the importance of thinking in a more integrated way and hopefully fostering better integration of adaptation solutions in a complex world.

Indeed, adaptation solutions for agriculture have implications for natural ecosystems, social cohesion, population health, natural resource and infrastructure planning, as well as regional and national economic development. The eight themes are based on major questions that Adaptation Futures 2023 will attempt to answer:

### 1. Learn from Indigenous and local knowledge and know-how on adaptation

Indigenous peoples have looked after the land, water, and ocean for generations, anticipating and responding to climate variability and change. How can we integrate Indigenous knowledge and the experiences of other knowledge holders to ensure long-term resilience?

### 2. Managing multiple risks: Composite, cascading, and cross-border risks associated with climate change

Populations face many simultaneous challenges, and climate change is just one stress factor. How can we take into account the complexity of the situation and the interactions between the multiple vectors of climate change and vulnerabilities when defining and implementing the necessary measures?

### 3. Making adaptation choices: Managing compromises and striving for efficiency

It is essential to integrate perspectives to promote adaptation choices that value diversity and limit maladaptation. How can we make an integrated assessment of systemic and transformational adaptation and maintain long-term resilience?

### 4. When adaptation is no longer possible

Adaptation (and mitigation) efforts will not be enough to meet the complexity of all climate risks and vulnerabilities. So, what should we do when our adaptive capacity is no longer enough to face climate challenges and to achieve the United Nations' Sustainable Development Goals?

### 5. Who loses, who wins, and who decides?

#### Fairness and justice in the face of adaptation

The effects of climate change disproportionately affect marginalized and vulnerable groups. Efforts to support adaptation must therefore address fundamental issues of ethics, equity, and justice.

### 6. The power of nature in climate action

Human and natural systems are deeply interconnected. More must be done to analyze the climate-nature-society connection and understand the potential of nature-based approaches to adaptation.

### 7. Teaching and learning to adapt in a changing climate

Education systems must ensure effective learning about adaptation, in a world where, for many, climate change is a reality. How can teaching and learning inspire hope, embrace knowledge plurality, and nuance the realities (and suffering) associated with the climate crisis?

### 8. Inclusive adaptation of governance and finance: How do we get there?

Adequate governance mechanisms, effective and inclusive decision-making processes, and a favourable institutional and financial environment are essential to build, accelerate, and sustain climate-resilient development. How can this be achieved?



Furthermore, recognizing participants' declining interest in traditional scientific sessions, where communication is essentially unidirectional and involves detailed presentation of results and methodologies, the conference will give preference to interactive panels, discussion workshops, and other dynamic approaches that maximize the presence of a large community, while leaving specific details and results to be accessible in articles and reports.

## The Many Challenges and Opportunities of Adaptation

**O**rganizing an international conference for an issue as diverse and global as adaptation to climate change is no easy task. For example, although the eight priority themes were identified with the participation of adaptation leaders, a significant proportion of the papers and sessions received in the call for papers were aligned around the thematic and organizational silos

of adaptation players. What's more, despite the desire of developed countries to help the most vulnerable to adapt, visa processes and the prohibitive costs of even hybrid conferences point to a multitude of obstacles to the development of global adaptive capacity. Despite these minor challenges, it's a safe bet that, for the many organizers and partners involved, as well as for the participants representing over a hundred countries, the actions that will result from the meetings will be compatible with the conference slogan, "**Time to innovate: Adapting Together.**" Indeed, beyond the small barriers to adaptation, it is above all the political will of individuals, organizations, decision-makers, and politicians to innovate collaboratively that will enable us to meet the challenge of adaptation in the most effective way possible.



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adriana



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## Outlook

# QUEBEC'S STRATEGIC POSITION IN THE ENERGY TRANSITION

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**T**he energy transition is underway. Renewable energies offer cheaper kWh than fossil fuels almost everywhere in the world. The financial markets are anticipating an oversupply of and falling demand for fossil fuels in the long term, despite geopolitical upheavals such as the war in Ukraine in 2022. Between governments and private companies, commitments to the zero-emissions target for 2050 are multiplying. However, the global community is not yet on the road to deep decarbonization.

The energy transition is therefore an opportunity for Quebec to seize: to reduce its GHG emissions while creating jobs and boosting the province's economy, so it can adapt to and benefit from a new energy reality. There are three ways to gain a strategic advantage in the transition: (a) exporting green electricity or fuels; (b) controlling the natural resources needed for clean energies, such as lithium and cobalt; (c) taking the lead in technologies, notably for electric transport (cars, trains, trucks), including charging stations. This article explores the prospects for these three strategies in Quebec between now and 2050.

## Electricity Exports

**T**he North American market for clean electricity is set to grow over the coming decades. For example, by 2030, the United States aims to achieve 100% decarbonized electricity.

With Quebec's abundant clean energy, stable institutional and regulatory environment, and expertise, the province could become a leading exporter of clean electricity and benefit from this growing demand. Indeed, the successful development of the wind energy sector is evidence of the province's ability to implement new energy developments (Fournis, 2017). With this in mind, it is important to estimate the projected demand and supply of clean electricity, as well as the potential contribution of complementary sources such as solar and wind power.

If Quebec is to meet its climate objectives while ensuring its economic prosperity, the province will need to develop its electricity production. According to Hydro-Québec (HQ) estimates for 2022, electricity demand is set to increase by 20 TWh by 2029, and by 100 TWh by 2050. Following the trajectory of current needs, the province will require new electricity supplies as early as 2027.

In terms of energy supply, electricity production was around 212.9 TWh in 2019. In its 2022–2026 strategic plan, HQ aims to increase its production capacity by around 10% and is banking on energy efficiency to increase its energy supply. In 2019, Quebec's energy balance revealed that 52% of Quebec's energy was lost due to inefficiencies in energy transformation, transportation, and consumption. HQ's target for 2032 is to save 8.9 TWh of energy through more optimal use. These data suggest that Quebec is capable of meeting its needs in the short term. However, the supply for more distant time horizons, such as 2050, remains uncertain.

## SOLAR INDUSTRY

Solar energy is underdeveloped in Quebec. In 2019, it represented less than 1% of the province's energy mix (Belmokhtar and Durette, 2021). Nevertheless, Quebec's solar potential is not negligible, at an average photovoltaic potential of 1,183 kWh/year/m<sup>2</sup>. Quebec's potential surpasses that of Canada, which stands at 1,131 kWh/year/m<sup>2</sup>, but remains below, for example, the 1,800 kWh/year/m<sup>2</sup> of southern California (Global Solar Atlas, 2023). Incorporating solar energy into Quebec's energy supply would enable it to diversify its energy mix and meet the growing energy demand (Belmokhtar and Durette, 2021). Nevertheless, solar energy development poses challenges in terms of social acceptability, land rights, contribution to the national economy, and consultation with citizens directly affected by the project, particularly when it is to be set up in an inhabitable or agricultural

area, or Indigenous community. Environmental concerns linked to the extraction of essential minerals may also be raised. Solar energy therefore has interesting potential for Quebec, but we must also consider its counterparts in terms of social justice and equity, and then environmental costs (Chapman, McLellan, and Tezuka, 2018).

## WIND ENERGY

In 2019, wind power was responsible for around 5% of the province's electricity production. Quebec's theoretical wind power potential is very high considering the territory's vastness, which is estimated at 12,250 TWh (Herrman and Huraux, 2015). However, the potential that is technically exploitable and can be integrated into the grid would be in the range of 61 to 74 TWh (Herrman and Huraux, 2015), that is, around one third of the current electricity production<sup>1</sup>. Wind power could therefore play an important role in Quebec's future supply of clean electricity. Like solar power, the wind energy sector faces several challenges, not the least of which is the clash of views on the place and role of wind power in regional socioeconomic development (Fournis, 2017).

Even so, the above developments suggest that Quebec will be able to meet its clean energy needs in the medium term (i.e., 2030). However, in the long term, before exporting more to its neighbours, the province will need to take full advantage of the opportunities presented by its wind and solar energy sectors and consume its electricity optimally.

## Critical Minerals

**C**anada is a major global mining producer, and Quebec makes a major contribution to this, as the widest variety of critical minerals are mined in the province. Considering both operating and exploration sites, Quebec has mining potential in the energy transition for the production of graphite, titanium and vanadium, lithium, nickel, copper, cobalt, platinum-group elements, rare earth elements, niobium, and zinc. (MERN, 2020). Nevertheless, it seems clear that Quebec will not be a key player in the market for critical and strategic minerals, but it will have the opportunity to make its mark if it plays its role well (MERN, 2020). However, there is still a debate to be had as to whether the population is ready, after a slowdown in these sectoral activities, to relive a mining boom that could have major consequences for the environmental, social, and economic landscape of Quebec.

If Quebec were to take the path to exploitation, it would have the opportunity to distinguish itself in three crucial ways, which could elevate it to the status of an international leader in mining development.

1. However, this estimate does not take into account possible gains in the improvement of wind turbines.

Firstly, through significant investment and effort in research and development, Quebec could develop an internationally competitive and valued expertise in critical mineral mining practices. Indeed, this is all the more feasible given that a sizable and promising training pool is already in place in Quebec (training centres, colleges, and universities) and could stand out even more abroad if given the opportunity to do so (MERN, 2020).

Secondly, critical minerals mined in Quebec would have the opportunity to stand out and become select products on the market, thanks to the socially and environmentally responsible production in Quebec. Indeed, the province's high social and environmental production standards could enable it to stand out from imposing players such as China and Russia. The province's standards are already high, but could be even higher, as demonstrated by the arsenic emissions scandal at Glencore's Horne smelter (where the private sector was not forced to comply with chemical pollutant emissions standards to protect the health of local populations). While China, which owns a huge proportion of the mines in sub-Saharan Africa, acquires and confirms a reprehensible reputation in terms of environmental standards and human rights (Simon, 2022), Quebec offers products that provide a more ethical and responsible option than its competitors. The province could enhance its difference in this area by strengthening its current standards, for instance by promoting consultation with First Nations and controls on industrial discharges, by adhering to existing standards and certifications, and potentially by creating new standards (MERN, 2020).

Lastly, Quebec has already come to the realization that, in order to meet the exploding demand without ecological catastrophe, it is necessary to recycle these critical materials. By making the circular economy a pillar of its strategy, Quebec could not only further enhance its image as a responsible mining producer, but also increase its production by offering recycled products. Above all, through research and development, it could export its expertise and technologies for recycling these minerals, which are still very poorly recycled at present (MERN, 2020; PwC, 2021)

The question remains as to who will benefit from Quebec's potential new mining boom. For the time being, the government seems to be doing more to facilitate external access to Quebec's resources, with numerous tax advantages being offered to mining companies to encourage foreign companies to set up operations. However, according to the guiding principles of the Quebec government's plan to develop critical and strategic minerals, it would be preferable to promote mining by provincial companies, which are sufficiently numerous and able to tackle the task if given the means to do so (MERN, 2020; PwC, 2021). Otherwise, we would be failing the guiding principle of "maximizing the

impacts in the [critical and strategic]—producing regions, thus contributing to their economic prosperity" (MERN, 2020). This would also call into question the possibility of achieving genuine energy sovereignty as part of the transition. The governance of the mining sector in the energy transition remains to be clarified, failing which, without coordination, the sustainability of activities cannot be guaranteed.

## Taking the Lead in Clean Technologies

Quebec is well positioned to take the lead in the low-carbon technologies that will be crucial to its energy transition. Since the beginning of the 2010s, the Quebec government has opted for the electrification of its transportation system as a means of reducing GHG emissions. Similarly, in 2020, the Quebec government announced that the sale of fossil-fuel vehicles will be banned by 2035. Quebec must therefore invest in the technologies that will enable it to achieve this electrification of transport.

### ELECTRIC TRANSPORT

In 2021, Quebec's electric transport industry represented revenues of 3.3 billion Canadian dollars and employed 9,308 people in 177 companies. The evolution of the electric transport manufacturing industry is also noteworthy. In five years, between 2016 and 2021, the industry's revenues increased more than 300%, the number of jobs rose 375%, and the number of companies climbed 120% (Propulsion Québec, 2021). As regards freight transport, Pedinotti-Castelle et al. (2020) project that rapid electrification will take place as early as 2030 for light trucks. The same study projects that the medium- and heavy-duty transport industry will move toward hybrid vehicles. However, in a scenario with a significant increase in GHG reduction targets, the market share of medium- and heavy-duty electric vehicles would increase considerably. Thus, there is development potential in Quebec to manufacture medium- and heavy-duty vehicles, light trucks, and electric vehicle components, and the government would benefit from providing more support to companies operating in this sector (Pedinotti-Castelle et al., 2020).

### BATTERIES

Quebec is home to a number of key players in the value chain for lithium-ion batteries, which are essential for electric transport. Global demand for lithium-ion batteries is projected to reach over 3,500 GWh by 2040. At present, Europe and the United States, two major players in

electric vehicle production, do not have the production capacity to meet the rising demand for electric vehicles. So, according to a 2019 Propulsion Québec report, a race to increase battery production has been launched, resulting in a tenfold increase in projected global battery cell production capacity by 2028, as compared to 2017 levels, reaching around 1,500 GWh. In addition, the North American market share of global battery production is set to increase from 5.5% in 2017 to 13.4% in 2028. It would therefore be in Quebec's interest to contribute to the expansion of this market. Indeed, the province already possesses significant know-how in mineral extraction, as well as in the development and assembly of electric vehicles, which are two important stages in the battery production chain.

## Conclusion

**A**fter analyzing three strategies, we can conclude that Quebec could position itself favourably during the energy transition, to the benefit of its economy. In terms of electricity exports, given the growing demand in the province, Quebec will need to focus on energy efficiency, as well as on the supply from new sources, such as solar and wind power, which offer considerable potential. When it comes to controlling the natural resources needed for clean energy, the province will have the opportunity to rise to the status of an international leader by focusing on the development of its operating practices, respect for high environmental and social standards, and recycling of critical materials, while also relying on provincial companies. Finally, the province must exploit its potential in the development of electric transportation technologies, in particular batteries, light trucks, and medium- and heavy-duty electric vehicles.

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Photo credit: Axel Drainville



Photo credit: Kanrawee Jinpanich

## Outlook

# COMMUNICATING FOR BIODIVERSITY ADAPTATION

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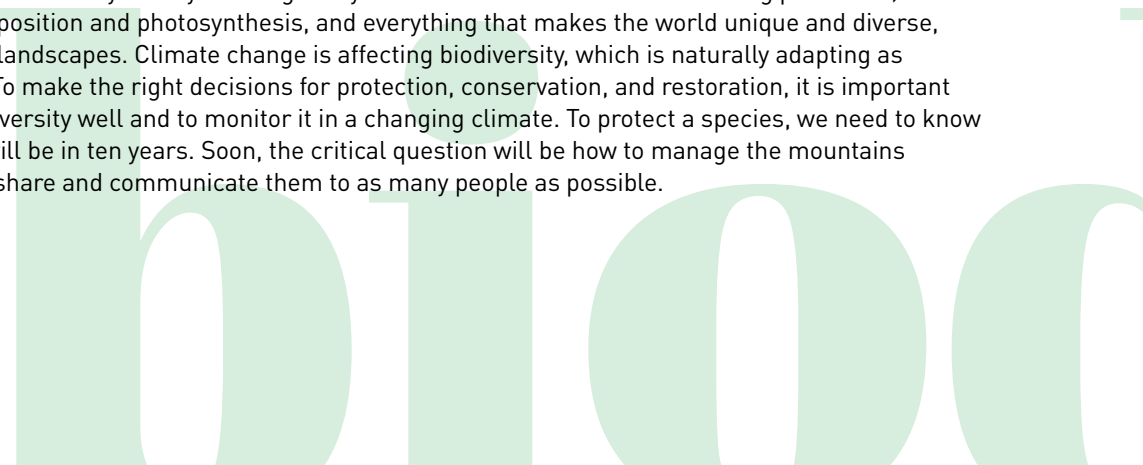
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**B**iodiversity is the extraordinary variety and originality of life on Earth. It also includes living processes, such as soil decomposition and photosynthesis, and everything that makes the world unique and diverse, such as genes and landscapes. Climate change is affecting biodiversity, which is naturally adapting as much as possible. To make the right decisions for protection, conservation, and restoration, it is important to understand biodiversity well and to monitor it in a changing climate. To protect a species, we need to know where it is today and where it will be in ten years. Soon, the critical question will be how to manage the mountains of biodiversity data and how to share and communicate them to as many people as possible.



Climate change adaptation is defined as the process of adapting natural and human systems to a changing environment. Climate modelling—in addition to predicting the response of natural and human systems to climate changes—is a discipline fraught with many unknowns. Consequently, dealing with uncertainty is at the heart of adaptation strategies, which must necessarily be dynamic, as part of a cycle of assessment, planning, implementation, and performance monitoring. This means that any adaptation approach must include a system for monitoring the actions taken. However, this information must be available to society at large, and especially to journalists, land managers, civil society, and citizens, so they can be involved in a feedback process.

Advances in scientific knowledge about biodiversity and its changes are keeping pace with those on climate change. However, information about climate change is increasingly getting coverage in national and international media, unlike information on biodiversity and its changes (Legagneux et al., 2018), which tends to remain within the research community. Thus, effective communications on issues of biodiversity, its changes, and adaptations in the context of global warming is proving to be a major challenge and should be a research priority (Gravel, 2021).

In this context, a new scientific partnership, Biodiversité Québec, has been established to facilitate the monitoring, analysis, and exchange of information on the state of biodiversity in Quebec. The corollary of this approach is that close communication between science, politics, and the rest of society is necessary to enable natural and human systems to adapt to climate change. On the sidelines of the 15<sup>th</sup> Conference of the Parties (COP) to the United Nations Convention on Biological Diversity, held in Montréal, in December 2022, the Biodiversité Québec web portal was officially launched.

## Biodiversité Québec: A Concrete Solution

**T**he mission of Biodiversité Québec is to collect observational data, improve biodiversity monitoring in Quebec, and provide summaries and analyses to the public through a web portal (see Box 1). This scientific partnership also aims to raise Quebecers' awareness of biodiversity issues and assist policymakers and land managers in decision-making by providing them with sound information.

The Quebec government, university researchers, and numerous partners are involved in this interdisciplinary

endeavour, which brings together a variety of disciplines, including biology, design thinking, business intelligence, computer science, geomatics, strategic communications, modelling, statistics, law, governance, and applied policy.

## A USER-CENTRED APPROACH

The web portal is the culmination of a long process of *design thinking*, a problem-solving approach that emphasizes gaining a deep understanding of user needs, generating creative ideas, and rapidly creating iterations to achieve innovative solutions (Brown, 2008). By putting themselves in the shoes of users, designers can better understand the context of the problem and come up with innovative solutions. In our case, the crux of the problem was to create a showcase for Quebec's remarkable biodiversity.

The first step in the design thinking process is to understand the needs, motivations, and challenges of the target users. The designers took an entirely new approach, working with the scientific team to develop *proto-personas*. This iterative collaboration made it possible to describe Biodiversité Québec's various target audiences: land managers, opinion leaders, scientists, and the general public, with a focus on the younger generation. Each target group was represented by a fictional character, with a brief biography, a description of their biodiversity aspirations and goals, and an assessment of their technical and scientific capabilities (see Figure 1). Unlike approaches that focus on data collection, design through proto-personas is more empirical and relies on the designers' imagination and experience. However, the use of this approach is susceptible to conscious and unconscious biases, so our approach was supplemented by qualitative interviews, from which the personas emerged.

## THE PORTAL PROTOTYPING PROCESS

After creating personas characterizing the different target audiences, the team turned to two cohorts of graduate students from Université Laval's master's program in interaction design. More than a dozen teams designed different application models: interactive games about butterflies for the younger generation, assistants for citizen observations during hiking trips, and an interactive table to assess the impact of different development projects on biodiversity. A synthesis of this material then informed the final design presented to the development team. Four products were targeted: an interactive table providing access to the inventories of the Quebec Biodiversity Monitoring Network; an atlas

# ÉMILIE ROCHEFORT | La jeune étudiante pleine d'espoir.



## STATUT

Représente un membre du grand public de la génération Y ou Z qui s'informe et s'intéresse aux enjeux liés à la biodiversité.

ÂGE: 19 ans

EMPLOI: Étudiante, sciences humaines

FAMILLE: En couple

VILLE: Sherbrooke

## PERSONNALITÉ

Introverti  Extraverti

Thinking  Feeling

« Pense, crois, rêve et ose. »

## BIO

Émilie est étudiante au Cégep de Sherbrooke en sciences humaines. Comme la majorité des jeunes de son âge, elle a de la difficulté à imaginer son futur. Ne sachant pas encore ce qu'elle souhaite réellement faire de sa vie, elle a décidé que les sciences humaines seraient un bon choix de départ pour explorer le plus d'avenues possible.

Elle s'implique déjà dans quelques comités, que ce soit pour la radio du Cégep ou encore au sein d'un groupe d'écolo amateur qui a pour désir de faire bouger les choses! Ils ne savent pas encore comment s'y prendre, et surtout comment se faire entendre, mais ensemble, ils rêvent d'un monde vert et équitable.

OBJECTIFS
<ul style="list-style-type: none"> <li>Faire la majorité de ses déplacements en vélo ou à pied.</li> <li>Introduire tranquillement le composte chez ses parents.</li> <li>Faire un voyage humanitaire pour aider les gens dans le besoin.</li> <li>Fabriquer elle-même certains produits d'hygiène personnelle.</li> <li>Diminuer sa consommation de viande.</li> </ul>

FRUSTRATIONS
<ul style="list-style-type: none"> <li>Elle trouve que le système politique est loin de sa réalité et qu'il ne semble pas comprendre ce que les jeunes adultes veulent.</li> <li>Elle trouve que les baby-boomers prennent trop de place et croit que certains enjeux seraient déjà réglés si c'était les jeunes qui s'en occupaient.</li> <li>Elle aimerait voir autant de publicités sur les enjeux environnementaux qu'il y en a pour le savon à vaisselle.</li> <li>Elle trouve que le suremballage est beaucoup trop présent lorsqu'elle aide ses parents à ranger l'épicerie.</li> </ul>

CONNAISSANCES DES OUTILS TECHNOLOGIQUES
Faible <input type="checkbox"/> Élevé <input checked="" type="checkbox"/>

INTÉRÊT POUR LA TECHNOLOGIE
Faible <input type="checkbox"/> Élevé <input checked="" type="checkbox"/>

CAPACITÉ À MANIPULER DES COMPOSANTES INTERACTIVES
Faible <input type="checkbox"/> Élevé <input checked="" type="checkbox"/>

ATTITUDE FACE AUX CHANGEMENTS
Faible <input type="checkbox"/> Élevé <input checked="" type="checkbox"/>

CONNAISSANCES DES PROBLÈMES DES PROBLÈMES ENVIRONNEMENTAUX
Faible <input type="checkbox"/> Élevé <input checked="" type="checkbox"/>

INTÉRÊT FACE AUX PROBLÈMES ENVIRONNEMENTAUX
Faible <input type="checkbox"/> Élevé <input checked="" type="checkbox"/>

SOURCES D'INFORMATIONS
Publicité (Télé/Radio) <input checked="" type="checkbox"/>
Reportage (Télé/Radio) <input checked="" type="checkbox"/>
Articles de journaux <input checked="" type="checkbox"/>
Bulletins de nouvelles <input checked="" type="checkbox"/>
Affiches publicitaires <input checked="" type="checkbox"/>
Réseaux sociaux <input checked="" type="checkbox"/>

PROPOSITION D'OUTIL:
<p><b>Application adaptée à un public informé</b></p> <ul style="list-style-type: none"> <li>L'application serait l'outil le plus approprié puisqu'elle aime utiliser son téléphone intelligent partout où elle va.</li> <li>L'application permet également d'offrir plusieurs couches d'information, ce qui lui permet d'approfondir ses connaissances comme elle le désire.</li> </ul>

Figure 1. Sample proto-persona sheet on the up-and-coming generation.

providing access to all Quebec biodiversity observations as well as geomatic layers (e.g., climate change scenarios); an indicator table giving an overview of the state of Quebec biodiversity; and a Discovery section that contextualizes all this material through short popularization articles, podcasts, and interactive capsules.

The work of Biodiversité Québec shares many similarities with business intelligence. This emerging science at the crossroads of management, economics, and computer science relies on and analyzes strategic analysis, information technology, statistics, and data repositories to provide information for strategic decision-making. The web portal is a typical example of this approach, which combines the development of databases (known as *back end*) and their representation by various interactive web tools (*front end*). Between these two layers is an analysis stage that processes information and delivers it to users in a specific format.

## Adapting Biodiversity Communications

**O**ne issue driving Biodiversité Québec is how to talk about biodiversity and how to get people talking about it. To find out, Biodiversité Québec wants to test different communications models in its Discovery section, especially to reach the younger generation, journalists, and policymakers.

In the field of biodiversity, it's difficult to find a symbol as effective and hard-hitting as the famous 1.5°C ratified in the 2015 Paris Agreement. This number, which was introduced into the public debate in 2019 by the report from the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (sometimes referred to as the "IPCC of biodiversity") means that one million animal and plant species are at risk of extinction in the coming decades, as we explained in a previous article for *Le Climatoscope* (Gravel, 2020).



But is a number really the best communications tool we have at our disposal? After all, biodiversity has sympathy capital that climate just can't match: are you more moved by the formula  $CH_4$  or by a baby raccoon (Figure 2)?

## DO WE ONLY PROTECT THOSE WE LIKE?

It gets harder when we talk about other species, some of which are endangered, that are less cute, like the useful southern longhorn moth (*Adela caeruleella*), which decomposes wood; the Eastern pearl mussel (*Margaritifera margaritifera*), which makes pretty pearls from grains of sand; or the *Cheumatopsyche*<sup>1</sup>, which is at the bottom of the food chain. It's easy to see that if we based our communications about biodiversity solely on the criterion of cuteness, we'd be doomed to talk excessively about polar bears (*Ursus maritimus*) and to shamelessly neglect the eastern dobsonfly (*Corydalus cornutus*).

Perhaps the Holy Grail of communicating about living things would be the ability to communicate the value of biodiversity itself, without aesthetic judgement and without preference among species. In this search, the focus is no longer on emblematic species, but on the diversity and complexity of the living world itself. For example, what ingenious natural technologies make the air breathable and the soil fertile? What an incredible masterpiece of nature is the decomposition of soil by microorganisms with innumerable names.

## BUT HOW CAN WE SAY IT?

Of course, communication is about the message, but also the medium. It's about conveying information in a form that is intelligible to the person receiving it. In other words, what tools and channels can be used to communicate effectively about biodiversity?

The public's attention is in high demand, notably by the worsening climate problem. Some authors have even coined the neologism *infobesity* to describe the information overload of the recent decades (Sauvaol-Rialland, 2014). How do we add the layer on biodiversity? One interesting avenue is to communicate the solutions offered by nature. Indeed, nature is a precious ally for our well-being, our health, and climate action! If climate issues are filling people's heads, then biodiversity might well quicken their pulse.

As explained above, traditional channels like the media seem to be underutilized when it comes to biodiversity issues. This is also true for Instagram stories and YouTube channels. These creators of stories and emotions may hold keys to unlocking an awareness of nature. Examples include Captain Jacques-Yves Cousteau's film *The Silent World*, which won the Palme d'Or at the 1956 Cannes Film Festival and the Oscar for Best Documentary, and, more recently, the documentary *My Octopus Teacher*, which also won an Oscar, in 2021.



**Figure 2.** Biodiversity issues can capitalize on an endearing brand image, like this baby raccoon. Photo credit: G. Bendig, Unsplash.

1. [https://biodiversite-quebec.ca/fr/decouverte/quesse\\_ca\\_cheumatopsyche](https://biodiversite-quebec.ca/fr/decouverte/quesse_ca_cheumatopsyche)

## BOX 1: QUEBEC'S BIODIVERSITY AT A GLANCE

*Do you know about biodiversity in your region? Perhaps you have seen a *Dryocopus pileatus*, better known as the pileated woodpecker, the species of the famous Woody Woodpecker? What type of tree did you see it on? A red pine (*Pinus resinosa*) or perhaps a red spruce (*Picea rubens*)?*

To date, the Atlas has inventoried more than 2,200 different species since 1950, most of which were observed by citizens, some using iNaturalist. In addition, the field inventories provide information for the Quebec Biodiversity Monitoring Network (<https://www.environnement.gouv.qc.ca/biodiversite/reseau-suivi-biodiversite.pdf>), which is designed to assess changes in ecosystems and document the effects of climate change on various species, such as butterflies and grasshoppers (Figure 3). Biodiversity indicators provide clear and important information on the state of biodiversity in Quebec. Finally, the Discovery tab introduces visitors to Quebec's biodiversity through popular content that informs, explains, surprises, and even fascinates!

## BOX 2: THE NEW GLOBAL BIODIVERSITY FRAMEWORK AND ITS FOLLOW-UP PROGRAM

*Negotiations at the 15<sup>th</sup> Conference of the Parties to the United Nations Convention on Biological Diversity concluded with the adoption of the Kunming-Montreal Global Biodiversity Framework. The Government of Québec "aligns itself with this agreement and commits to support it in accordance with its responsibilities, timetables and resources" [Translation] (Gouvernement du Québec, 2022).*

Adopted by 195 countries, the Global Biodiversity Framework is divided into four overarching goals for 2050. Goal A focuses on the protection of the various dimensions of biodiversity, and in particular on halting human-induced extinctions. Goal B focuses on the sustainable use and enhancement of nature's contributions to people. Goal C concerns the fair and equitable sharing of ecosystem services. Finally, Goal D focuses on the means to be put in place, including financial resources, to fully implement the Framework.

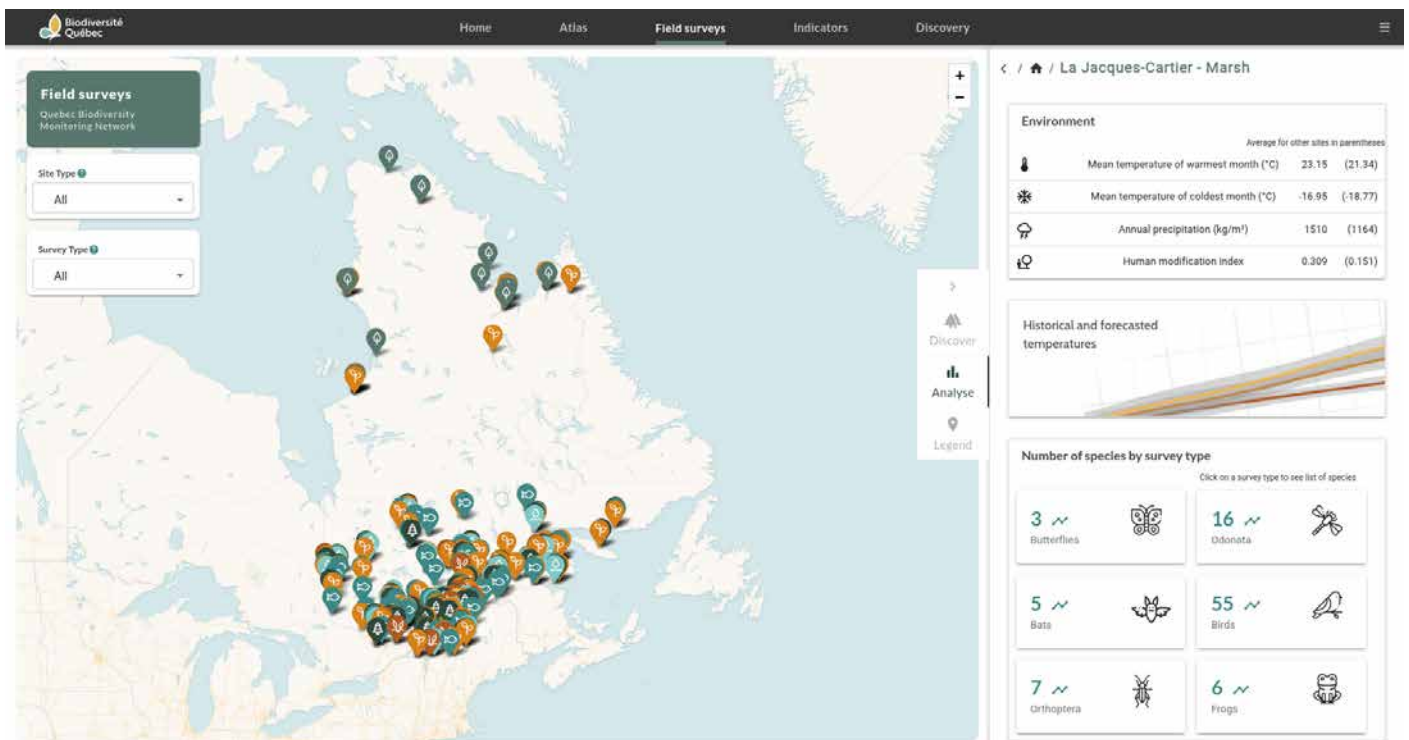


Figure 3. View of the inventory sites of the Quebec Biodiversity Monitoring Network.

The Global Biodiversity Framework also includes a comprehensive biodiversity monitoring framework, with numerous indicators that states will have to assess and report on. Each country will have to specify its monitoring plan at the next COP on biodiversity. Some indicators are precise and easy to calculate for Quebec (e.g. percentage of territory under a certain protection category). Others are more difficult to regionalize (e.g. the Red List Index on species' extinction risk) or are still under development (e.g. the extent of natural ecosystems).

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## Outlook

# JUST CLIMATE ADAPTATION AND LOSS AND DAMAGE ACTION IN AN EMERGENCY

Photo credit: Phil Roeder

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According to Intergovernmental Panel on Climate Change (IPCC) reports, the risks of negative impacts from climate change are very high (IPCC, 2022). Many world regions must already take action to cope with the adverse effects of climate change and minimize the risks of climate losses and damages, for example, loss of lives or cultural heritage, damage to housing or agriculture. Particularly in smallholder farming communities, these climate impacts threaten to undermine livelihoods and food security, likely leading to famine and other catastrophic consequences for survival and social stability. This article explores the ethical implications of different framings of both the need to adapt to changing climatic conditions and the actions that must be taken should unavoidable or unavoids climate losses and damages materialize (Roderick & Verheyen, 2008).

To explore the moral implications of climate adaptation and of loss and damage (L&D) action, consider a variation of Peter Singer's famous pond case (Singer, 1972). You walk by a deep pond and see a stranger's child drowning<sup>1</sup>. In such a case, it seems clear that you have a duty to help, at least if you do not have to risk anything of similar moral importance. If you cannot swim and would risk drowning yourself, it would be too much to expect you to jump into the pond and save the child. On the other hand, if you can swim well enough, it would be perfectly reasonable to expect you to jump into the pond and miss an important appointment. This is the "child in a pond" case. Intuitively, everyone would agree that it concerns an emergency.

1. My variation of the original example is rather small. Singer speaks of a shallow pond; I imagine the pond to be deep enough to make it necessary to swim to save the child.

Now consider what I call the “ball in a pond” case. A mean adult kicks a small child’s ball into a pond so far out that someone must jump in and swim to get it back. This is not an emergency. Immediate help is not necessary. It would be appropriate to argue for some time with the mean ball-kicker to have them jump into the pond to retrieve the ball, because they caused the unpleasant situation. In what follows, I show why framing the challenges of climate adaptation and climate L&D in a similar way to the “child in a pond” case changes the way responsibilities in climate policy should be assigned.

In my view, international climate negotiations tend to deal with challenges of managing the negative impacts of climate change as if they were “ball in a pond” cases. The pace of these negotiations deals with these challenges as though they were not emergencies requiring immediate action. The negotiations mainly focus on how much those who have contributed most to climate change should pay to support those who must adapt to changing climatic conditions (Vanhala & Hestbaek, 2016).

In this paper, I argue that this is not the best way to frame the challenges of climate adaptation and climate L&D. I show why these challenges are more like emergencies and should be framed similarly to the “child in a pond” case. Depending on whether a case of climate adaptation or L&D is framed as an emergency, the justification for the fair differentiation of responsibilities changes. I argue that in the case of an emergency, it is not of primary importance who contributes or contributed most to the problem at hand but who is best positioned to help most effectively and efficiently.

To justify this claim, I first explain why the framing changes the moral norms for assigning responsibility to act. I then show why climate adaptation and L&D should be framed as emergencies, providing reasons for focusing mainly on ability rather than contribution to climate change in assigning responsibilities. This leads to the conclusion that in situations of adaptation or L&D where help is needed, those with the most knowledge, resources, and financial capacity should help to the best of their ability, regardless of their contribution to climate change. However, I do not mean to suggest that the major contributors to climate change are off the hook. I am simply arguing that, currently, the priorities for assigning responsibility should be different.

## Context Sensitivity of Moral Norms

**T**o see why and how context defines the relevant norms for assigning responsibility, consider my two cases again. In the first case, the life of the drowning child is at stake. If no one helps, the child will die. In

the case of the ball in the pond, the child who owns the ball may be very sad because she has lost her ball. It is also sad for all her friends who played soccer with her. However, what is at stake does not have the same moral importance as in the case of the child in the pond. This also changes what can be expected of the swimmers involved. Much more can be expected in the child case than in the ball one. But in both cases, it would be asking too much of someone who cannot swim to jump into the pond and save either the child or the ball. The moral importance of the object of responsibility under consideration, the urgency to act, and the abilities of potential agents are relevant in determining how responsibilities should be assigned. I will discuss each in turn.

Assigning responsibility always involves assigning responsibility for something. The latter is usually called the object of responsibility (Wallimann-Helmer, 2019). In our two cases, it is either saving the child or saving the ball. The difference in the moral importance of these two objects of responsibility is related to the moral values under consideration. In the case of the ball, the values relevant to the situation are the ownership of the ball, the value of playing soccer with friends, and the character of the mean adult. In addition, we may be in an area of a park where ball games are prohibited. These are all important moral considerations, but in no case can they outweigh the moral importance of the value of a life. The right to life is one of the most fundamental moral values that must be protected and preserved at almost any cost. The moral importance of the value of life explains in part why, in the case of the child in the pond, it seems less important who is responsible for the child drowning. In the situation of the drowning child, the only thing that matters is that the child be saved. This is not the case with the ball.

According to Singer, we can expect anyone who has the power to prevent something morally bad from happening to do so if they do not have to sacrifice anything of “comparable moral importance” (Singer, 1972). Such a sacrifice may concern the nature of the action to be taken or its consequences for oneself or others. If someone must do something involving costs of comparable moral importance to a child’s life, they cannot be expected to help the child. Similarly, if helping the child has negative consequences for bystanders or non-human nature, which outweigh the child’s death, it would also be asking too much from potential agents. Finally, risking one’s life to save a drowning child may be heroic, but it is also asking too much. One’s own life is of comparable moral importance to the life of any other person. However, if a passerby does not have to risk their life, it is not asking too much to expect them to save the drowning child.

These considerations may lead to the view that if fundamental moral values are at stake, then those who are in the best position to act have a duty to do so, regardless of whether they have contributed to the negative consequences in question. This is especially important in emergencies, such as a child drowning in a pond (Rubenstein, 2007). An emergency is usually characterised as a situation in which immediate action is urgent. In the case of a drowning child, someone must act immediately, or it will die. In the case of the ball in the pond, we are not faced with an emergency in the same way.

With these considerations, I am not arguing that in an emergency it becomes irrelevant who caused the problem or why the challenge arose in the first place. I am arguing, however, that in an emergency, in a situation where fundamental moral values are at stake, it is of paramount importance to assign responsibility according to ability. The less weighty the moral values involved, and the less urgent the need to solve a challenge immediately, the more other moral considerations can and must play a role.

In the next section, we turn to climate adaptation and L&D action. It becomes crucial to understand whether they are better framed as “child in a pond” or “ball in a pond” cases. In what follows, I argue that it is the former, even though international climate politics tend to frame these issues as the latter.

## Priorities in Climate Adaptation and L&D Emergencies

To see whether the challenges of climate adaptation or climate L&D should be framed as more of a “child in a pond” or “ball in a pond” case, we need to be clear about the nature of the challenge facing the communities that need to act. We know from the IPCC reports that climatic conditions are already changing around the world (IPCC, 2022). They are leading to longer periods of drought, more frequent extreme weather events, sea level rise and flood risks, and many other negative impacts. Adaptation measures are needed to reduce the risk of losses and damages in exposed regions, and where these cannot or will not be avoided, L&D measures will be crucial (Mace & Verheyen, 2016).

Adaptation means taking measures to reduce the risk of droughts, protecting assets from extreme weather, or building levees to minimize the likelihood of flooding. L&D actions include measures to reduce the negative impacts of losses and damages, such as insurance schemes to compensate for damage that has occurred or early warning systems to reduce coming losses. In addition to financial and other non-economic resources,

know-how and functioning institutions are crucial for the successful implementation of all these types of measures. In most cases in which adaptation or L&D measures are required, fundamental moral values are at stake. This points towards a framing of adaptation and L&D action as “child in the pond” cases.

The case of the child in the pond represents an emergency where immediate help is needed to prevent loss of life, a fundamental moral value. But while the number of climate change-related emergencies is already increasing, many of them are most likely to occur only in the near or distant future (IPCC, 2022). This means that, for these cases, a “ball in a pond” framing still seems appropriate. In international climate negotiations, this is the most common framing. At these meetings, the focus is most often on negotiating the extent to which high emitters, especially historically high emitters, will have to contribute more to adaptation and L&D finance. Parties, especially developed countries, seem to negotiate the need for climate adaptation and L&D as if there were no fundamental moral values at stake, and as if there was still time, but no urgency, to argue about who should help communities in need adapt or prepare for losses and damages occurring.

It is clear, at least from the perspective of many developing countries, that the negative impacts they face involve fundamental moral values demanding urgent action. However, there are still many arguments in international negotiations about how much developed countries must contribute because of their current and historical emissions, as though there is still time to argue about this at length. I disagree with such a framing for one simple reason. Both adaptation and L&D measures need to be taken well in advance of the negative climate impacts that make them necessary. Not taking action now to adapt to climate change and to support such action would be like knowing about the risk of children falling into a pond and drowning, but doing nothing to prevent it. Not preparing to save the children from drowning would be like accepting that such a risk of loss (or damage) exists but doing nothing to mitigate its effects.

I argue that, in both cases, even though the emergency is not immediate, it is urgent to do everything possible to prevent it or to minimize the impact of such an emergency happening now. As a consequence of such a “child in a pond” framing, it seems more important that those who face the need to adapt and who need assistance in preparing for L&D be helped in the most efficient and effective way (Wallimann-Helmer, 2016; Wallimann-Helmer, Meyer, Mintz-Woo, Schinko and Serdeczny, 2019). This means that, for assigning adaptation and L&D responsibility, it is much more important to consider which parties can best help than to define who does and has contributed how much

to climate change. As a result, many countries, but especially developed countries, have an obligation to provide as much assistance as is necessary to ensure that all affected communities have adequate adaptation and L&D measures in place soon.

While this may imply placing the highest burden of responsibility on the same actors as if responsibilities were allocated according to the actors' contributions to climate change, the justification for such an allocation is fundamentally different. It is not because they contributed to the problem but because they have the capacity to help solve that problem. But again, the heaviest contributors to climate change are not off the hook. In times of emergency, we might not have time to argue about payments being proportional to individual contributions to climate change. But, as soon as the emergency is resolved, redistributing burdens according to contributions to climate change will become crucial<sup>2</sup>.

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Outlook

# WHAT IF WE CULTIVATED OUR (SELF-)EMPATHY IN ORDER TO ADAPT?

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Futur Simple et Unpointing

***“Yesterday I was clever,  
so I wanted to change the world.  
Today I am wise,  
so I am changing myself”***

– Rumi, 13<sup>th</sup> century poet

**S**olutions to climate change (CC) adaptation are usually infrastructural and based on engineering, economics, or nature. However, the human dimension of building resilience to the increasing threats caused by climate disruption is rarely mentioned.

Yet activating the human factor is essential to support adaptation to CC and requires an understanding of our internal and often unconscious mechanisms for changing our behaviour in the face of environmental challenges. One promising avenue for collective (re)action is to better understand the role of emotions, basic needs,

and empathy in climate communication. Empathy for others (empathy) and for oneself (self-empathy), even among the most vocal climate skeptics, is a necessary step for real change toward environmentally friendly behaviour.

This article aims to clarify the connections between emotions, needs, (self-)empathy, and resilience. It also seeks to explain how a better understanding of these interdependencies could be a favourable tipping point for our individual and collective climate action and our ability to cope with future climatic and geopolitical disruptions.

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# Understanding the Concept of Empathy

In academic circles, empathy gets people riled up. Definitions and views are varied and sometimes contradictory. Despite the confusion, most experts agree that empathy is a comprehensive concept with two main components: emotional empathy and cognitive empathy (Abramson et al., 2020).

Emotional empathy is the ability to feel a similar emotion as another person. However, it can lead to a form of personal suffering when we empathize for the other, like a child who begins to cry upon seeing a sad friend. Cognitive empathy, on the other hand, is the mental ability to put oneself in another's shoes, to intellectually understand their internal state. This means, for example, understanding that the situation is painful for the other person, but without feeling that pain oneself.

Both these forms are important to cultivate in our society, since observable empathic and benevolent behaviour would be a combination of the two (Abramson et al., 2020). Moreover, recent studies have shown that emotional and cognitive empathy are skills that are acquired through practice (Abramson et al., 2020; Weisz and Zaki, 2018; Zaki, 2017). These data are encouraging and reassuring for our humanity because there are ways to develop our empathy.

## Developing Our Empathy by Connecting with Our Needs

While the intellectual understanding of empathy is relatively simple, putting it into practice is something to work on during a whole lifetime. The collective enthusiasm for cultivating empathy has meant that the term is often overused. To clarify the concept, we present one of the views of empathy that is based on better responding to emotions and basic needs.

A basic need is an abstraction that we cannot make, take, or touch, but that is essential to our mental health (Rosenberg, 2015). Emotions are physical sensations that inform people of whether or not their basic needs are being met. Emotions are the body's way of communicating with our mind (Greenberg, 2015).

To understand the view of empathy based on basic needs, we need to delve deeply into the theories of a few 20<sup>th</sup> century humanistic psychologists. The pioneer was Carl Rogers, an American psychologist who overturned the

main therapeutic trends of the 1950s with his person-centered therapy. His theory is based on the principle that basic needs are neither good nor bad but are common to all people and form the basis of well-being. In the 1960s, Marshall Rosenberg, another American psychologist who followed in Rogers' footsteps, developed a— theoretically—simpler and more highly structured method, nonviolent communication (NVC). The term is often criticized, which is why it is often given another name in the professional world, such as conscious communication or authentic dialogue.

In NVC, empathy means helping others to recognize their feelings and needs, while self-empathy means understanding our own feelings and needs. The goal of NVC is to maintain an attitude that fosters connection with others. If we use the technique with the intention of manipulating the other or being right, we are not practising NVC.

The mechanics of NVC are essentially based on this path: Observations > Emotions > Needs > Strategy. An *observation* is based on objective information that we take in with our senses (sight, smell, hearing, touch, taste). This observation can trigger *emotions*: joy, sadness, fear, anger, disgust, or surprise. As a reminder, these emotions act as messengers that tell us whether or not our basic needs are being met (Greenberg, 2015). *Basic needs* can be divided into some categories, such as survival, integrity, autonomy, interdependence, self-expression, and celebration. A *strategy* is the means chosen to satisfy one or more needs, but is often confused with the need itself (Rosenberg, 2005). Any means based on a decision or action (buying things, a person you want to keep in your life, etc.) is in fact a strategy.

For example, buying clothes (strategy) meets physiological needs of the survival type (comfort, protection, care, etc.), but may also meet psychological needs for autonomy (self-assertion, self-esteem, etc.), interdependence (belonging, acceptance, attention, etc.), self-expression (creativity, novelty, recreation, etc.), and pleasure (beauty, enjoyment, etc.).

NVC is typically used in two-way communication (two people), but some of its principles can also be applied in introspective or even one-way communication (e.g., media to target audiences, awareness campaigns to the general public, etc.) (Williams et al., 2021). For example, an environmental awareness campaign focusing on transportation and mobility would gain effectiveness and popularity if it focused on understanding the underlying needs of users BEFORE suggesting alternatives. The risks involved in bypassing this important empathy stage and focusing exclusively on alternative solutions (substitution strategies) are discussed in the next section.

To date, there has been a small (but growing) number of studies showing the positive effects of NVC training on the development of empathy and emotion management in the health and social-work fields, but very few in the environmental and climate fields (Kansky and Maassarani, 2022). Furthermore, to the best of our knowledge, the scientific literature includes no studies linking NVC to the abovementioned forms of empathy. According to some NVC specialists, this approach could be a combination of emotional and cognitive empathy, but this remains to be proven.

However, there is another much-studied theory in psychology, self-determination theory (SDT), which ties in with several ideas promoted by Roger and Rosenberg (DeRobertis and Bland, 2018). For example, SDT also incorporates the concept of psychological needs and shows how responding appropriately to those needs can motivate us to take action. Unlike NVC, SDT has the advantage of having extensive empirical data. It also shows that people who are able to meet their psychological needs are healthier and experience greater wellness than the average (Ryan and Deci, 2015). However, the connections between SDT, needs, and adaptation to CC are a separate area of study in itself that we cannot discuss in detail here.

In short, Roger and Rosenberg's approaches show us how the environmental community might explore two new ways to (re)initiate individual and collective engagement in environmental and climate action: 1) recognizing our needs and nurturing them appropriately, and 2) separating what is a need from a strategy as a new path. The latter is explained in the next section.

## Separating Needs from the Strategies to Meet Them

**T**o achieve a society that is more resilient to CC and that cares for itself, for others, and for nature, it is important to understand what choices or actions truly meet our needs.

However, needs and strategies are often confused. For example, saying that I need a car or that I need people to understand the urgency of CC illustrates this confusion. The result? We cling to the strategy without being clear about what need(s) it does, or does not, satisfy.

Let us take a simplified example: buying clothes. For many people, it is an unconscious need for novelty that drives them to constantly buy new clothes. If these people do not take the time to recognize this need, they will not be able to replace this strategy (buying clothes) with a sustainable strategy that better meets both their need for novelty and their environmental values. As a result, people risk sporadically decluttering their closet, only

to have it overflow again a few months later. In this particular example, there are several clothing strategies that meet the need for novelty and the need for a healthy environment: trading, using a rental service, buying second-hand, or satisfying the need for novelty in ways other than buying clothes.

By taking the time to listen to people's needs and then incorporating the difference between needs and strategies into its initiatives, the environmental community can help society see purchases and possessions as strategies rather than needs. To do this, one must first empathize with the target audience by helping them connect to their needs. For example, what needs are Quebec residents trying to satisfy with their car or their overflowing closet? Depending on the context, we can then suggest a short list of greener alternative strategies that align with those needs. Presenting a short list is important because giving only one alternative strategy may exclude a segment of the public that feels that the proposed alternative strategy does not meet their needs.

Some might even believe we are asking them to give up a basic need. It is difficult for people to continuously give up their needs without compromising their well-being. Perhaps this explains why some people react so strongly to ecological discourse, which often proposes strategies, bypassing the step of connecting to needs.

On the other hand, it is possible to let go of a strategy that is inappropriate for oneself, for others, or for the ecosystem, and replace it with one that is more consistent with one's ecological values.

## Overcoming Inappropriate Strategies to Adapt

**T**he concept of grief does not only refer to the death of a human being. The Larousse dictionary defines it as "a psychological process set in motion by the subject at the loss of an external object of love" [*Translation*].

Be it foregoing buying new clothes frequently or giving up driving a car to work, this produces more or less intense grief in the person who is used to this strategy. So it takes a conscious and a not-inconsiderable effort to grieve our maladapted strategies and replace them with more altruistic or environmentally friendly ones, without compromising our own needs. However, we can hope that, through this process, over time, we are intentionally increasing our psychological resilience, that is, our ability to bounce back and keep our sanity despite disruption and adversity (Moser, 2019).

For the environmental community, cultivating our empathy for others has tremendous potential to depolarize the population and pacify the social climate to mobilize the

critical mass needed for climate action to become the norm. As for cultivating our self-empathy, it could help us better understand ourselves so that we can make conscious, coherent choices that meet our fundamental psychological needs as well as our physiological need to live in a healthy environment. These habit changes require that we learn to move more consciously through the inevitable processes of grief, which, we hope, would ultimately develop our psychological resilience—an indispensable skill for adapting and coping with the profound climatic and geopolitical upheavals we face (Moser, 2019).

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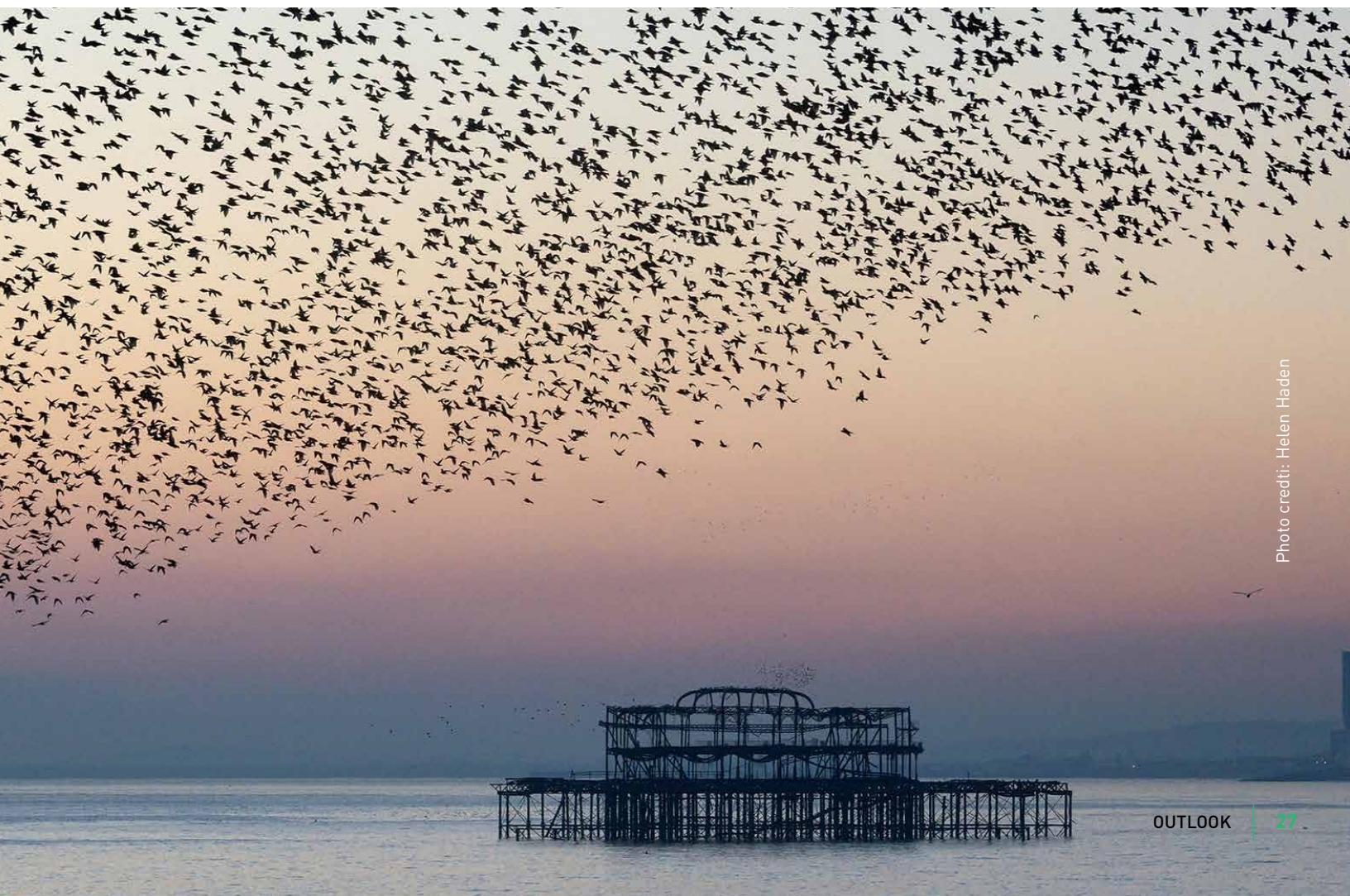


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## Outlook

# WEAVING KNOWLEDGE: ROLES INVOLVED IN COORDINATING THE SCIENCE OF CLIMATE CHANGE ADAPTATION

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**T**he sixth report of the Intergovernmental Panel on Climate Change (IPCC) (2022) states that the political commitments made at the Glasgow United Nations Convention on Biological Diversity (COP) in November 2021 are insufficient to contain global warming to the level of the Paris Agreement (below 1.5 °C). Beyond this threshold, our societies' will be progressively less able to cope with the impacts of a destabilized climate. Yet the international scientific consensus points to a range of adaptation and mitigation options whose feasibility and relevance have been demonstrated. How can we explain this discrepancy between ever more precise knowledge of present and future perils, and the actions actually taken to transform our societies? This pitfall, well identified in sociology, is being explored on several fronts, leading to the deconstruction of the representation of linearity between science and action.

One of these is the study of science–society interfaces, and more specifically, of the knowledge issues and relationships that arise and unravel at these interfaces. This article takes this perspective by showing, firstly, how “knowledge is not action” and why it's important to let go of a view that separates knowledge rather than weaving it together to respond to multidimensional problems. Secondly, based on the experience of a team<sup>1</sup> responsible for coordinating climate change adaptation science, we will highlight how the function and work of coordination helps weave knowledge that is conducive to action. In particular, we will discuss *coherence* and *mediation* roles that this implies. We will then look at this coordination as a process of *translation*, i.e., a shared cross-fertilization of the protagonists' interests in light of a common problem, which can lead to agreement if successful. Finally, this article argues in favour of professionalizing the coordination role and recognizing the expertise of its members.

1. This text has been proofread by the entire Ouranos adaptation science coordination team, whom I would like to thank.

# Overcoming the Illusion of Linearity Between Science and Action

## KNOWLEDGE IS NOT ACTION

Several scientific communities are increasingly producing precise and detailed knowledge of the causes and impacts of climate change. Climatologists, who are among the most active, have demonstrated the accumulation of greenhouse gases (GHGs) and their impacts on atmospheric temperature. This led to the establishment of the IPCC in 1988 and to the United Nations Framework Convention on Climate Change (UNFCCC) in 1992. Since then, warnings have been issued one after the other, and the economic, social, and environmental impacts have been quantified. It would be wrong to say that nothing has been done or that no action has been taken. For example, at this early stage of the climate problem, governments have agreed on a system of financial compensation from countries that have historically emitted GHGs to those at the front line of the impacts. However, the level of action undertaken since then has neither sufficiently reduced the causes of the problem (mitigation) nor protected human and non-human societies by anticipating the consequences of climate disruption (adaptation). Knowing does not imply acting accordingly, so this is a problem that calls into question the linearity between science and action.

Before the climatologists, another community was confronted with this stumbling block: alter-globalists, ecologists, and environmental scientists have long denounced the expansion of a development model based on natural- and energy-resource consumption and worker exploitation. Their experience, particularly in the field of environmental education, confirms that changing the practices or behaviours of a sector, profession, territory, or nation cannot be achieved by a one-off information transfer, even to a decision-maker (Ardoin et al, 2020). The main reason for this discrepancy between scientific knowledge and the effectiveness of action taken lies in the implications of environmental action as climate action. This is not just a matter of science but also of political choices, and it raises democratic issues, such as deciding who will bear the brunt of the effort and how constraints will be applied. Does this mean scientific knowledge is useless in the arena of implementation?

## WEAVING KNOWLEDGE TOGETHER RATHER THAN SEPARATING IT

It is acknowledged that with a multidimensional problem such as climate or the environment, the challenge lies in weaving together the different types of knowledge



that will enable us to understand needs, seek operational responses, gain partners' support, and ensure that the end goal—the environmental or climatic ambition—is not lost from sight (Salles, 2006).

Among the obstacles to such knowledge weaving that have been identified are the deeply rooted cleavages, particularly in Western societies, for instance between theory and experience or science and action, which lead to the exclusion of scientific knowledge from the arena of implementation debates (by confining it to a diagnostic stage, for example). It also leads to a refusal to take into account actors' knowledge, thereby closing the door to scientific reflection. This separation of knowledge is often accompanied by influential presuppositions, such as that of conferring neutrality on certain types of knowledge (notably knowledge that is quantitative or derived from the physical and natural sciences), while a form of suspicion prevails about "non-academic" knowledge, such as that of Indigenous peoples, users, or professionals, which is relegated to the opinion level. One possible way of building links between forms of knowledge is to focus on developing "how to do—



Team work - Photo credit: J0

what to know” relationships (Schmitt and Avenier, 2007), which places the coordination function at the heart of the process.

## Building Knowledge at the Borders of Communities

**O**uranos<sup>2</sup>, the Quebec consortium on regional climatology and adaptation to climate change, has chosen to dedicate a particular team to this coordination function. This team is responsible for maintaining the coherence of the organization, whose activities take place over different timeframes, and for providing interdisciplinary mediation to give substance to the science of adaptation. We will explain these two roles, of *coherence* and *mediation*, and then propose

2. This article is based on a research residency carried out in the ASC team at Ouranos, between September and November 2023.

a complementary reading of this coordination work around a *translation* role. These three approaches show how knowledge is woven and constructed at the borders of communities of practice and research.

## THE COORDINATION FUNCTION AT OURANOS: STRIVING FOR COHERENCE

The primary role of the Ouranos Adaptation Science Coordination (ASC) team is to maintain the organization's coherence. Indeed, the field of adaptation to climate change involves working on a wide range of subjects and in multiple configurations. Ouranos stands at the crossroads of different communities, and its mission is to bring these communities together on several occasions: as part of its structural scientific programming, during short-term projects, and sometimes in the wake of crises.

Moreover, Ouranos was founded following two major consecutive crises that made an impression on people as the 2000s approached: 1) the Saguenay deluge, a major moisture-laden low-pressure system that dumped more than 250 mm of rain in 48 hours on the regions surrounding the Saguenay River, and 2) the ice storm, a weather disturbance that lasted five consecutive days and dumped more than 100 mm of freezing rain in places, causing accidents and power outages. These events resulted in loss of life, physical, and psychological injuries, and considerable material losses. Confronted with this powerful reminder of the vulnerability of Quebec society, the Quebec government, Hydro-Québec, and Environment Canada created Ouranos. Their aim was to understand the role played by climate change in such events and to take advantage of the anticipatory capabilities of climate research tools to help prepare and protect Quebec society. Today, two types of funding guarantee its operation: core funding, which supports the consortium's orientations and personnel, and project-specific funding, which develops around research program's areas of focus<sup>3</sup>. This economic model enables the organization to absorb the time differences between its various activities, for example between the ongoing work of fundamental research in climatology and the support or consultancy projects commissioned by ministries or cities. As the organization grows, the ASC team's role in ensuring coherence becomes increasingly important.

## COORDINATION : ACTING AS MEDIATOR

The ASC team (6 to 10 people) was formalized when the Ouranos scientific program was renewed in summer 2020, but their professional identity was built up over the years within the Vulnerability, Impacts and Adaptation Department that had coordinated the previous program.

3. [2020–2025 Adaptation Priorities | Ouranos](#)

One of the key skills developed by its members is associated to a scientific mediation role, with climate science and political and socioeconomic partners, which are the two facets of interdisciplinarity that are essential to provide a science–society interface.

When it comes to adapting to climate change, building a continuum between climate science and public and private strategic decision- or choice-making seems obvious. However, it is still rare for political investment and planning to be based on different warming or impact scenarios. In France, it is only with the forthcoming energy-climate programming law that there are plans to integrate at least two IPCC scenarios<sup>4</sup>.

As seen earlier, Ouranos' original purpose was to produce knowledge and tools from the climate sciences to address the concerns of communities of practice. To make sure we don't miss this target, the ASC team positions itself as the common interlocutor for these two hubs and facilitates discussion in a number of ways. One way is to link the climate science strategy to the adaptation programming developed with partners. Another takes place in "adaptation priority" consultation committees, which are made up of stakeholders outside academic research and include a climate scientist, paired with the person in charge of that priority from the ASC team. In this way, the science–society interface captures the stakeholders' initial concerns in their initial formulation. Then, the coordination team mediates to reformulate them into research needs or it serves as a space to learn theoretical elements from academic work.

## THINKING ABOUT COORDINATION: A TRANSLATION ROLE

The two previous roles show how the function and work of coordination is exercised. We now focus on the expertise developed by coordinators, to emphasize that "experts are not simply users of knowledge, but transform the knowledge they mobilize, or even help to construct new forms of knowledge more suited to action" [*Translation*] (Crespin and Henry, 2015). To grasp how knowledge is transformed, particularly during the implementation of adaptation to climate change, the conceptual approach of translation in sociology (Callon, 1986) can provide elements. In summary, translation in this framework is defined as a process linking a problem to its resolution through a set of moves that the parties involved can agree to. These moves are the actors' re-readings of their own interests as discussions progress. In France, for example, such moves were documented in the case of the Rhône River's ecological restoration (Guerrin and Barone,

2020). This highlighted how protagonists with divergent interests, representing hydroelectricity, tourism, the environment, navigation, local authorities, and state agencies, came to agree on the idea of ecological restoration. The idea was proposed by one of the driving forces (the French Water Agency), without however setting a framework or strict rules, leaving space for *translation*. Taking on a translator's role means speaking several disciplinary languages and the language of communities of practice, to help decipher the problems to be solved. This entails a degree of diplomacy and trust, which the protagonists must be willing to allocate to the interpreter of their points of view, before they themselves, in the event of agreement, adopt the proposed interpretation and act as spokespersons for their peers. Acknowledging this aspect of the job could help improve the transition to action on climate change adaptation (and mitigation), as it involves bringing out formulations of the problem at the heart of social, economic, and natural realities. What's more, keeping a record of the paths taken by heterogeneous stakeholders toward a meaningful agreement could track the links between the initial interpretations of adaptation to climate change and the action actually taken, with a view to evaluating and analyzing the conditions for success or failure.

## Conclusion

**F**ighting climate change means imposing a drastic and lasting constraint on the socioeconomic activities around which industrial societies have organized since the 19th century. This constraint will have to be negotiated, guided, and constructed with the help of knowledge weaving to ensure its relevance and deployment. One challenge in this process is coordination, as a means of making or breaking links between multiple, entangled interests. This resonates with analyses of *boundary planners* (in English in the text) (Goodrich et al, 2020), which point out that this coordination function is often performed as a task implicit in a core activity, without specific, meaningful, and collegial support (the Ouranos experience is original in this respect). Recognizing this role, particularly through professionalization, could be an important lever for effective collaboration between communities of practice and knowledge networks. Similarly, developing and recognizing the expertise and roles of these professionals, which goes beyond simply supporting the activity, will enhance their legitimacy and the chances of success of the processes they support.

4. [L'adaptation entre dans une nouvelle ère - I4CE](#)



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Photo credit : Joan

# LONG-TERM IMPACT OF FLOODING ON MENTAL HEALTH

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## Flooding in Quebec

**A**ccording to climate projections, the several types of extreme weather events that have already hit Quebec, including floods, forest fires, tornadoes, and ice storms, are expected to become more frequent and more intense.

These events share various characteristics that can impact communities: often sudden onset, evacuation and relocation (sometimes long-lasting), human and material losses, stress and uncertainty, disruptions to infrastructure and services, complex and slow government response (Institut national de santé publique du Québec, n.d.).

In spring 2019, the province experienced major flooding for the second time in three years. Heavy precipitation in late April, combined with a late, rapid snowmelt, caused damages estimated at 127 million Canadian dollars (Ministère de l'Environnement et de la Lutte contre les changements climatiques, 2022). In addition to damaging infrastructure, disrupting public services, and causing economic losses, this type of disaster can also have health and social impacts, affecting health at the physical (e.g. injuries, respiratory problems), psychological (e.g. post-traumatic stress, depression), and social (e.g. isolation, violence) levels. In order to effectively prevent, prepare for, respond to, and recover from these events, it is necessary to have a proper understanding and recognition of flood impacts as well as of vulnerability factors. While flood-related mortality is low in Canada, flooding can also create a significant burden on the health and well-being of people affected (Sanhi et al., 2016). These health problems can occur during or immediately after flooding, and can also lead to long-term sequelae.



Photo credit: Teresa Alexander-Arab

# Population Survey

**A** study was set up to document health status and vulnerabilities following the 2019 spring floods in Quebec. The aim of this research is ultimately to propose solutions to the players involved (health and social services network, civil security, municipalities, etc.) in order to mitigate the impact of future events. The project is being carried out by an interdisciplinary, interuniversity team, funded under the Quebec government's *2013–2020 Climate Change Action Plan*.

The research consists of a series of two surveys, conducted by telephone or online questionnaire, of a sample of people living in flooded areas in the six health regions most affected by the 2019 spring floods in Quebec (Laurentides, Laval, Mauricie-Centre-du-Québec, Montérégie, Montréal, Outaouais). Various health impacts were examined in the survey, including those on mental health, which will be presented in greater detail in this article.

## IMPACT ON MENTAL HEALTH

In the first survey, several mental health problems were assessed:

- Perception of fair to poor mental health
- Level of psychological distress (moderate or severe)
- Level of post-traumatic stress (moderate or severe)
- Anxiety and mood disorders diagnosed by a physician
- Presence of a probable mental health disorder

Two measurement scales were used: K6 (Kessler et al., 2002) to assess the presence of psychological distress, and IES (Horowitz, Wilner, and Alvarez, 1979) for the level of post-traumatic stress. Perceived mental health status, anxiety, and mood disorders were self-reported by study participants. Finally, likely mental health disorder is defined as the presence of at least one of the following three problems: post-traumatic stress, anxiety disorder, or mood disorder.

Although they all lived in flooded areas, the citizens recruited for the study did not all experience the same intensity of flooding. They were therefore classified into one of three exposure categories: flooded, disturbed, and unaffected (presented in the box below). To document the impact of flooding on mental health, statistical tests (Z-tests) were carried out to compare the frequency of different mental health problems according to level of exposure to flooding. All the results presented below are statistically significant at an alpha level of 0.05, i.e., there is a statistical difference between the three levels of exposure.

## Three levels of exposure examined in people living in flooded areas<sup>1</sup>:

- 1- **Flooded:** Having reported at least one flooded habitable room
- 2- **Disturbed:** Did not report flooded living quarters but reported at least one of the following flood-related disruptions: evacuation; interruption of home services; difficulty accessing community services; flooded non-habitable areas (e.g. grounds, garage)
- 3- **Unaffected:** reporting no impact from flooding

The first survey was carried out **eight to ten months after the spring flood**, with a final sample of 3,437 households responding to the questionnaire. The results of this survey highlight the fact that, almost a year after the event, people who had been flooded and those who had been disturbed by the floods were significantly more likely to have perceived mental health problems, as presented in Table 1. After performing statistical analyses, it is possible to observe a dose-response gradient of mental health impacts according to exposure. In other words, the greater the exposure to flooding, the greater the impact on mental health. More detailed results from this initial data collection are available elsewhere (Généreux et al., 2020).

A follow-up survey was carried out **one year after the first collection** with a portion of the sample (680 of the 3,437 respondents). The non-participants either did not agree to take part in another survey or were not reachable the second time. One of the aims of this collection was to assess the evolution of mental health problems (i.e., perceived mental health and psychological distress) from the first to the second post-event year. These data were again examined according to level of exposure to flooding.

Over time, mental health perceived as fair or poor decreased from 37% to 24% among the flooded, as shown in Table 2. There was also a slight improvement among those who had been disturbed by flooding, but it was not significant. A significant decrease in psychological distress was also noted, but only among the flooded, as presented in Table 3. Prevalence fell from 41% to 22% from the first to the second year.

1. For the purposes of this study, flooded areas correspond to neighborhoods with at least one claimant from the 2019 floods, as reported by the Ministère de la Sécurité publique du Québec.

	Flooded	Disturbed	Unaffected
Fair or poor mental health	32.5%	11.8%	5.2%
Psychological distress	38.4%	15.0%	7.3%
Post-traumatic stress	44.1%	14.6%	3.0%
Anxiety disorder	20.3%	11.3%	7.2%
Mood disorders	19.5%	8.2%	5.4%
Probable mental health disorder	52.2%	24.8%	12.2%

**Table 1.** Mental health status by level of exposure to flooding, nearly one year after flooding.

Exposure level	Mental health perceived as fair or poor		
	Prevalence at T1	Prevalence at T2	p-value
Flooded	37.0%	24.3%	0.004
Disturbed	16.0%	13.5%	0.28
Unaffected	5.6%	6.0%	1.00

**Table 2.** Changes in perceived mental health as a function of exposure to flooding.

The McNemar test was used to examine changes in mental health status between the first survey and the follow-up survey.

Exposure level	Psychological distress		
	Prevalence at T1	Prevalence at T2	p-value
Flooded	41.1%	22.4%	p<0.001
Disturbed	13.5%	13.8%	1.00
Unaffected	7.0%	6.3%	0.839

**Table 3.** Evolution of psychological distress as a function of flood exposure level.

The McNemar test was used to examine changes in psychological distress between the first survey and the follow-up survey.

As a result, the flooded group showed almost half as much moderate to severe psychological distress, and less frequently perceived their mental health as fair or poor at the follow-up survey, compared to the first survey. Despite this, it should be noted that the flooded participants remained statistically significantly more affected than those disturbed by or unaffected by flooding, two years after the event. The persistence of a difference between the three exposure groups over time suggests the presence of long-term psychological sequelae in a good number of people who have been exposed to major floods, such as those experienced in Quebec in 2019.

In order to confirm that persistent symptoms are more often observed among the flooded, the evolution of symptoms was observed according to four trajectories (presented in the box below). We found that levels of psychological distress improved at the follow-up survey for a large proportion of flood victims (25%), echoing our previous findings. However, within this same group, 16% showed persistent distress over time. Similar observations were made for perceived mental health status.

## Trajectories of perceived mental health:

1. Perception of mental health remained good
2. Improved perception of mental health
3. Persistent perception of fair or poor mental health
4. Perception of deteriorating mental health

## Trajectories of psychological distress<sup>2</sup>:

1. Distress levels remained low
2. Improved distress level
3. Persistent moderate or severe distress level
4. Deteriorated distress level

## Primary and Secondary Stressors

To better understand the factors impacting mental health during floods, two families of stressors were studied: primary and secondary stressors. Different types of stressors may explain why some people are more vulnerable to flooding than others. A primary stressor arises during or immediately after the event, while a secondary stressor is present during the post-event recovery period. The primary stressors studied in this survey are exposure, water level in homes, extent of material losses, and flood recurrence. Secondary stressors include the negative perception of tangible or moral help received, the lack of financial help received to cope with costs, the lack of insurance covering floods, the use of bank loans to meet expenses, and the inability to reuse all parts.

## Influence of Stressors

To better understand the factors associated with a persistent mental health problem, two trajectories were combined: “persistent perception of fair or poor mental health” and “persistent moderate or severe distress

2. According to the scale used, there are three levels of psychological distress: low, moderate, and severe. The trajectory is therefore evaluated according to whether or not the level of distress has changed from the first to the second data collection. For example, note an improvement if the person has gone from a high to a moderate (or moderate to low) level of distress.

level”. Their prevalence was examined according to the presence of primary and secondary stressors. It was noted that participants expressing greater primary stressors (presence of a water level of 30 cm or more on the first floor and material losses of \$50,000 or more) were more likely to report persistent mental health impacts. Disaster victims (flooded or disturbed) who experienced secondary stressors were also more likely to report a persistent mental health problem.

These investigations conducted one and two years after the 2019 spring floods in Quebec highlight the adverse and persistent effects of flooding on the mental health of those affected, but also among those who were indirectly exposed. In addition, the present study allows us to consider the effects of several stressors, both primary and secondary, on measures of mental health.

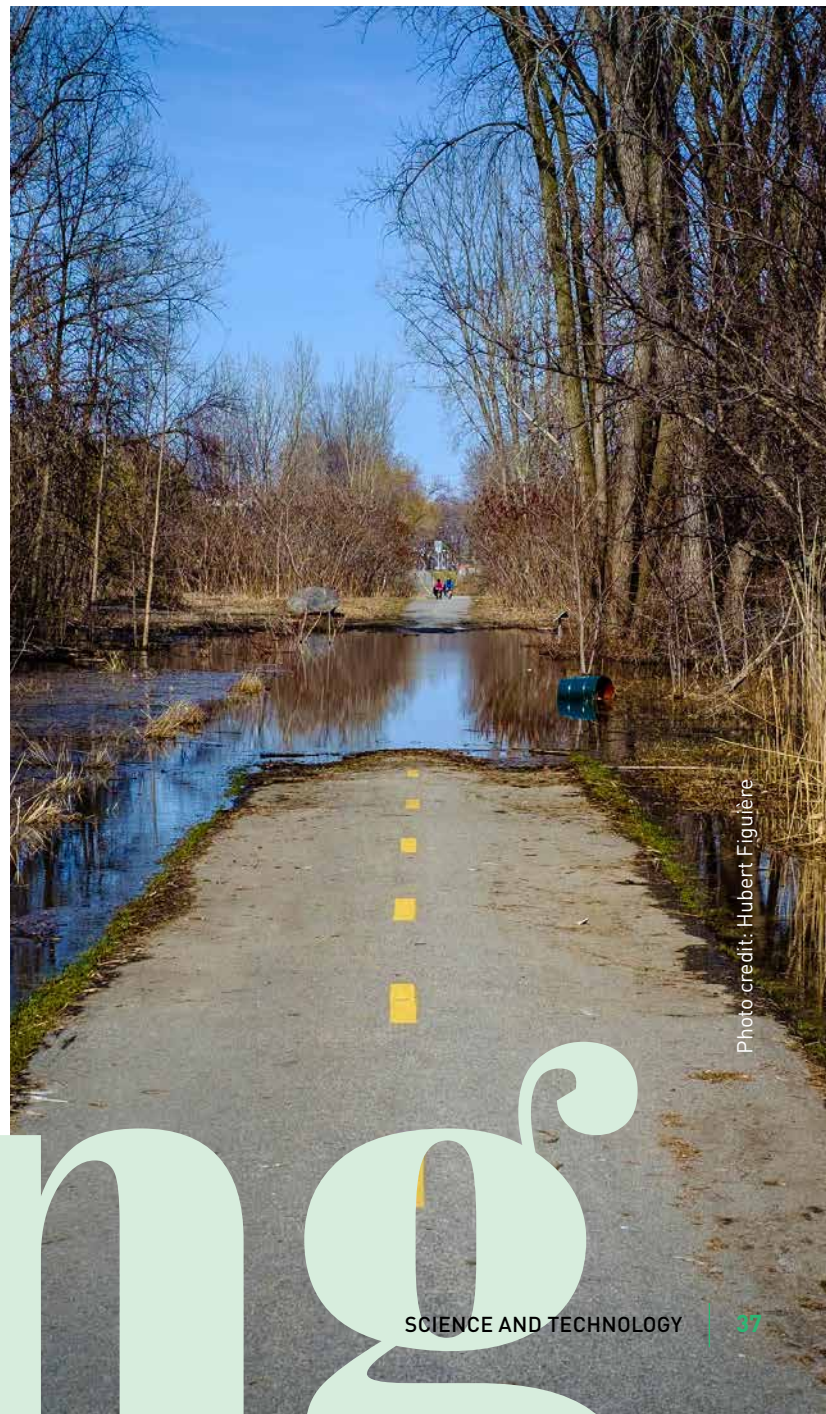


Photo credit: Hubert Figuière

	Persistent mental health problems
<b>Primary stressors</b>	
Water level	
No water	6,4%
Less than 30 cm	19,4%
30 cm or more	24,7%
Residence or land flooded before 2019	
Never flooded	4,8%
Only flooded in 2019	23,7%
Flooded in 2019 and before	13,0%
Extent of material losses	
No losses	5,5%
Less than \$5,000	12,7%
Between \$5,000 and \$49,999	15,4%
\$50,000 or more	32,7%

	Persistent mental health problems
<b>Secondary stressors (among flood victims)</b>	
Tangible or moral help received	
Less than expected	28,6%
As much or more than expected	14,4%
Bank loan to cover costs	
Yes	21,6%
No	13,1%
Amount received to cover expenses	
All expenses	11,8%
Half or less of the costs	30,4%
Flood insurance	
Yes	16,2%
No	25,9%

**Table 4.** Association between stressors and the presence of a mental health problem (fair to poor mental health or psychological distress) persisting at the follow-up survey.

Although they only concern a portion (around one fifth) of the initial sample, the results of the follow-up survey remain interesting. They suggest that the psychological impacts of flooding may still be present almost two years after the 2019 floods. Indeed, flooded participants report mental health problems more frequently in the follow-up survey than do the other participants who were less exposed to flooding. Both exposure to primary and secondary stressors appear to influence the long-term mental health of flood victims. Similar observations were also found in a study by Jermacane et al. (2018). The prevalence of mental health impacts among flood victims two years after the floods remained high despite a decrease compared to the previous year (Jermacane et al., 2018). The study also highlighted the importance of secondary stressors, as the prevalence of psychological morbidity among flood victims who had reported persistent damage was higher (Jermacane et al., 2018).

One might assume that disaster victims are more socio-economically disadvantaged from the outset. However, our data do not seem to point in this direction. In fact, of the 1,576 disaster victims (flooded or disturbed) surveyed at the first collection, 90% lived in detached single-family homes (over 90% of them were homeowners), 69% were part of a couple, and 26% had an annual household income of \$100,000 or more. This suggests that, despite a certain degree of affluence, flood victims may be under such stress that their mental health is affected in the medium to longer terms.

## How Can We Reduce the Impact?

**T**his study highlights some of the psychological impacts of flooding and underscores the need to act on both primary and secondary stressors to reduce their magnitude. As floods, like many other extreme weather events, are predicted to increase due to climate change, it is even more important to consider ways of better supporting those affected by such events.

Various social and economic measures could be put in place in the wake of flooding to support the health and well-being of affected individuals and communities. The findings of the survey suggest that such measures, whether in the form of concrete, moral, or financial support, could be an avenue worth exploring in order to reduce the psychological impact on citizens who become unwilling victims of such disasters, and to support individual and community resilience. In concrete terms, these measures could take the form of community mobilization, psychological assistance from professionals and community members (e.g. psychological first aid), improved financial programs, and support by social workers in the reconstruction or relocation process. At this critical time of climate change, compounded by a pandemic, it is more important than ever for Quebec society to develop recovery plans to reduce the social and health impact of disasters, both in the short and longer terms.

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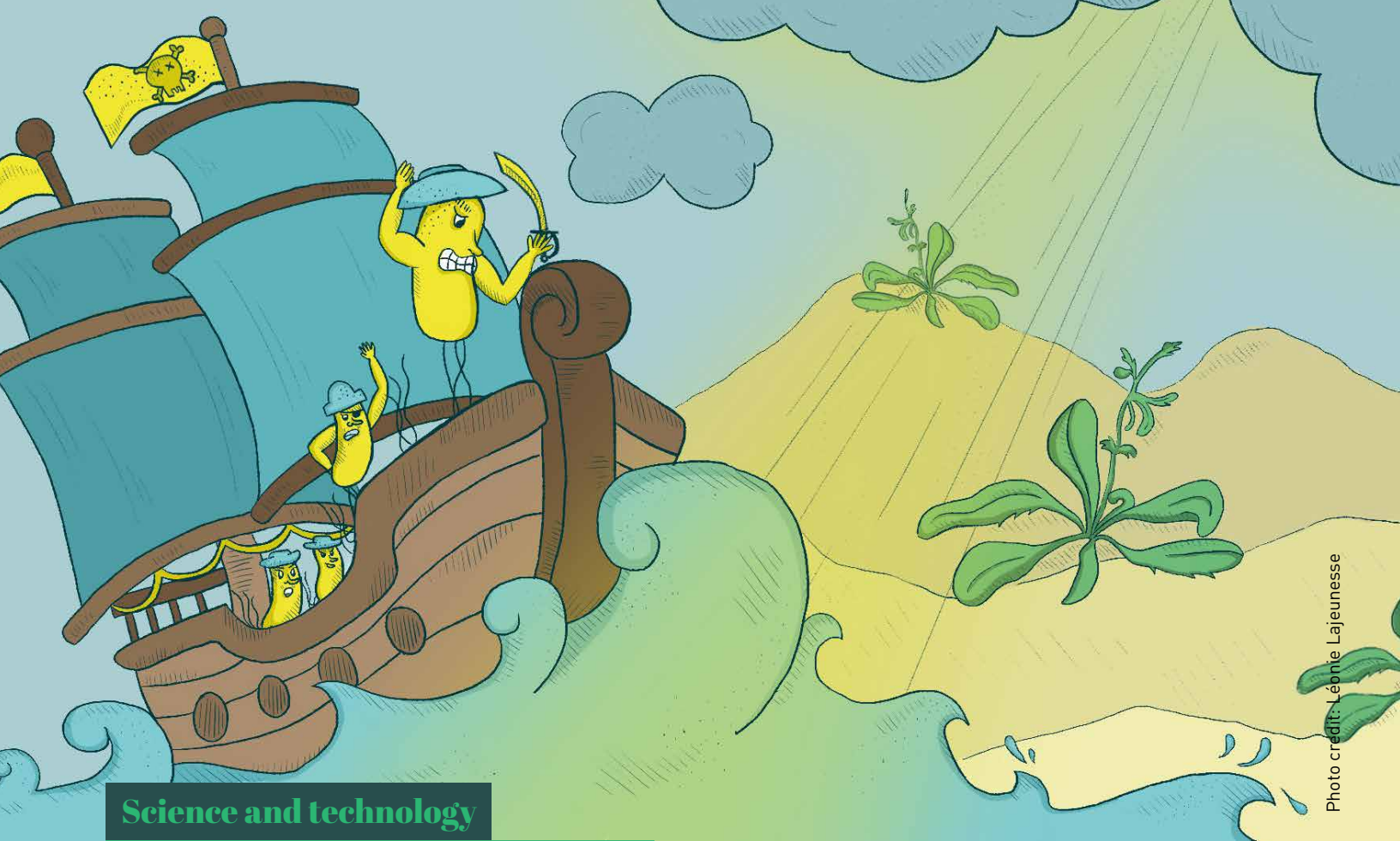


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## Science and technology

# CLIMATE CHANGE: THE OPTIMAL ENVIRONMENT TO DEVASTATE OUR CROPS

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**T**he world's population has tripled since 1950, having reached 8 billion at the end of 2022 and having the potential to exceed 10 billion by 2060 (IPCC, 2021). This demographic explosion is accompanied by enormous pressure on food production, which essentially depends on the productivity of the agricultural sector. Although many complex factors influence the distribution of food resources, more sustainable agriculture is required to meet the long-term needs of the human population. This agricultural transition should also make it possible to free ourselves, as far as possible, from certain chemical tools currently in use (e.g. antibiotics, pesticides), which have harmful impacts on the environment and on human populations (Dodds and Rathjen, 2010; Boyd et al., 2013). A revolution is underway as agricultural production turns to integrated pest management. Moreover, phytopathogens (i.e., microorganisms that cause plant disease) have a major impact on agricultural production, as they can lead to reduced plantation yields, downgrading of products due to changes in their organoleptic properties, or even total crop loss (Boyd et al., 2013). Plant pathogens are all the more devastating under monoculture conditions (Stukenbrock and McDonald, 2008), a technique that continues to be the standard in modern agriculture due to its profitability.



# Greenhouse Production in Quebec

In Quebec, tomato production has undergone a revolution in the last 20 years through the acceleration of greenhouse production, which now exceeds ~19,000 tonnes per year on ~69 hectares, of which ~20 are farmed with organic management (MAPAQ, 2018). In addition, in 2020, the Quebec government implemented a strategy to increase greenhouse production in order to promote provincial food self-sufficiency. The strategy's main objective is to double the area of greenhouse crops by 2025 (Gouvernement du Québec, 2023). In a context of climate change, an increase in summer temperatures accompanied by a rise in ambient humidity could create favourable conditions for exacerbating the impact of plant pathogens, particularly in agriculture. Managing plant pathogens is therefore a priority if we are to achieve our growth objectives while remaining part of the global movement toward sustainable agriculture.

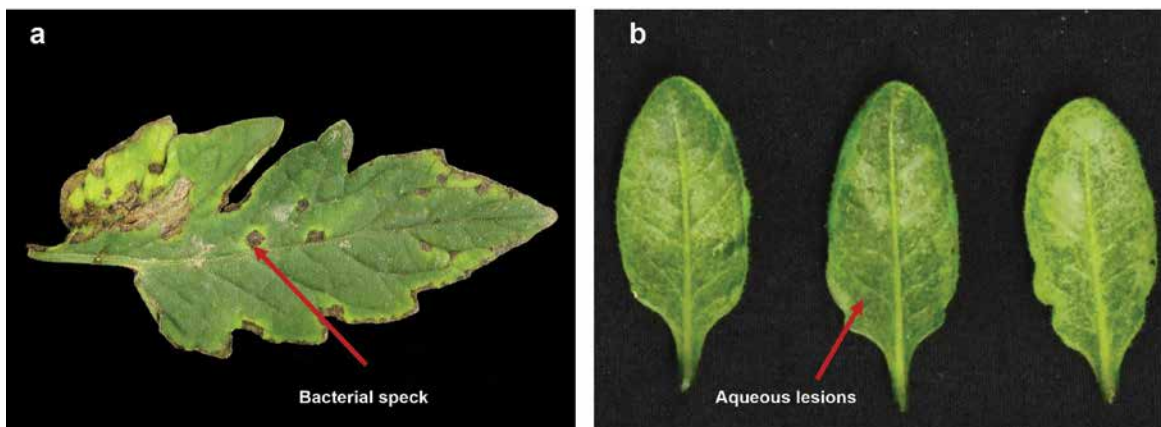
## Plant Pathogens and Crops

Techniques currently used to fight phytopathogens in agriculture include the use of plants resistant to various pathogens, be it (1) naturally or (2) through transgenic construction; (3) chemical control substances; and (4) biological alternatives (Sharma et al., 2022). The use of these mitigation strategies is limited by (1) the need for time and energy to obtain plants that are both resistant and have the desired traits for the market; (2) the illegal status of transgenic plants in many countries and their long-term loss of efficacy due to plant pathogen adaptation; (3) the adverse effects of chemical tools on

ecosystems and human health; and (4) the slow pace at which the efficacy of biocontrol products is demonstrated in agriculture (Sharma et al., 2022). Moreover, given the inevitable emergence of new plant pathogens, it is vital to find sustainable solutions to reimagine our agricultural crop and plant protection systems (Stukenbrock and McDonald, 2008).

## *Pseudomonas syringae*: Causal Agent of Bacterial Speck

The causal agent of bacterial speck, *P. syringae*, is an important phytopathogen in Quebec, particularly in tomato production. Bacterial speck of tomatoes is characterized by the presence of a multitude of black and yellow spots on both leaves and fruit, and also leads to the drying out of the aerial parts of the plant (Figure 1a). Controlling *P. syringae* is very difficult and requires crop rotation, the use of certified or treated seeds, or the use of copper in combination with bactericides. However, this last solution has major impacts on the environment and human health. It is therefore important to develop new strategies to limit the impact of plant pathogens through sustainable alternatives. The process for discovering them depends first and foremost on fundamental research experiments. These experiments in controlled environments enable us to gain a better understanding of plant pathogen infection systems and the associated plant responses (known as plant immunity; see Box). To facilitate the study of *P. syringae*, a model plant named *Arabidopsis thaliana* is used. Also known as thale cress or mouse-ear cress, this plant is also susceptible to the phytopathogen *P. syringae*, suffering what are known as aqueous lesions (i.e., an apparent accumulation of water within the leaves) in the early stages of infection (Figure 1b).



**Figure 1.** Phenotype of infection by the plant pathogen *P. syringae*. Notes : a. Tomato leaf showing signs of bacterial speck. Brown spots (signs of *P. syringae* infection) can be seen. Source : MAPAQ. b. Leaf of the model plant *Arabidopsis thaliana* infected by *P. syringae*. Aqueous lesions can be seen (darker spots representing the accumulation of water within tissues). Source : Lajeunesse et al. 2023

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## BOX: PLANT IMMUNITY IN BRIEF

*Unlike humans, for whom immunity is assigned to a specific group of cells, all plant cells possess a degree of immunity, enabling them to defend themselves against attack. In brief, plants have two levels of defense against different types of attack: constitutive (always present) and inducible (activated upon detection of a plant pathogen). The first of these is the physical barrier (e.g. the layer of wax covering the leaves of certain plants), whose role is to prevent pathogens from entering. However, the level of defense most studied in fundamental research is that of inducible defenses. One of the steps in the activation of inducible defenses is the recognition of plant pathogens via numerous receptors. When a microbial invader is recognized by the plant, it can activate its defenses against this particular type of microorganism. In return, pathogens have evolved to evade recognition by plants and thus still cause disease (Dodds and Rathjen, 2010).*

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## The Impact of Temperature

**T**he concept of the disease triangle, well known in plant pathology, emphasizes that plant-pathogen interactions are highly dependent on three factors: environmental conditions, host susceptibility, and plant pathogen virulence. Until recently, there was no scientific consensus on the effect of certain environmental factors, including temperature, on plant-pathogen interactions. Moreover, forecasts by the Intergovernmental Panel on Climate Change (IPCC) suggest that we will see an increase in ambient temperature of 2 to 5 °C by the end of the century (IPCC, 2021). The impact of this temperature rise on agriculture cannot be ignored. A recent study showed that higher temperatures increase the susceptibility of the thale cress (*A. thaliana*) to the plant pathogen *P. syringae* (Huot et al., 2017). There are many reasons for loss of resistance and increased virulence. For example, it is known that the inducible defenses of plants include the detection of molecules produced by pathogens, such as effector proteins, as well as the biosynthesis of an important phytohormone for plant defense, salicylic acid. A controlled greenhouse production environment could help limit the effect of rising temperatures due to climate change and mitigate the impact of plant pathogens on our crops. It is important to note, however, that if greenhouse temperature control requires the use of additional energy (e.g. fossil fuels), this could in itself contribute to the acceleration of climate change.

## The Impact of Light

**L**ight is another important abiotic factor in the fight against *P. syringae*. It was recently demonstrated that a short treatment of constant light (48 hours of uninterrupted artificial light) allows thale cress infected by this phytopathogen to recover (Lajeunesse et al., 2023). To infect plants effectively, *P. syringae* uses stomata, which are openings on the leaf surface that allow plants to transpire, among other things. The pathogen uses these natural openings to enter leaf tissue, then closes them behind itself to block transpiration and prevent water from leaving the leaves. This accumulation of water within the leaves is visible to the naked eye and creates aqueous lesions (Figure 1b). This is an ideal environment for the growth of *P. syringae*. An important fact to note is that these aqueous lesions are more easily created when relative humidity is high. Thus, the predicted rise in atmospheric relative humidity could exacerbate infections by this plant pathogen and, at the same time, have a negative impact on crops like tomatoes. Fortunately, light can be manipulated to our advantage. Constant light prevents the pathogen from closing the stomata once it has penetrated the tissue. This inhibits the formation of the aqueous lesions it so desperately needs to create disease (Lajeunesse et al., 2023). In a greenhouse environment, it would be possible to turn on the lights for a few days to help farmers get rid of infections such as *P. syringae*. It should be mentioned, however, that there could be potential drawbacks to such a treatment (e.g. physiological effects, financial, and environmental costs). More studies on this subject are therefore needed.

## Outlook

**A**t a time when adaptation to climate change is at the heart of research priorities at both the local (municipal initiatives) and global (major intergovernmental discussions) levels, it is vital to emphasize the importance of fundamental research in achieving the goal of sustainable agricultural production. Several recent studies have highlighted the potential impact of increased temperature and humidity on the virulence of plant pathogens. The development of alternative methods to reinforce integrated pest management is vital to limit the harmful effects of chemical agents on the environment and human health. With this in mind, our paper has highlighted the control of temperature, humidity, and light as important avenues for sustaining agricultural production. Future applied cost-benefit studies for greenhouse tomato production in Quebec will confirm the usefulness of these measures.

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## Science and technology

# NATURE-BASED SOLUTIONS FOR COASTAL PROTECTION IN CANADA: LESSONS LEARNED FROM MULTISCALE LABORATORY EXPERIMENTS

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Over one third of the world's population resides within 100 km of a coast, and this is expected to increase to 50% by 2030 (Bilkovic et al., 2017). This places a significant proportion of the globe in the direct path of coastal hazards including erosion, flooding, and extreme events such as hurricanes and tsunamis. For decades, hard coastal protection structures (e.g., seawalls, breakwaters) have been implemented to protect against such hazards. However, these structures have also caused adverse environmental impacts, including biodiversity loss from habitat replacement, and coastal wetland loss because of changes to critical sediment supplies (Bilkovic et al., 2017).

Coincidentally, the very ecosystems that have been historically degraded by shoreline armoring can themselves provide coastal protection. Vegetated coastal ecosystems, such as salt marshes, act as buffers to coastal hazards, with demonstrated reductions in incident wave heights of up to 72% (Rahman et al., 2019). These environments are also self-repairing and can adapt to rising sea levels through sediment deposition (ecosystem engineering), meaning they can provide protection in a changing climate.



The effective functioning of coastal vegetation for wave attenuation and erosion protection has incited an interest in its use for coastal protection infrastructure. With nearly 10% of the total saltmarsh extent in Canada located along the St. Lawrence’s estuary and gulf—309 km<sup>2</sup> of marsh [Rabinowitz et al., 2022]—these environments could play a critical role in long-term coastal protection strategies for the region. Efforts are currently being made to understand just how much protection these ecosystems can provide, how we can begin to implement them on the ground, and in what settings they may be most effective.

This article aims to provide an overview of nature-based solutions (NbS) for coastal protection, introduce the key controllers of wave attenuation by vegetation, and explore lessons learned from experimental studies of NbS performed by researchers from the University of Ottawa (Ottawa, Canada) and the Institut national de la recherche scientifique (INRS) (Québec, Canada), in collaboration with the National Research Council (NRC) (Ottawa, Canada).

## Nature-based Solutions and Coastal Marshes

### OVERVIEW OF COASTAL MARSHES

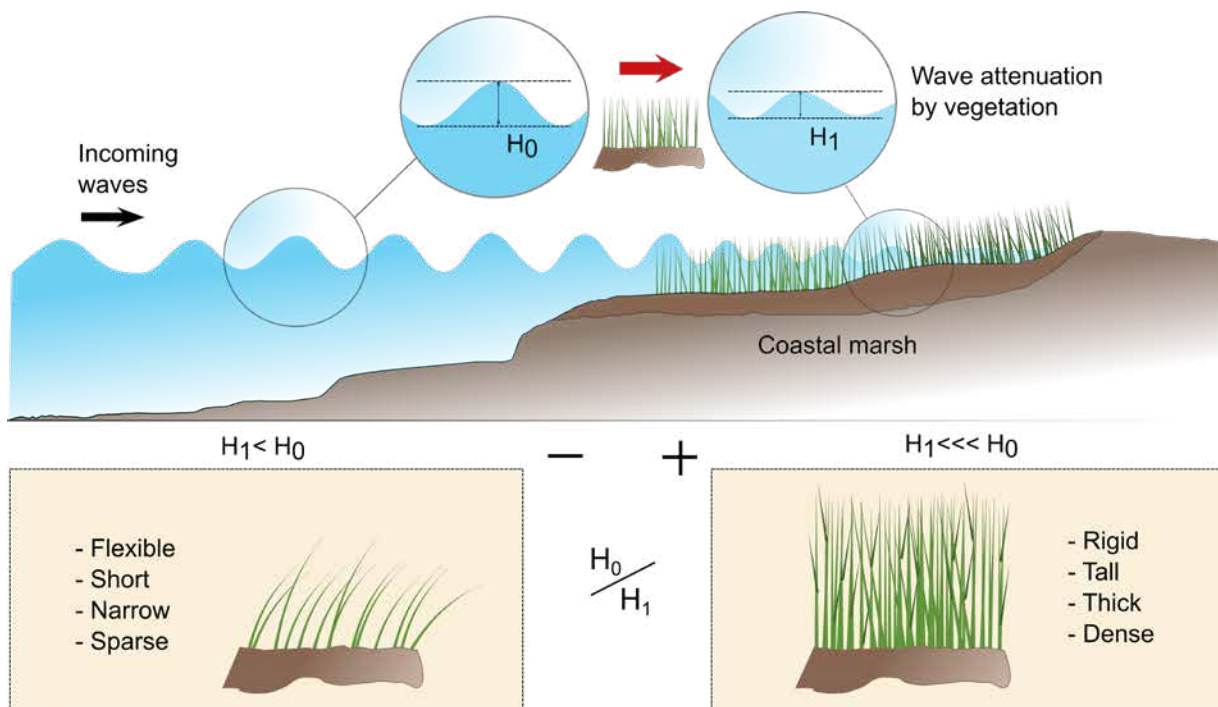
Coastal marshes are intertidal grasslands, often found along protected shorelines or at the edge of estuaries [Barbier et al., 2011]. They are characterized by low

species diversity and distinct zonation of plants between high and low marsh regions [Barbier et al., 2011]. In the context of coastal protection, saltmarsh plants can stabilize the soil with their roots and capture sediment during tidal flooding, increasing the marsh platform elevation to reduce erosion even under rising sea levels. Vegetation also acts as flow resistance, exerting a friction force on the water, which reduces the velocity and height of incoming waves (Figure 1). Frequent tidal inundation and nutrient uptake through enhanced sediment deposition also make these environments effective carbon sinks and highly valuable for climate change mitigation [Barbier et al., 2011].

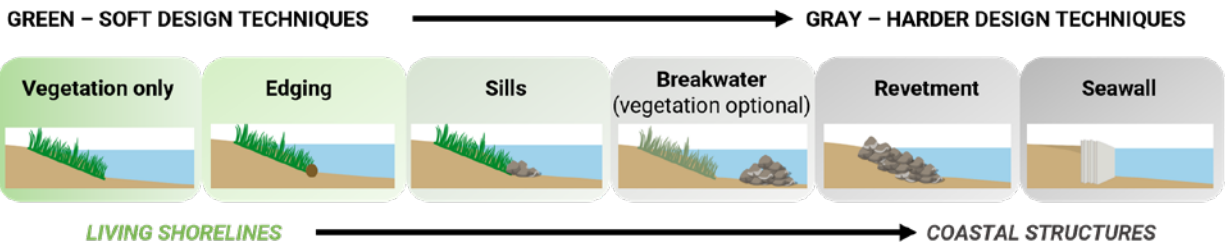
### COASTAL PROTECTION WITH VEGETATION

Coastal marshes exist in many forms in nature, ranging from vast complexes, enclosing tidal creeks, to narrow bay-fringing marshes. Similarly, they may be used in many forms for coastal protection. Large-scale managed coastal realignment projects support coastal protection through restoration of vast expanses of wetland area. On a smaller scale, marsh vegetation may be directly incorporated into engineered coastal structures often referred to as “living shorelines” (Figure 2).

Some of the key factors determining the level of coastal protection provided by NbS with vegetation (e.g., living shorelines) are **vegetation submergence** (water depth),



**Figure 1.** Wave Attenuation by Coastal Marsh Vegetation. Flow resistance (friction) induced by vegetation reduces the height and speed of waves moving onshore ( $H_1 < H_0$ ). The degree of wave height reduction (expressed here as the ratio of incoming wave height,  $H_0$ , over the reduced wave height,  $H_1$ ) is impacted by vegetation parameters including flexibility, plant height, stem density, and plant thickness.



**Figure 2.** Coastal Marsh Vegetation in Engineering Applications. Adapted from NOAA (2015). Living shorelines consist of vegetation planted on a constructed mild slope, with the primary purpose of providing additional wave energy dissipation. The addition of edging, sills, or an offshore breakwater shift toward gray infrastructure but remain within the umbrella of living shoreline design.

**marsh canopy height, plant biophysical properties** (morphology, stem diameter, flexibility), and flow **energy setting** (waves, currents) (e.g., van Veelen et al., 2020). Flexibility plays an important role, as the bending or passive motion of vegetation with the water can reduce flow resistance and thus overall wave energy dissipation. Many of these factors are highly region-specific, depending on the characteristics of native vegetation species as well as local environmental conditions. This emphasizes the need for region-specific studies and guidelines for NbS design.

## Laboratory Experiments for Coastal Marsh NbS

**E**xperimental studies, or physical models, of NbS aim to recreate natural coastal environments in a laboratory setting to investigate wave-vegetation interactions in a more controllable and accessible location than the field. These studies can support the development of design guidance for NbS, allowing quantification of coastal protection services considering different plant species, coastal settings (tides, wave conditions), and vegetation configurations. For the present study, a multiscale experimental approach was used to investigate the coastal protection services associated with *Sporobolus* species in a living shoreline design (Figure 2, leftmost panel, and table 1).

Large-scale wave tests with live *Sporobolus alterniflorus* (smooth cordgrass, previously *Spartina alterniflora*) and *Sporobolus pumilus* (*Spartina patens* or saltmarsh hay) plants were conducted in summer 2021 at the Laboratoire Hydraulique Environnemental (LHE) of the INRS in Québec. *Sporobolus* species were selected for testing as they are both native to Canada and widespread globally. Within Canada, the native distribution of *S. alterniflorus* is primarily limited to the east coast, whereas *S. pumilus* are also found along the west coast (Natural Resources Conservation Service, 2021). Live plants

were sourced from a natural marsh located near Trois-Pistoles, province of Quebec (Figure 3). In nature, flood-tolerant *S. alterniflorus* dominates low marsh areas, while *S. pumilus* thrives in the high marsh. The two species were planted in the experimental facility accordingly.

Experiments with live vegetation were performed to obtain **fundamental knowledge of plant biophysical properties**, while investigating differences between the two species and observing how these differences might impact coastal protection functions. The latter aspect was investigated using **underwater video cameras** (Figure 4), **observing movement** of the plants as they were subjected to different wave and water level conditions.

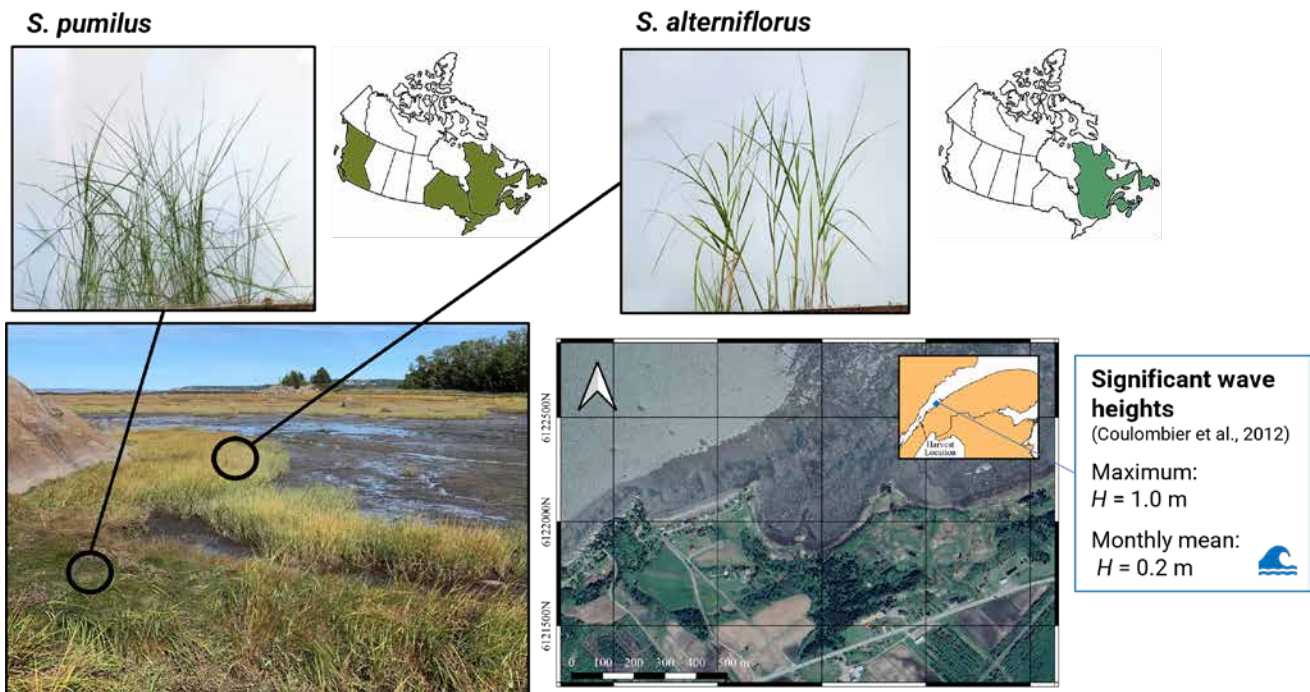
The small-scale laboratory experiments conducted for this project aimed to investigate the **wave attenuation provided by a living shoreline structure** vegetated with *S. alterniflorus* (Figure 5). The structure built in the NRC-OCRE laboratory represented a 1:4 scale model and used simplified plant mimics to represent *S. alterniflorus*. Mimics were developed using the measured properties from live vegetation experiments and included both a flexible (silicone rubber tubing) and a rigid material (wooden dowel).

The plant diameter and meadow density were selected to preserve flow-stem interactions and obtain a vegetation volume fraction equivalent to that of a prototype-scale living shoreline with staggered plantings spaced at 15 cm. This produces a meadow with a lower plant density than would be expected in a natural marsh in Atlantic Canada (100–350 stems/m<sup>2</sup>, Virgin et al., 2020), instead representing a newly constructed or planted marsh scenario. The meadows of flexible and rigid plant mimics underwent wave testing separately, to investigate the influence of flexibility in small-scale experiments with NbS. An overall vegetation field length of 15 m (3.75 m in the laboratory) was tested under a range of increasingly energetic waves, with wave heights between 0.3 m and 0.9 m (0.075–0.23 m in the laboratory), and with two water depths (partially submerged and fully submerged vegetation conditions).

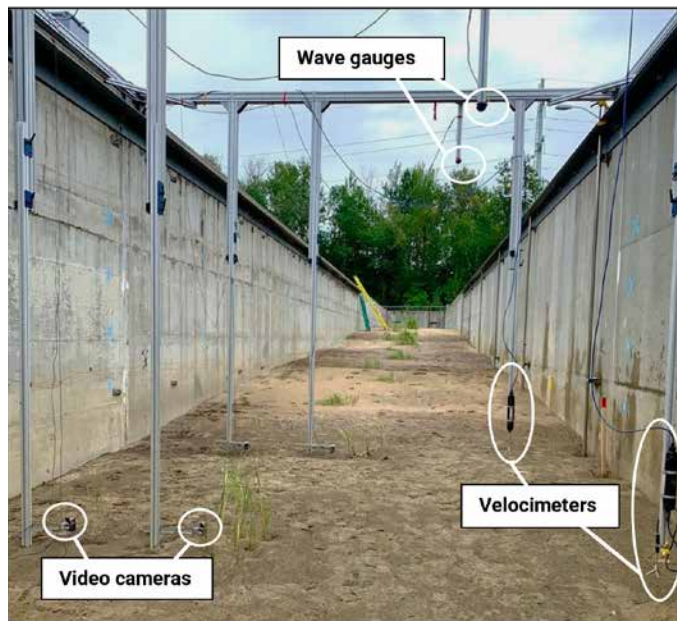
## Experimental Objectives

Large-scale (1:1)		Small-scale (1:4)					
	<ul style="list-style-type: none"> <li>• Develop methods for outdoor wave testing with live plants</li> <li>• Compare bending of different plant species under waves</li> <li>• Document species-specific plant properties influential to wave attenuation</li> </ul>		<ul style="list-style-type: none"> <li>• Develop methods for wave testing with small-scale plant mimics</li> <li>• Estimate wave attenuation for a constructed “living shoreline” design</li> </ul>				
Scale	Facility	Plant species	Plant material	Marsh properties	Shoreline slope	Wave height (m)	Wave period (s)
1:1	INRS-LHE, Québec (outdoor)	<i>S. alterniflorus</i> , <i>S. pumilus</i>	Live plants	$b_v = 4.5, 1.4$ $l = 62.55$ $N_v = n/a$ $x_b = n/a$	1:18	0.10 - 0.20	2.5 - 10.0
1:4	CNRC-OCRE, Ottawa (indoor)	<i>S. alterniflorus</i>	Wooden dowels (rigid), latex tube (flexible)	$b_v = 4.5 (9.5)$ $l = 62 (15.5)$ $N_v = 51 (51)$ $x_b = 15 (3.75)$	1:20	0.30 - 0.92 (0.075 - 0.23)	4.0 - 6.5

**Table 1.** Summary of large- and small-scale wave experiments with *Sporobolus* species. Acronyms for marsh properties:  $b_v$  = plant stem diameter (mm),  $l$  = plant stem length (cm),  $N_v$  = number of stems per unit area (stems/m<sup>2</sup>),  $x_b$  = marsh length (m) in the direction of waves. Live vegetation properties are averages. For small-scale experiments, prototype-scale values are reported with actual model values in brackets.



**Figure 3.** Live Vegetation Used in Large-scale Wave Test. Live vegetation used in large-scale wave tests (*S. pumilus*, *S. alterniflorus*) including their native distribution in Canada, plant harvest location near Trois-Pistoles, and approximate wave climate for the site (Coulombier et al., 2012). Distribution maps adapted from Natural Resources Conservation Service (2021).



**Figure 4.** Experimental Setup with Live *Sporobolus* species in the Large Wave Canal of LHE-INRS. Live plants were transplanted directly into the wave testing facility and, for three weeks, were watered and monitored to allow them to establish in the soil before the experiments.

## Outcomes

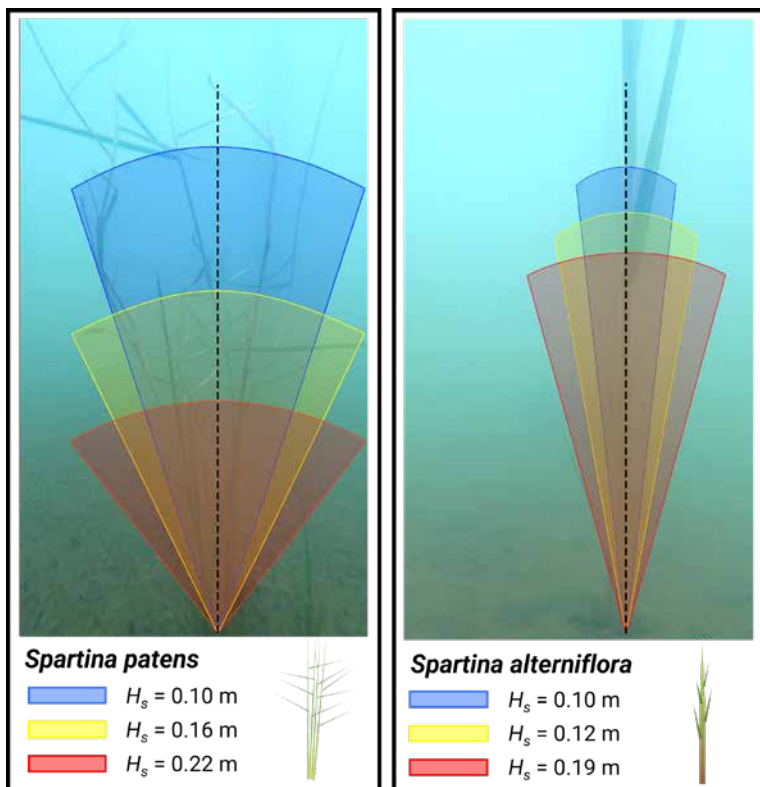
Very few experimental studies of NbS use live vegetation, due to challenges with plant sourcing, transportation, and care in laboratory facilities. Alternatively, the majority have used plant mimics of various materials and complexities to represent live vegetation in the lab. The use of mimics not only eliminates the complexities associated with live plant care, but also allows testing at model (reduced) scales and offers better reconfigurability (i.e., many design scenarios can be tested efficiently). However, some accuracy may be lost in these studies, as vegetation is reduced to a simple morphology with uniform material properties. Thus, the use of live vegetation in laboratory studies is essential to investigate the fundamental behaviours of marsh vegetation in coastal settings (i.e., with waves). Live plant studies realistically capture vegetation structure and allow for comparative testing of different plant species, capturing inter- and intra-species heterogeneity in plant properties, as well as phenomena such as stem bending and motion.

Overall, the use of a multiscale approach in this project benefited from both experimental settings, supporting a more holistic approach to understanding NbS and coastal protection by *Spartina* species. Some key findings from the experiments are presented below.

### PLANT PROPERTIES AND WAVE ATTENUATION

The plant properties measured during live vegetation experiments highlighted key differences between *S. alterniflorus* and *S. pumilus* that may influence their respective role in NbS design. *S. alterniflorus* plants were characterized by an individual semirigid stem with several wide, flexible leaves, whereas *S. pumilus* plants consisted of a collection of several flexible, narrow stems, with long, flat leaves. These differences, particularly in stem flexibility, led to significant differences in plant motion when exposed to waves: *S. pumilus* plants consistently exhibited more stem bending than *S. alterniflorus* under comparable incident wave conditions (Figure 5).





**Figure 5.** Bending Range for *S. Pumilus* and *S. Alterniflorus* Stems. Bending range for *S. pumilus* and *S. alterniflorus* stems, corresponding to sample wave conditions from large-scale experiments; obtained from underwater video footage. Results are from irregular wave tests with a wave period ( $T_p$ ) of approximately 2.5 s.

Coastal vegetation often adapts one of two strategies when faced with flow forcing: “avoidance” or “resistance.” Plants that “avoid” flow are often small, highly flexible, and may bend or move passively with waves to minimize stress. Plants that “resist” may be larger or more rigid to withstand flow forces. Both strategies result in a trade-off for coastal protection. Avoidance plants provide little resistance to flow and thus less wave energy dissipation. Resistance plants provide more potential for wave dissipation but are also more susceptible to damage in high-energy environments. In fact, there are benefits to combining both types of species in coastal protection strategies, as the resistance species provide greater protection below their threshold for breakage, and avoidance species may provide prolonged protection with a greater chance of survival (Schoutens et al., 2020).

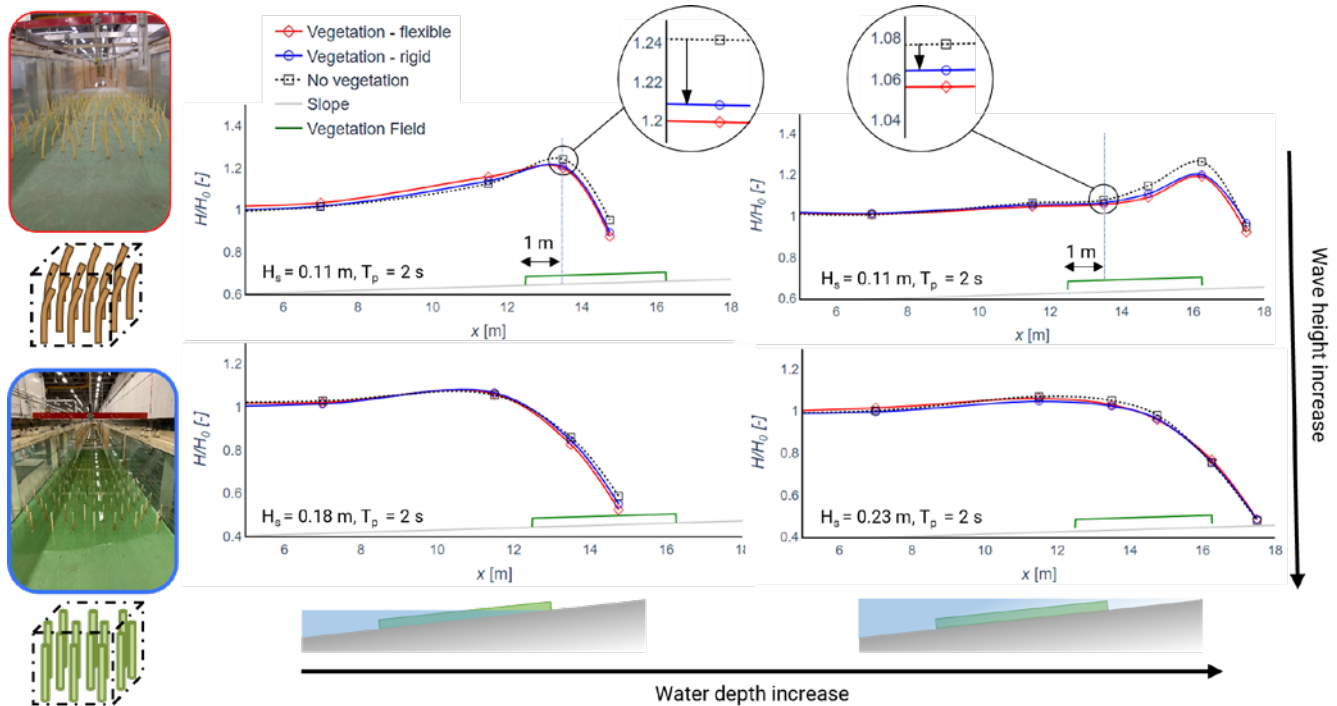
With respect to the *Sporobolus* spp. observed in this project, *S. pumilus* appears to take more of an avoidance strategy, and *S. alterniflorus* a resistance strategy. This indicates that we can potentially derive benefits from the combined attenuative capacity of *S. alterniflorus* and the resilience of *S. pumilus*, when paired together in coastal protection strategies.

## NBS & LIVING SHORELINE DESIGN

In the small-scale experiments, *S. alterniflorus* mimics were used to directly investigate the wave attenuation associated with a living shoreline structure. Sample results from these experiments are shown in Figure 6. Overall, tests with flexible and rigid plant mimics produced very similar results.

Living shorelines often consist of a sloping structure vegetated with coastal marsh plantings. The slope alone can alter incoming waves through processes such as shoaling (wave height increases as water depth decreases), and wave breaking. The latter occurs if the wave becomes too steep, as the water becomes increasingly shallow. Therefore, when investigating the performance of vegetation in NbS designs such as living shorelines, it is important to consider the relative contribution of the vegetation to wave energy dissipation, versus the effect of the slope itself.

In the current experiments, the largest attenuation due to vegetation occurred for the smallest incident wave conditions (lab : 0.075 m, real-world: 0.30 m), with a maximum wave height reduction of 11–19%, depending



**Figure 6.** Sample Results of Wave Height Evolution over a Scaled Living Shoreline Model. Sample results of wave height evolution over a scaled living shoreline model, using mimic vegetation (rigid and flexible) to represent *S. alterniflorus*.

on the wave period, compared to the bare slope. With increasing wave heights, wave attenuation due to vegetation decreases in comparison to attenuation due to slope-induced wave breaking: for the largest waves tested (lab : 0.23 m, real-world: 0.92 m), the vegetation provided almost negligible energy dissipation compared to the slope alone. For design purposes, it is expected that wave height reduction could be improved through increasing the vegetation density; however, this may not yield improvements for cases of large incoming waves, due to the dominance of slope effects.

The results from these experiments also demonstrated the importance of vegetation placement relative to the still-water level (SWL). For cases where the SWL was located at the end of the vegetation field (Figure 6, left), the first 1 m (or ~25%) of model vegetation has a measurable impact on the waves. However, when the SWL is raised higher (Figure 6, right) vegetation effects are not evident until several metres into the canopy. This indicates that the total marsh length on a living shoreline may not be equivalent to the length of vegetation that will produce wave attenuation effects, and this should be considered in their design.

Overall, the results from model-scale experiments must be interpreted keeping in mind their limitations arising from the use of mimic plants and downscaling effects.

## Conclusions and Outlook

The incorporation of native marsh vegetation (such as *Sporobolus pumilus* and *Sporobolus alterniflorus* on Canada's east coast) in coastal infrastructure has the potential to provide adaptive coastal protection in the context of climate change. To improve the rate at which these solutions are implemented on the ground, more studies like those presented here are needed, to support the development of design guidance for coastal marsh-based NbS. While this research is being conducted worldwide, region-specific studies are also integral. Based on the findings and limitations of this project, the following future studies to support NbS implementation in Canada are recommended:

- Identify thresholds for vegetation damage, and potential associated reductions in coastal protection.
- Investigate seasonal effects, including the presence of ice and vegetation biomass fluctuations.
- Consider other native coastal marsh species, particularly for the Pacific coast of Canada where *S. alterniflorus* is considered invasive and thus restricted from NbS design.
- Develop pilot-scale living shoreline projects, to test hypotheses derived from laboratory models.

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St-Lawrence Seaway - Photo credit: Eric Bégin

# URBAN BIODIVERSITY: PORTRAITS OF MONTRÉAL, BORDEAUX, AND BARCELONA

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Photo credit: Montréal – barnyz

**A**t a time when people are concerned about the effects of climate change and increasing urbanization, a host of bold initiatives are emerging in cities around the world. Urban green spaces bring psychological well-being, encourage social interaction, and promote healthy lifestyles. However, the consequent fragmentation of the urban landscape generally means that green spaces are small. Nevertheless, green spaces are important, particularly for small organisms (small animals, insects, micro-organisms). A single fragment of vegetation (e.g. a hedge) can be a habitat (for a bird), a corridor (for a small mammal), a wall (for an insect) or an entire ecosystem (for a microbe). It is therefore essential to study the urban ecosystem, its biodiversity, and their functions. To inspire future sustainable urban adaptation projects that promote biodiversity, this article showcases projects from three metropolises: Montréal, Bordeaux, and Barcelona.



**Figure 1.** Bird's-eye view of Montréal, Bordeaux, and Barcelona (respectively, from left to right). Credits: pataqueja2007, Rosshelen, thetechcreative

## Resilient Montréal

**L**ike all major North American cities, Montréal has a Hippodamian layout (straight streets intersecting at right angles; Figure 1) and a high level of urban sprawl for a moderate population density. Built around Mount Royal, the metropolis is rethinking the nature it contains through a number of urban projects. Two initiatives in particular are looking at how to manage the urban forest to make it more resilient and the role of urban biodiversity in human health.

### WHY AIM FOR RESILIENCE?

Increasing biodiversity reduces natural risks (bad weather, pests, diseases). The situation of the emerald ash borer (*Agrilus planipennis*), an insect whose larvae kill infected trees, has been a perfect illustration of this since 2011 in Quebec. Before the epidemic, ash trees accounted for around a fifth of urban trees in the province. In Montréal, over 50% of ash trees have been felled in the last 10 years, having a major impact on its urban forest, which had already suffered from Dutch elm disease in the 1970s and 1980s. In particular, this sudden loss of trees may have increased human mortality from heart and respiratory diseases (Donovan et al., 2013). It is therefore essential to prepare the urban environment

to make it more resilient in the face of accelerating climate change and the spread of insect pests.

### DIVERSIFY TO LIMIT LOSSES

One of the best ways to reduce natural risks is to diversify, i.e., to improve the variety of tree communities. It's not enough to add species that are similar to one another, we also need to focus on their functional traits (morphological, physiological, and temporal characteristics). These enable species to respond to changes in their environment. For example, we can observe different life strategies linked to functional traits, such as rapid growth with early sexual maturity and a large number of small seeds, or the opposite. It is then possible, in greening projects, to take into consideration the functional traits present and select tree species with different traits (to limit the impact of future disturbances).

### IMPROVING URBAN FOREST MANAGEMENT

An interesting Montréal initiative is the *IDENT-Cité* project: a double spiral arboretum planted in 2015 in Basile-Routhier Park. This project aims to raise public awareness of the importance of trees and the diversity of their functional traits. Along the way to the centre of the arboretum, the public discovers varied tree species

adapted to living conditions in an urban environment, with increasingly diversified functional traits. This is a planting model for a more resilient urban forest.

## URBAN FOREST OBSERVATORY

In Montréal, an urban forest observatory was set up in 2021 through a network of 25 permanent plots (Figure 2). This novel network covers different urbanization and vegetation profiles on the Island of Montréal and was initially set up to monitor pollens. Over time, the observatory has expanded to measure a wide range of variables, such as air properties, tree microbes, and insect communities. Complex relationships are also studied, such as the impact of predator-prey interactions on tree defoliation (leaf loss). For example, cat predation of birds is beneficial for insects (birds' prey) but unfavourable for trees (insects feed on their leaves). Finally, as human health is at the heart of urban concerns, the observatory also aims to monitor health variables, such as allergies and asthma.

## Foresighted Bordeaux

Bordeaux's urban ecology is shaped by the geographical and historical context of the city and its outlying communes. The metropolis, which was founded on the banks of the Garonne River in ancient times and has built up around the river. It has a low population density and encompasses territories featuring a wide variety of landscapes, urban planning, socioeconomic characteristics, and political orientations, making the governance of biodiversity-related public policies a complex task.

## FROM YESTERDAY TO TODAY

Bordeaux's urban centre is organized on low-lying neighbourhoods that, despite their built-up appearance, make the most of back gardens (Figure 1). The outskirts are made up of wetlands, limestone hillsides, and maritime pine monocultures, typical of the region's forests. However, the attractiveness of the metropolis is increasing the pressure on biodiversity in outlying natural spaces and residential areas, where private gardens are often collateral victims of urban densification.

## PRESERVE BEFORE RESTORING

In Bordeaux, actions are being taken to preserve, better manage, or restore natural environments, using an interventionist approach. The most widely publicized program is the planned planting of a million trees. However, these plantations are often carried out using the controversial Miyawaki method, which involves planting young trees at very high densities in very small areas of public space to create micro-forests. Their effectiveness in terms of biodiversity, environmental resilience, and improved quality of life for local residents has yet to be demonstrated. It is therefore crucial to preserve existing natural and agricultural areas on private property (gardens, farms, vineyards, waterways, and wetlands). To this end, there is a scientific program to restore a network of alluvial meadows in the Bordeaux region (Alard et al., 2020). For its part, the French government is attempting to support initiatives of this kind with a national biodiversity plan and its Action 10: "zero net artificialization". This could give a boost to preservation actions, but its implementation in the field is proving complex.

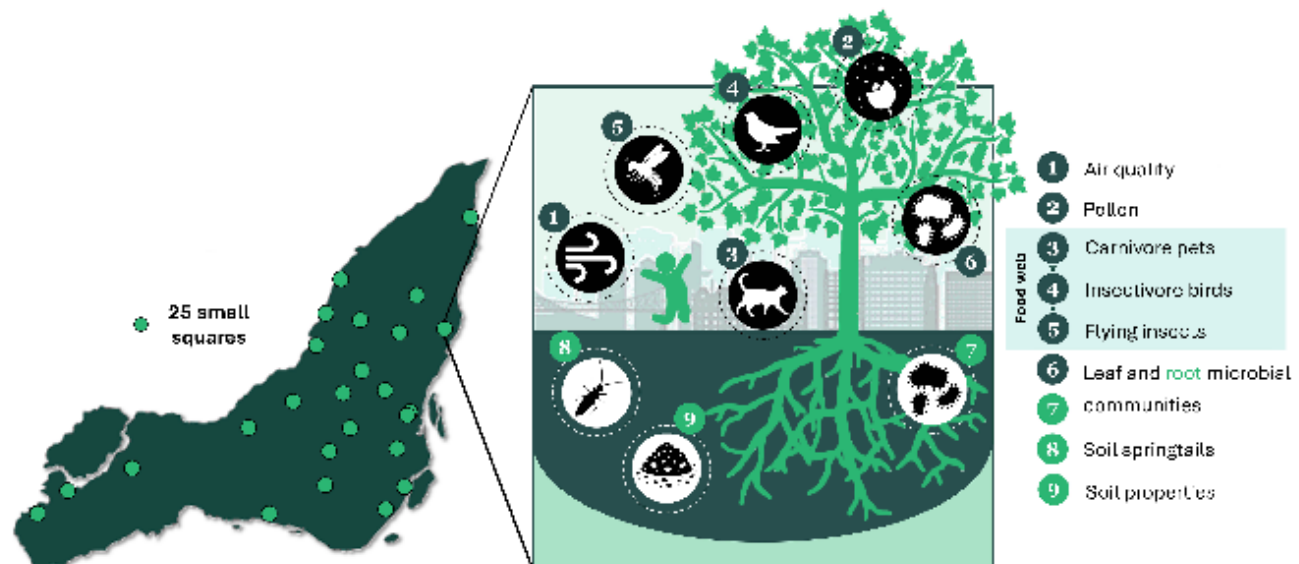


Figure 2. Montréal's Urban Observatory and its nine research directions. All rights reserved.

## A CENTRAL COLLECTIVE INITIATIVE

To meet conservation challenges, the scientific community has organized around a collective research project, part of the *Biodiver'Cit * action plan. Supported by Bordeaux M tropole, this plan brings together players from natural environment management, research, and naturalist associations. This collaboration aims to improve knowledge of urban and peri-urban biodiversity and thus identify possible levers for improving its preservation or restoration. Since 2018, community monitoring has been carried out on multiple taxa: birds, insects, reptiles, amphibians, fish, and terrestrial and aquatic flora. These surveys have already revealed a high level of biological richness throughout the metropolitan area's periphery (Barraquand et al., 2020).

## FORESEEING THE FUTURE

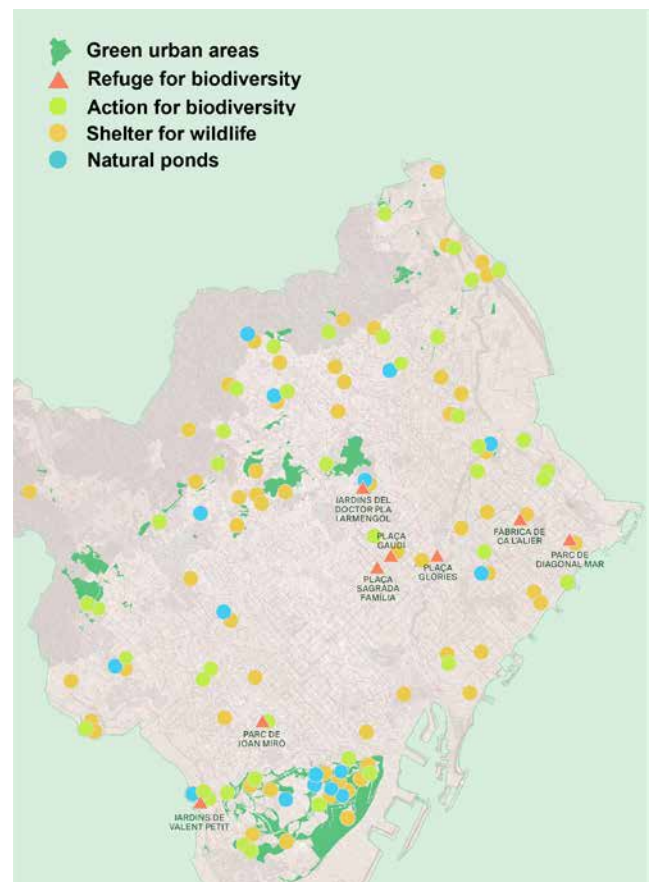
As in other world cities, the decline of most ecosystem services (benefits offered to human societies by the environment, e.g. reduction of urban heat islands, improvement of air quality) is well known for the Bordeaux metropolis. In response to this, the *Biodiver'Cit * plan's stakeholders have developed several possible scenarios for the territory's evolution (Sahraoui et al., 2021). These analyses showed that the current urbanization scenario for Bordeaux's outlying communes, that is, the "business as usual" scenario, would lead to a significant decline in ecological connectivity (connection between the natural patches of an ecosystem). The "densification" and "urban sprawl" scenarios would have a comparable impact. On the other hand, "de-artificialization" and "radical restoration" scenarios (return to a natural state) would only slightly increase ecological connectivity. These scenarios are concrete and useful tools for future urban planning in Bordeaux.

## Participatory Barcelona

**W**hile Barcelona's metropolitan area has a similar surface area to Montr al's and a similar density to Bordeaux's, its inner city is one of the most densely populated in Europe, with a compact, Hippodamian urban grid (Figure 1). These characteristics, combined with a hot and humid climate and the poorly adapted infrastructures and public spaces, mean that it is highly exposed to heat islands. In spite of this, the city is rich in green initiatives that link different players around sustainable projects.

## SEEKING TREES

Barcelona has a very urban profile, with little public green space per capita (7 m<sup>2</sup> compared to the 10–15 m<sup>2</sup> recommended by the WHO). To meet this need, the city council has set up several action plans. Among them, its *Climate plan for 2018–2030* aims to reduce Barcelona's environmental impact. Its main objective is to anticipate climate risks in order to ensure and improve the city's ability to respond to them. With public health at the heart of the plan, it aims to reduce people's vulnerability to climate change to ensure their health and well-being. Another initiative, *Barcelona's nature plan for 2021–2030*, aims to improve urban green infrastructures (e.g. green roofs, private gardens) and their services (Ajuntament de Barcelona, 2021). The plan is structured around three foci: conserving, increasing, and promoting the value of green spaces and their biodiversity. One of the objectives is to build 10 biodiversity refuges and gain up to 100 hectares of habitat for flora and fauna in the metropolis (Figure 3).



**Figure 3.** Barcelona's green infrastructure and biodiversity actions in 2021. Adapted from *Pla Natura Barcelona* (Ajuntament de Barcelona, 2021)

## COMMITTED TO YOUTH

While these projects involve people of all ages, Barcelona's city council is also working with the youngest. One of its first flagship actions was to set up "climate shelters" by greening 11 of the city's schools. The Transforming School Grounds program is part of this action, involving the installation of children's playground equipment, trees, and vegetation in all Barcelona schools to create shaded areas and reduce impermeable school surfaces. In addition, a flagship project, rePLANTing the School Environment, is being carried out in three schools (2021–2022) to promote and evaluate the effect of environmental education and student participation on urban biodiversity (Ferrandiz-Rovira, 2021). In addition to raising young people's awareness of their everyday environment, these investments are helping to shape the citizens of tomorrow.

## AN EXPOSED METROPOLIS

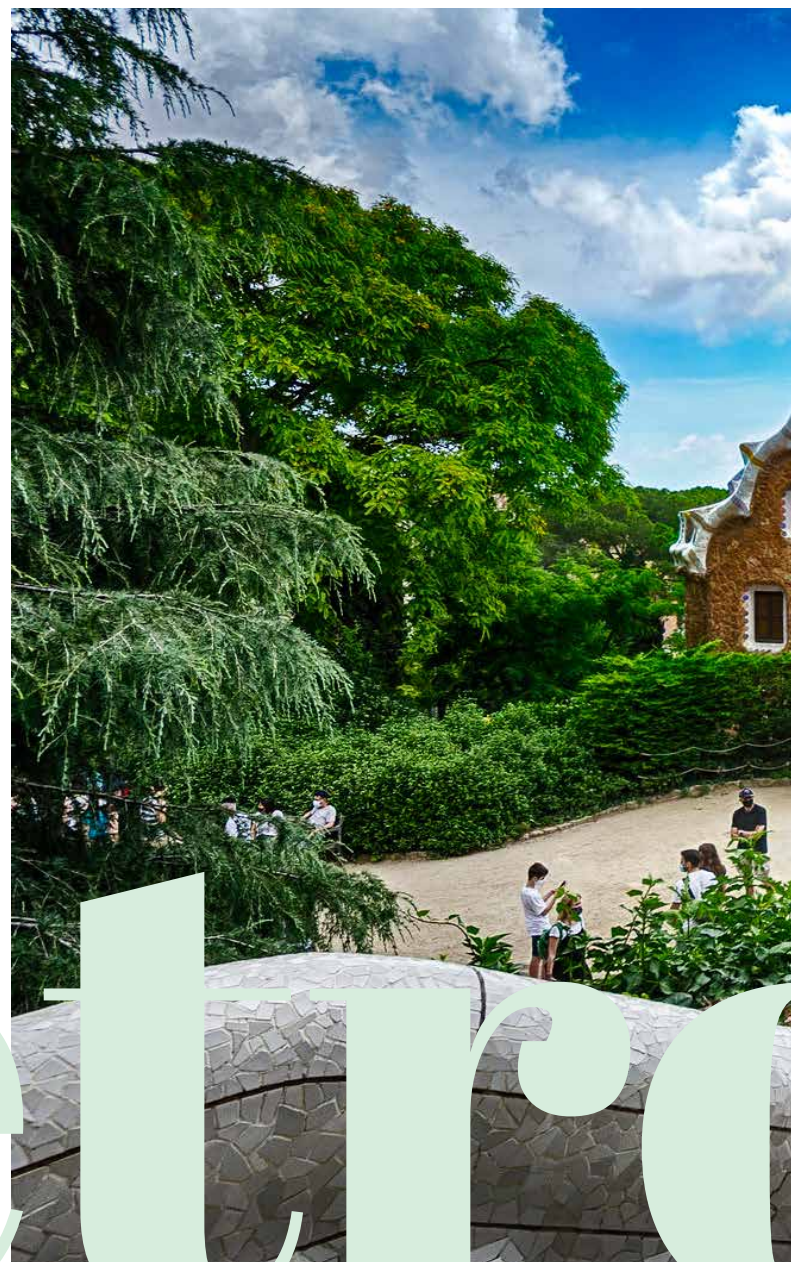
Despite its green initiatives, Barcelona remains highly exposed to climate change and the impact of exotic species (non-native species introduced by human activities). In 2022, the metropolis was home to a total of 413 exotic species, which is 80 more than in 2013. As exotic species colonize new urban sites at a rapid pace, they force native species to relocate as a result of predation or competition. They therefore endanger local biodiversity, especially when exotic species are invasive. Attempts to eradicate and control them have been fruitless. In light of this, it is important not to forget independent citizens' initiatives, which are also important in improving and protecting urban biodiversity.

## PARTICIPATORY SCIENCE AT HEART

Since 2012, the Barcelona metropolis has had its own participatory science office, involving around 13,000 people in more than 20 active projects. Five of these are notable for their links to biodiversity and urban ecology. Since 2010, Bioblitz has provided a whole-day biological inventory once a year. MosquitoAlert combats the spread of mosquito-borne diseases by signposting these insects and their breeding grounds. The Observadores del Mar project is involved in detecting the presence of invasive species, mass mortality of organisms, and the accumulation of microplastics on beaches. Ritme Natura observes seasonal changes in plants and animals, to help understand the effects of climate change on the natural ecosystems of the Catalan metropolis. Finally, the uBMS project provides information on the state of biodiversity and ecosystems by collecting data on Barcelona's butterfly populations. All these actions, on their own scale, contribute to combating the loss of biodiversity in Barcelona.

## Conclusion

In the face of urban growth, several initiatives by local authorities, the scientific community, and citizens' groups are being put in place to counter the loss of green spaces in cities and thus protect urban biodiversity. These diverse projects highlight the need for ambitious governance, backed by a strong public commitment to preserve biodiversity and its services. While Montréal is seeking to improve the resilience of its green spaces and is multiplying its research initiatives, Bordeaux is rallying its stakeholders around a wise project that seeks to prevent rather than cure. Barcelona, for its part, is exposed to heat islands and exotic species, but can count on its many action plans, some of which are citizen initiated. In the current context of economic and demographic attractiveness policies, it is essential to highlight the diversity of urban initiatives around the world. Montréal, Bordeaux, and Barcelona offer urban profiles and sustainable projects that, while different, are complementary and applicable





to other urban contexts. There's no doubt that urban forests and green infrastructure support biodiversity and its food chain. These living spaces benefit flora and fauna as well as human populations, through their numerous ecosystem services. From the promise of greater resilience through diversification, to organizational and scientific commitment, by way of community involvement, there are many ways in which we can transform our cities and foster the urban biodiversity of tomorrow.

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Photo credit: Björn Stefansson

## Science and technology

# SEALS AND PACK ICE: CONTRASTING BEHAVIOURS IN RESPONSE TO CHANGING ICE CONDITIONS IN THE GULF OF ST. LAWRENCE

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**S**easonal ice floes are vast expanses of temporary ice that float on the surface of the oceans in polar and subpolar regions. They play an important role in regulating the planet's climate and are an important habitat for many animal species. They form in winter when seawater cools to the point where small ice crystals form and coalesce into increasingly thick ice masses. Under ideal conditions, these ice floes can reach a thickness of over one metre and extend over several thousand square kilometres. However, the freezing point of salt water is lower than that of fresh water (-1.9 °C compared to 0 °C), which is why pack ice is particularly sensitive to water warming. In recent decades, their gradual disappearance has become a constant reminder of the impacts of climate change.

# The Importance of Pack Ice in the Gulf of St. Lawrence

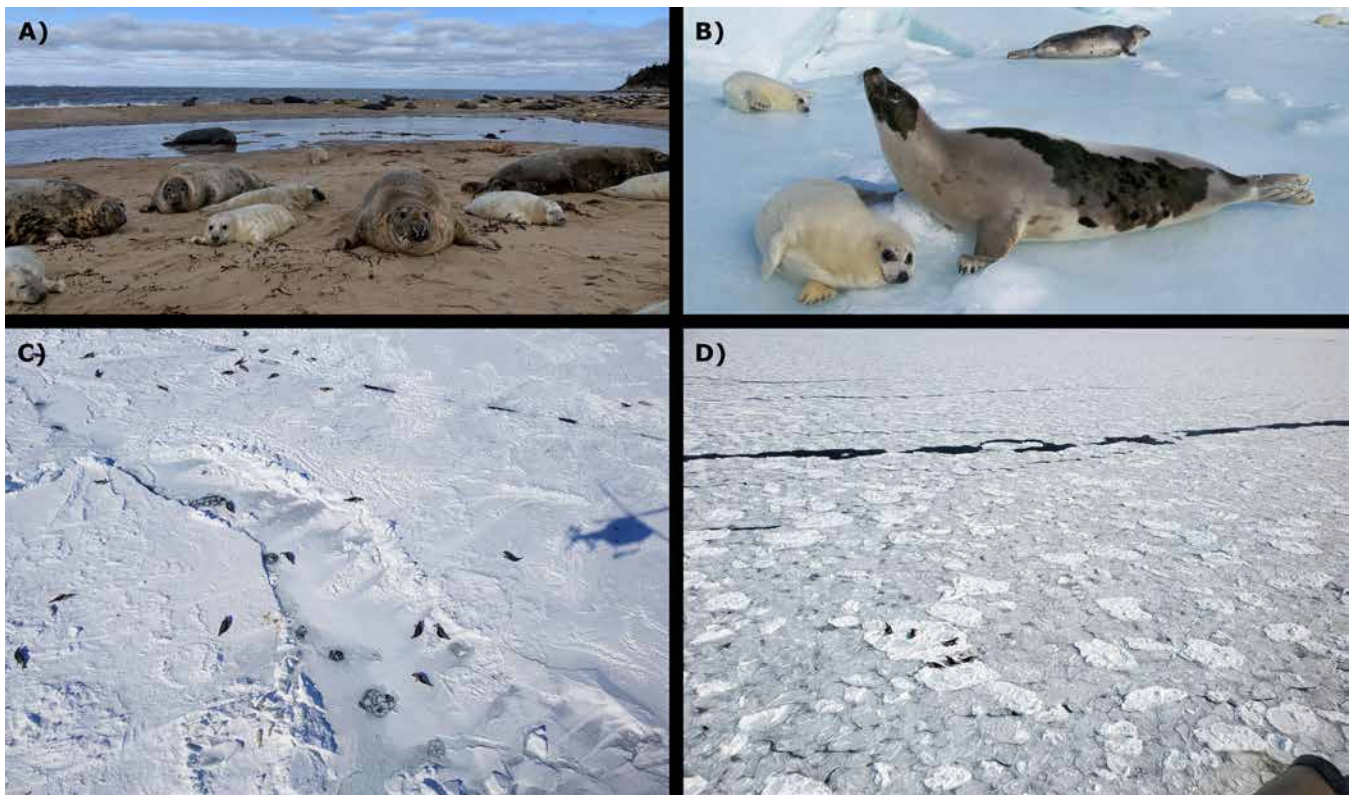
**T**he Gulf of St. Lawrence represents the southern limit of seasonal pack ice formation in the Northwest Atlantic. It usually forms in December in the St. Lawrence estuary and the shallow areas of the northern Gulf. Pack ice gradually extends toward the Îles de la Madeleine, in the middle of the Gulf, and then south toward Cabot Strait, reaching its maximum around mid-March. Thicker sea ice may also enter the Gulf from the Labrador Shelf. Since the early 1990s, atmospheric temperatures have been increasing, resulting in a warming of surface waters in the Gulf. As a result, the quantity and quality of ice cover has decreased, and the frequency of low-ice years has increased. Eight of the twelve years with the lowest ice conditions ever recorded since monitoring began have occurred since 2010 (Galbraith et al., 2022).

Many species of Gulf wildlife benefit from the presence of pack ice in winter. Seals, in particular, use it to rest at sea between feeding periods. Grey seals (*Halichoerus*

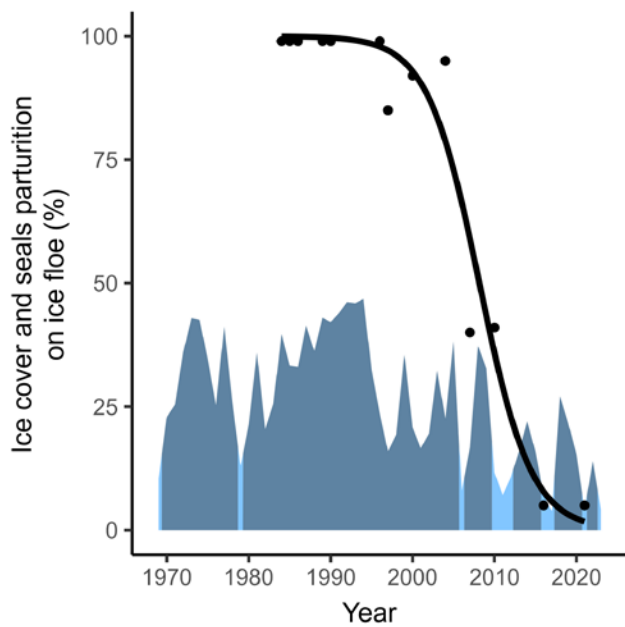
*grypus*) and harp seals (*Pagophilus groenlandicus*) also use it to give birth to their babies, called pups (Figure 1: A, B). It provides a solid, isolated platform for females to give birth and provide maternal care, safe from predators and close to food sources. In years with poor ice conditions, the pack ice has less surface area and is thinner (Figure 1: C, D). Therefore, it is more likely to break up and persist for shorter periods of time, which can lead to high pup mortality (Hammill and Stenson, 2011; Stenson and Hammill, 2014). Thus, changes in ice conditions in recent decades have had a significant impact on the breeding habitat of these two species. Faced with this new reality, grey seals and harp seals have exhibited contrasting behavioural solutions.

## The Grey Seal

**T**he grey seal is a permanent resident of the Gulf of St. Lawrence. For most of the year, individuals in this population are scattered throughout the Gulf, using exposed reefs and secluded island beaches to rest between feeding trips. In winter, adults gather for breeding, with births peaking around the end of January. In the past, these gatherings took place on pack ice in the southern



**Figure 1.** Seals and Ice Conditions in the Gulf of St. Lawrence During the Breeding Season. Grey seals on Pictou Island beach (A). Harp seals on pack ice near Îles de la Madeleine. (B) Harp seals on pack ice in years with good (C) and bad (D) ice conditions. Photo credits: X. Bordeleau (A); slowmotingli (B); M.O. Hammill (C, D).

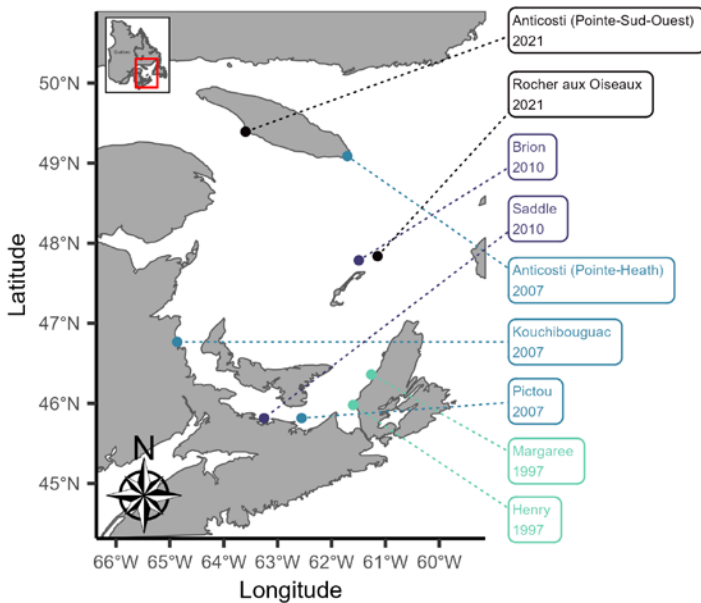


**Figure 2.** Ice Cover and Use of Pack Ice as a Grey Seal Pupping Site in the Gulf of St. Lawrence. The blue area represents the percentage of the Gulf covered by ice during the breeding peak (week of January 29). Light blue areas indicate ice-poor years [coverage < [mean coverage from 1969 to 2023] - standard deviation from 1969 to 2023]]. The black dots and line represent the percentage of calving on pack ice. Data: Canadian Ice Service; Hammill, Gosselin and Stenson, 2017.

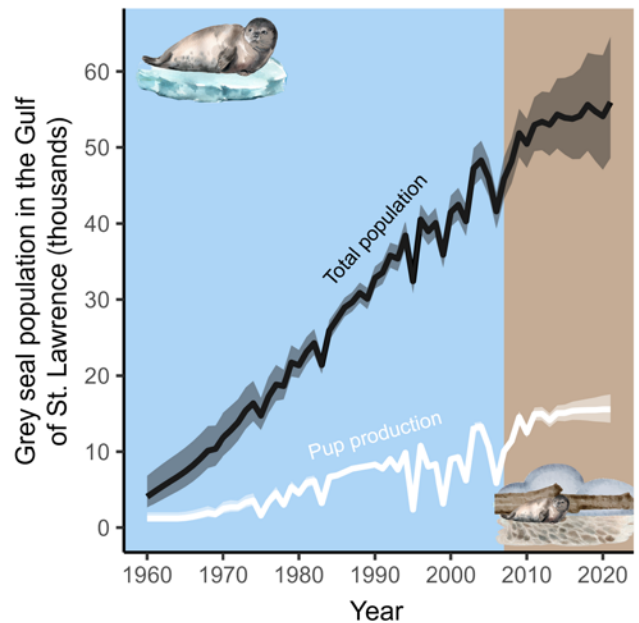
Gulf. However, in recent decades, the amount of ice in the Gulf at this time of year has gradually decreased, and the frequency of years when pack ice is almost absent in the Gulf has increased (Figure 2).

In response to these changes, grey seals have gradually abandoned the pack ice as a birthing site. Until 2004, nearly all pups (over 85%) were born on the ice. Since then, this number has dropped dramatically, and today fewer than 5% of births occur on the ice (Figure 2). With the disappearance of the ice, Gulf grey seals began to use isolated islands as breeding sites. They first occupied islands in the southern Gulf and then moved north to Anticosti Island (Figure 3). Today, Brion Island, near Îles de la Madeleine, is the most important birthing site for grey seals in the Gulf.

The period when grey seals were breeding on pack ice was characterized by strong population growth due to cold climatic conditions that favoured ice formation, reduced hunting pressure, and the collapse of populations of other important ecosystem predators such as sharks and Atlantic cod. The Gulf grey seal population was estimated at about 4,000 individuals in 1960 and increased to over 45,000 when pack ice was abandoned as a breeding site (Figure 4). During this period, the size of the herd was also subject to large year-to-year fluctuations due to years of high pup mortality associated with poor ice conditions (Hammill and Stenson, 2011). Since then, the herd has stabilized at about 56,000 individuals, with a much more stable production of about 16,900 pups each year (DFO, 2022; Figure 4).



**Figure 3.** Location and Year of Establishment of New Grey Seal Colonies in the Gulf of St. Lawrence.



**Figure 4.** Grey Seal Population and Pup Production in the Gulf of St. Lawrence During Whelping Periods on Pack Ice (Blue) and on Land (Brown). Data: Rossi et al., 2021.

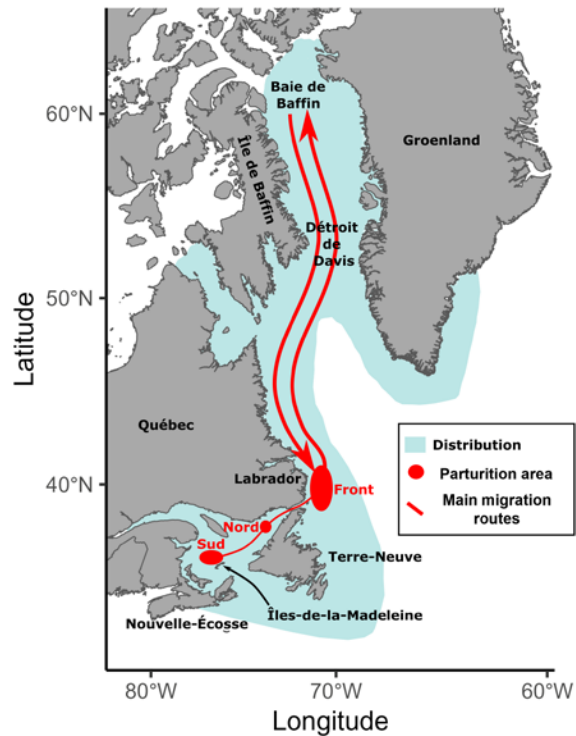
However, in the last two years, there have been increased sightings of white sharks in Gulf waters, particularly near the grey seal colonies in Îles de la Madeleine. We're also seeing more seals with wounds resembling shark bites. With warmer waters and the potential recovery of the white shark population, we can expect shark presence in the Gulf to increase in coming years. In addition to its predation effects, the presence of sharks near colonies could change seal behaviour. They could spend more time ashore or farther away from the main colonies, where the threat of predation is lower, and less time feeding in coastal waters, where sharks are concentrated at certain times of summer and fall. If this is the case, the increased presence of white sharks could reduce the feeding time of grey seals, help stabilize their population, and lead to a change in their distribution in the Gulf. However, the extent of white shark impacts on grey seals remains unclear, and Fisheries and Oceans Canada is currently testing these research hypotheses in the Gulf.

## The Harp Seal

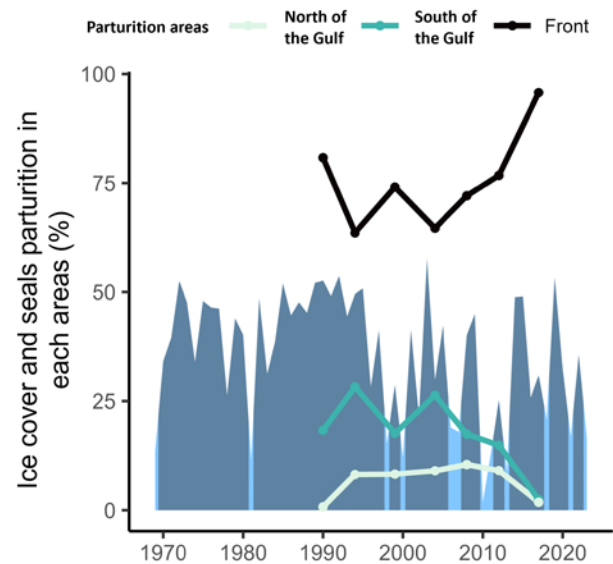
**H**arp seals are seasonal visitors to the Gulf of St. Lawrence. Most of the year, they are found between Baffin Bay, Davis Strait, and the Greenland coast. In the fall, adults migrate south to spend the winter and breed.

They congregate on the pack ice in the frontal region off the coast of southern Labrador, in the northern Gulf near the Strait of Belle Isle, and in the southern Gulf near the Îles de la Madeleine (Figure 5). Traditionally, births occurred in early March, with 70% of pups born in the front range, and 30% in the southern or northern Gulf.

This species, whose scientific name translates to “Greenland ice lover,” requires pack ice for reproduction. It serves as a calving and raising area and is used by pups for several weeks after weaning. Even if only small amounts of ice are available at the beginning of the breeding season, females will use it. This results in high pup mortality in years with seasonally low ice cover, when pack ice is more likely to break up during storms or under the weight of the seals (Stenson and Hammill, 2014). When ice is not available in more southerly areas, females move north to find suitable ice. Unlike grey seals, there is no evidence that they give birth on land, and pups that drift ashore have high abandonment and mortality rates. In recent decades, the years of poor ice conditions in the Gulf of St. Lawrence have become increasingly frequent (Figure 6). In response, there has been a decrease in birth percentages in the north, and in particular the southern Gulf, in favour of the front, located farther north (Figure 6). If this trend continues



**Figure 5.** Distribution and General Locations of Harp Seal Popping Areas in the Northwest Atlantic. Data: Hammill et al., 2021.



**Figure 6.** Ice Cover and Whelping Distribution of Harp Seals in the Gulf of St. Lawrence. The blue area represents the percentage of the Gulf covered by ice during the breeding peak (week of March 5). Light blue areas indicate ice-poor years [coverage < [mean coverage 1969–2023 – standard deviation 1969–2023]]. The dots and lines represent, respectively, the percentages of whelping in the three traditional breeding areas (Front, Southern Gulf, Northern Gulf). Data : Canadian Ice Service ; Hammill et al., 2021.

over the next few decades, we could see the eventual disappearance of harp seal reproduction in the Gulf of St. Lawrence (Stenson and Hammill, 2014).

In years with very poor ice conditions, a northward shift in calving sites along the Labrador coast has also been observed. In extremely low ice years, births may even occur outside traditional calving areas (Stenson and Hammill, 2014). As the climate warms, the absence of ice on the front is likely to become more common (Han et al., 2019), and we expect calving locations to shift northward in the coming decades. However, current breeding grounds are located at the southern limit of the spring distribution of polar bears, for which harp seals are important prey. Therefore, a northward shift could result in increased seal mortality due to bear predation and reduced pup production. On the other hand, this could be good news for polar bear populations in the Canadian Arctic, as the presence of harp seals has a positive impact on their survival and population growth (Peacock et al., 2013).

## Implications for Human Populations

**T**he response of seals to changing ice conditions also has implications for human populations in the Gulf of St. Lawrence. Harp seal hunting is a culturally and economically important activity for some Gulf communities.

It is traditionally practised on pack ice shortly after the March whelping season. In recent years, however, the lack of ice in the Gulf has made seal hunting difficult, if not impossible. The lack of pack ice and low demand for seal products have led to a decline in catches, even though quotas have been increased. To compensate for economic losses associated with the decline in the hunt, some companies organize helicopter tours to observe the whitecoats on the pack ice off the Îles de la Madeleine. In 2023, however, these excursions had to be cancelled for the seventh time in ten years due to low ice cover. Whether for hunting or observation, catching harp seals in the Gulf is becoming increasingly difficult.

Paradoxically, Gulf residents must contend with an increasing presence of grey seals. Unlike harp seals, they stay in the Gulf year-round, so conflicts with human activities are more common. This is especially true for fishermen, who are concerned about the impact of grey seal predation on fish stocks. Grey seals can also conflict with fishermen directly, consuming fish caught on fishing lines, damaging lobster traps while retrieving bait, or tangling ropes, making it difficult to retrieve fishing gear.

Grey seals are also the final hosts of parasitic worms that can be transmitted to bottom-feeding fish and must be removed during fish meat processing. This is a costly process that can result in significant losses, especially when parasite loads are high. Some Gulf islands have also been used by residents as bathing and holiday resorts. The presence of hundreds, if not thousands, of seals on the beaches of these islands makes their use for these types of activities inadvisable.

The greater presence of grey seals on Gulf islands, particularly during the breeding season, could also have positive consequences for human populations there. The breeding season on land is much more predictable and less variable than on pack ice. This could be an opportunity to maintain traditional seal hunting, concentrating on grey seals in the Gulf islands rather than harp seals on pack ice. This is a sustainable activity which, as currently managed, could represent an important source of income for Gulf residents if the market for seal products develops.



Scientific

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ES

# THE CHANGING IMPORTANCE OF THE ENVIRONMENT IN QUEBEC PUBLIC OPINION



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Analyzing political issues is essential to understand the positions of political parties and the media coverage they receive. One of the most important components is the *importance* that political actors attach to a particular issue. This importance can vary among political actors, such as citizens, the media, and political parties. In this article, I offer a synthesis of what is known about the meaning attributed to the environment. In particular, I focus on public opinion in Quebec during provincial (2008, 2012, 2014 and 2018) and federal (2006, 2008, 2011, 2015, 2019 and 2021) election campaigns, both of which represented key moments in the implementation of public policy.

Surprisingly, there is no synthesis of public opinion on the importance of environmental issues. The literature focuses mainly on media coverage (Martel and Nadeau, 2023), and when the citizen perspective is considered, it is never in a longitudinal perspective to track the evolution of an issue. This situation is even more surprising considering that Quebec is playing a fairly active role in the fight against climate change in Canada. A summary of the evolution of public opinion on environmental issues is necessary, especially since the Quebec government's implementation of flagship measures to combat climate change seems to depend on the pulse of public opinion (Gajevic Sayegh et al., 2022).

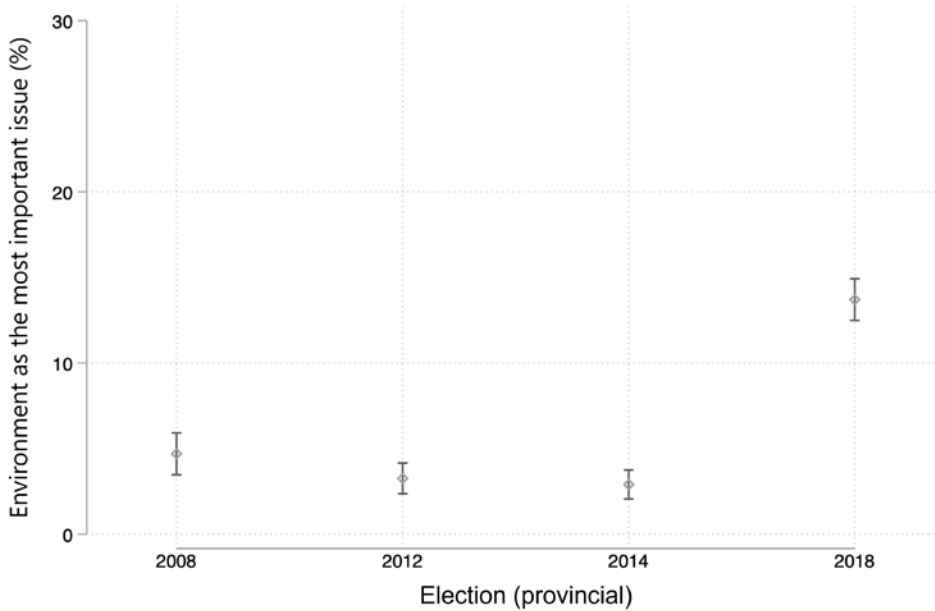


# Is the Environment Considered an Important Issue?

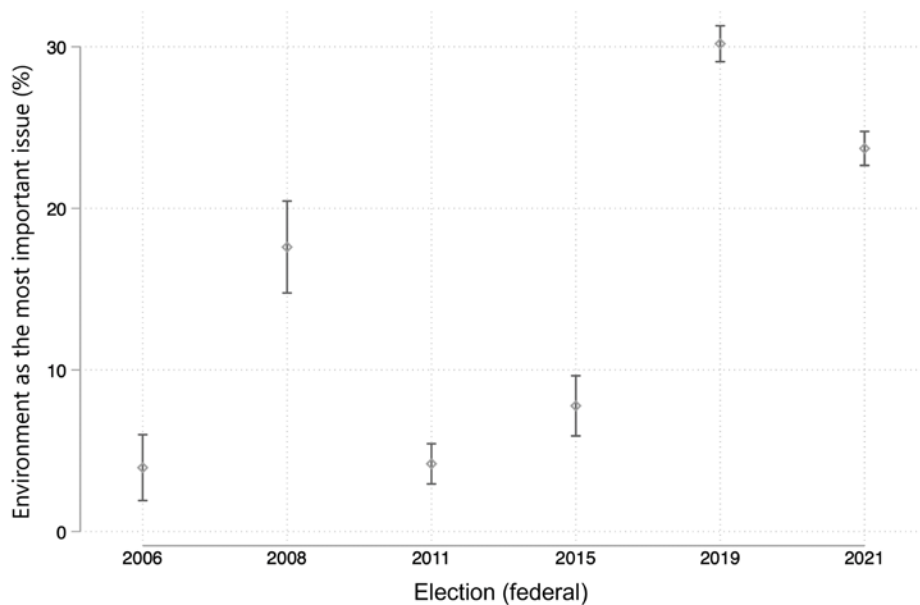
The Quebec Election Study (QES) and Canadian Election Study (CES) databases provide the best data to summarize the importance citizens have attached to the environment over time. At the provincial level, elections between 2008 and 2018 are considered, while at the federal level, elections between 2006 and 2021 are used. Data for the most recent provincial election (October 2022) collected by the C-Dem Consortium is not currently public. I hope others will investigate the importance placed on environmental issues in 2022 to complete

the perspective presented in this article. In each poll survey, a question is asked to identify the issue that voters consider most important. Not surprisingly, the top three issues are the economy, health, and education (Bélanger and Nadeau, 2009). But what about the environment? Figures 1 and 2 below show the percentage of respondents who chose the environment as the most important issue. At both the provincial and federal levels, one thing in particular stands out: the proportion of citizens choosing the environment as their most important issue is significantly higher in recent elections (2018 in Quebec and 2019/2021 in Canada).

At the provincial level, focusing on citizens' perspectives prior to 2018, the environmental issue was relatively marginal. In 2008, 2012, and 2014, fewer than 5% of respondents indicated that the environment was their top priority (represented by the y-axis in the graphs).



**Figure 1.** The importance of the environment, Quebec elections (2008–2018 ).  
*Note :* Vertical bars represent the 95% confidence interval.



**Figure 2.** The importance of the environment in Quebec, federal elections (2006–2021).  
*Note :* Vertical bars represent the 95% confidence interval.

It should be noted that the context was not favourable: the 2008 election took place in the shadow of an economic crisis, with heated discussions about the rushed and strategic nature of the election, in addition to a flurry of identity-based debates relating to the issue of “reasonable accommodation”; during the 2012 election, the student crisis was in full swing; and 2014 focused in particular on the separatist threat related to the spectacular candidacy of Pierre Karl Péladeau (Bélanger and Nadeau, 2009; Bélanger et al., 2013; Daoust and Péroquin-Skulski, 2021). The 2018 election seems to represent a clear break, as the environment was chosen as the most important issue by about 12% of citizens, ranking second behind health, which received 27%, and just ahead of the economy, which got 11% (Bélanger et al., 2022).

There is also a clear break in the federal elections around 2018. However, the 2008 election also stands out, with over 15% of respondents saying that the environment was their top priority. It is not easy to explain why this figure is so significant compared to the previous and subsequent elections (2006 and 2011), but two lines of thoughts may be considered. First, Stéphane Dion, former Minister of the Environment, was the leader of the Liberal Party of Canada and was associated with greater sensitivity to environmental issues. Second, this was the first election in which Elizabeth May, leader of the Green Party of Canada, participated in the official debate. In short, 2008 stands out, while in 2011 and 2015, the environment took on a much lower level of importance.

The real break at the federal level can be observed between 2015 and 2019: the environmental issue is considered most important by 30% of citizens in 2019. Two years later, in 2021, the issue remains very important, at over 22%, despite a much more difficult economic environment. Finally, it should be noted that the percentage of people who say the environment is their top priority is generally higher at the federal level than at the provincial level. Again, it is difficult to explain this situation, and the heightened presence of the Green Party does not seem very fruitful, since its success, albeit modest, is not associated with either an increase or a decrease in the importance of environmental issues in public opinion. That said, there have been very few studies on the relationship between the importance attached to the environment and support for a green party, although the electoral context in Canada and Quebec raises several interesting questions. In Quebec, for example, the Québec Solidaire party has clearly taken up the environmental issue (Bélanger et al., 2022) and does not allow the Green Party in Quebec to get much benefit from the issue. In this context, it is difficult to estimate the impact of a party on the importance attached to an issue, or even the direction of causality, which could be in the opposite direction, i.e., from the election result to the increase in an issue’s importance.

## Changing Issues and Public Opinion in Quebec

**S**ubstantial changes in the importance of issues, as observed above, can be caused by structural and/or contextual factors. Structural factors refer to profound, usually long-term changes, such as shifts in values. Contextual factors tend to refer to a specific context, where there may be many considerations that are unique to that context (as opposed to the general trends that are part of structural changes).

At the structural level, the tendency for the environment to become a more important issue for Quebec’s citizens, especially since 2018, is consistent with various analyses expressing the idea that a long-term restructuring of political cleavages (for example, since the 1995 referendum failure) was taking place. The national question (i.e., Quebec sovereignty), which used to be the structuring factor of political life, remained central, but faded, leaving more room for “new issues” (Daoust and Jabbour, 2020; Dubois et al., 2022; Guay and Gaudreault, 2018). These new issues would overlap under the headings of diversity (e.g., debates on immigration, the French language, etc.) and the environment (Cossette-Lefebvre and Daoust, 2020; Martel and Nadeau, 2023). In other words, the structure of political cleavages and its reorganization favoured an increase in the importance of environmental issues. Thus, the importance of the environment seems to depend in large part on the evolution of this restructuring.

This does not mean, however, that contextual elements specific to the times when citizens were interviewed are not important. For example, Martel and Nadeau (2023) show that the media’s agenda, which varies according to the context of each campaign (e.g., is there a corruption scandal?), focuses more on the economy when economic conditions worsen. This suggests that the economic context at a given time may influence the growth of new issues, including that of the environment. More specifically, poor economic conditions would be unfavourable for prioritizing the environment, since many people might set the environment aside and focus on the economy in such a context. This contextual element seems particularly important for the future, given the economic devastation caused by the COVID-19 pandemic and by inflation. It may also partly explain why there was less focus on the environment in the 2021 federal election than in 2019. In addition to the economic context, the situation of cultural and linguistic minorities in Quebec could also lead to an increase in identity-related issues—the 2007 provincial elections are a striking example of this (Bélanger and Nadeau, 2009)—at the environment’s expense.

## Conclusion

The summary in this article shows one clear constant: in Quebec, many more citizens consider the environment a priority issue since the last election. However, this increase has not been linear, and around 2018 there seems to have been a clear break at both the provincial and federal levels. This suggests that the media and political parties should give more importance to the environmental issue, as it seems to destabilize the traditional top three priorities of Quebec political life (economy, health, and education). Context, especially economic, can change public opinion about the importance of various issues, but an increase in the importance placed on the environment is consistent with the restructuring of political divisions in Quebec (Bélanger et al., 2022; Dubois et al., 2022).

Having made these observations, the next challenge, which seems intuitive to me, is to understand who is behind this rise in the importance of the environment. Is it a homogeneous effect, i.e., are all population groups increasingly interested in environmental issues? Or are one or more subgroups responsible for the observed increase? The second hypothesis seems more likely. Intuitively, one might suspect a generational gap, but further research will be needed to go beyond that. Among other things, the urban-rural divide could also play a role. There are many opportunities for future research, and much remains to be done. It's up to researchers to rise to the challenge—and on funders and elites (including governments) to give them the means to achieve their ambitions.

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## Law and Politics

# TOWARD RESILIENT SOCIOECONOMIC DEVELOPMENT: MAKING DECISIONS THAT TAKE CLIMATE RISKS INTO ACCOUNT

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In Canada, adaptation scientists emphasize how challenging decision-making is (Boyd and Markandya, 2021). More specifically, the main challenges involve bringing together an economic appraisal for a diversity of risks emerging from climate change, in order to estimate the costs of inaction, but also the costs of adaptation solutions as well as their effectiveness and impacts, such as opportunity costs or exacerbation of inequalities, and uncertainties.

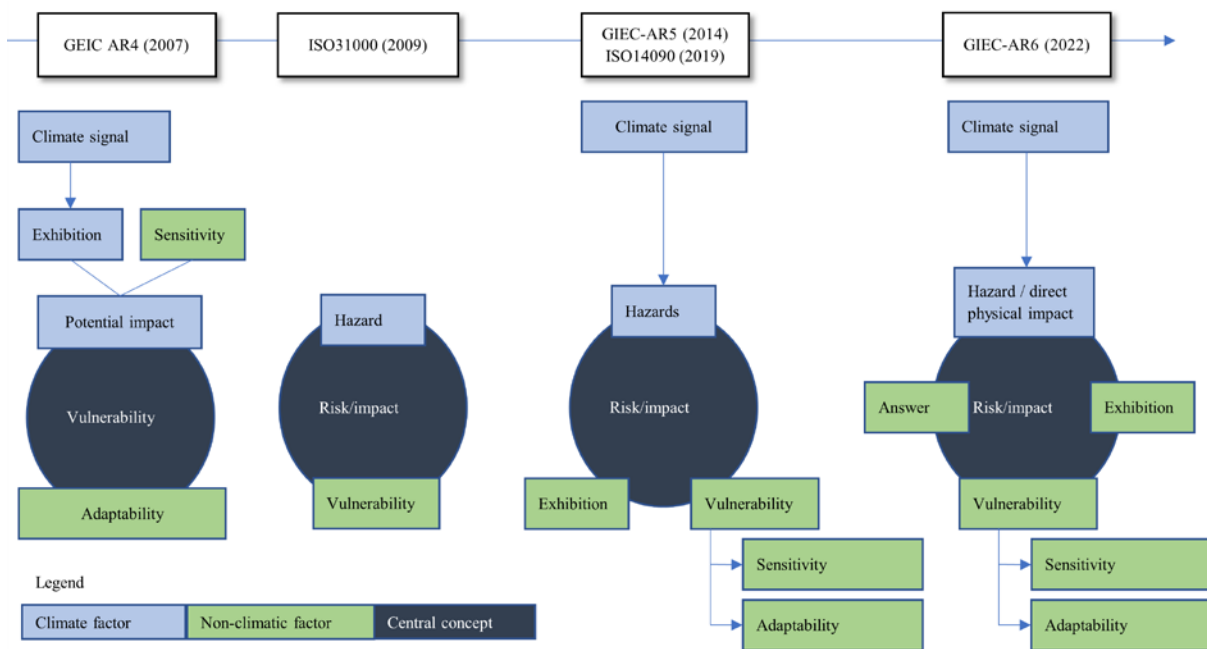
That said, the very notion of climate risk is evolving. It is now based on the intersection of four main axes: hazards / direct physical impacts; exposure; vulnerability (sensitivity, adaptive capacity); and response (IPCC, 2022; see Figure 1). Decision-making needs to be based on this definition for both slow-onset risks (climatic stresses) and rapid-onset risks (climatic shocks) and for both current and future climate contexts.

Moreover, as collective concern for environmental and social issues has evolved, the evidence-based practices of economic analysis have adapted to support efficient collective decisions, as illustrated by the most recent cost-benefit analysis (CBA) guides (e.g. OECD, 2018; see box text below).

This approach to long-term efficiency is within the reach of organizations, but does it hold up in the context of climate change adaptation in Quebec? This article illustrates best practices for adapting CBA to the context of climate change, by analyzing a case study carried out in Quebec in 2016 on coastal risks in Percé, on the Gaspé Peninsula (Circé et al., 2016), in order to highlight the benefits of this approach, as well as lessons, recommendations, and avenues for research.



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**Figure 1.** Evolution of the concept of risk through IPCC reports.

Source: Original figure, inspired by GIZ and EURAC (2017), IPCC (2022).

The notion of climate risk is evolving both theoretically and operationally. Starting in the 2000s with a vulnerability-centric conception from the IPCC (2007) and centred on a two-axis risk (vulnerability and hazards) in risk management (ISO31000), the publication of the most recent IPCC report (2022) now defines risk at the intersection of four main axes: hazards / direct physical impacts; exposure; vulnerability (sensitivity, adaptive capacity); and response. However, current operational practices (e.g. ISO14090) are still based on the intermediate 3-axis version of risk (hazards, exposure, vulnerability) (IPCC, 2014).

## WHAT IS COST-BENEFIT ANALYSIS IN THE CONTEXT OF CLIMATE CHANGE ADAPTATION?

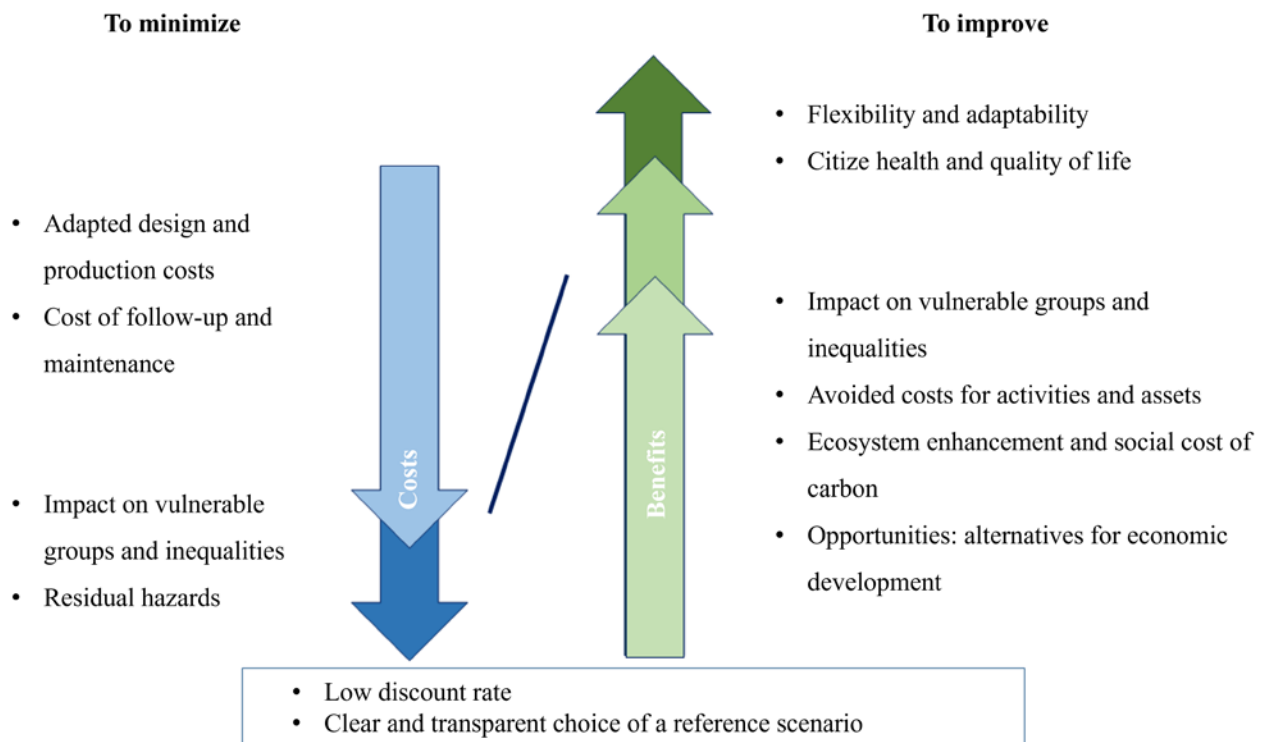
Cost-benefit analysis (CBA) compares the sum of the net benefits of each adaptation option from society's point of view. It is a method that has been widely used by various levels of government for several decades. Over a given period, it can be used to estimate the economic value of a project's impacts on its economic, environmental, and social components. CBA makes it possible to compare different adaptation options over time on a common basis through the use of indicators (net present value [NPV]; benefit-cost ratio [BCR]), and thus to classify the options studied according to their economic performance.

A CBA differs from a financial analysis in that it considers an option's direct and indirect economic, environmental, and social benefits and costs, whereas a financial analysis is concerned only with cash flows for the promoter and does not take into account the externalities associated with carrying out a project, such as its social and environmental impacts.

Carrying out a CBA includes six main steps: 1) identification of adaptation options; 2) identification of the perceived impacts of adaptation options and non-intervention; 3) monetization of negative impacts (costs) and positive impacts (benefits); 4) estimation of the costs of implementing adaptation options; 5) comparison of costs and benefits; 6) sensitivity analysis of results (Adapted and translated from Circé et al. 2016).

In the context of climate change adaptation, solutions designated as "optimal" following a CBA are those that

- minimize costs (design, implementation, maintenance, impact on vulnerable groups, etc.),
- increase benefits (averted costs for risky activities; ecosystem enhancement including the social cost of carbon; enhancement of regional economic drivers, health, and quality of life),
- offer flexibility and adaptability in the future, while remaining robust (see diagram below).



Factors to be minimized or increased for optimal adaptation solutions to be evaluated with the CBA.

Source: Original figure.

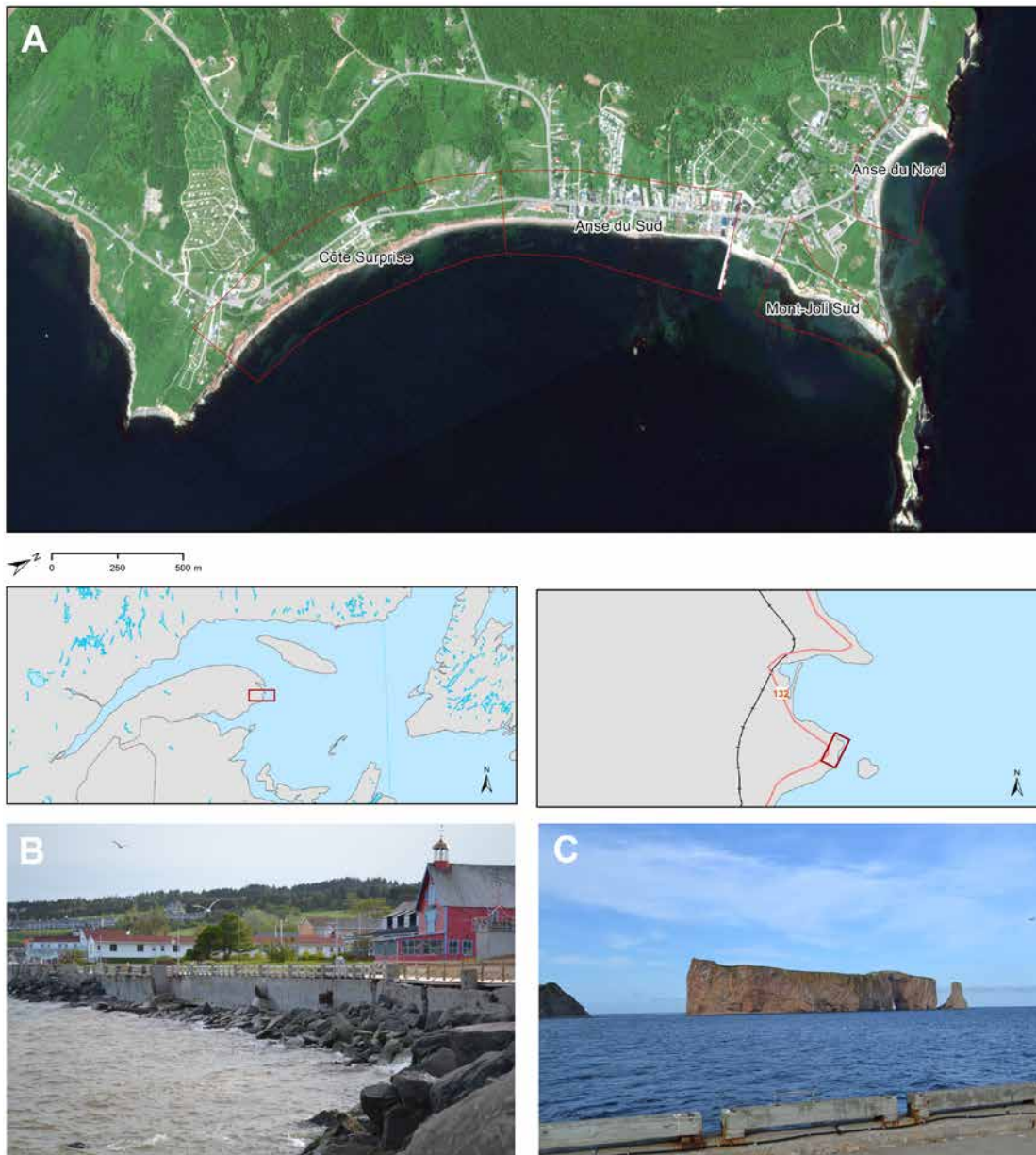
# Considering Costs and Benefits: The Case of Percé's Boardwalk in the Face of Bank Erosion

## INFORMED COLLECTIVE CHOICE: RISK-BASED CBA FOR CLIMATE CHANGE

Percé's iconic promenade provides a privileged view of the spectacular Percé Rock and attracts around 4,000 tourists annually (Circé et al., 2016). However, coastal hazards—mainly bank erosion—have damaged the boardwalk, which dates back to the 1960s, with an

anticipated erosion rate of 9–15 cm/year, jeopardizing infrastructure. Faced with this situation, the municipality and the provincial and federal governments joined forces to make an informed decision about whether or not to jointly invest in repairing the boardwalk. And, if so, which option would be most advantageous in the long term. The following options were considered:

- Non-intervention
- Rebuilding a boardwalk that can withstand future conditions
- Pebble beach nourishment
- Pebble beach nourishment with groynes (structures perpendicular to the shoreline to attenuate wave energy)



**Figure 2.**  
**A.** Location (Circé et al., 2016) and  
**B.** Percé Promenade before its rehabilitation (2014)  
**C.** View of Percé Rock from the quay.

Photo credits: Ouranos.

To make this informed collective choice, a CBA was carried out, comparing several adaptation options. However, certain key points were modified to account for climate change:

1. Extending the timeframe for decisions
2. Integrating climate risks
3. Choosing solutions to take greater complexity into account

The modifications and improvements made to the CBA for the Percé case are summarized in Table 1. To reflect the state of the art since 2016, additions have been made (CBA Guide, OECD, 2018, and Guide ACA Inondations, Boyer-Villemare et al., 2021). The glossary below lists and defines the technical terms used.

GLOSSARY	
Term	Definition
CBA	Cost-benefit analysis: Compares the sum of the net benefits of several adaptation options from society’s point of view, on a common economic basis, in order to classify the options studied according to their economic performance (modified and translated from Circé et al., 2016).
GBA Plus	Gender-based Analysis Plus: A rigorous method for assessing systemic inequalities, as well as for assessing how diverse groups of women, men, and gender-diverse people may experience policies, programs, and initiatives (according to the Government of Canada).
SCC	Social cost of carbon: Measures the present value in monetary terms of the damages incurred when an additional ton of carbon is released into the atmosphere. It is determined by the institutions that manage public environmental policies (OECD, 2018).
InVEST	Integrated Valuation of Ecosystem Services and Tradeoffs: A suite of models used to map and value the goods and services from nature that sustain and fulfill human life. It helps explore how changes in ecosystems can lead to changes in the flow of many different benefits to people (Natural Capital Project).
Discount rate	Expresses the speed at which values depreciate over time, to reflect people’s preference for the immediate satisfaction of their needs. It makes it possible to report values in net present values (NPV), and thus compare scenarios on this common “discounted” basis (translated from Boyer-Villemare et al., 2021).
NPV	Net present value: The sum of present and future values discounted over the period to compare options (translated from Circé et al., 2016, and Boyer-Villemare et al., 2021).
RCP 4.5 and 8.5	Radiative concentration pathways: The greenhouse gas concentration scenarios used in the fifth IPCC report. RCP4.5 corresponds to intermediate emissions, and RCP8.5 to high emissions.
SSPs	Shared socioeconomic pathways: Scenarios used in the sixth IPCC report, which take into account not only emissions scenarios, but also socioeconomic choices relating to decarbonization. The equivalent of RCP4.5 is SSP2-RCP4.5; the equivalent of RCP8.5 is SSP4-RCP7.0.



CBA improvements to incorporate climate risks	Best practices	CBA coastal zones (Circé et al., 2016) *other more recent sources
<b>1. Extending the timeframe for decisions</b>	Temporality (study period)	50 years, divided into 3 climate horizons
	Intergenerational equity, inclusion, and environmental assets and services	Integrated into solution design as well as impact assessment
	Decreasing discount rate	4%, sensitivity at 2% and 6% *4% for 30 years, then 2% for 20 years, sensitivity to 2% and 6%
<b>2. Integrating climate risks</b>	Climate hazard information	<i>Erosion</i> : UQAR, based on expert opinion, probabilistic <i>Submergence</i> : Ouranos technical analyses, RCP4.5 and 8.5, simple probabilistic, with sensitivity analysis by safety margin
	Impact chains <ul style="list-style-type: none"> <li>• Consequence levels</li> <li>• Integration</li> </ul>	Project-specific approach: Consequences at 2 levels: direct, then indirect with indicators for the 3 pillars of sustainable development
<b>3. Choosing solutions that take into account system complexity and socio-environmental co-benefits</b>	Reference scenario	Non-intervention
	Quantifying ecosystem goods and services and SCC	Compensations and profit transfers, without SCC *Carbon flow modelling and monetization with SCC, water quality, and biodiversity; for example with InVEST
	Impact on health	Transportation costs to alternative healthcare sites *Function of psychosocial damage per victim
	Equity and distribution analyses	*NPV calculation by type of stakeholder; assessment of the impact of intangibles (social cohesion) in a multicriteria approach
	Residual risks	Residual risk assessment in a multicriteria approach
*Other sources: Boyer-Villemare et al., 2021; OECD, 2019.		

**Table 1.** Good decision-making practices with climatic risks, according to the Percé case.  
Source: Original table.

## EXTEND THE TIMEFRAME FOR DECISIONS: STUDY PERIOD, LONG-TERM LIVING CONDITIONS, DECREASING DISCOUNT RATE

The likelihood of climatic hazards is increasing, and a continuous risk assessment (identification, analysis, and evaluation) is becoming a necessity. In addition to historical hazards, future and emerging risks (typically over a few decades) are better integrated into long-term planning. So, in the case of Percé, a 50-year decision-making period was selected, and the period was divided into three time horizons, in which the climate was considered stable.

In addition, the IPCC calls for the enhancement of minimum and dignified living conditions (“development first”) to be placed at the heart of resilient development trajectories. This includes preserving environmental integrity and redefining the bases of profitability. In the case of Percé, these values were expressed by the various stakeholders, integrated into the adaptation scenarios, and then into the impacts considered in the decision-making process.

Finally, NPV has been used in CBA as an economic indicator of the balance between costs and benefits. The discount rate is applied as a corrective to reflect individuals' preference for the present time; however, this preference exacerbates inequalities between generations. Thus, in the Percé study, a low discount rate of 4% was used, compared to the 6–8% recommended for public policy. Since the Percé case, practices have evolved, and international guides (e.g. OECD, 2018) favour low and decreasing rates over time (see Boyer-Villemare et al., 2016).

## INTEGRATING CLIMATE RISKS

Climate information develops climatic scenarios affecting the likelihood of climatic hazards. The Ouranos Climate Portraits<sup>1</sup> portal supports the prior identification of hazards, which are then refined and applied to the geographical area at issue. It remains a good practice to assess the effect of climate models and scenario choices on decision-making (Charron, 2016), and the sixth IPCC report published new global climate simulations (the CMIP6 ensemble) and global scenarios (SSPs).

At Percé, two emissions scenarios were used for the economic evaluation (RCP4.5 and RCP8.5) to test the sensitivity of the decision.

1. <https://www.ouranos.ca/en/climate-portraits>

Once climate scenarios and variables are determined, the climate impact chains are integrated into the systems using risk assessment standards (ISO14090, -91, -92) and operational tools (CVIIP, BARC from ICLEI, VACCIn). These impact chains are characterized by the following:

- Levels of impact (direct, indirect, and systemic)
- Degree of integration: a diversity of exposed elements (specific vulnerability of assets and activities), but also of impacts on the environment and on the health and safety of populations

In Percé, the risk analysis was based on a modelling approach using expert contracts. The consequences of the erosion hazard were considered both directly (e.g. loss of land) and indirectly (e.g. loss of visitors). As submergence was not an issue, only sea-level rise was considered in the design of solutions. In addition, indicators from the three pillars of sustainable development were used for the integrated impact assessment (see next section).

## CHOOSING SOLUTIONS TO TAKE GREATER COMPLEXITY INTO ACCOUNT

With a range of parameters evolving in time and space, complexity lies at the heart of climate adaptation decisions. This affects the reference scenario, the integrated impact chains, the handling of uncertainties, and the need for complementary analyses.

The choice of reference scenario is between the status quo (current practices) and non-intervention. In the Percé study, the non-intervention scenario was used, reflecting an openness to revisiting previous choices.

In climate adaptation, the diversity of impacts—over and above financial impacts—is central and includes the following:

- Maximized avoided costs: The chosen solution is effective in reducing damage (60–70% of the status quo; Boyer-Villemare et al., 2021), at an affordable total cost.
- Quantifying environmental goods and services: The optimal decision implies no effects, or even marked benefits, for the environment (assessed by using, among others, Markandaya's classification of environmental services (OECD, 2018)).
- The social cost of carbon (SCC): The optimal solution will mitigate the flow of carbon and be effective at reducing risk. The value of SCC is determined by Environment and Climate Change Canada at C\$50/tonne of CO<sub>2</sub> (ECCC, 2016) (research now suggests \$290/tonne of CO<sub>2</sub> (Rennert et al., 2022)).

- Quantifying impacts on health: Analysis of additional healthcare expenditures (lost productivity, loss of quality of life, and additional costs).
- Emergency management costs: The reduction in emergency management costs differentiates certain solutions that significantly reduce exposed assets.

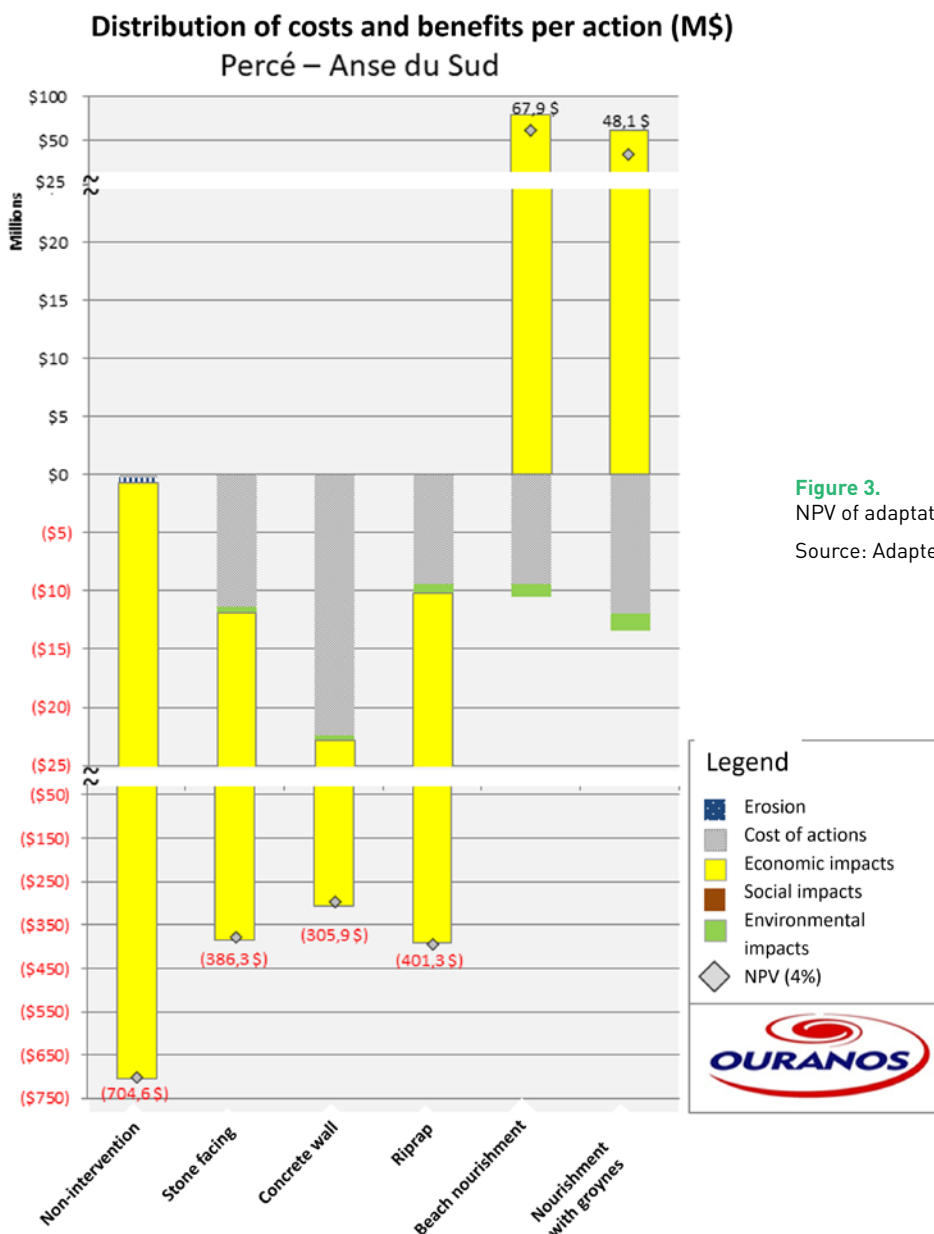
In Percé, the chosen solution avoided 100% of the damage. The environmental impacts of the solutions were considered by transferring benefits according to encroachment and compensation costs, but carbon was not considered. On the health side, the impact considered the loss of access to a beneficial location (daily walking), and was estimated by the additional travel time to an alternative location. The costs of emergency management were not considered.

Finally, additional analyses were necessary to assess the robustness of the decision. In Percé, quantitative

sensitivity analyses (discount rate, climate modelling, hazards) were carried out, but more recently, an a posteriori multicriteria approach is being recommended to integrate more uncertainties into the decision, such as consideration of intangibles and social aspects (e.g. GBA Plus method), residual risks, and others (Boyer-Villemare et al., 2016).

## PERCÉ CBA RESULTS

According to the NPV of the segment at the centre of Percé (Figure 3), non-intervention would generate losses of \$700 million; hazard control solutions (concrete wall, riprap) would lead to losses of \$300 to \$400 million; and, two clearly advantageous solutions (beach nourishment and nourishment with groynes) make it possible to maintain tourist traffic at low realization costs.



**Figure 3.** NPV of adaptation scenarios assessed at Percé  
Source: Adapted from [Circé et al. \(2016\)](#).

# Lessons and Recommendations

## THE BENEFITS OF THIS APPROACH

The Coastal Zone CBA project not only supported the Municipality of Percé and other regional players in the improved management of coastal developments and assets, but also convinced the Quebec government to take action. Indeed, the benefits of this series of cost-benefit analyses are still materializing today (Table 2).

- First level: Collective justification for investing locally
- Second level: Transfer of this CBA approach, based on coastal risks, to other territories or other climatic hazards
- Third level: Transformation of coastal zone institutions and governance, the ultimate level of collective learning for society.

Finally, it should be noted that the follow-up of the outcomes has been carried out through sporadic contacts. This would benefit from being more structured.

## MULTIDISCIPLINARY DIALOGUE FOR ROBUST DECISIONS

Bringing together a wide range of disciplinary knowledge and skills (climate and environmental sciences, disaster risk management, economics, and management) has certainly strengthened the approach. However, it is essential to plan for a multidisciplinary project coordination role.

The climate change adaptation approach also reveals the importance of agreements to make decisions in a context of growing uncertainty (modelling, climate, socioeconomic evolution). To take robust account of uncertainty without hampering decision-making, we need to do the following:

- Adopt a participatory framework that engages stakeholders in dialogue to build consensus on the notions of acceptable risk, intergenerational equity, environmental integrity, and reconsideration of past choices.
- Integrate climate change by analyzing the many uncertainties (Charron, 2016) and providing for updates.

The climate crisis and the biodiversity crisis are interrelated. It is therefore important to integrate environmental benefits into decision-making, environmental impact assessments, and potential adaptations based on nature, like natural or hybrid infrastructure.

Outcome levels	Benefits
First level - Local prevention initiatives (0–5 years)	Following the submission of the project, and encouraged by a storm that caused damage in eastern Quebec, the government announced in January 2017 an investment of \$15 million to support beach nourishment with pebbles and the refurbishment of the quay.  Within five years of the project’s completion, two further investments were made, in line with the most advantageous solutions from the various segments studied.
Second level - Actions to generalize the approach (4–6 years)	Other municipalities and regional county municipalities have joined forces to finance (via the Federation of Canadian Municipalities) the development of a CBA tool for coastal zones, supported by Ouranos. The next step would be to increase its interoperability (with erosion and flooding map updates) and accessibility on government portals.  The approach was transferred to the management of riparian flooding and other river-related risks, and led to a guide on risk-based CBA in the context of climate change. Improvements include: estimation of psychosocial damage to victims; valuation of ecosystem services; distribution of costs and benefits among the different categories of stakeholders involved (agriculture, citizens, municipalities, provincial government).
Third level - Institutional transformation (5 years and over)	The CBA coastal zones project is one element in a broader context of coastal damage management. In 2022, the Quebec government announced the creation of regional interdepartmental offices dedicated to the fight against shoreline erosion and flooding, scheduled for implementation in 2023.

Table 2. Outcomes of the CBA coastal zone project at three levels

## NEED TO ACCELERATE RISK-BASED DECISION-MAKING AND SUPPORT

Finally, as food for thought, it is clear that the various players involved in adaptation want first and foremost to find solutions, which would require a better operationalization of the conceptual framework of risk resulting from the sixth IPCC report. There is also a need for accessible tools and support to generalize and accelerate decision-making based on climate risks, in both public and private organizations. These tools and methods may exist at the boundary between research and society but these questions remain: what operational, accessible, and effective tools can science offer, and what support can organizations receive to help them make the shift to integrating climate risks into their decision-making?

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# REFLECTIONS ON THE AVOID–MINIMIZE–COMPENSATE MITIGATION SEQUENCE IN REGIONAL WETLAND AND WATER BODY PLANS IN QUEBEC

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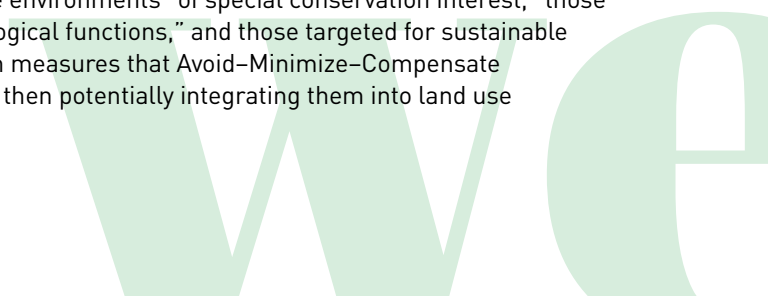
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**W**etlands and water environments (WWEs) are recognized as ecosystems that perform a number of ecological functions, such as protecting biodiversity, sequestering carbon, and controlling water levels. Their conservation and restoration are important for solving the joint crises of biodiversity loss and climate change, as these environments are part of nature-based solutions and contribute to community resilience.

In Quebec, regional county municipalities and RCM cities (hereinafter RCMs) must develop and implement regional wetland and water body plans (RWWBPs), as required by sections 15 to 15.7 of the *Act to Affirm the Collective Nature of Water Resources and to Promote Better Governance of Water and Associated Environments* (the Water Act). RWWBPs must respect three main principles: the objective of no net loss, coherent watershed management, and adaptation to climate change.

According to section 15.2 of the Water Act, RWWBPs must include environments “of special conservation interest,” those “that could potentially be restored to improve their state and ecological functions,” and those targeted for sustainable use. In this way, RCMs become responsible to establish mitigation measures that Avoid–Minimize–Compensate any disturbances to WWEs, by thinking on a watershed scale, and then potentially integrating them into land use planning documents.





Boucherville – Photo crédit: Márcio Cabral de Moura

This sequence is a three-step approach, commonly applied on a project basis, which involves preventing impacts insofar as possible, minimizing any unavoidable impacts, and ultimately balancing residual losses through compensatory actions. Under sections 46.0.1 *et seq.* of the *Environment Quality Act (Loi sur la qualité de l'environnement, or LQE)*, certain projects located in WWEs are subject to a prior authorization procedure and must implement the mitigation sequence. This project-by-project analysis approach applied by Quebec's environment ministry (Ministère de l'Environnement, de la Lutte contre les changements climatiques, de la Faune et des Parcs, or MELCCFP) has significant limitations (Dupont and Lavallée, 2021). The Commissioner for Sustainable

Development (CSD) recently confirmed that the avoidance step, which takes the form of geographical avoidance, by way of demonstrating an alternative site, was not rigorously applied by the MELCCFP (Commissaire au développement durable, 2023).

Integrating the mitigation sequence on a watershed scale enables alternative sites to be identified from a broader spatial perspective, and restoration opportunities to be considered in such a way as to contribute to the ecological network. It also makes it possible to consider issues that are not easily visible at the project scale, for instance, pollution at the head of a watershed that spills over to other municipalities downstream, the cumulative impacts of multiple projects (including those exempt from authorization), regions with high historical WWE losses, or diffuse pollution by various contaminants such as pesticides. Indeed, it can be difficult to establish a causal link between a specific project, which is spatially restricted and delimited, and these forms of pollution, which are complex to detect. Furthermore, the principle of proportionality dictates that the promoter of a project should only have to pay for the damage it causes. Spatial planning thus makes it possible to spatialize and anticipate mitigation measures, without placing a disproportionate burden on project owners, by involving municipal players and others, such as watershed organizations, who play key roles in the implementation of mitigation measures.

Despite this, the integration of the Avoid–Minimize–Compensate sequence into land use plans remains under-studied and under-exploited (Bigard, 2018). With this in mind, this article aims to report on the law relating to RWWBPs, to better understand the opportunities for conservation and restoration when developing them, as well as the implementation challenges regarding the mechanisms of the *Act Respecting Land Use Planning and Development (Loi sur l'aménagement et l'urbanisme, or LAU)*. Some thoughts on the future of RWWBP are proposed throughout the text.

## Regional Planning of WWEs Through the Water Act: Possibilities and Limits

**R**WWBPs are planning tools developed by players who are responsible for land use planning but have jurisdiction over administrative territories that do not necessarily coincide with watershed boundaries. For example, an RCM may exercise its authority within a certain portion of a watershed or over a territory that cuts across several watersheds.

Acknowledging these problems of lack of correspondence and the perverse effects of an overly centralized approach, the idea behind the RWWBP is to leave sufficient space for RCMs to manoeuvre within a system of WWE co-management. The MELCCFP is given a supervisory role, notably in approving RWWBPs and publishing an implementation report every 10 years, as stipulated in sections 15.4 and 17.2, respectively, of the Water Act. The MELCCFP can also “request the amendment of the metropolitan plan or the RCM plan in force” if it considers that it does not adequately protect WWEs, in accordance with sections 53.13 and 165.2 of the LAU; however, in practice these powers are rarely used.

To strengthen the avoidance phase, the scientific literature reminds us that limits must be set on what can be compensated for irreplaceable, difficult-to-restore, or vulnerable environments (Dupont and Lavallée, 2021). RWWBPs are relevant in this respect, as they identify WWEs of interest by evaluating and prioritizing them according to a scale of ecological value that takes into account their conservation or restoration potential. However, under section 46.0.4 of the LQE, the MELCCFP is only obliged to take into consideration the elements contained in the RWWBPs, which allows the Minister to authorize projects even in WWEs designated as being of interest by the RCMs.

In addition, the Water Act stipulates that regional plans should focus only on WWEs, that is, highly valued ecosystems that provide a number of ecological services. Some RCMs have included other, more common and less valued, natural environments in their plans, in order to take a broader view of biodiversity. For example, the four RCMs of the Centre-du-Québec region have included wastelands, woodlands, conservation cores, and natural corridors. The scientific literature recognizes that ecological compensation is most successful when it takes the form of restoration and targets degraded or rapidly regenerating ecosystems, i.e., ecologically simple ecosystems (zu Ermgassen, 2022).

Although the RWWBPs have not yet been adopted, it is already possible to reflect on content elements to be improved for the next generation of RWWBPs, in 2032–2042. In our view, it would be desirable to include all natural environments in the RWWBP. This would make it possible to consider ecological corridors, as well as forest environments, wastelands, and agricultural meadows. In addition, the MELCCFP should also consider WWEs designated as having ecological interest in a RWWBP as reasonable grounds for refusing to issue a ministerial authorization.

## Implementation Promises to Be Difficult, Given the Mechanisms of the LAU

Land use planning mobilizes planners and elected city councillors, who are called upon to think about conservation and restoration measures on more strategic scales when drawing up RWWBPs. One of the difficulties faced by WWE conservation planners is convincing elected representatives and the general public to adopt enforceable standards that restrict use rights and limit economic activities that were previously permitted.

Recall that RWWBPs are neither development plans nor legally binding; these plans express a planning intention by symbolically designating WWEs of interest, but their protection requires the adoption of regional or municipal laws. This is due to the legislator's preference for an obligation of compatibility, as required by section 15.5 of the Water Act. Unlike irreconcilability or conformity, compatibility is an unfamiliar concept in Quebec municipal law, which is likely to give rise to some debate.

Once the RWWBP has been adopted, RCMs must amend their land use and development plan to make it compatible with the content of the RWWBP. The land use and development plan is a mandatory planning tool that has no direct effect on the population but must be





incorporated into municipal bylaws. Local municipalities will thus have to comply with the plan adopted by the RCMs by integrating the WWEs it identifies into their urban plans (UPs) and urban planning bylaws.

However, the legislator's choice to opt mainly for regional (from land use and development plan to UP) and local (from UP to zoning bylaw) LAU compliance mechanisms seems to us suboptimal, as they involve lengthy procedures and delays, which reduce their effectiveness (Rochefort, 2021). Although the process is clear and compulsory, the fact remains that some land use and development plans have not been amended for over 30 years. What's more, once initiated, the plan review process is slow and takes several years, even decades. To speed up the process, RCMs can adopt interim control bylaws or regional bylaws, notably on natural constraints, water drainage, or deforestation. These offer interesting restrictive powers but are optional and left to the discretion of RCMs.

Also, the integration of mitigation measures into urban planning documents is necessary to better anticipate the deployment of avoidance and compensation (Bigard, 2018). This represents significant progress, since it is increasingly recognized that urban planning documents improve the effectiveness of the mitigation sequence. To achieve this, local municipalities have numerous powers to conserve WWEs (buffer strips, density, use restrictions, discretionary permits, etc.).

In this context, since property rights are not absolute, local municipalities will be able to limit uses, for example by restricting tree logging in accordance with section 113 (12.1) of the LAU. However, the exercise of this ability was interpreted as a disguised expropriation in *Dupras v. Ville de Mascouche* (2022). Consequently, it seems less risky for municipalities to rely on the constraint zones of section 113 (16) of the LAU, which allows them "to regulate or prohibit all or certain land uses," as confirmed in *Pillenière, Simoneau v. Saint-Bruno-de-Montarville* (2021).

In addition, recent decisions by the Supreme Court in *Annapolis Group Inc. v. Municipalité régionale d'Halifax* (2022) and the Superior Court in *Sommet Prestige Canada inc. v. Ville de Saint-Bruno-de-Montarville* (2023) would seem to justify legislative intervention to clarify the scope of municipal regulations on the conservation of natural environments, to increase legal certainty and predictability. Current legislative amendments to the *Expropriation Act* should be followed up in this regard. It would also seem desirable to clarify the scope of zoning bylaw powers by adding a principle of non-compensation to section 113 of the LAU. Such a clarification would make it possible to limit compensation when uses are restricted by regulation.

To sum up, the mechanisms of the LAU can generate significant delays and even legal proceedings. To facilitate the work of local players, it would seem desirable to revise the LAU to review land use planning in light



Photo credit: Gilles Douaire

of contemporary issues (Mercier and Simard, 2020), thereby facilitating biodiversity conservation and the fight against climate change. This could be accompanied by a review of voluntary conservation tools, such as personal servitudes, or by the introduction of a real environmental duty, to encourage property owners to undertake conservation actions (Racicot, 2022).

## Outlook for RWWBPs in an Uncertain Legislative and Institutional Context

**A** WWE co-management system, including regional plans, is not necessarily effective as soon as it is implemented; rather, it becomes effective through learning and continuous improvement. The system's agility is crucial if we expect an improvement from feedback experiences. The ten-year assessment provided for in section 17.2 of the Water Act is encouraging, but more is needed for truly adaptive governance. Let's hope that the global assessment will make it possible to report on avoidance, minimization, and compensation measures, particularly in terms of their variety of forms and effectiveness, so as to gain more insight into what is actually being done in the field. For the time being, a cross-analysis of the RWWBPs is difficult due to the heterogeneity of the data and methods followed by the RCMs.

On the other hand, ignoring the avoidance phase, as was reported by the CSD, generates too many compensation requirements, which risks (over)mobilizing farmers when searching for potential areas to accommodate compensation. It therefore seems desirable to exempt active restoration from requiring authorization from the *Commission de protection du territoire agricole du Québec* (CPTAQ), to limit the CPTAQ's discretionary power in this area. This would require an amendment to section 26 of the *Act to Preserve Agricultural Land and Agricultural Activities*, to add a reference to the fact that "the conservation and restoration activities of WWEs make it possible to maintain the agricultural purpose of the parcel concerned, even if the use made of it is not devoted to agriculture."

Ultimately, the municipal world can and must act in concert with the provincial government to help achieve the objectives of the RWWBPs. More than a legal obligation, RWWBPs represent an opportunity to finally recognize and value these natural environments, and to align government action toward a shared vision of climate change adaptation and biodiversity conservation.

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## Law and Politics

# THE BIDEN ADMINISTRATION'S CLIMATE REPORT: DISTINGUISHING THE POSSIBLE FROM THE DESIRABLE

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**O**n January 20, 2021, Democrat Joe Biden was sworn in as the 46<sup>th</sup> president of the United States, ending Donald Trump's four years of dismantling the US federal government's ability to address climate change (Cloutier-Roy, 2020). Power came into the hands of an administration that, during the election campaign, had touted an ambitious vision for the climate issue. In the first two years of the Biden administration, climate issues were again high on the White House agenda. While the progress made in 2021 and 2022 was not optimal, it demonstrates the president's limited ability to effect profound change. Still, there is reason to hope that some of this progress can be sustained over time, even if Republicans return to power after the 2024 election.



## From Promises to Results

**B**etween an unprecedented pandemic and an insurgency that threatened the transfer of power, the 2020 election left little room for substantive policy debate. For the first time in its history, the Republican Party didn't even have an election platform and was content to reaffirm its unwavering support for President Trump. The Democratic Party, on the other hand, came up with one of the most progressive platforms in its history. Biden, considered a moderate Democrat, wanted to avoid a repeat of 2016, when Hillary Clinton failed to sufficiently mobilize the supporters of social democrat Bernie Sanders. Biden was therefore careful to include people from the Sanders (also a candidate in the 2020 presidential primaries) camp in developing the Democratic platform. In the environmental arena, the influence of progressives was noticeable: the word "climate" appeared 63 times and the concept of "climate justice" was mentioned for the first time (Democratic Party, 2020).

It makes sense for Biden to focus on the climate issue. Not only does it allow him to mobilize the left wing of the Democrats without alienating moderate party members, but it also clearly differentiates him from climate skeptic Donald Trump at a time when two-thirds of the American people think the federal government isn't doing enough to combat climate change (Tyson and Kennedy, 2020). Biden's commitment, however, goes beyond electoral calculation. The former senator from Delaware is part of a generation of Democrats who came to Congress in the 1970s, when environmental issues were much less politicized, and they mobilized members of both parties, including Biden himself. During the campaign, Biden boasted several times that he was the author of the first climate change-related bill, which was passed in 1987 (Kruzel, 2019). On the campaign trail, Biden promised a "plan for a clean energy revolution and environmental justice" that would include carbon-neutral energy production by 2050, building resilient infrastructure to address the climate crisis, returning US leadership onto the world stage, and protecting disadvantaged communities from abuse by polluting companies. These commitments are to be funded through investments of \$1.7 trillion over a 10-year period. To win public support for his pharaonic plan, Biden has promised to create 10 million jobs in the green energy sector. An optimist, Biden espouses the "Sternian consensus" (named after British economist Nicholas Stern), according to which the fight against climate change can spur economic growth by investing in the energy transition (Séguin, 2022).

As the president, Biden has taken several actions related to climate issues, including administrative, legislative, and international policy actions. On the administrative side, within hours of taking office, he issued an executive order, titled *Protecting Public Health and the Environment and Restoring Science to Tackle the Climate Crisis*, directing federal agencies to prioritize the climate crisis and review any Trump administration policies that contradict that directive. It also called on them to prioritize assistance to disadvantaged communities disproportionately affected by pollution and climate change. The decree also rescinded the construction permit for the Keystone XL oil pipeline between Canada and the US, which was presented as a violation of US national interests. On January 27, 2021, a second executive order, titled *Tackling the Climate Crisis at Home and Abroad*, confirmed the creation of the position of Presidential Climate Envoy to represent the administration in international negotiations. This position would be entrusted to John Kerry, who, as Barack Obama's Secretary of State, was involved in the negotiations that led to the adoption of the Paris Agreement on climate in 2015. The executive order also announced the establishment of the White House Office of Domestic Climate Policy and of the National Climate Task Force, with representation from most Cabinet members and led by the National Climate Advisor (Gina McCarthy, former Administrator of the US Environmental Protection Agency, until September 2022). Lastly, in October 2022, the White House released its National Security Strategy (NSS), an exercise conducted by each administration to identify threats facing the United States. The word "climate" appears 63 times in this 48-page document, and the climate crisis is described as an existential threat to all nations on the planet. This (re)securing of the climate issue stands in stark contrast to the Trump administration's 2017 NSS, which completely omitted the climate threat, except to highlight the danger to US economic and energy interests posed by activists with an "anti-growth energy agenda"!

On the legislative front, the White House must contend with a marginal Democratic majority in Congress. Despite this limitation, several of the major bills passed in the 117<sup>th</sup> Congress (2021–2022) contain elements related to the climate crisis and energy transition. The *American Rescue Plan Act*, passed in March 2021 to revive the US economy after the COVID crisis, includes hundreds of billions of dollars to fund mass transit and help communities upgrade their infrastructure to cope with climate change (Meyer, 2021). The *Infrastructure Investment and Jobs Act* of November 2021 is a massive \$1.2 trillion infrastructure plan, including \$50 billion to help American communities address the impacts

of climate change, and \$65 billion for electric infrastructure modernization and energy transition. Lastly, the Inflation Reduction Act of August 2022 provides hundreds of billions of dollars in investments and tax incentives to accelerate the energy transition. Although these sums are only a fraction of the \$1.7 trillion promised during the campaign, the Act has been enthusiastically welcomed by much of the scientific community, which salutes the fact that it should help the United States achieve carbon neutrality by 2050 (Seltzer, 2022).

President Biden quickly signalled the United States' return to the global fight against climate change. Just hours after being sworn in, he announced that the country was rejoining the Paris Agreement. In April 2021, the White House hosted a Leaders Summit on Climate, attended by 38 heads of state and governments (including adversaries Xi Jinping and Vladimir Putin). At the end of the summit, all participants made new greenhouse gas emissions reduction commitments that, if met, will bring the international community closer to the Paris Agreement goal of limiting temperature rise to 1.5 degrees (Climate Action Tracker, 2021).

## What Is the Outcome?

**T**o take stock of the Biden administration at midterm, it is important to distinguish what is possible from what is desirable. Admittedly, Biden has not delivered on some of his more ambitious 2020 campaign promises. However,

we must not lose sight of the extraordinary constraints to which his administration is subject. These are threefold.

First, the President must cope with the institutional constraints of a fragmented political system, characterized by a vertical separation of powers (between the federal government and the states) and a horizontal separation of powers (between the executive branch of the president, the legislative branch of Congress, and the judicial branch of the Supreme Court). This dual separation of powers means, for example, that the White House cannot intervene in a state's environmental policy without risking being overruled by the courts, and it cannot decide to spend energy transition funds that have not been approved by Congress. At the federal level, the fragmentation of power slows down the political process. Time becomes a precious commodity for the President, who has a limited window of opportunity to pass the most ambitious elements of his agenda.

Second, Biden is operating in a context of heightened polarization. With marginal Democrat majorities in the Senate and House during the 117th Congress, the White House could not count on Republican support and therefore had no room to advance its environmental agenda. As a result, it had to make more concessions to more moderate Democrats, such as the senators Joe Manchin (West Virginia) and Kyrsten Sinema (Arizona). Biden, who entered the Senate in 1973, can attest to how the inexorable growth of polarization has proven harmful to environmental policy. Polarization can also have long-term effects. For example, the appointment



Photo credit: Thomas Hawk

of three Supreme Court justices under Donald Trump has created a conservative supermajority there that is likely to strongly influence the fight against climate change for a long time to come, as evidenced by the 2022 *West Virginia v. EPA* decision limiting the Environmental Protection Agency's ability to impose caps on greenhouse gas emissions at the state level.

Third are the constraints associated with the particular situation of 2021–2022. Biden, elected to lead a divided nation grappling with the worst health care crisis in more than a century, saw his political capital rapidly erode in the summer of 2021, as a result of the botched withdrawal of American troops from Afghanistan and the inflation crisis. The inflation problem is particularly pernicious because it creates an environment in which politicians can hardly talk about the fight against climate change without giving the impression that they have nothing to do with the everyday concerns of the population. As of 2022, the war in Ukraine is again putting the brakes on the Biden administration's climate policy ambitions. Not only is the war exacerbating inflation (which peaked at 9.1% in June 2022), but it also consumes the White House's foreign policy attention. There has been no follow-up to the 2021 leaders' summit (from which Putin would presumably be excluded), and we are still waiting for a return to cooperation between Washington and Beijing on the climate crisis, which was put on hold under Trump. Then, 2023 began with the Republican Party taking control of the House of Representatives, which bodes ill for the Democrats' ability to advance their climate change priorities in the 118th Congress.

As the next presidential election nears, the future of the fight against climate change in the United States is still shrouded in uncertainty. As of the writing of this report, in May 2023, none of the major declared or likely Republican candidates (Ron DeSantis, Nikki Haley, Asa Hutchinson, Mike Pence, Mike Pompeo, Tim Scott, and Donald Trump) have spoken out on the climate issue. The degree of their climate skepticism varies, but all indications are that the White House would take a step back on this issue if a Republican took office in 2025. On the world stage, this would likely mean a waning of US leadership, similar to what was seen under Trump and, before that, under George W. Bush. Domestically, however, a complete departure from the policies adopted under Biden seems unlikely unless further changes occur. Unlike Barack Obama, the 46th president of the United States has managed to pass his most important measures in the form of legislation rather than executive

orders. Repealing them would therefore require new legislation. A Republican administration would do well to avoid such an undertaking. Not only is the outcome in Congress uncertain, but the Republican Party would likely suffer from the repeal of measures that include federal funds and tax credits, both popular measures to promote the energy transition, which a majority of the electorate wants anyway. In short, while Biden may not be the president who can bring about the climate revolution many hope for, his approach to politics as the art of the possible suggests that, from his first two years in office, he will leave a legacy for a viable energy transition process in the United States.

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## Law and Politics

# WHEN STANDING IS NO LONGER AN OPTION: CREATION OF A LOSS AND DAMAGE FUND AT COP27

Photo credit: Climate Alliance

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**A**t the conclusion of the 27<sup>th</sup> Conference of the Parties (COP27) of the United Nations Framework Convention on Climate Change (UNFCCC) (in Sharm el-Sheikh, Egypt, November 6–18, 2022), countries agreed to set up a new fund to support vulnerable countries suffering losses and damage from climate change (UNFCCC 2022a, para. 3; 2022b, para. 46). Although the modalities of this fund have yet to be determined, its creation will mark a turning point in international climate negotiations. And with good reason: this avenue has long been rejected by developed countries, despite the repeated insistence of those countries particularly vulnerable and sensitive to the harmful effects of climate change. These countries consider such a fund to be vital, since they suffer disproportionately from the damage caused by climate change, without being responsible for it and without having the necessary resources to deal with it.

This article takes a closer look at the creation of this new fund and outlines the main advances made at COP27 on the issue of loss and damage (L&D). To do so, it first offers some definitions of this generally little-known concept, and then situates the issue of L&D in the broader context of international climate negotiations. Finally, based on field observations and an analysis of the decisions handed down in Sharm el-Sheikh, it looks at the concrete achievements of COP27 on the issue of L&D, as well as the next steps leading up to COP28 (November–December 2023).

COPs, or Conferences of the Parties to the UNFCCC, are annual gatherings of around two weeks during which countries negotiate on how to mitigate climate change and its impacts. The 27th Conference of the Parties, or COP27, was held in November 2022 in Sharm el-Sheikh, Egypt.

## What Is Loss and Damage?

Simply, *loss and damage* refers to the negative impacts of climate change that cannot be avoided despite the implementation of measures to mitigate or adapt to climate change. These damages may result from rapidly evolving climatic events (e.g. violent storms, extreme heat waves, floods) or from slowly evolving ones (e.g. rising sea levels, soil desertification, biodiversity loss). To varying degrees, they give rise to economic losses (e.g. destruction of infrastructure, reduced agricultural yields) and non-economic losses (e.g. loss of human life, damage to cultural heritage) (UNFCCC, 2018a).

Developing and least-developed countries are generally the hardest hit by L&D, while their geographical location and lack of resources make them particularly vulnerable to the impacts of global warming. Think, for example, of the countries of Sub-Saharan Africa, which are suffering the aftershocks of increasingly frequent and intense droughts, or of small Pacific islands, whose very existence is threatened by rising sea levels.

## An Issue Long Neglected

The idea for a financial mechanism to respond to the damage caused by climate change is not new. It first appeared in international climate negotiations in 1991, when the UNFCCC was being negotiated. This treaty laid the foundations for global climate governance and the various international climate actions we know today.

At the time, the Alliance of Small Island States proposed the creation of a collective loss-sharing system to compensate developing countries threatened by rising sea levels. The proposal was not accepted.

This setback set the tone for negotiations on L&D until the late 2000s. No action or structuring mechanism emerged during this period. It wasn't until 2013, at COP19, that the issue officially returned to the table, with the creation of the first official structure dedicated to the issue of loss and damage: the Warsaw International Mechanism for Loss and Damage (WIM). Although it was a significant first step, this new structure did not address the very essence of the problem, namely, the question of the liability of major greenhouse gas (GHG) emitters and the ensuing compensation. Even today, WIM aims, at best, to 1) improve understanding of the concept of loss and damage; 2) facilitate discussion between the stakeholders involved; and 3) strengthen action and support in the event of loss and damage (UNFCCC, 2018b).

Subsequently, in 2019, COP25 led to the creation of the Santiago Network on Loss and Damage, a new WIM structure made operational at COP27. Today, it enables vulnerable countries to benefit from technical assistance from experts to help them cope with the impacts of climate change (UNFCCC, 2020). Once again, this new mechanism did not address the issue of compensation nor the creation of a fund, much to the dismay of the most vulnerable countries affected by climate disruption.

The main bone of contention was, and still is, the reluctance of developed countries to be held legally responsible for the impacts of the climate changes we are experiencing today, though they have historically been mainly responsible for them (Dunne et al., 2022). This would legally oblige them to provide compensation, which could be colossal, to countries suffering L&D. This is a Pandora's box they do not want opened. Moreover, the question remains: who would pay such compensation? This question is another major sticking point in the negotiations, as developed countries want emerging countries such as China and India, which have also become major GHG emitters, to also contribute to paying this massive bill (Sguazzin and Rathi, 2022).

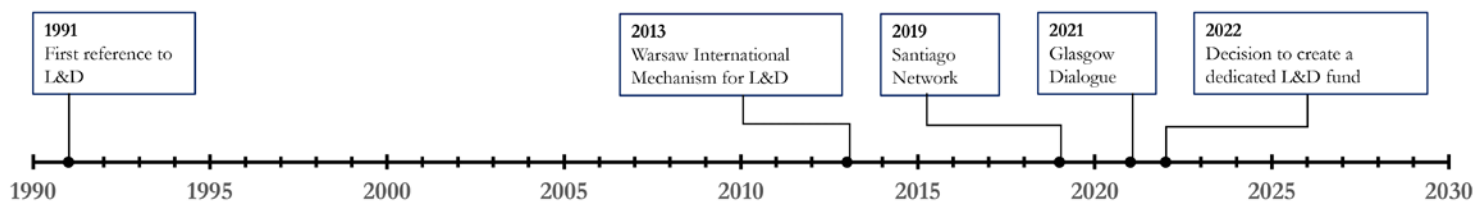


Figure 1. Historical overview of the issue of L&D in international climate negotiations



Nevertheless, a way forward opened up at COP26 in Glasgow in 2021, with the establishment of the Glasgow Dialogue, a three-year platform to “discuss modalities for financing activities to prevent, minimize and address loss and damage from the adverse effects of climate change” (UNFCCC, 2021, para. 73). Although this Dialogue makes no reference to the notions of responsibility or compensation by developed countries, it does not close the door to the creation of a fund for the L&D of the most vulnerable countries. Such a fund was central to negotiations at COP27 in 2022 and will be again at COP28 in November–December 2023.

## Outcome of COP27 and Follow-up for COP28

**E**xpectations for COP27 were particularly high from member states and observers alike. Presented by the Egyptian presidency, with a slogan of “Together for Implementation,” the conference was billed as the implementation COP. It was intended to accelerate the fulfillment of climate commitments in the areas of GHG emissions reduction, climate financing, and adaptation to climate change, in addition to advancing discussions on L&D. (Beaudoin et al., 2023). In this respect, an analysis of the decisions handed down at COP27, combined with observations in the field, lead us to conclude that the issue of L&D saw several significant advances.

At the symbolic level, COP27 led to a more explicit recognition of the existence and severity of the problem of L&D. This was reflected in the conference’s closing decision, in which, for the first time countries, “underline[d] the importance of an adequate and effective response to loss and damage” and expressed their “deep concern regarding the significant financial costs associated with loss and damage for developing countries” (UNFCCC, 2022b, para. 44-45). In political terms, this recognition now makes the issue of L&D a challenge to which the international community must respond, specifically by tackling its financial dimension.

The decision to set up a dedicated fund for L&D appears to have been the biggest breakthrough on this issue of COP27, and perhaps even of the Conference itself. It is both a political and symbolic victory for the developing and most vulnerable countries, which have been campaigning for decades for such a fund to be established and which redoubled their efforts in the

run-up to COP27 in order to present a common position. It also represents an important step forward in terms of climate justice. For the first time we see the potential for the planet’s major GHG emitters to help pay for the damage caused by climate change, which they are primarily responsible for.

However, much remains to be done to put this decision into practice, as the operating procedures and sources of financing for this new fund have yet to be determined. This will be the subject of negotiations during COP28 (November–December 2023), notably via a Transitional Committee set up by COP27. This committee of 24 members, including 10 from developed countries and 14 from developing countries, is mandated to issue recommendations for consideration and adoption at COP28 (UNFCCC, 2022a). More particularly, the committee will aim to make the new fund operational by the end of COP28, by seeking to do the following, among other things:

- Establish the form this new fund will take, i.e., its mandate, structure, governance, modalities, and institutional arrangements;
- Define aspects of other financing terms;
- Identify and expand funding sources; and
- Ensure coordination and complementarity with existing financing mechanisms (UNFCCC, 2022a, para. 5).

Clearly, negotiations at COP28 will have to determine the technical details and major parameters of this new fund. Some thorny issues will need to be resolved (Åberg, 2023), including the one mentioned above: which of the developed and/or emerging countries will finance this fund? Also, who will benefit, and under what circumstances? The Sharm el-Sheikh decision states that the new financing modalities agreed to at COP27 will be used to assist “developing countries that are particularly vulnerable to the adverse effects of climate change” (UNFCCC, 2022a, para. 5). However, the list of countries in this category has yet to be determined, as has the list of L&D that will be covered by the fund. What’s more, there is no guarantee at present that the fund will be sufficiently endowed to meet the growing needs of the countries affected. Therefore, what mechanisms and provisions should be put in place to encourage, or even compel, financing countries to contribute sufficiently? This is another question to be answered at COP28.

## Conclusion

**C**OP28 is already attracting the attention of many observers, not least because it will be held in Dubai, in the United Arab Emirates, one of the world's largest oil-producing and exporting countries. This conference should enable significant progress to be made on reducing GHG emissions, adapting to climate change, climate financing, and loss and damage (Beaudoin et al., 2023). It will also be decisive for the countries most vulnerable to climate change, which impatiently await the creation of a fund to enable them to repair the damage caused by the growing impacts of climate change. These countries and civil society organizations have high hopes for this fund. Will the international community be able to deliver the goods?

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# CARBON BORDER ADJUSTMENT MECHANISM ADOPTED BY THE EUROPEAN UNION



Photo credit: Parlement Européen

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**T**he European Union (EU) has lofty ambitions in the fight against climate change and the will to develop effective tools to do so. Ursula von der Leyen, President of the European Commission, unveiled the European Green Deal in December 2019, which sets out the EU's roadmap for revising all European regulations and introducing new ones, to align with its environmental ambitions. The Green Deal targets a 55% reduction in greenhouse gas (GHG) emissions by 2030 compared to 1990, and carbon neutrality by 2050, in line with the Paris Agreement (European Commission, 2021). Moreover, these targets have been incorporated into the European climate law that came into force in July 2021. Ultimately, this Green Deal sets up the future European economy through policies concerning biodiversity, building renovations, agriculture, the industrial sector, and innovation.

The task facing the EU is enormous. It is one of the world's leading economic powers, with exports totalling EUR 2,123 billion in 2020, and imports of EUR 1,868 billion. Moreover, imports account for 20% of its GHGs. This is a challenge to which the EU would like to find a solution.

Until now, the European carbon market, known as the Emissions Trading System, has granted free allowances to some industrial sectors. However, the Green Deal's "Fit for 55" package of proposals includes plans to abolish free allowances for these industries and to increase the price of allowances (European Commission, 2021). However, the EU fears that implementing these initiatives will increase *carbon leakage*. This phenomenon occurs when industries react to increasingly stringent environmental regulations, such as a high carbon tax, by relocating their production to a country with less stringent regulations or a lower carbon tax. It is possible that the price of carbon will rise. If this is the case, European companies may find themselves competing with products manufactured abroad, where there is a lower or non-existent carbon price, resulting in a lower product price than the European one.

This is the main goal of the Green Deal's trade component. To achieve its GHG reduction targets and prevent European companies from suffering from unfavourable competitive conditions, the EU has been working on introducing a carbon tax applicable to imports, payable upon entry onto European territory. This is the Carbon Border Adjustment Mechanism (CBAM), proposed by the European Commission on July 14, 2021, and agreed to on December 13, 2022, after intense tripartite negotiations between the European Commission, European Parliament, and Council of the European Union. The agreement reached between the three European institutions was fully adopted on April 18, 2023, by the European Parliament, and on April 25, 2023, by the Council of the European Union. The CBAM is due to become effective, gradually, as of October 2023. The EU's proactive strategy is an original one. By introducing this mechanism, it aims to encourage non-EU countries to align with its own climate ambitions. The progress report on the EU's climate action states that "limiting global warming requires unprecedented action by all countries and all sectors." The EU is well aware that it cannot fight climate change alone.

## Overview of the CBAM

### A GRADUAL, SECTOR-BASED MECHANISM

The EU has designed the CBAM in a cautious and predictable way and will apply it gradually, creating a transitional period. This transitional period is of course necessary, on the one hand to allow the EU to hone its application of this particularly technical mechanism, and, on the other, to allow the industries of the EU's trading partners that will be subject to the mechanism to adjust to the new regulations.

As mentioned previously, the mechanism will come into force on October 1, 2023 (European Parliament, 2023). From December 31, 2024, in accordance with Articles 5 and 17 of the regulation establishing the CBAM, importers will have to apply for authorized declarant status before importing goods into the EU. From December 31, 2025, customs authorities will have to inform declarants of their obligations under Article 35 of the regulation, which requires importers to produce a quarterly declaration containing information on imported goods (quantity of products, quantity of GHGs emitted, carbon price paid in the country of production, etc.). However, on January 1, 2026, the regulation will come into force in its entirety. The key point here is that negotiations on the regulation's entry into force was correlated with the negotiation of the abolition of free allowances under the Emissions Trading System (ETS). The EU has thus planned to phase out free allowances gradually as of 2026, then fully by 2034, which is precisely when the CBAM will reach its full potential.

As regards practical application, the CBAM will apply to products from industries deemed by the EU to be most at risk of carbon leakage. Tripartite negotiations on this issue were particularly intense. The European Commission's proposal concerned only steel, iron, aluminum, cement, nitrogen fertilizers, and electricity generation. After lengthy negotiations, the CBAM will also apply to hydrogen, indirect emissions, and some end products such as bolts and screws. These sectors account for no less than 60% of carbon dioxide (CO<sub>2</sub>) emissions from the region's industrial sector. At the end of the transitional period, the European Commission will study the possibility of expanding the list to other products, including organic chemicals and polymers.

### HOW THE MECHANISM WORKS

The CBAM has a technical design. European institutions had no choice but to optimize and simplify procedures in order to adopt a mechanism that would be applicable by all member states as soon as it came into force. However, the previously mentioned transitional period will also enable the EU to study the mechanism's operation and adjust the process if necessary.

The plan is for importers to purchase carbon certificates corresponding to the price of carbon that would have been paid if the product had been manufactured in the EU, in line with European regulations on carbon pricing. The amount of the carbon certificates will be based on the weekly average price of the ETS allowances sold at auction (in EUR/tonne of CO<sub>2</sub> emitted). Given that the ETS price is calculated daily, the use of a weekly calculation is intended to simplify procedures for importers and member states. The aim of this measure is to tax products in the same way, whether they are manufactured in the EU or imported. The burden of

paying a tariff for GHG emissions created in producing a good is then spread across European industries and third countries. Ultimately, the measure responds effectively to the EU's position that it cannot fight climate change alone.

As mentioned above, the CBAM is technical. The first criticisms levelled at the European Commission's proposal concerned the implementation of the mechanism by member states: it had been proposed that each country create infrastructure to set up the importer registry. On a practical level, this suggestion represented an unnecessary administrative burden. At its very first reading of the Commission's proposal in March 2022, the Council of the European Union proposed centralizing the registry, which would be managed by the Commission itself, and to which national customs services would have access. This simplification was justifiably welcomed (Council of the EU, 2022b).

## A MECHANISM WITH EXEMPTIONS

The CBAM necessarily had to be designed to include exemptions; firstly, so as not to scare off trading partners, and secondly, to comply with the requirements of World Trade Organization law (Dufour and Thool, 2023). From the outset, the European institutions agreed on an exemption for countries and territories listed in Annex II, section A. This exemption therefore applies to countries and territories that have an agreement formally linking

them to the ETS, and if the carbon price paid in that country or territory for goods is effectively allocated without discount.

The CBAM also stipulates that it will not apply to goods of "negligible value," according to the meaning of Chapter V, Article 23, of Council Regulation (EC) no. 1186/2009 of November 16, 2009, which establishes a Community System of Reliefs from Customs Duty. In other words, under this provision, goods with a value not exceeding EUR 150 will not be subject to the CBAM. This provision also applies to travellers' personal goods.

But the most noteworthy exemption concerns products imported from countries that already impose carbon pricing. Article 9 of the regulation states that "an authorised declarant may claim in its CBAM declaration a reduction in the number of CBAM certificates to be surrendered in order for the carbon price paid in the country of origin for the declared embedded emissions to be taken into account" (European Parliament, 2023). To do this, the carbon price must actually have been paid in the country of origin. In other words, the authorized declarant must be able to provide proof of actual payment. Tripartite negotiations led European institutions to specify this obligation, specifically for situations in which importers have obtained discounts or other types of compensation. In such cases, they must have in their possession all documents referring to the legislation in force on carbon pricing discounts or compensation, so that the CBAM can be applied according to the particular situation (European Parliament, 2023).



Photo: Parlement Européen

## Impact on Third Countries

**T**he CBAM was designed to enable European companies to remain competitive, while at the same time raising the level of climate ambition within Europe. At the same time, the mechanism was designed to encourage non-EU countries to increase their contribution to the fight against climate change. In other words, any country wanting to keep importing its products into the EU must either introduce carbon pricing at home or increase its pricing, or the importing industries will have to pay the price in Europe. As the project rapporteur Mohammed Chahim summed up, “It is one of the only mechanisms we have to incentivise our trading partners to decarbonise their manufacturing industry” (European Parliament, 2022).

The EU has included in its CBAM regulations the possibility of concluding agreements with third-party states that already have a carbon pricing system, so as not to impose double taxation (European Parliament, 2023). A number of developed countries have said they are open to the possibility of introducing a similar mechanism or at least of cooperating with European institutions on its CBAM. For example, Canada and the EU have jointly declared their desire to “coordinate on respective approaches to carbon pricing and carbon border adjustments” (Council of the EU, 2022a). However, the question of the impact on developing, and particularly least-developed, countries remains. The tripartite negotiations were difficult in this respect. The European Parliament proposed including an exemption for least-developed countries and small island developing states. However, the Commission’s proposal did not include this exemption. Now, the agreement includes a provision stating that the report to be presented by the Commission before the end of the transitional period must include a study of CBAM’s impact on developing and least-developed countries (European Parliament, 2023). The preamble, however, states that the Commission should provide technical assistance to these countries. It should be remembered that many countries will be affected by the mechanism, such as Trinidad and Tobago and Algeria for the fertilizer sector, Mozambique and Ghana for aluminum, and Zambia and Zimbabwe for steel and iron (Gore et al., 2021). Developing and least-developed countries rightly fear that they will have to bear the consequences of this mechanism’s entry into force.

## Conclusion

**T**he CBAM may have an environmental objective, but it is also designed to meet commercial challenges. This is a real turning point for the EU, which is positioning itself as a leader in the area of climate change and, at the same time, inviting its trade partners and third countries to make a similar move. The first few years of CBAM’s implementation will be crucial in getting the mechanism up and running, and enabling trading partners to adjust to the new measures and customs formalities. In conclusion, it will be interesting in the near future to observe the reaction of developing and least-developed countries and their ability to adapt to these new European regulations while continuing to develop economically.

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## Lancement prévu : Automne 2023

Law and Politics

# THE ROLE OF HEALTH IN NATIONAL ADAPTATION PLANS IN DEVELOPING COUNTRIES

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Measles campaign. Photo credit: hdptcar

## Climate and Health: A Time Bomb

Climate change represents one of the greatest challenges in human history. It brings into question the right to health, which is a fundamental human right (WHO and Health Canada, 2021). According to the World Health Organization (WHO), climate change will cause an additional 250,000 deaths per year by the end of the current decade, due to malnutrition, malaria, diarrhea, and heat stress (WHO, 2014). Under these conditions, the implementation of public health adaptation measures is a priority if we are to protect the health and well-being of the population. This includes designing relevant and effective national adaptation plans (NAPs) (UNFCCC, 2015).

At the 26th Conference of the Parties in Glasgow in 2021, a number of countries pledged to make their health systems resilient to climate change as part of the Alliance for Transformative Action on Climate and Health (ATACh) (WHO, 2023). To help them achieve this, the WHO (2021) has defined quality criteria for Health National Adaptation Plans (HNAPs): 1) leadership and a suitable environment, 2) cross-sectoral coordination and policy coherence, 3) comprehensive treatment of climate-sensitive health risks, 4) comprehensive treatment of adaptation options and measures, 5) resource allocation and, finally, 6) monitoring, evaluation, and communication of results. The aim of this article is to present a comparative assessment of the NAPs submitted to the United Nations Framework Convention on Climate Change (UNFCCC) by different developing countries. This type of analysis highlights the similarities and dissimilarities, and above all the conformity of the content of these plans with accepted standards.

1. The author was awarded the excellence scholarship from Regroupement étudiant de maîtrise, diplôme et doctorat de l'Université de Sherbrooke (REMDUS)



We begin with a definition of the concepts and a brief review of the links between health and adaptation. We then present the chosen methodological approach, before commenting on the results. Finally, we make some recommendations.

## Human Health, Adaptation, and National Adaptation Plans

**H**ealth is “a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity” (WHO 1948). Climate change can therefore affect health in a number of ways. Physical health can be altered: the steady rise in Lyme disease in Canada, where the number of diagnosed cases has increased 1,844% over the last decade, is a meaningful example (Government of Canada, 2022). Not to mention altered mental health due to stress, anxiety, and depression (WHO and Health Canada, 2021). Finally, on a social level, climate change hinders the achievement of sustainable development goals by exacerbating poverty and inequality, particularly for vulnerable populations and geographical areas (WHO and Health Canada, 2021).

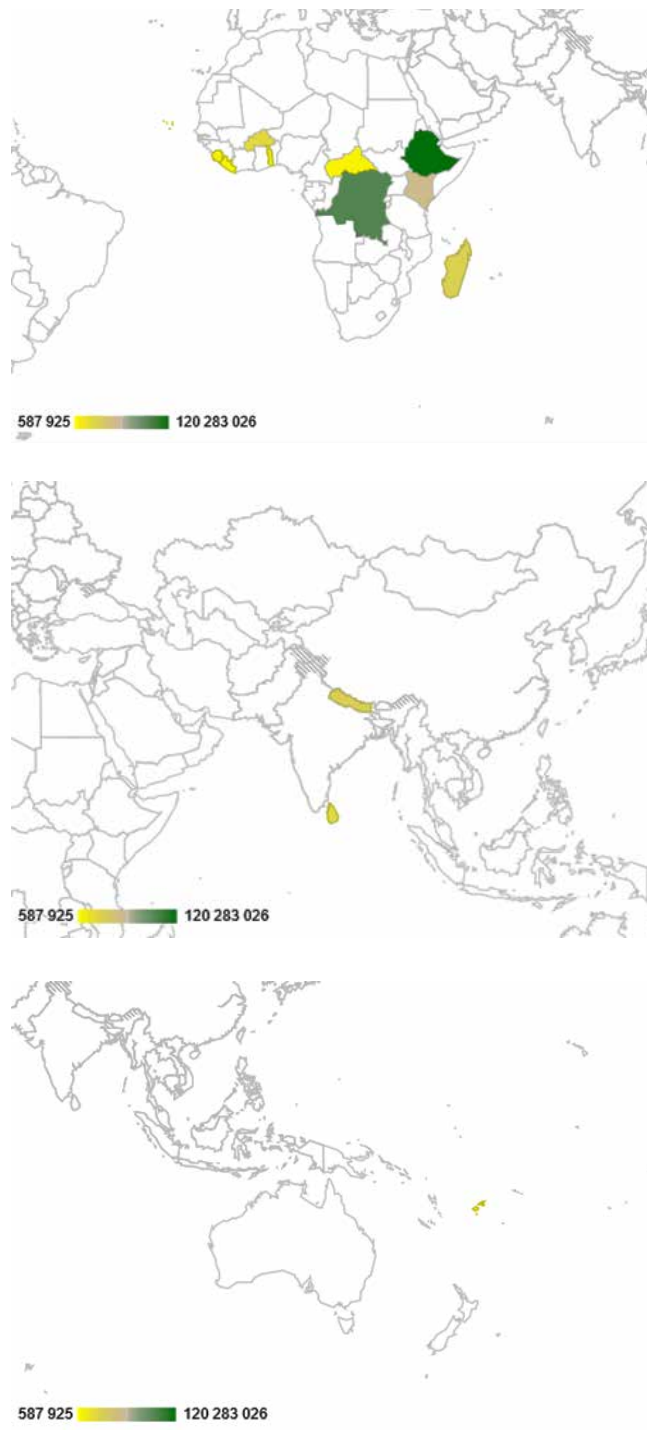
To respond to the health impacts of climate change, it is crucial to assess the strengths and vulnerabilities of healthcare systems, in order to plan the modifications needed to increase their resilience<sup>2</sup>. With this in mind, we thought it would be interesting to study whether and how public health is taken into account in the process of national adaptation plans, with a view to making recommendations for their improvement.

## Methodology

**F**or the purposes of this article, we have chosen to include ATACH (Alliance for Transformative Action on Climate and Health) member countries, as this organization is, to our knowledge, the only emanation of a universal institution whose aim is to increase the resilience of health systems to climate change. The countries selected are those that have officially and freely committed to ATACH and have honoured this commitment by submitting a plan to the UNFCCC. They are Togo, Sierra Leone, Madagascar, Kenya, Ethiopia, Cape Verde, Central African Republic, Sri Lanka, Fiji, Liberia, Nepal, Burkina Faso, and the Democratic Republic of the Congo (Figure 1). Although the number of countries included is small, this

2. It is the capacity of a human community or health system exposed to hazards to withstand, absorb, adapt to, transform, and recover from their negative impacts quickly and effectively (WHO and Health Canada, 2021).

methodology is relevant, as all are developing countries particularly vulnerable to the disastrous health consequences of the climate crisis.



**Figure 1.** Country location and demographics.

World Bank data (2021)

- 500 x 10<sup>3</sup> inhabitants – 31 x 10<sup>6</sup> inhabitants
- 31 x 10<sup>6</sup> inhabitants – 90 x 10<sup>6</sup> inhabitants
- More than 90 x 10<sup>6</sup> inhabitants

We collected the health-related data from a careful and rigorous reading of the NAPs and added them to an Excel spreadsheet. For each content item corresponding to a quality criterion, we added a row to the spreadsheet and created a column for each country in order to visualize the results and create graphs and tables. Finally, we carried out an interpretative analysis of the results, which we present in the next section.

## Results

### IS HEALTH ONLY THE FIFTH PRIORITY FOR ADAPTATION?

Most of the NAPs analyzed (12/13) identified health as a priority and as a particularly vulnerable sector. However, while all the countries opted for a sector-by-sector approach in designing their plans, three of them did not devote a chapter to health, and on average, health only ranked fifth among the priorities. Table 1 summarizes the other results.

Indicators	Percentage
Description of the adaptation objective in the healthcare sector	9 (69.23%)
Definition of roles and responsibilities, in particular those of the ministry of health	5 (38.46%)
Permanent role of the health sector in NAP coordination	12 (92.30%)

**Table 1.** Significance of health in NAPs. Number of NAPs exhibiting the indicator and percentage of total NAPs analyzed (out of 13).

Among the countries that have presented their health adaptation objectives, some simply give the objectives of their national health policy in general terms (Togo). Others mention programs to combat the health impacts of climate change, with objectives for each program, without necessarily providing a global vision (Nepal). Still others present strategic objectives, described with the local context (Madagascar, Kenya, Ethiopia, Fiji, Burkina Faso). This overview shows that even when health adaptation objectives are mentioned, there are disparities in terms of precision.

None of the 13 NAPs analyzed achieved 100% compliance with the identified indicators. This result might be explained by the fact that these countries are mostly developing and do not have sufficient technical resources to carry out the NAP development process. Progress

remains to be made on several indicators, notably in terms of precision regarding needs, measures, and the role of health actors in adaptation policies. While we agree that a NAP devoted solely to health would have the merit of a higher level of precision, only the NAP of the Central African Republic mentions that an HNAP is under preparation. Finally, many health risks have not been considered in the NAPs analyzed, an issue we address in the next section.

### ZOONOSES AND MENTAL ILLNESSES: THE GREAT NEGLECTED ASPECT OF HEALTH RISK ASSESSMENT

Only 9 out of 13 NAPs provide a comprehensive assessment of the country's vulnerability to health risks (Table 2). Moreover, for almost all of them, this assessment is very cursory, based on global rather than national data, and taking little account of the country's specific situation.

Indicators	Percentage
Assessment of the country's vulnerability to health risks	9 (69.23%)
Use of a clear methodology	7 (53.84%)
Better understanding of the health vulnerability of populations and healthcare facilities	9 (69.23%)

**Table 2.** Assessment of countries' vulnerability to health risks. Number of NAPs exhibiting the indicator and percentage of total NAPs analyzed (out of 13).

Several NAPs describe a methodology for assessing health risks (Madagascar, Fiji), providing a better understanding of vulnerability. However, most of the NAPs analyzed could be improved by using contextual data, establishing baselines and projections, and having a clear methodology. Similarly, the links between the choice of adaptation measures and the identified vulnerabilities would benefit from greater precision. These results can probably be explained by the fact that governments lack resources, expertise, and exhaustive data on health risks at the national level. The NAP for the Democratic Republic of the Congo is a good example of this issue. Indeed, the country's plan explicitly recognizes the need for regular updates, and for human and institutional capacity building to increase research, analysis, and data management, and to fill existing gaps. The plan also recognizes the urgent need to produce information and vulnerability assessments that are useful

for decision-making, using clear, organized, harmonized, and popularized methodologies. The same applies to Fiji's NAP, which mentions informational, technological, institutional, financial, and economic barriers to NAP implementation. This is particularly important since, without the means to overcome them, these barriers can relegate health to the background in adaptation policies.

In addition to the shortcomings mentioned above, all the plans mention climate-related health risks. Our analysis shows that the risks most frequently mentioned are vector-borne and waterborne diseases. Figures 2, 3, and 4 show the distribution of climate-sensitive health risks found in the NAPs.

These results show that zoonoses and mental illnesses are among the health risks least represented in NAPs. This is paradoxical, considering the upsurge in zoonoses in recent years in most of these countries, and the numerous epidemics currently underway (WHO, 2022). Similarly, the ravages of mental illness linked to extreme weather phenomena and other manifestations of climate change are given very little consideration in these NAPs. Think, for example, of the climatic migrations linked to the destruction of the homes, living environments, and economic activities of the inhabitants of these countries, particularly those in disadvantaged rural areas. These events are vectors of numerous mental illnesses that represent a major public health problem.

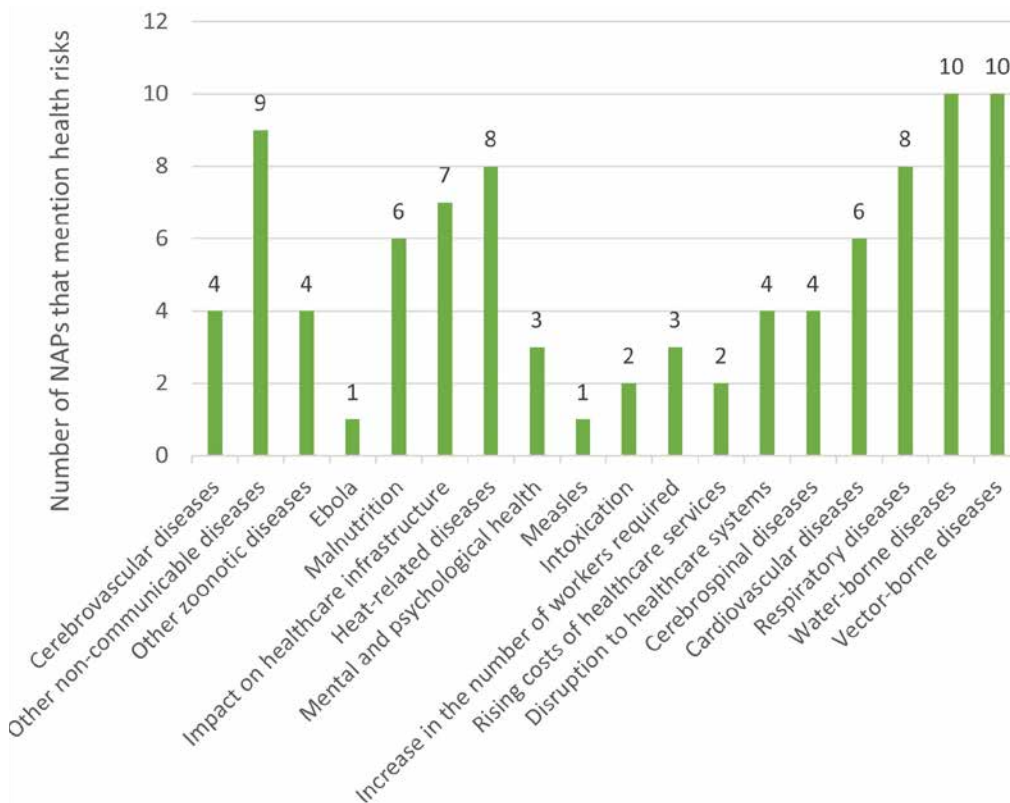


Figure 2. Distribution of climate-related health risks

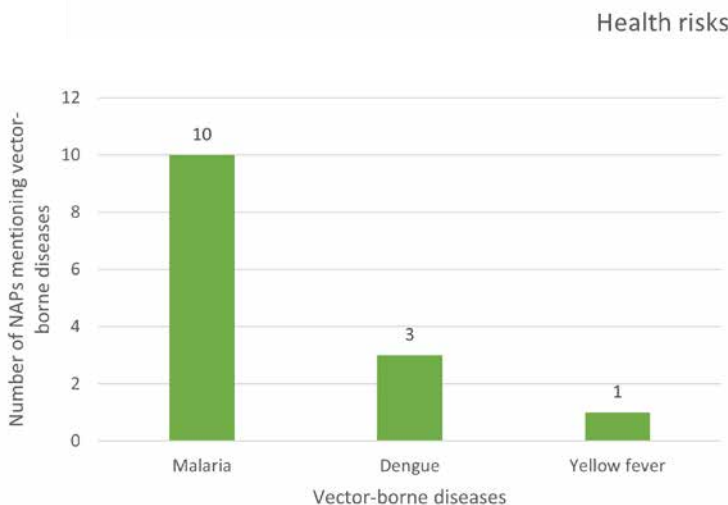


Figure 3. Distribution of vector-borne diseases mentioned in NAPs

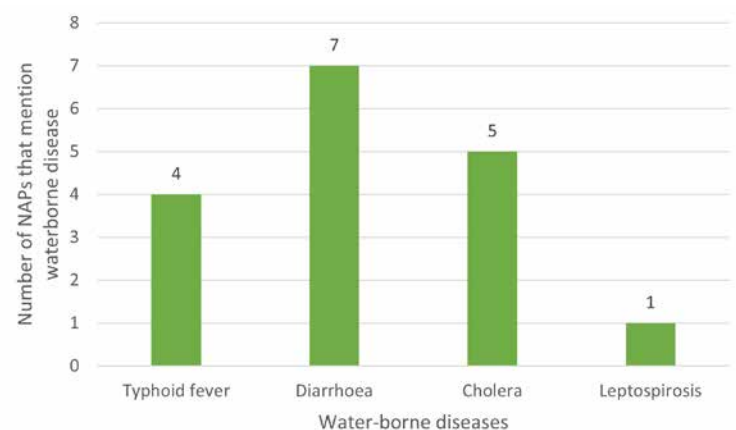
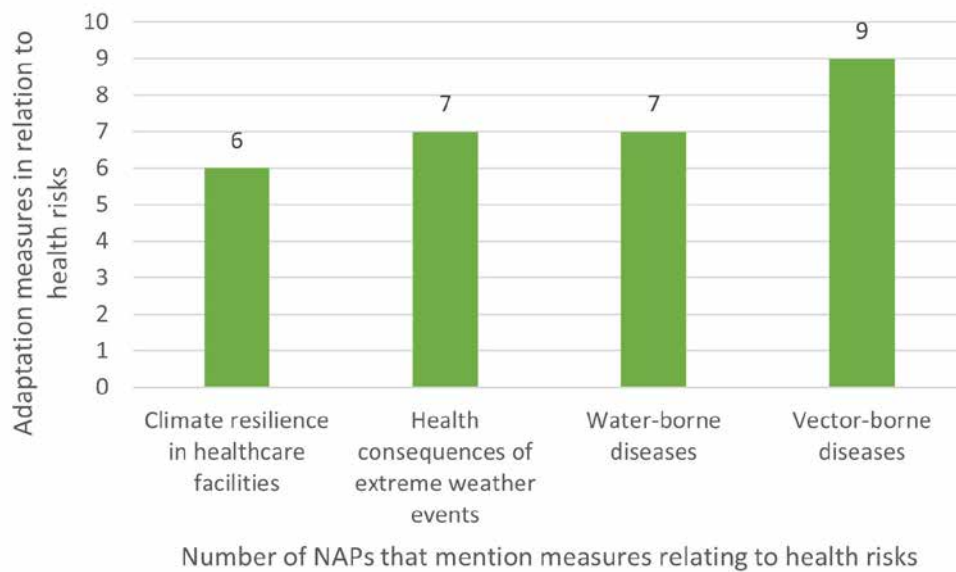


Figure 4. Distribution of waterborne diseases mentioned in NAPs



**Figure 5.** Distribution of the main health adaptation measures related to health risks.

The identification of health risks must be followed by the definition of adaptation measures to address them. In the next section, we analyze the suitability of the measures presented in the NAPs for the risks identified.

### INSUFFICIENT ADAPTATION MEASURES

Ideally, HNAPs should contain adaptation options for the medium and long terms. Figure 5 shows the distribution of the main health-related adaptation measures in relation to the risks identified.

In the NAPs analyzed, the measures chosen concerned, for example, strengthening disease surveillance, prevention, and treatment, and stepping up scientific research (Burkina Faso, Cape Verde), improving access to drinking water (DRC), modelling disease incidence (Sri Lanka), building climate-resilient healthcare infrastructures (Ethiopia, Nepal), and strengthening early warning systems (Madagascar). However, there is a gap between the climate risks identified and the specific measures chosen to address them. For example, six NAPs mention malnutrition as a climate-sensitive disease, but only half propose adaptation options to address it. Similarly, of the ten NAPs that identify water-borne diseases, only seven mention measures to address them. Finally, the response to zoonoses and mental illnesses is virtually non-existent in these measures.

In our study, all the NAPs mention specific population groups as priorities for health adaptation measures. These are mainly rural populations (11), women (10), people with low incomes (10), young people (9), and people

with disabilities (8). In order to protect the health of these vulnerable populations, WHO suggests that measures identified in NAPs take into account health co-benefits, provide sufficient resources for implementation, and be subject to periodic evaluation.

### LITTLE MENTION OF CO-BENEFITS, INADEQUATE RESOURCES, AND MONITORING

We identified only three NAPs (Sierra Leone, Madagascar, Cape Verde) that clearly demonstrate the health co-benefits of measures taken in other sectors. Similarly, only eight NAPs have calculated the budget required to implement health adaptation measures, corresponding to an average of \$67.5 million. Finally, only three NAPs have defined indicators for monitoring progress in health adaptation (Ethiopia, Sri Lanka, Burkina Faso). Sri Lanka, for example, has identified as an indicator the number of research studies carried out on the links between health and the climate crisis.

## Recommendations

A limitation of our research is the heterogeneity of the NAPs in terms of structure and methodology, making the analysis tedious. This limitation was overcome by careful reading of the NAPs, rigorous data collection and systematic interpretative analysis of the results, on the basis of which we make the following recommendations:

**Recommendation 1:** Set up an international mechanism to provide technical expertise to countries in the NAPs development process.

**Recommendation 2:** Increase ministry of health involvement in NAP processes, to improve understanding of the health consequences of the climate crisis and how they can be considered.

**Recommendation 3:** Improve NAPs through comprehensive identification of health risks, contextual data, and coherent health adaptation measures.

**Recommendation 4:** Plan a strategy for mobilizing the resources and funds needed to implement measures and to remove informational, technological, and institutional barriers.

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Photo credit: hdpitcar

# SHORELINE EROSION IN THE ST. LAWRENCE RIVER: SHOULD NAVIGATION LAW BE ADAPTED?

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Protecting coastal territory from erosion, navigation, and shoreline occupation involves several challenges, not the least of which are the population density along the St. Lawrence and the seaway's importance. Climate change also adds to the complexity of the situation, since, on the one hand, projections indicate an expected rise in sea levels and, on the other, Canadian and Quebec policies favour the development of the maritime sector to transport goods because of its carbon footprint, which is ten times smaller than that of land transport (Ministère des Transports du Québec, 2021). Several regulatory measures have already been adopted by the governments of Quebec and Canada, as well as by riverside municipalities, to reduce coastal erosion, including preventive measures related to land use and defensive measures such as the construction of protective dykes (Choquette et al., 2019). However, while the Quebec government and municipalities can act to protect shorelines, they cannot intervene in navigation, to counter its coastal impacts, nor install protective structures in the St. Lawrence, since these areas of jurisdiction fall exclusively within the purview of the federal government under constitutional law. Moreover, current litigation against the Government of Canada for damage caused by marine traffic to shores in the municipalities of Varennes, Verchères, and Contrecoeur is a reminder of the importance of concerted action in environmental matters, despite the federal government's progressive disengagement from the St. Lawrence ship channel (Class Action of 2021). Indeed, at least from the 1950s until the federal shoreline protection program was abolished in 1997, Canada contributed financially to erosion protection work required for navigation in the channel. Regardless of the courts' final verdict, compensating riparian populations and doing protective works in areas most prone to erosion will not, on their own, encourage the establishment of responsible navigation based on integrated water management nor the sustainable development of the maritime industry: it would merely be tantamount to mitigating part of the consequences, economic or otherwise, of one use.

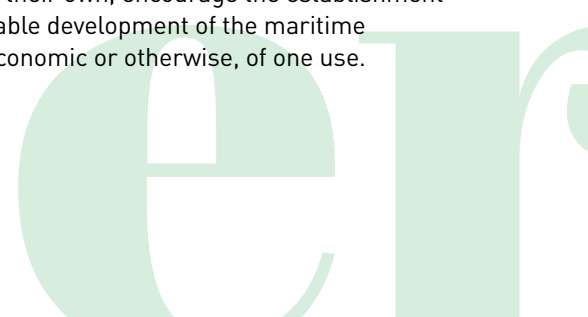




Photo credit: Gary Paakkonen

It was in this context that the EMPHASE project<sup>1</sup>, supported by the National Institute of Scientific Research (INRS), brought together a multidisciplinary team between 2020 and 2023 to model the hydrodynamic changes created by the passage of boats, a phenomenon known as *wave action*, and to analyze some of the socioeconomic issues associated with wave action in the St. Lawrence.

## Wave Action: The State of an Erosive Phenomenon

**W**hile around half of the 4,500 km of shoreline in the St. Lawrence estuary is showing signs of erosion, and the phenomenon is on the rise, the cumulative effect of boat wakes

is a major stressor on coastal environments, sometimes leading to significant shoreline retreat. In some areas near Montréal, up to 85% of erosion is caused by commercial vessels, whereas, in general, the contribution of wave action to coastal recession is closer to 15% (Dauphin, 2000). The erosive impact of nautical movements varies according to the craft (speed, hull morphology, etc.) and the water body (bathymetry, wind regime, sediment coherence, etc.). Two main factors influence the rate of shoreline recession attributable to wave action: boat speed and distance from shore. Erosive impact is certain when a boat is within 600 metres of the shoreline, and it gradually diminishes when the boat is farther away (Dauphin, 2000).

## The Canadian Approach to Regulating Navigation on the St. Lawrence River

**R**egulation (laws, regulations, etc.) is the usual tool used by governments to intervene. Despite the explicit recognition of the impacts of wave action by Canadian authorities (Canadian Coast Guard, 2022), Canadian law stands out for its low level of regulatory production linked to the protection of the banks of the St. Lawrence. Indeed, there are no general speed restrictions on this waterway designed to protect the coastal environment, the only legal restrictions being those aimed at preventing marine pollution or protecting marine mammals. As a result, the federal legislator has chosen instead to trust the captains, who have full authority on board to determine the course and speed of their vessel, if only after a general consideration of potential environmental damage. Those at the helm of pleasure craft have similar latitude, subject to obtaining their boating licence. It should be noted that the *Pilotage Act* (R.S.C. 1985, c. P-14) requires certain vessels (foreign or large) to carry pilots qualified to navigate in the more problematic areas between Les Escoumins and Montréal. Although they are not obliged to protect the riverbanks, these pilots have a thorough knowledge of the river and, with sufficient awareness and incentives, could represent an opportunity to ensure both safety and environmental protection, at least in these sectors.

Boating restrictions, found in the *Vessel Operation Restriction Regulations* (SOR/2008-120), are of restricted application and generally only apply to certain areas of the river. For example, speed is restricted to 10 kph over the bottom in certain channels near Montréal. It is

1. The EMPHASE project, carried out in part as part of the first author's master's degree, was funded by the SSHRC and the Agence nationale de la recherche. The principal author has also received research excellence grants from the J.A. DeSève Foundation, the FRQSC, and the SSHRC.

also forbidden to navigate on the St. Lawrence at more than 25 kph between 9 p.m. and 7 a.m. Obviously, these restrictions are justified more by the need to ensure safe navigation in narrow passages and at night than by environmental concerns. Yet most Canadian provinces (Ontario, Manitoba, Saskatchewan, Alberta, British Columbia, and Nova Scotia) have general restrictions in place to reduce the erosive effect of boat motion and, incidentally, to protect coastal ecosystems. In all their bodies of water, mechanically propelled vessels may not travel at more than 10 kph within 30 metres of the shoreline. Although this measure is not very effective against the wave action of commercial vessels, it does reduce the erosive impact of pleasure craft due to their proximity to the coast. It should also be noted that federal regulations allow municipalities to request speed or navigation restrictions. While the decision to regulate boating usages lies with the federal department of transport (Transport Canada), local authorities at least have a procedural means of requesting restrictions in their area for reasons such as environmental or public interest. Regulation, however, is only one of the techniques used to regulate navigation on the St. Lawrence. Governance tools have also been developed to promote responsible navigation.

## State Governance

**S**tate governance refers to the use by public bodies of non-binding instruments (guides, guidelines, etc.), which nonetheless guide or modify the behaviour of those to whom these standards are addressed. For example, federal regulations on boating safety require large vessels to carry the *Notices to Mariners* produced by the Canadian Coast Guard (2022) to encourage responsible boating. This document explicitly recognizes the negative impact of wave action on shorelines and promotes a weak regulation of speed as long as “each person in charge of navigating a vessel, who best knows its characteristics, exercises restraint and reduces speed as necessary” (Canadian Coast Guard, 2022). Transport Canada produces similar guidelines on boating safety in a recreational context that recommend monitoring wake and propeller wash to limit shoreline erosion (Transport Canada, 2019). State governance standards are often considered “soft law.”

## Non-State Governance

**N**on-state governance refers to various systems of private normativity (certification, self-regulation, etc.). The federal government's timid regulatory interventions in the St. Lawrence seek to avoid unduly restricting

navigation, particularly commercial shipping, and rely instead on the voluntary accountability of captains and the shipping industry. The Minister of Fisheries and Oceans and the Canadian Coast Guard spoke on this point in 2020, following a citizen petition calling for speed limits on the St. Lawrence to protect the riverbanks:

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*The Government of Canada is supporting initiatives aimed at preventing shoreline erosion. The Government of Canada is working closely with the commercial shipping industry on the St. Lawrence River to monitor and promote voluntary speed-reductions for vessels operating in erosion-sensitive zones. (Parliament of Canada, 2020 )*

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In concrete terms, voluntary speed reductions by the shipping industry are taking place at four sites between Sorel and Montréal, for a total length of approximately 25 km. In these areas selected by the shipping industry, ships are encouraged to travel at no more than 10 knots. While its extremely limited geographical scope may be criticized, the approach nonetheless works, as the measure has been 99% complied with since 2019 (Marine Information Office, n. d.). We should also mention the creation in 2007 of Green Marine, an environmental certification developed for and by the North American shipping industry. Under the terms of this program, compliance with voluntary speed reductions is an essential measure for mitigating air pollution and GHG emissions.

Since they are not binding, non-state governance standards (voluntary speed reductions, etc.) must, to be effective, provide sufficiently strong incentives to change the behaviour of those to whom they are addressed. These incentives can be economic (higher revenues, new market shares, marketing strategies, etc.), social (social pressure, peer expectations, etc.), or personal (acting according to a community of values, etc.). In the case of shipping, there is no direct economic interest for the maritime industry to protect shorelines. On the contrary, reducing the speed of commercial vessels or taking alternative routes increase travel time and can affect profitability. Nor is there much social pressure on commercial shipping, since shippers' links with communities are often limited or non-existent. For pleasure boating, this link will only be present for a minority of local boaters. What remains are the moral values associated with respect for the environment by ship authorities. In the St. Lawrence, these environmental values must include, from a risk management perspective, the protection of marine mammals, the reduction of aquatic and air pollution, and the protection of shorelines. However, when it comes to boating, socioeconomic issues generally take precedence over these values.



## The Relative Effectiveness of Canada's Approach to Responsible Shipping

**C**learly, time is precious when it comes to shipping, and speed restrictions and deviations can be counterproductive. Does Canada's multinormative approach encourage the development of responsible shipping, sensitive to integrated water management and aware of the need for the maritime industry to develop in a sustainable manner?

Canadian regulations strictly protect some vulnerable sectors of the St. Lawrence. However, they do not seek to prevent the overall impact of navigation on the riverbanks; rather, they respond to requests for protection from local communities. This approach can be effective if communities actually request protective measures, and if the standard is actually monitored. However, this approach cannot be reconciled either with the application of integrated water management or with the precepts of sustainable development, since a sectoral and unsystematic analysis of navigation risks does not integrate riverbank erosion in a holistic way. Indeed, if fragile shorelines are not identified and taken care of by local communities, federal regulations will not focus on them, as they do not seek to identify the location of navigation impacts *a priori*, even though they recognize the risks.

This low level of acceptance of the issue of wave action can be explained by the difficulty of environmental values when economic imperatives are at stake, as is the case with commercial shipping. This explains the state's regulatory intervention in a multitude of areas (marine discharges, marine mammals, etc.), although it is deficient in the case of shorelines. By relying on non-state governance to protect the banks of the St. Lawrence, the federal government can only hope for a small number of spontaneous adoptions of preventive and responsible behaviour. As for state governance to protect the riverbanks, although the law can give binding force to directives or guides, this is not the case here. Moreover, the Notices to Mariners (Canadian Coast Guard, 2022) and other similar documents only recommend caution to avoid erosion. Making these documents mandatory would therefore not necessarily improve shoreline protection.



Photo credit: Martin Cairree

# Toward Truly Responsible Navigation

When it comes to shipping, an area where negative externalities are difficult to prevent and control, the state is best positioned to intervene. In the case of protecting the banks of the St. Lawrence, we can't expect ship authorities to pay particular attention to the shoreline without imposing on them, at minimum, a requirement of due care. The federal government could draw inspiration from France's transport code, which requires boaters to take all precautionary measures dictated by the general duty of vigilance and good navigation practice, in order to avoid damage to shorelines or the environment. The code even adds that speed must be regulated to avoid creating eddies or a suction effect likely to cause damage to the banks.

In conclusion, responsible boating involves identifying all the issues arising from this use and internalizing them effectively into boating practice. Here, it is up to the federal government to take action, especially since marine transport's low carbon footprint, compared to land transport, suggests we can expect an increased use of boating, to reduce global GHG emissions. From a sustainable development perspective, this modal shift, which is essential to the fight against climate change, must take into account all relevant issues, particularly coastal ones.

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Law and Politics

# FROM A “HISTORIC BANDUNG” CONFERENCE TO A “CLIMATE BANDUNG”: ON THE DRC-INDONESIA-BRAZIL BLOC FOR CLIMATE PROTECTION AND TROPICAL FOREST ENHANCEMENT

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**O**n November 14, 2022, Brazil, Indonesia, and the Democratic Republic of the Congo (DRC) officially launched a partnership focused on preserving their vast tropical forests, which are threatened by exploitation and agriculture, as part of the search for climate solutions. This partnership, signed in Bali, Indonesia, highlights the crucial aspect of climate. Indeed, these three countries are home to key forest ecosystems, namely, the Amazon Basin, the Congo Basin, and the Indonesian Basin, all of which are threatened by the effects of climate change and the pressures of agricultural exploitation. By joining forces to preserve these vast tropical forests, they are acknowledging the importance of these ecosystems in the fight against climate change.

This partnership is especially significant in the context of South-to-South cooperation. The DRC's Deputy Prime Minister in charge of the Environment and Sustainable Development points out that these countries face similar challenges and share the opportunity to become a solution to global climate challenges (Deskeco, 2023). By emphasizing cooperation between the nations of the South, this partnership challenges the dominant model of global forest governance, which is often influenced by the geopolitical interests of the industrialized countries of the North. It is important to underscore that the consequences of climate change are largely determined by the prevailing development models. These models are often imposed by the industrialized countries of the North, which exercise their political, economic, and even military power during international climate negotiations (Aykut and Dahan, 2014). Consequently, this South-to-South cooperation initiative challenges this power asymmetry and seeks to rebalance geopolitical influences in the area of climate.

In this article, we provide an in-depth analysis of the partnership between these three Southern states (DRC, Indonesia, and Brazil) in order to draw potential lessons on the geopolitics of climate change and on the future of tropical forests in the global debate on forest governance.

Given that the original text of the agreement is not yet available to the public, we will rely on a media discourse analysis methodology to obtain information and support our analysis (Chartier, 2003). The agreement, signed in November 2022 between the three states, highlights three key points of cooperation, namely, a shared policy of forest exploitation and preservation, interministerial cooperation in international climate negotiations, and the development of bilateral economic and industrial treaties. The method of collaboration is interministerial but has not led to the creation of a permanent framework.

In a first analysis, we will question the scope of the agreement as well as its political and legal possibilities of and limitations to really influencing international climate negotiations.

In a second analysis, we will question the resurrection of a chapter of contemporary political history—the 1955 Bandung Conference, which had established a “non-aligned” bloc in the Cold War—and its relevance now with the new rivalry between the US-EU bloc and China over climate challenges.



# The DRC–Indonesia–Brazil Tripartite Agreement and Its Political Potential to Influence International Climate Negotiations

**T**he DRC–Indonesia–Brazil partnership on forest protection, signed in November 2022, seems to formalize the long-standing demands of Southern countries in the area of international climate negotiations. Indeed, the agreement, signed in Bali on the sidelines of the G20 summit, highlights an important demand relating to these countries' common desire to move the lines in international climate negotiations. Through this agreement, the ministers of three countries hope to use their respective forests as a political tool that can act as a counterweight to claim compensation from the biggest climate polluters. "As for polluters, compensation payments (and not donations) must be proportional to the mitigation and adaptation role played by our forests and minerals" [*Translation*], stated the DRC's Minister of Industry, who was also present in Bali for the signing of this agreement (Journal des nations, 2022). Such a demand had already been stated at COP27 in Egypt and its wording foreshadowed the agreement signed on the sidelines of the G20 summit in Bali. The DRC's Deputy Prime Minister in charge of the Environment and Sustainable Development had already expressed this demand in the following terms:

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*"We're going to speak with one voice about the price per tonne of carbon. It's inconceivable that in the South, the price of a ton of carbon is \$5, while in the North it's much higher. We want to take a coercive approach, and this could enable us to help less advanced countries or island nations that are in danger. In this respect, we are solution states. We also want to talk about the transformation of our natural resources (...) We need local processing of our natural resources, our strategic ores, our precious metals, to create jobs, wealth and help us with the ecological transition." (TV5-Monde, 2022).*

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However, the tripartite DRC–Indonesia–Brazil agreement faces political and structural challenges that could affect its ability to make a real impact in international climate negotiations. In fact, this agreement brings together three states that do not have the same economic and, consequently, political weight. On the one hand, Brazil and Indonesia are members of the G20, with respective GDPs of US\$9,821 per capita for Brazil and \$3,847 per capita for Indonesia, and on the other hand is the

DRC, with a GDP of \$463 per capita (Atlasocio, 2019). This shows that, in terms of responsibility for forest preservation, Brazil and Indonesia do not have the same long-term interests as the DRC, since Brazil in particular is truly an emerging state that seems to carry the entire Latin American economy, and it is keen to maintain this position, not without impacting the preservation of its tropical forests (see the policy initiated by Jair Bolsonaro). As for Indonesia, its desire for greater industrialization is also putting pressure on its forests, to increase its extractive potential, to support its development model. This pressure on Indonesian forests is currently bordering on serious human rights violations against some of its communities (e.g., land grabbing from Papuan communities) (Meyer-Hilfiger, 2022). Indonesia and Brazil are also interested in the DRC's natural resources market (Deskeco, 2023). This strategic interest could be an opportunity for the DRC to benefit from the experience of these two countries, in terms of win-win economic cooperation, notably through the transfer of technology from these two countries, which have made progress in managing and providing basic public infrastructure. This cooperation is generally characterized by a lack of political conditionalities (obligation of democratic governance) or financial conditionalities (public aid with prohibitive interest rates), which are sometimes counterproductive in North-South cooperation. Given this feature of cooperation, which respects the sovereignty of the party nations, can we deduce that the agreement signed in Bali, Indonesia, in 2022, could resurrect the spirit of the 1955 Bandung Conference? This is worth thinking about.

## Toward a Climate Bandung? Reflections on a New Climate Order Arising from the DRC–Indonesia–Brazil Tripartite Agreement

**I**t is important to put the Bandung Afro-Asian Conference into historical context before analyzing its contemporary implications or similarities.

Indeed, "The Bandung Afro-Asian Conference was initiated by Burma (Myanmar), Ceylon (Sri Lanka), India, Indonesia, and Pakistan. It met in Bandung, Indonesia, from April 18 to 24, 1955... Dealing with the capitalist and communist blocs, the participants in the Bandung Conference expressed their opposition to all forms of colonialism... The Afro-Asian Conference studied the role of Asia and Africa, and examined the means by which the people of the countries represented could achieve the closest economic, cultural, and political cooperation"

[Translation] (Perspective Monde, 2023).

Among other objectives, the final communiqué of the Bandung Conference, recognised:

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*the urgency of promoting economic development in the Asian-African region (...) on the basis of mutual interest and respect for national sovereignty (...) The participating countries agreed to provide technical assistance to one another, to the maximum extent practicable, in the form of: experts, trainees, pilot projects and equipment for demonstration purposes; exchange of know-how and establishment of national, and where possible, regional training and research institutes for imparting technical knowledge and skills in co-operation with the existing international agencies (...) [Also, t]he Conference welcomed the initiative of the Powers principally concerned in offering to make available information regarding the use of atomic energy for peaceful purposes (Ministry of Foreign Affairs, Republic of Indonesia, 1955).*

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In view of these various historical points that figured in the economic section of the 1955 *Final Communiqué of the Asian-African conference of Bandung*, two main comments should be made regarding the tendency toward a contemporary resurrection of the spirit of this conference in the DRC–Indonesia–Brazil tripartite agreement signed on November 14, 2022, in Bali.

On the one hand, the final communiqué of the Bandung Conference seems to emphasize the economy as the socio-historical driving force behind nations' progress, placing its priorities in a particular context of decolonization marked by the desire to make up for the socio-economic development gap between states (Peemans, 2022). Sixty eight years after the Bandung Conference, its spirit seems to be resurfacing in several South-to-South cooperation agreements (the emblematic case being BRICS, i.e., Brazil, Russia, China, India, and South Africa) and, especially, in the tripartite DRC–Indonesia–Brazil agreement under analysis here. This tripartite agreement is interesting insofar as it raises the environmental challenge, which has shown the limits of the classical economic paradigm, whose growth model was based on the inexhaustible nature of natural resources. By pooling efforts to protect the forests of three respective countries in return for a fair and equitable payment for their economic development, the agreement seems to advance the spirit of the Bandung Conference by making the environmental challenge the new political line for the “non-aligned” in major climate negotiations.

On the other hand, with a view to finding a solution to the energy problems at the heart of economic projects, the Bandung Conference had clearly defined two priorities: on the one hand, “the exchange of information on matters relating to oil, such as remittance of profits and taxation, might eventually lead to the formulation of common policies” (Ministry of Foreign Affairs, Republic of Indonesia, 1955). (Note this point undoubtedly dictated the advent of the Organization of the Petroleum Exporting Countries (OPEC)), which was created five years after the Bandung Conference, in 1960). Secondly is “the particular significance of the development of nuclear energy for peaceful purposes” (Ministry of Foreign Affairs, Republic of Indonesia, 1955). The issue of atomic energy had therefore not escaped the attention of the signatory countries of the *Final Communiqué of the Asian-African conference of Bandung*.

Returning to the DRC–Indonesia–Brazil tripartite agreement, we are to believe that this agreement could lead to the promotion of civil nuclear power, a middle route that could, relatively speaking, reduce pressure on forests, although the sustainable nature of nuclear energy is still a deeply divisive issue among scientists. The DRC has to date been unable to follow through on its nuclear reactor project in Kinshasa. It began in 1973 and was abandoned in 1994. Indonesia has advanced plans to set up civil nuclear power plants for its energy autonomy, while Brazil is well advanced in the actual exploitation of such energy.

## **The Ultimate Challenge for the DRC–Indonesia–Brazil Tripartite: Neutralizing Bipolar China–West Rivalries in International Climate Negotiations**

**I**n conclusion, this tripartite agreement between the DRC, Indonesia, and Brazil represents a significant development in (re)emerging South-to-South cooperation, as initiated at the Bandung Conference. This agreement takes place in a changing context, marked by current economic disruption and in particular by the emergence of new international powers, such as China, which is a difficult to classify player in the context of the non-aligned movement heritage, particularly as regards the climate issues affecting forest preservation. The major geopolitical challenge for this tripartite DRC–Indonesia–Brazil



Photo credit: Axel Fassio-CIFOR

alliance is to influence the world's two major polluters: China and the West (US and EU), based on tangible concerns for the ecological power of their respective rainforests. By positioning itself as a new leader in the non-aligned camp, and working to neutralize rivalries between China and the West, this tripartite alliance can play a decisive role in realizing the South's aspirations in a binding way, overcoming recurrent blockages in international climate negotiations. The tripartite DRC–Indonesia–Brazil agreement thus represents a strategic response to contemporary geopolitical challenges, seeking to forge an alternative path in global climate cooperation and to overcome divisions between emerging powers and industrialized countries. This ambitious alliance aims to influence international dynamics and promote a more balanced and binding approach in the search for solutions to preserve tropical forests and meet the challenges of climate change.

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# Les Jeunes pousses

The research carried out by master's and doctoral students is an essential element in the production of scientific knowledge in universities. Under the guidance of their research supervisors, students are trained in documentary research methods, rigorous experiment design, and accurate data analysis, all the while contributing to the emergence of new knowledge. These pages introduce the research work of up-and-coming members of the scientific community: les jeunes pousses (budding scientists).

## NATURE KNOWS BEST

*Using the properties of nature to limit flood risks*

**Stéphanie Paradis-Léger**, University of Sherbrooke

Climate forecasts for Eastern Canada predict more frequent and extensive flooding, particularly as a result of torrential downpours and rapid snowmelt. Conventional infrastructures like dams and retaining walls need to be rethought to offer greater adaptive flexibility to these new realities.

The concept of nature-based solutions is to harness natural processes to solve social issues, such as flood and erosion risk mitigation, as well as socioeconomic development issues, such as heat islands.

This study evaluates the most appropriate nature-based management strategy for the Rivière-à-la-Truite (Témiscouata) watershed to mitigate flood risks. An analysis of nature-based management methods shows them to be a viable alternative to conventional infrastructures, despite certain technical and conceptual limitations. The proposed development strategies provide decision-support tools for local authorities, enabling them to draw up an informed action plan for flood risk mitigation in the region.

### To read the document:

Stéphanie Paradis-Léger (2023). *Planification de stratégies d'aménagement du territoire fondées sur la nature pour l'atténuation des risques d'inondation : étude de cas du bassin versant de la Rivière-à-la-Truite* [essai en environnement, Université de Sherbrooke]. Savoirs UdeS, 170 pages.



Photo credit: Boréal Rivière Saint-Charles parc Chauveau July 2009



# MILLENNIA OF ADAPTATION

## *Threats to the ancestral practice of pastoralism in the Sahel*

**Bassirou Bâ**, University of Sherbrooke

Pastoralism is a form of livestock farming that uses natural pastures (extensive livestock rearing) and is still highly developed on the African continent (25% of the population). In the Sahel region, which is marked by aridity and scarcity of water and fodder resources, pastoral populations, notably the Peul people, have developed a great capacity for adaptation through the spatiotemporal mobility of their livestock, punctuated by a well-established seasonal cycle.

However, climate change-related warmer temperatures and irregular, unevenly distributed rainfall, along with the overexploitation of natural resources, which increases pressure on ecosystems, are all contributing to making pastoral systems more fragile, thus jeopardizing the very survival of the peoples who depend on them.

This essay paper identifies the main factors of vulnerability and their multiple interlinkages, in order to propose targeted adaptation strategies capable of increasing the resilience of the pastoral peoples of the Sahel.

Recommendations are made to the relevant authorities in Sahelian countries to help maintain this ancestral way of life.

### **To read the document:**

Bassirou Bâ (2021). *Quelles capacités d'adaptation et de résilience des éleveurs transhumants peuls du Sahel face aux mutations du pastoralisme dans un contexte de changements climatiques et d'insécurité* [essai en environnement, Université de Sherbrooke]. Savoirs UdeS, 110 pages.



Photo credit: Guillaume Colin et Pauline Penot

# GROWTH VERSUS POST-GROWTH

## *Analysis of another possible world*

**Charles Duprez**, University of Quebec at Montréal

Contemporary Western societies have proved incapable of reconciling continuous production and consumption growth with inequality reduction and ecosystem sustainability. In the face of this failure, radical critics are advocating for the advent of post-growth societies, which imply moving beyond the horizon and ideology of economic growth. To assert itself as a credible alternative, the post-growth movement must overcome major social, political, and economic challenges, including the ability to combine a reduction in economic activity with a reduction in inequality.

This essay analyzes proposals for post-growth societies, taking a closer look at the concept of the inequality regime developed by Piketty. This concept highlights the structure of inequalities and the ideological role of growth in justifying the existence of these inequalities. It emerges from this work that post-growth proposals are consistent with the principles of distributive justice, which are also constitutive principles of the value system of contemporary capitalist societies. This continuity in value systems suggests that it is possible for post-growth to establish itself as the basis for a new social-ecological compromise.

### **To read the document:**

Charles Duprez (2022). *Justice sociale et transition écologique : la réponse de la post-croissance aux crises des régimes d'inégalités capitalistes* [mémoire en sciences de la gestion, Université du Québec à Montréal]. 380 pages.



Photo credit: Micheile Henderson

# TENSIONS BETWEEN OPINION AND INFORMATION

## *The role of the opinion press in polarizing the climate debate*

**Marouane Joundi**, University of Montreal

Climate change is a textbook case of issue complexity: the biophysical complexity of the mechanisms and consequences of climate change; and the complexity of the solutions to be implemented and their level of social acceptability. This creates fertile ground for tensions to emerge between the will of governments, of electorates, and of interest groups, and the need for public policies to combat climate change.

This dissertation analyzes the opinions published and broadcast in the media of Quebec, Quebec's leading media group, about pro-climate mobilizations during the 18 months following the publication of the 2018 IPCC Report. A mixed analysis (quantitative, qualitative, argumentative, and rhetorical) of a varied corpus

(columns, TV shows, radio interviews with activists) shows that the opinions aired were mainly at odds with the mobilizations. However, observing the areas of agreement, nuances, and positive rhetoric puts this picture into perspective, and helps to identify ways of depolarizing the debate on the urgent issue of climate change.

### **To read the document:**

Marouane Joundi (2022). *Québecor et les écologistes : Polémique, polarisation et pistes de dépoliarisation* [mémoire en science politique, Université de Montréal]. Papyrus, 168 pages.

# ADAPTATION FOR EVERYONE, EVERYWHERE

## *Implementing adaptation plans in small Quebec municipalities*

**Kamille Bareil-Parenteau**, University of Sherbrooke

Current levels of greenhouse gases in the atmosphere are already causing harmful changes to the climate, requiring strategies to adapt to these new climatic realities. In Quebec, climate change programs cover around 80% of the population, but less than 10% of the province's municipalities.

With the ultimate aim of equipping municipal players with an appropriate adaptation approach, the main objective of this essay is to assess the applicability of existing climate change adaptation approaches to the contexts of small Quebec municipalities (< 10,000 inhabitants). Elected officials or managers from thirteen municipalities and seven regional county municipalities were consulted, and a multicriteria analysis of the applicability of five adaptation approaches was carried out. Based on these results, the approach developed by the international organization C40 Cities Climate Leadership Group and that of the Ministère de la Sécurité publique appear to be the most appropriate for small municipalities.

Among other recommendations, far-reaching changes at the provincial level, including a coherent vision and regional partnership, are needed if municipal climate strategies are to be implemented effectively.

### **To read the document:**

Kamille Bareil-Parenteau (2023). *Faire face aux changements climatiques dans les petites municipalités québécoises : analyse de l'applicabilité des approches d'adaptation* [essai en environnement, Université de Sherbrooke]. Savoirs UdeS, 124 pages.



Photo credit: Dennis Jarvis

# WHAT A DIFFERENCE A DEGREE MAKES

## *Analysis of the effects of temperature on living organisms on several temporal and spatial scales*

Azénor Bideault, University of Sherbrooke

Temperature is a major abiotic (physicochemical, non-biological) factor for the living world: it induces a strong latitudinal gradient on biodiversity (increasing biodiversity from the poles to the equator), varies over time, and has direct and indirect effects at multiple levels of organization, from the individual to the ecosystem. In the context of climate change, it is essential to understand the many effects of temperature on the functioning of ecological communities.

This thesis uses theoretical and empirical approaches to study how species and their trophic interactions (food chain) are affected by temperature at 1) different spatial scales, from local to global, 2) different time scales, ecological and evolutionary, and 3) different levels of organization, from populations to communities.

In particular, these results demonstrate the existence of an adaptive temperature limit for microorganisms, guided by the thermodynamic limits of the physical chemistry of

living organisms. This work opens up new avenues for a mechanistic understanding (cause-and-effect relationships) of the effects of temperature on food web dynamics.

### To read the document:

Azénor Bideault (2021). *Effets de la température sur les interactions trophiques : une perspective à différentes échelles spatiales, temporelles et organisationnelles* [thèse en biologie, Université de Sherbrooke]. Savoirs UdeS, 293 pages.



# IT CASTS A CHILL

## *A tool to optimize the use of electric vehicles in winter conditions*

David Ramsey Herrera, University of Lille and University of Quebec at Trois-Rivières

Electric vehicles (EVs) represent a solution for reducing greenhouse gas emissions, particularly when there is a low-carbon electrical energy mix. Their development remains limited by their autonomy and the impact of climatic conditions on their performance: 1) extreme temperatures reduce battery performance and autonomy; 2) winter driving conditions increase energy consumption; 3) cabin heating uses battery energy. Together, these factors can reduce EV battery life by more than 50% in severe weather conditions.

The aim of this thesis is to develop a flexible EV simulation tool that studies energy performance under various climatic conditions: ambient temperature, relative humidity, and sky conditions. Thus, a systemic modelling approach is adopted in order to consider the dynamic interactions between subsystems (autonomy, traction, heating).

The simulation tool developed makes it possible to carry out energy studies that are useful for daily use: analysis of

the frequency and/or time of recharging depending on the season; duration of recharging depending on temperature.

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Credit photo : Luca Moglia

Society

## THE FRENCH CASE FOR CLIMATE JUSTICE IN THE CARIBBEAN

**Vanessa L. Deane**

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The plantation-based economies that warring colonial factions established in the Caribbean fuelled the Industrial Revolution and laid the foundation for the geopolitical power dynamics currently in place. For centuries, Caribbean economies developed around the export of a single agricultural product; it was not in the colonizers' interest to promote development beyond the seaport. In fact, the capital cities of most Caribbean countries were established on their coastlines with the sole purpose of exporting raw materials to Europe and other global markets. These same Caribbean countries today are now among the most susceptible to climate change impacts such as sea-level rise, coastal erosion, and extreme weather events (IPCC AR6 SYR, 2023, p. 6). Furthermore, climate shocks largely account for why the region of Latin America and the Caribbean is the second-most disaster-prone area in the world (United Nations Office for the Coordination of Humanitarian Affairs, 2020).

While most Caribbean nations have similar climate risk profiles, due to their geographic size, as small island developing states (SIDS), their abilities to adequately respond vary in part due to their postcolonial governance structures (Robinson, 2018). For example, countries like Guadeloupe and Martinique are former French colonies that now belong to the Outermost Regions of the European Union (EU). This means that they are non-sovereign countries that are governed with the same laws and regulations as mainland France itself, despite being separated by oceans and miles. These Outermost Regions of the EU also help maintain an EU presence in the geographical regions where they are situated. Note that the Outermost Regions of the EU differ from Overseas Countries and Territories (OCTs) of the EU. While OCTs are also former colonies of an EU member state, OCTs are semiautonomous and are not members of the EU like the countries of the Outermost Regions (OCTs are granted special considerations by the EU, however). This paper emphasizes the Outermost Regions of the EU given their non-sovereign status.

## Why France Should Lead on Climate Justice

France, Portugal, and Spain are the three member states with countries in the Outermost Regions of the EU. Six of the nine countries in this grouping belong to France, with four of these six located in the Caribbean. Additionally, of the thirteen OCTs of the EU, six are linked to France, another six are associated with the Netherlands, and the remaining one, to Denmark. France therefore has the largest share of non-sovereign EU countries. It is also the only EU member state with both Outermost Regions and OCTs. France's exclusive economic zones and maritime areas—of which its overseas territories comprise 97 percent—also make it the second-largest maritime power in the world (Ferdinand, 2018). Resilient climate adaptation measures, like wetland restoration, green infrastructure, structural upgrades, and more, are especially needed for the *Outre-mer* (as these non-contiguous French territories are referred to nationally) as sea levels continue to rise and coastlines erode, amid ongoing postcolonial development challenges like poverty reduction and more.

Despite the socioeconomic conditions of French Caribbean countries (French Guiana, Guadeloupe, Martinique, and Saint Martin) being similar to those in most sovereign countries in the Global South, their status as Outermost Regions of the EU precludes them from capitalizing on assistance they would otherwise be eligible for (Ferdinand, 2018). Consider the Green Climate Fund (GCF), which “is the most important financial mechanism under the global climate regime” (Onifade, 2021). Even though France was the second-largest GCF contributor for 2020–2023, France's own Outermost Regions are unable to leverage these funds—or other international financing arrangements like it—since they are politically situated in the Global North (Permanent Mission of France to the United Nations in New York, 2020). This reality contributes to the countries and people of the *Outre-mer* being the most climate vulnerable, nationally among the French, and geopolitically among SIDS populations worldwide (Ferdinand, 2018). With claims to slightly more than half the EU's postcolonial presence globally, France is thus well positioned to lead on climate justice<sup>1</sup>, even though it is not the only EU member state with postcolonial territories.

1. This paper builds on Ferdinand's (2018) analysis of climate justice for the French *Outre-mer* and offers a multiscalar approach that also incorporates several of his initial arguments.

## Defining Climate Justice

Climate justice is a concept that makes explicit the reality that climate change is not solely an environmental or economic issue, but one that affects people's livelihoods and has social and justice implications within and across countries (Sultana, 2021). Moreover, climate justice requires that greater attention be paid “to how climate change impacts people differently, unevenly, and disproportionately, as well as redressing the resultant injustices in fair and equitable ways” through the climate “adaptation or mitigation interventions pursued” (Sultana, 2021). Climate justice thereby offers a framework through which the climate crisis can be addressed while simultaneously creating opportunities to strive toward a postcolonial world that is fairer, more inclusive, and just, at the local, national, regional, and geopolitical scales.

To this end, the Paris Agreement was the first global treaty to mention the concept of climate justice. It also called for more climate adaptation measures on behalf of developing countries, as well as for a reduction of carbon emissions through voluntary commitments from all countries, regardless of development status or size (Onifade, 2021). While the Paris Agreement encouraged developed countries to financially support the adaptation needs of developing countries, it was not compulsory (Onifade, 2021). Further, whereas mitigation is an issue that has had better success garnering geopolitical support for collective action, climate adaptation has sometimes been viewed as a domestic issue that is instead the responsibility of individual nation states (Barrett, 2012; Onifade, 2021). Onifade (2021) therefore states that “state sovereignty appears to be a fundamental challenge facing climate justice.” If so, the institutional responsibility for climate adaptation measures within non-sovereign countries in the Outermost Regions of the EU would then fall on the associated mainland European state, notwithstanding the reality that climate change impacts are most acutely felt at the subnational level in local communities situated throughout the Outermost Regions.

To be clear, climate justice is less about blaming and shaming. Rather, it is more about safeguarding the wellbeing of marginalized countries, people, and local communities so that they can flourish physically, socially, and economically, now and in the future (Onifade, 2021). In terms of the French Caribbean, this would require an institutional evaluation of existing postcolonial

governance structures, to assess whether there are political economic considerations that are fostering or inhibiting resilient climate adaptation planning and implementation efforts— such as improved land and water management, structural upgrades, green infrastructure, crop diversification, etc.—using a multiscalar approach (Ferdinand, 2018; Onifade, 2021).

## A Multiscalar Approach to Climate Adaptation

**A** multiscalar approach to climate adaptation is one that explores the interplay between global, national, and subnational levels of governance, in terms of how well they reduce the climate vulnerabilities of people and communities most adversely affected yet least equipped to respond to climate change (Barrett 2012). Relatedly, the “Governance and Policies” section of the sixth Intergovernmental Panel on Climate Change (IPCC) assessment report states, “Effective climate action is enabled by political commitment, well-aligned multilevel governance, institutional frameworks, laws, policies and strategies, and enhanced access to finance and technology” (IPCC AR6 SYR, 2023, p. 34). The section continues:

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*« Effective multilevel governance for mitigation, adaptation, risk management, and climate resilient development is enabled by inclusive decision processes that prioritize equity and justice in planning and implementation, allocation of appropriate resources, institutional review, and monitoring and evaluation” (IPCC AR6 SYR, 2023, p. 34)..*

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Thus, the extent to which intergovernmental structures, policies, and processes align or fail to align can impact how effectively climate action, such as the adaptation approaches mentioned above, are conceived and executed. Without addressing such structural elements, countries in the Outermost Regions of the EU will remain unable to access certain global financial instruments (like the GCF), which could accentuate their climate vulnerability rather than reduce it.

Nationally, France has been engaging its regions and localities in climate adaptation planning efforts since the early 2000s. In 2019, a national High Council on Climate (HCC) was created as an independent body to monitor the progress of public policies and mitigation measures toward the 2015 Paris Agreement. The HCC concluded that “as front runners on climate issues, regions must play an important role in coordinating actions between

the different territorial levels and territorial climate governance” though it is not readily apparent whether the Outermost Regions of France were also included in this reference (Climate Chance, 2021). Accordingly, concerted attention to addressing the unique political and institutional arrangement of France’s Outermost Regions in the Caribbean may be useful in assessing their ability to adequately plan for and implement robust climate adaptation measures, given their greater exposure to intensifying hurricane seasons, rising sea levels, and other climate-related threats, as compared to their Europe-based counterpart.

Notably, the Agence Française de Développement (AFD) has been employing a “Three Oceans Strategy”<sup>2</sup> since 2019 to promote regional integration of the country’s foreign aid activities including climate resiliency. Notwithstanding, there appears to be an inherent contradiction between how this strategy engages the Outre-mer compared to and how it deals with sovereign nations in the regions where it is coordinating its efforts. For example, most of the funding in AFD’s Atlantic Ocean Strategy is in the form of development loans rather than intergovernmental grant transfers between the central and subnational levels of government. AFD committed €192 million for Martinique in 2021, with €152 million of this total designated as public sector loans and €38 million as private sector loans (Agence Française de Développement, n.d.). Government grants comprised the remaining €2 million. Guadeloupe likewise had €84 million allotted that year, with only €3 million assigned as grants. By comparison, the Dominican Republic, as a sovereign nation, received €86 million in foreign aid loans from France, with a nominal €0.2 million in grants (Agence Française de Développement, n.d.). It is not clear if geographically connected mainland departments, like Rhône or Paris, have a similar intergovernmental relationship with the central government, but the fact that the loan-to-grant distributions for the departments of Martinique and Guadeloupe are indistinguishable from a foreign aid package to a neighbouring independent country might merit further investigation. Subjecting its own subnational departments to such debt burdens, specifically those most susceptible to the dangers of extreme weather events, seems to underscore the likelihood that overseas France exists outside of the French state rather than as a component of it. Assessing the relationship between the French central government and its Outermost Regions, through the lens of climate justice, thus seems appropriate.

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2. France has overseas departments and territories in the Indian Ocean and Pacific Ocean regions as well, in addition to the French Caribbean jurisdictions in the Atlantic Ocean region.

## Conclusion

**T**he world is at a critical juncture, where a variety of climate change responses are needed more than ever and at multiple scales (Barrett, 2021). Particularly, affected countries that exist outside traditional “sovereign” versus “non-sovereign” binaries are in a precarious position due to their status as overseas extensions of a Global North country. Previous instances, such as with the Green Climate Fund, revealed that this postcolonial institutional arrangement precludes them from being eligible for certain global financial resources, despite their environmental, economic, and social conditions being more reflective of the Global South. France, as a Global North country with 12 territories and 2.6 million citizens in the Global South, may have an opportunity to expand its global leadership on climate change response by working more intentionally with its overseas jurisdictions in the Caribbean (where most of its non-sovereign regions are located) through a climate justice approach.

More specifically, a future study could investigate:

- whether France could help support all eligible states—like the Outermost Regions of the EU—in accessing global climate financing tools geopolitically;
- whether or how mainland France might streamline the central government’s institutional arrangements with overseas France nationally; and
- whether or how mainland France might promote sizable, context-specific, appropriate, resilient climate adaptation measures in its Outermost Regions locally.

While not all-encompassing, findings from this future research may underscore new ways forward, where the distinct impacts of climate change on the French Outre-mer are better acknowledged and addressed, as France works to safeguard the wellbeing of all French citizens, whether in Europe or abroad. In all, this is climate justice.

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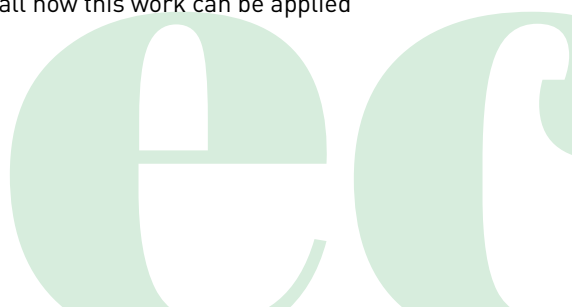
Society

# TALKING ABOUT "ECOLOGICAL ART" IN CLASS TO SPARK INTEREST AND ENVIRONMENTAL MOBILIZATION

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**T**he world of education is increasingly concerned with the mission of schools today, which is to prepare students to develop learning competencies that address real-life issues and whose goals extend far beyond the classroom, as discussed in Quebec’s ministry of education guidelines on the “Broad Areas of Learning” for elementary levels (Ministère de l’Éducation, 2006). This positioning is supported by research aiming to encourage students to think about important contemporary issues—questions often addressed in the context of “education for” (citizenship, health, biodiversity, etc.)—and to become active, responsible, and critical participants in society. In this context, we have explored the contribution of school subjects (in this case, the plastic arts) to the “development of participatory democracy, to the empowerment of citizens” [*Translation*] (Sauvé, 2009).

We want to show how, in this work of reflection about and mobilization around social causes, “art does its part” [*Translation*], through the involvement of artists, especially contemporary artists, in civic life and social debates (Paquet and Rouleau 2022). Based on the idea that art has a special power to raise awareness about social issues, we will give examples of artistic productions focused on environmental reflection and action, and then recall how this work can be applied in schools.





## Toward Socially Engaged Art

Over the last two centuries, the field of the visual arts has undergone a series of changes that have completely revolutionized its practices and social integration (Morel, 2015). The first was a technical change: it began in the 19th century with the invention of the flexible paint tube and the country-style easel that gave artists mobility, and it continues today with a variety of materials, tools, and techniques that allow for all kinds of experimentation (Zarka, 2010). The second was aesthetic: having freed itself from the dictates of representationalism in the 19th century with the advent of photography, art has subsequently moved away from the traditional notion of beauty to focus more on the emotional impact a work can have on the viewer. Lastly, the greatest change was social: once subject to the ruling powers (financial, religious, academic), the artist has gradually become—without entirely renouncing patronage and commercialism—a citizen who can make their own choices. This new status has led increasing numbers of artists to participate in the public debate on so-called socially acute questions (SAQ), including many environmental issues (Simonneaux and Legardez, 2011).

## Artwork as Catalyst

Can art change the world? The question is debatable (Ardenne, 2019), but the fact is that, by appealing to the senses, it reaches audiences with little or no receptivity to rational argument. The work of art acts as a kind of catalyst: the emotion it triggers, which may be accompanied by astonishment or even incomprehension, does not convey information. It is in itself a form of immediate and lasting cognition. It promotes or provokes cognitive recomposing mechanisms that question the individual's existing conceptual frameworks and open them up to other solutions.

## The Artist as Whistleblower

Equipped with this power, artists are increasingly present in the public sphere, and it has become common for them to see themselves as whistleblowers or consciousness raisers (Zask, 2007). Their

work has become an active part of our physical and cultural space. To allow ourselves a play on words, we would say that such a work of art is a reflection of the world not only because it reflects it, but also because it thinks it, insofar as it expresses and transmits, in its own way, an opinion about it. The street artist Banksy is perhaps the most famous example of this attitude. His or her real identity and physical appearance are not known, which leads to the fact that his works seem to emerge from themselves, as though born spontaneously from the context and place where they are found, rather than from a conscious human intention. For example, in the fall of 2022, in various Ukrainian cities destroyed by Russian bombardment, seven works by Banksy appeared (which the artist has claimed) and immediately became symbols of the country's resistance to its aggressor.

The same committed attitude, aimed at warning and mobilizing society, can also be found among artists whose practice falls under the umbrella of ecological art.

## Ecological Art

The plastic arts have long had a close relationship with nature: painting and sculpture have studied and imitated it, highlighting its beauty and drawing on its symbolic resources. Consider the numerous schools of landscape art that developed in the 19th and 20th centuries, such as the Hudson River School in the U.S. and the Group of Seven in Canada, which were often informed by issues of identity. Architecture and urban planning also drew a great deal of inspiration from the landscape, which they regarded as a kind of lost paradise that designers like Hundertwasser tried to restore in their designs. Land art, which emerged in the second half of the 20th century, attempts to reconnect human beings with nature in its most physical form. The works, mostly created outdoors, use natural materials. One of the best-known Canadian land artists is Bill Vazan, whose works can be seen in Quebec.

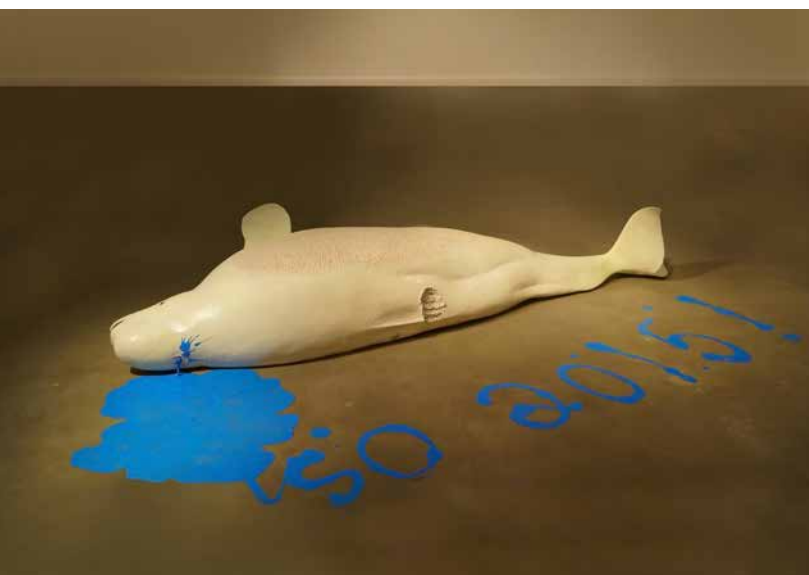
Although land art is, among other things, an expression of a need to rediscover a kind of deep contact with the natural environment, it is not necessarily militant. The same cannot be said of ecological art, which has emerged in recent decades and defines itself as a genuine commitment in which all manner of artists resolutely fight for the environment (Ardenne, 2019).

This battle is led by artists who often seek to combine an appeal to the senses with objective data and scientific analysis. Ottawa artist Valérie Chartrand, for example, explains in her artist statement on her website.

*I've always been fascinated by insects and by what their presence tells us about the world, both from a scientific and a metaphorical perspective. Insects through the ages have been perceived by various cultures as symbols and messengers. Today, the observation of insects as bioindicators also speaks of the state of our ecology. (<https://www.valeriechartrand.ca/fr/a-propos/>)*



**Photo 1.** Valérie Chartrand, *Décomposition 1-9*, 2017  
Prints on polyester film, 43.2 x 30.5 cm.  
**Photo credit:** Valérie Chartrand



**Photo 2.** Pierre-Étienne Massé, in collaboration with Yves Chabot, *Walter & Cie*, 2015. Fibreglass and acrylic, 40 x 150 x 100 cm.  
**Photo credit:** Pierre-Étienne Massé

Her first exhibition, *Ghost Hives*, which was presented in 2017, and was to be followed by other events on the theme of insects, aims to make us aware of the fate of bees (Photo 1).

Depending on the territory and personal sensibility, today's ecological art deals with the entire mineral, plant, and animal heritage. Many artists are also interested in the aquatic environment. This is of course related to the symbolic richness of this element in its various forms (still, flowing) and states (rain, rivers, seas, and oceans), but also to its economic and social importance and to how it is impacted by climate change (drought, floods, pollution). Pierre Étienne Massé offers us the opportunity to reflect on the threats to beluga populations (Photo 2). Created in collaboration with environmental specialists (Group for Research and Education on Marine Mammals, GREMM, in Tadoussac, Quebec, and the Faculty of Veterinary Medicine of University of Montréal in Saint-Hyacinthe), the work aims to raise public awareness about endangered or threatened marine species.

## Art and Environmental Issues in School

Given that it is rooted in reports published by Earth system scientists, in citizens' concerns, and in artist commitments, ecological art has naturally found its place in schools. In Quebec, this integration is facilitated by two provisions of the Quebec education program (Ministère de l'Éducation, 2006):

- The existence of a broad area of learning at the elementary level in Quebec called "Environmental Awareness and Consumer Rights and Responsibilities," whose pedagogical intent is "to encourage students to develop an active relationship with their environment while maintaining a critical attitude towards exploitation of the environment, technological development and consumer goods" (Ministère de l'Éducation, 2006).
- The desire to promote a cross-disciplinary approach to knowledge, because as described in the elementary program for Cross-Curricular Competencies, "certain skills involve more than one subject-specific competency and can only be taken into account if a context is associated with them" (Ministère de l'Éducation, 2006).

As in the rest of society, research groups and centres are being created in education with the goal of raising awareness of environmental issues. One example is the *Centre de recherche en éducation et formation relatives à l'environnement et à l'écocitoyenneté* (Centr'ERE), located at the University of Quebec at Montréal. Its mission is to "contribute to the development of a society

committed to improving the network of relationships between individuals, social groups, and the environment” [Translation] (<https://centrere.uqam.ca/>) .

Centr’ERE hosts an Arts & ERE section (<https://www.arts-ere.net/>) that focuses specifically on the relationship between arts education and environmental education and how they can cross-pollinate. The Arts & ERE section is aimed at teachers and presents the work of contemporary artists (including two of the works presented above) as it relates to environmental issues and provides elements of understanding and educational interpretation for use in the classroom.

Activities aimed at appreciation and/or creation provide opportunities for reflection on a range of environmental issues that, without moralizing or collapsing connotations, raise awareness of the impact of human activities on the natural world. Asking students questions related to their feelings and/or imagination (*What do you think of this work? What do you see? What might the threads around the bee be? What happened to the beluga? Why does it have blue blood?*), followed by reasoned questions (*Why is the artist showing us the dead bee? Do you know why there are fewer bees today than in the past? What is the artist’s intention with this beluga whale? Do you know what threatens this species?*) combines sensitivity and intellect to help young people acquire the knowledge, values, and skills they need to understand environmental issues.

These examples are just a small sample of an educational movement that works to link the arts with environmental issues until this dimension becomes an integral part of education (Deslauriers, 2017).

## In Conclusion

In recent decades, environmental concerns have gained an enviable place in public and private discourse. While it is welcome, this popularity is not enough. The solutions to the environmental crisis proposed by the various decision-making bodies are generally based on efforts to rationalize production systems, the results of which fall far short of expectations. Increasingly, Earth system science experts are calling for a radical rethinking not only of how we work, but also of how we think about the world and our place in it, challenging, for example, the prevailing myths of self-actualization based on a race to consume.

In this context, the “educational and formative hope” [Translation] that art inspires in us (Kerlan, 2007), the interest of contemporary art practitioners in environmental concerns, and the new ways of looking at art in general represent, in our view, a transformative opportunity not only for schools and education but for society as a whole.

Ecological art, therefore, should not be viewed as a fad, and certainly not as a simplistic form of artistic expression in the service of an external cause. It is an expression of a civic commitment that has become determinative of contemporary art. As such, it is certainly destined to grow, and we are convinced that it can play a crucial role in raising the necessary awareness of the environmental challenges facing modern societies.

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Photo credit: Meriwether Lewis Elementary School

Society

# THE COMPLEXITY OF RECOGNIZING TRADITIONAL KNOWLEDGE IN CLIMATE CHANGE RESILIENCE PROJECTS: THE CASE OF THE SALOUM ISLANDS IN SENEGAL

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**T**he current climate crisis is triggering a variety of international initiatives to address the dramatic impacts of climate change and increase the resilience of the most vulnerable local communities (UN, 2015). These initiatives seek to introduce more “sustainable” forms of resource and territorial management, in line with international agendas. However, the affected local communities also have tradition-related knowledge and practices. Any initiative aimed at building community resilience to the impacts of climate change should therefore be accompanied by reflection on the relationship between proposed actions and what already exists, without assuming these categories are inherently at odds with each other. Our article shows the complexity of these considerations at the epistemological, methodological, and operational levels.

Senegal  
Photo credit: Gabriel de Castelaz

We draw on a case study from a project to strengthen the resilience of the Saloum Islands (Senegal) to climate change, which was funded by Quebec's International Climate Cooperation Program. Our research questions focused on knowledge recognized as "endogenous," on the continuities and tensions between such knowledge and knowledge that communities consider "external," and on recent upheavals that have led to the delegitimization of some type of knowledge in favour of others.

Our results show that there are indeed several elements of continuity and rupture, but we also highlight "concordant" knowledge, that is, where knowledges coming from different sources have similar implications for ecosystem protection and conservation.

## Historical Background and Issues

Since the Convention on Biological Diversity, international institutions and non-governmental organizations (NGOs) have attempted to integrate "so-called" traditional knowledge into climate resilience projects. The 2002 World Summit on Sustainable Development in Johannesburg reignited the debate on this issue (Landrieu, 2021). In many communities, colonization has played a major role in the devaluation and even loss of local knowledge, as "the colonial impact modified all spheres of life" [Translation] (Coquery-Vidrovitch, 2005).

Various criticisms have been levelled at the concept of integrating traditional knowledge into development projects, particularly regarding the actual motivations that lead international organizations and NGOs to take an interest in traditional knowledge, and the effectiveness or even impact of such integration in achieving the UN Sustainable Development Goals. The argument we put forward here is rather different. We believe that these initiatives are rarely accompanied by reflection on the theoretical, methodological, and operational complexity of such an endeavour. It is this complexity that we present.

## Epistemological Complexity

The term *traditional knowledge* has become very popular in recent decades. We find it in international development projects, in academia, and in everyday language. However, the first complexity we encounter

arises from the question, what is traditional knowledge? This gives rise to two subquestions: What is knowledge? And what does "traditional" mean?

We answer this question by looking at how the term is used in international organizations and scholarly publications. According to UNESCO (2021), traditional knowledge refers to the knowledge, skills, and philosophies developed by societies with a long history of interaction with their natural environment. Traditional knowledge refers to "what connects the people of today with the people of yesterday, that is, how today's societies interpret what they have received from their predecessors" [Translation] (Roué 2012).

A closer look at this term reveals that it is often used interchangeably with other, similar terms, such as indigenous knowledge, local knowledge, endogenous knowledge, ethno-science, etc. These terms are always in a dichotomous, binary relationship, in contrast to, for example, modern knowledge, scientific knowledge, Western knowledge, science, and so on.

This article demonstrates that the concept of traditional knowledge is not necessarily the most productive in accounting for the diversity of knowledge types and practices related to natural resource management. Instead of engaging in the semantic and epistemological debates surrounding the concept, one can rely on so-called *-emic* concepts. Thus, instead of looking to the category of "traditional knowledge" and trying to find elements that fall under it, another option is to focus directly on natural resource management practices that communities perceive as their own, as opposed to those perceived as originating externally. This approach has brought to light local accounts of the socioeconomic and political upheavals that have affected local practices, and it has made it possible to pay attention to the historical conditions of delegitimizing some types of knowledge in favour of others.

Our findings show that so-called modern and traditional forms of knowledge about resource management in the Saloum Islands are often similar in practice but differ in terms of their source of authority and way of being communicated. For example, biological rest periods in watercourses, which are legislated by Senegalese authorities through local fisheries committees, are very similar to what was practised prior to the introduction of these regulations. However, our interlocutors noted a linguistic distinction and nuance between the two practices. This finding shows that the categories of traditional and modern are not always truly at odds with each other in practice.

## Methodological and Operational Complexity

**F**rom a methodological perspective, we address the limitations of the survey methods traditionally used by NGOs to recognize and assess so-called traditional knowledge. In the Saloum Islands, for example, there is a long history of foreign NGOs coming in with so-called development projects, and leaving when their funding expires. The method they use to get information about the communities they work with is often similar to a focus group: a target group is brought together, questions are asked, some speakers express themselves, and then the group votes. This often results in biased, erroneous, or incomplete data. This is an observation shared by several stakeholders in the field: it is difficult to find out the real desires, experiences, or concerns of the people we meet. This blockage is due to the historical, economic, and social dynamics that shape NGO-community relations, but also to the methods used to obtain the information needed to justify the validity of funded initiatives.

NGOs are also rarely methodologically equipped to carry out this type of research. For example, NGOs often target only a small portion of the population, using specific criteria such as “youth” or “women”. Canada’s international feminist policy, for example, has led Canadian NGOs to work almost exclusively with women. This sometimes leads to bias in interventions and outcomes. The research presented here has therefore distanced itself from these approaches and instead included a variety of actors, to provide a more complete and nuanced picture: Women, men, traditional authorities, the elderly, youth, and those working to protect and conserve ecosystems as part of government services or local institutions.

Our findings confirmed that local resource management practices based on traditional knowledge are better considered by Saloum Island communities, even if new practices aligned with international agendas are introduced. The accentuation of sustainability issues, particularly those of a socio-environmental nature, has led to a search for solutions by state actors, supported by international donors, generally at the expense of local community norms and conventions. These communities push back against new policies and techniques that are often imposed on them, wishing to preserve their traditional knowledge and practices.

## Conclusion and Findings

**T**his research is part of a decolonial perspective that deconstructs hegemonic universalism by foregrounding the knowledge and practices of local communities. We have presented the theoretical, methodological, and operational complexities of acknowledging traditional knowledge in climate change resilience projects.

In the Saloum Island communities of Senegal, many local practices based on traditional knowledge contribute to ecosystem protection and conservation. According to our research, there are both continuities and discontinuities in natural resource management knowledge and practices. However, we also highlighted knowledge and practices for ecosystem conservation that we termed “concordant”, i.e. not historically continuous but with similar effects.

Our results support our hypothesis that there are dynamics of expropriation and replacement of endogenous practices. Indeed, many government regulations are presented as new even though they are consistent, or concordant, with past practices. The difference often arises from the name given to the practice. For example, state agencies promote “biological rest”. Populations see this as something new, whereas even before state regulations, they practised a rotation of activities that allowed resources to regenerate and renew themselves. The practice remains the same. Only the designation is different.

In addition to what has already been discussed, we would like to add a few elements to mobilize results in the project supported by Quebec’s International Climate Cooperation Program and in other similar projects. Following up on the comment about methodology, it would be appropriate to diversify the interlocutors in order to nuance the points of view expressed. It is true that we work primarily with women, but to get a fuller picture of the dynamics involved in our projects, we need to make sure that the issues and challenges are shared at the community level. This is also necessary if we are to ensure that international projects do not disrupt existing norms and conventions.

As we have shown, many “modern” management practices are in fact consistent with “traditional” management practices. It would also be interesting to look into aspects of the sacred that, even if they do not come from the same source of knowledge,



Iles de Gorée  
Photo credit: Françoise Gaujour

also have a conservation effect that is highly valued by the population. Aside from this, it would be advisable to build on endogenous knowledge and practices that have proved their worth. It could also be useful to work on their transmission between older and younger people, in order to preserve territorial specificity

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Photo credit: OBY Capsa

## Society

# LEST WE FORGET: THE INSTALLATION OF HIGH-WATER MARKERS IN POPULATED AREAS

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**I**n North America, like everywhere else in the world, rivers have been closely linked to the development of agriculture and the sedentation of human societies. As soon as they settled, pioneer communities had to balance their prosperity with rising waters. Social norms, traditions, and identities emerged, helping to shape the culture of these riverside groups and the way they saw their present and envisioned their future. One of the key elements used in this quest was monitoring visual landmarks in order to assess water levels, anticipate rising water levels, and take protective measures when necessary.

These visual landmarks — or high-water (or flood-level) marks — whether formal or informal, metrical or part of the cultural heritage, appear to be essential for riparians who consider themselves adapted to recurrent flooding, as they help to keep the memory of flood risk alive and develop a riparian risk culture (Bouchard-Bastien, 2023). Based on these observations and following citizen initiatives to think of ways to better manage flood risks since 2014, a pilot project funded by the Quebec government was recently launched in the municipality of Saint-Raymond. This experimental project is in line with the Quebec government's goal of institutionalizing and placing uniform flood-level markers in specific town centres throughout the province, following the model established in France since the early 2000s (MEDD, 2005). This is a promising initiative, but it also poses some problems and challenges.



This article examines the relevance and effectiveness of flood-level markers in adapting to territorial, social, political, and climatic changes at the local or regional level. What factors foster their effectiveness? What is the role of risk memory in adapting to recurrent flooding? Does it make sense to collectively invest in this initiative, which has proven effective in the past but needs to adapt to the changing climate? To answer these questions, we briefly review the scientific literature on memory and risk culture, then describe the main applications of flood-level markers. After, we present the Saint-Raymond case study, highlighting the successes and challenges of this pilot project.

## Risk Culture and Memory

**T**he link between flood-level markers and flood adaptation can be seen in what is known as risk culture. This concept, which has been advocated for in scholarly writings since the 1980s, highlights the place of risk in the cultural construction of societies (Douglas and Wildavsky, 1983). These contributions represent a nuance of the prevailing positivist approach, which considers risk as “the probability of an undesired event occurring” (Flint and Luloff, 2005); however, in reality, not everything can be objectively calculated and measured. In this way, risk culture highlights societies’ ability to coexist with risk by developing knowledge and practices based on experience and transmission.

Risk memory is also based on historical knowledge, the experiences of loved ones, and personal experiences. However, unlike risk culture, it does not systematically lead to a particular behaviour and does not guarantee a sense that risk is permanent in an area (Labeur, 2013). Indeed, it is not only the memory of an exceptional flood that allows people to anticipate the next event. This nuance nevertheless positions risk memory as the substrate of risk culture, since it informs how floods are imagined, giving memory its essential nature (Durand, 2014).

To make the transition from risk memory to risk culture, and thus promote adaptation to recurrent flooding, flood risks must remain active and valued, rather than hidden. This is where the patrimonialization of risk comes into play, meaning the process of designating “objects<sup>1</sup> to be preserved and passed on by the community” [Translation] (Metzger and Linton, 2018). Patrimonialization makes remembering and forgetting explicit by inscribing the

memory of the event materially and symbolically (e.g., using a high-water marker) for preservation purposes. It is also the result of a relationship negotiated between the most impacted and the most powerful groups, whereby the context of its implementation contributes (or not) to the activation of risk consciousness (Ullberg, 2013).

## Definitions and Use of Flood-Level Markers

As mentioned in the introduction, flood-level markers are ancient and can be used for a variety of purposes. The oldest known examples are nilometers, which date back to the third century BCE. These metrical high-water marks, which measure water levels in metres or other units, were used by the pharaohs on the banks of the Nile (Egypt) to predict future crop yields and their associated tax revenues (Bonneau, 1986). Several metrical high-water marks are still in use today, especially by dam managers who must measure water levels on a regular basis. Such markers are also present on some road networks to ensure safety during floods.

Flood-level markers can also have a cultural heritage purpose when they aim to represent risk in time and space, becoming reference markers that can be shared by a group and passed between individuals (Metzger and Linton, 2018). These markers are typically placed after a major flood and can be found in a variety of forms (engravings, painted lines, metal plates, enamel tiles, knobs embedded in a wall, etc.) and can represent different types of flooding (inundation, rising water levels, runoff, etc.). Although many flood marks have been destroyed in urban development, some very old ones can still be identified, especially in Europe where centuries-old flood-level markers are still in use.

Unlike metrical high-water marks, historical high-water marks may be formal or informal. A notable example in the Sainte-Anne watershed is the Monument de la Vierge in the municipality of Saint-Casimir, and more specifically the boat-shaped structure that overlooks the confluence of the Noire and Sainte-Anne rivers (Figure 1). Many residents of this area have stated that they monitor the river water level using the red zone painted on the boat. When the red area is no longer visible, that means there is water in people’s basements, as this resident explained: “It gives us a good indication, compared to yesterday or the day before, of how high the water has

1. The ‘objects’ of patrimonialization can be a space, a property, a practice, and they are not immutable (Linton and Metzger, 2018).

risen [...] When you can no longer see the red mark, the water starts to enter basements, and then the pump starts” [Translation]. Other than this marker, no other examples were found in the study area until recently (July 2022) when several formal high-water marks were placed in the municipality of Saint-Raymond for heritage use.

## The Case of Saint-Raymond

Since its earliest days, downtown Saint-Raymond has been regularly affected by floods. However, it was only after a particularly striking flood (April 15–16, 2014) that the community mobilized to find solutions to the problems caused by the flood. Several factors seem to have fostered this momentum: the political will to involve the population in the search for solutions, the willingness of local stakeholders to address flooding as a priority issue in the context of the Water Master Plan for the Sainte-Anne River watershed, the impatience of citizens who had just experienced two major floods in a short period of

time (2012 and 2014), and the development of a disaster prevention framework by the Ministry of Public Security (Ministère de la Sécurité publique, MSP).

Against this backdrop, the River Committee was created. Coordinated by the local watershed organization (CAPSA), the committee brought together disaster victims, citizens, municipal employees, and elected officials, supported by representatives of various provincial ministries and university experts in hydraulic engineering. Most of the solutions proposed by this group were technical and focused on hazard (reducing the magnitude and frequency of flooding). However, the presence of engaged citizens also made it possible to propose initiatives aimed at preparing the population for flooding, including the installation of high-water markers and information boards in strategic locations of the town.

A total of 19 flood-level markers (Figure 2) and three panels describing the history, extent, and memory of the floods were installed in the town centre in 2022. The latter had been ready for installation in 2019, to mark the fifth anniversary of the 2014 flood. The delay between completion and approval was due in part to the



**Figure 1.** Flood Marker at the Monument de la Vierge, Saint-Casimir  
Photo credit : Emmanuelle Bouchard-Bastien, 2018



**Figure 2.** Example of a Formal Flood Marker on the Banks of the Sainte-Anne River in Saint-Raymond, on Public Land  
**Photo credit : Emmanuelle Bouchard-Bastien, 2022**

funding source (Quebec government), as the MSP sought to approve the explanatory signage texts prepared by the River Committee members, validate the methodology for determining the number and location of the markers, and agree on their design. The installation of markers on certain private buildings identified by the River Committee also presented problems that dragged out the process, as some owners were hard to reach or were unwilling to mark their buildings. In addition, notarized agreements with willing owners were needed to grant the city an easement for maintenance and to ensure the longevity of the project. A city employee dedicated to these innovative administrative procedures was a great asset in the final stages of implementation, not only facilitating the process but also ensuring that affected owners were properly informed of the project's goals.

## An Example to Follow?

**T**he example of Saint-Raymond, the first place in Quebec to install formal flood-level markers, highlights the successes and challenges of this initiative and its subsequent large-scale implementation.



Photo credit: OBV Capsa

For example, accompanying flood-level markers with interpretive signs undeniably allowed the local specificities of Saint-Raymond to be valorized as part of a commemorative effort. This appears to be fundamental in the exercise of collective memory, which must be territorially anchored in order to be meaningful (Metzger et al., 2018). The fact that flood-level markers are a local initiative, emerging from the flood-prone population itself, also facilitated their implementation and acceptance. Flooding is a bad memory for some individuals, and flood-level markers can potentially be stigmatizing in terms of buildings' property valuation. Therefore, only individuals and groups who have developed a sense of belonging to this particular feature of their living environment will be inclined to want to commemorate it. The notarized easement between the city and the owners will ensure that the high-water marks remain in place for as long as possible, preventing their demolition or relocation in the future.

On the other hand, it is important to note that flooding varies greatly from one region to another, in terms of course or causes, and that a similar flood marker across the province could "help impose a form of common, shared vision of flooding" [Translation] to the detriment of local specificities, different representations of events, and associated knowledge and practices, as noted by Metzger et al. (2018) in their review of the standardization of flood-level markers in France. From this perspective, the standardized use of flood-level markers would complicate the path toward collective memory and local risk culture. Specifically, in the case of Saint-Raymond, the MSP's adoption of this citizen initiative led to a sense of loss of control among some River Committee members due to the delays, requests for text amendments, required validations and approvals, re-readings, and final approvals. Ultimately, the River Committee members appear to have maintained a sense of ownership and accomplishment for the installation of the high-water markers and signs. However, it is unlikely that this project can be replicated in other municipalities, as the flattening of messages by the relevant authorities could weaken efforts to preserve heritage and create a culture of risk that must remain primarily local. High-water markers seem to be a promising way to contribute to adaptation to recurrent floods, provided that these installations reflect the experience and knowledge of the local residents living with rising waters.

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Society

# MINING PROJECTS IN TRANSITION: INTENSIFYING EXTRACTIVISM UNDER THE GUISE OF FIGHTING CLIMATE CHANGE

Val-d'Or  
Photo credit: Cédric Corbeil

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*"As Quebecers, we could make an important contribution to the fight against climate change by allowing these projects to emerge," says the CEO [of a Quebec mining company]. "What other options are there if we want to one day replace gasoline in our vehicles, boats, and planes? You have a choice between lithium from Australia that was processed in China, or lithium salts from South America, which are very difficult for groundwater, and with working conditions that are perhaps less attractive than in Abitibi." [Translation] (Léouzon, 2021)*

**T**his excerpt from a press article is about new projects that aim to contribute to the fight against climate change. More specifically, it is about an open-pit lithium mining project in Abitibi-Témiscamingue that is being challenged for its environmental impact. The line of reasoning expressed above is found in many mining projects involving critical and strategic minerals. How can a natural resource extraction project be legitimized with the argument of fighting climate change? Isn't there an inherent contradiction in legitimizing projects that have undeniable environmental impacts under the guise of green rhetoric? This article takes a critical look at these forms of justification, focusing on the concept of nature and the relationship between humans and nature.

The concept of extractivism and the proposals of anthropologist Arturo Escobar provide food for thought about the contradictory nature of discourse on and strategies to combat climate change that are based on intensifying the extraction of natural resources. With the onset of the energy transition, it seems necessary to open up perspectives on this facet of the energy transition that is based on intensifying mineral exploration in Quebec.

## Mining Projects Portrayed as Essential to the Energy Transition

**A**gainst the backdrop of a recognized global climate crisis, governments are attempting to propose a range of solutions to combat climate change, particularly through initiatives supporting the *energy transition*. The main objective of this transition is to revise our energy models by decarbonizing them. The Quebec government has identified the electrification of transportation as an essential component in this decarbonization. This is a technocentric, interventionist vision: the transition to a low-carbon economy will be achieved through technology, investment, and public policy (Audet, 2016).

To support this vision of an energy transition, the Quebec government launched the *Quebec Plan for the Development of Critical and Strategic Minerals 2020–2025* (QPDCSM) in late 2020. It lists 44 projects for the extraction of strategic and critical minerals (SCM). Lithium, graphite, and rare earth elements are among the minerals considered essential for the production of so-called green technologies. These transitional mining projects are spread out across Quebec, including in regions farther south that have been less affected by mining in the past. Several of these projects are controversial, bringing different actors together or against each other around diverging arguments. Some back these projects, in the name of fighting climate change, of economic growth, of Quebec's international reputation, and soon. Others oppose them to defend their territory, protect their groundwater, and so on.

Like the government, the mining industry presents these new mining projects as necessary for the energy transition and, more generally, for the fight against climate change. Mining company websites claim that these projects will “power the electric cars that are part of the solution to climate change” or “propel the energy transition.”

However, numerous studies have demonstrated the environmental impacts of mining, such as water resource depletion, soil pollution, and ecosystem destruction. Some studies even indicate that the intensification of mining projects for renewable energy poses an additional threat to biodiversity, such as a 2020 article published in *Nature Communications*. The authors note that new pressures on biodiversity could exceed those avoided by climate change mitigation measures based on renewable energy use (Sonter et al., 2020). In other words, these studies fundamentally question the proposed solution of increasing the number of mining projects to address the ecological crisis.



## Extractivism, Another Facet of Mining

**T**he extraction of natural resources has been the subject of numerous debates, particularly as regards the environmental and social issues associated with mining. Among the concepts that have been proposed to better understand the background of the extractive industry is the concept of extractivism. This term first appeared to describe the exploitation and accumulation of natural resources by colonial powers on the Latin American continent. It has been taken up by both activist groups and academics involved in critical development debates (Svampa, 2011; Bednik, 2019). For some, it refers exclusively to the massive extraction of non-renewable resources such as minerals and hydrocarbons. For others, it also refers to large damming projects, industrial agriculture, or forest monocultures (Bednik, 2019). Regardless of the type of resource, the concept is defined as massive exploitation and commercialization of nature without benefit to local communities, who nonetheless bear the environmental and social costs (materials are primarily mined for processing outside the extraction area or for export). It has its roots in colonial domination, which is still maintained today through the appropriation of resources for commercial purposes.

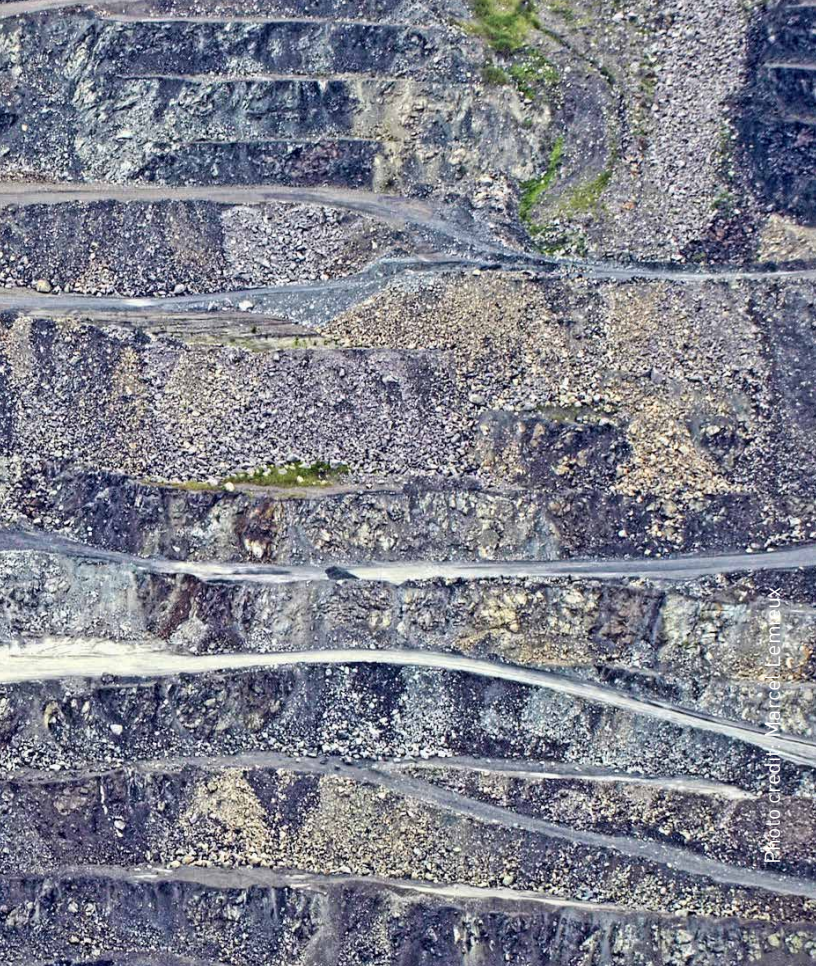


Photo credit: Marcel Lemieux

## Arturo Escobar's Relational Ontology for Changing Our Relationship with Nature

One way out of this productivist, disembodied interpretation of nature would be to rethink our relationship to it. The idea that nature is at the service of humans, who are capable of modifying and dominating it *ad infinitum*, has not always existed (White, 1967). Several researchers have put forward valuable ideas to help us move away from a view of nature as a commodity and understand how we have come to assign nature a passive role. One example is Colombian and American anthropologist Arturo Escobar, known for his critique of development and Western modernity. More specifically, he attempts to shed light on the logic and the discourses that tend to impose a single view of development and modernity as universal ideals to be achieved by all.

In a 1996 article, Escobar deconstructs and criticizes the discourse of sustainable development in which nature is reinvented as the *environment*. In this discourse, nature is no longer a separate entity with its own capacity to act. It is transformed into an environment, a concept in which humans are the active principle, while nature assumes a passive role (Escobar, 1996). While the QPDCSM proposes considering transitional mining projects as a solution to combating climate change, nowhere in the document is the word “nature” mentioned. Nature is not active, but basically inert, and therefore, it can be managed and exploited like a commodity.

Escobar continues his reflections in a book published in 2018. He formulates his work around the concept of *thinking-feeling*, which offers a rethinking of how we experience the world. He describes this concept as follows: “It is now up to each of us to learn to feel and think with people’s territories, cultures, and knowledge—their ontologies—rather than starting from the decontextualized knowledge that underlies concepts of ‘development,’ ‘growth,’ and even ‘economics’” [*Translation*] (Escobar, 2018). In other words, Escobar asks us to radically question the separation between body and mind, reason and emotion, propagated by modern thinking. He proposes that we change our way of being in the world by thinking simultaneously with the heart and the mind.

Like Bruno Latour, Escobar proposes a *relational ontology*, that is, a reality or set of worlds composed of a dense web of relations and materiality between beings (human and non-human) and the various worlds they inhabit.

Extractivism is based on a particular view of nature. Nature becomes an inert commodity that humans appropriate to exploit for the benefit of a modern logic of development, progress, and growth. Humans are separate from nature, and progress (identified with modernity) is established as a universal goal to be achieved by all. It so happens that the Quebec government justifies the intensification of SCM extraction based on this rhetoric of modernity (development, progress, growth). The QPDCSM proposal “presents concrete measures to take advantage of minerals indispensable to the green energy and technological transition, both nationally and internationally. This Plan offers us the possibility to extend Québec’s outreach all over the world.” (QPDCSM, 2020).

The concept of extractivism, then, allows us to think differently about transitional mining projects that propose to mine more SCM to address climate change. It highlights the domination relationship on which mining is based. The proposed extraction thus appears as a continuation of an extractivist model based on the exploitation of nature that does not benefit local populations. Presenting mining projects as a solution to climate change becomes untenable from an extractivist reading of these projects. To move away from this extractivist logic, we need to think of alternatives that are not based on the commodification of nature.

For example, nature (the rock, the mountain, the tree, etc.) is seen as a *feeling* being, no longer an isolated, inert being separate from humans. In this way, nature is revived. This statement is especially strong when we think of mining projects. A mining site becomes a vast network of interrelationships between minerals, rocks, watercourses, flora (trees, shrubs), and fauna (ants, butterflies, moose). Once the rock becomes a feeling being, its exploitation and destruction, as in the case of a mining project, presents itself in a very different way. In this relational perspective, portraying an increase in industrial natural resource extraction projects as a solution to achieve a more habitable world becomes questionable.

## Rethinking Our Relationship with Nature to Pave the Way for Alternatives

**T**he discourse of authorities and of the mining industry, proposing transitional mining projects as a solution to climate change, is rooted in a worldview that separates nature from culture, human from non-human, through hierarchization (Escobar, 2018). The technocentric, interventionist approach to the energy transition proposed in the QPDCSM is part of the same worldview that leads to the destruction of nature (the current climate crisis is a bitter example). However, there are alternative paths of transition that allow us to “overcome the models of capitalist modernity in which the human always thrives at the expense of the non-human” [*Translation*] (Escobar, 2018).

By assuming that the increasing exploitation of SCM is necessary for the energy transition, the government is perpetuating extractivist policies under the guise of combating climate change. However, massive exploitation of natural resources does not appear to be a solution that should be favoured in the current major crisis. It therefore seems essential to rethink the trajectory of an energy transition, so that it positions the defence of the living world (Gabriel, 2017) at the heart of the reflection process.

Escobar (2018) proposes that we think differently about our relationship with the world, and to restore nature's role as an actor of its own. In this way, humans and nature are no longer separate, and the former's relationship of domination over the latter disappears. Every human being thinks with both their heart and mind and exists in relation to other humans and natural

entities. This proposal appears a promising way of launching collective thinking and of charting alternative paths to that of the current mining policy. These alternative paths would no longer take as given that we must choose between a “sustainable” extractive project in Abitibi-Témiscamingue and an “environmentally challenging” one in Latin America, as was presented in the excerpt at the beginning of this article.

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## Society

# ENDOGENOUS AND LOCAL KNOWLEDGE FOR ADAPTATION TO CLIMATE CHANGE

Photo credit: Abass Mathie 2020

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## Climate Change: A Reality for French-Speaking Countries in the South

**C**limate change is one of today's most pressing concerns and one that continues to substantially alter the living conditions of people around the globe. The environmental inequalities between the countries of the North and South are well known, with the former being better prepared and relatively less affected than the latter, especially in French-speaking African and Caribbean countries, which are highly vulnerable. The survival of communities in these countries depends essentially on the exploitation of natural resources, notably through agriculture and livestock farming. Current climatic constraints are making life more difficult for these communities, leading to migration, food insecurity, disease, and more. International institutions, researchers, and non-governmental organizations are giving increasing attention to this phenomenon to act on mitigation and adaptation measures. Several initiatives based on measurements of climate phenomena are currently being implemented, but the potential contribution of communities suffering the consequences of climate change still remains underexplored and is rarely taken into account as a starting point in reflecting on and developing climate change mitigation or adaptation policies (Piron, 2019).

Yet these populations, especially those in the French-speaking countries of the South, have for decades been developing mechanisms for managing an unfavourable environment. As a result, they have a wealth of experience, knowledge, and know-how with which to adapt to their environment. For a sustainable answer to climate change, it is therefore necessary to understand the vulnerabilities and resilience strategies of local communities and to capitalize on their knowledge. This

## Definitions

**Yanayi:** This word means "climate" in Hausa and "fight against poverty" in Fon.

**Local knowledge, endogenous knowledge:** More appropriate than so-called traditional knowledge, local knowledge is defined by UNESCO (2005) as "sophisticated knowledge, interpretations, and systems of meaning accumulated and developed by peoples with a long history of interaction with the natural environment."

**Science shop:** As a mediation tool, a science shop connects academia and society by making it possible to transmit and use scientific knowledge by, for, and with local communities or civil organizations that express concrete problems they wish to address (Piron, 2009).

**Cognitive justice:** In response to injustices relating to non-hegemonic knowledge (which does not originate from Western science), this ethical principle aims for the democracy of knowledge and an "active recognition of the need for [its] diversity [*Translation*]" and plurality by overturning conceptions of private property, expertise, and law (Visvanathan, 2016).

**Open access:** By removing financial, legal, and technical barriers to online scientific publications and "allowing anyone to read, download, copy, transmit, print, search, or link to the full text," open access is an innovative practice for the circulation of diversified knowledge between researchers, institutions, and civil society.

article presents the Yanayi project<sup>1</sup>, situated within a theoretical approach of social ecology and cognitive justice (Piron et al., 2016; Piron, 2018), which aims to highlight, disseminate through open access, and sustainably archive the knowledge of and actions posed by a wide diversity of communities in French-speaking Africa and Haiti that are particularly hit by climate change.

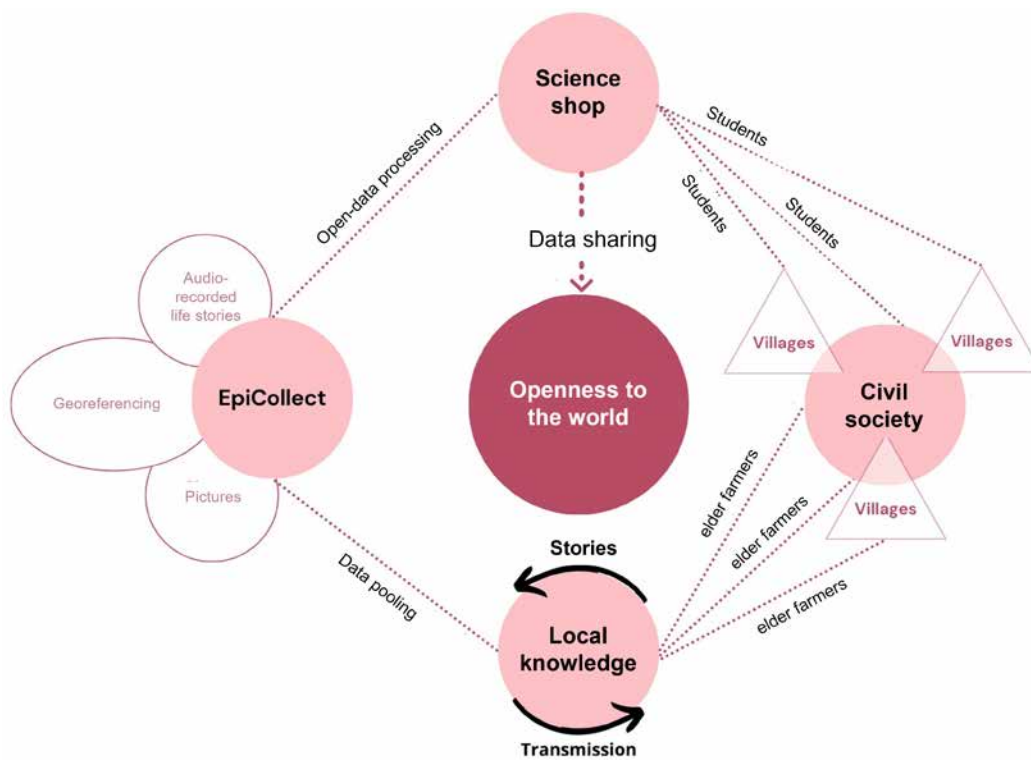
## Multisite, Decentralized Qualitative Research: A Renewed Approach to the Issue of Climate Change

**H**ow are African and Haitian populations, particularly those living in rural areas, dealing with climate change affecting their living environment? How do they identify and explain these changes? What have they done to resist, mitigate, or adapt? What resilience strategies have they devised, and what knowledge have they generated over time about their natural environment, its transformations, and the need to continue to extract from it the resources necessary for life? These questions mobilized ten science shops in eight French-speaking countries in the South<sup>2</sup>. In an attempt to answer them, taking into account their sometimes-difficult research contexts and the inseparable urgency of Sustainable Development Goal 13, a multi-site, decentralized, and simultaneous action-research project employing the life-story approach and free, open-source digital technology was set up (Figure 1). Around 100 students of the human and social sciences, affiliated with a science shop, travelled to the rural areas of their own countries to collect local knowledge stories about climate change and the resilience strategies developed by elderly men and women who are the guardians of collective memory. These stories were then archived in an open, reusable database on the Epicollect5 application.

This multi-site, decentralized research had two objectives: to consolidate the links within and the capacities for action of the science shop network, and to grasp the continuum of vulnerabilities and forms of adaptation in the context of the French-speaking South, without preempting the complexity and particularity of each person, village, and community. This research-action based on endogenous narratives and knowledge also aimed to bring about human, social, scientific, and political transformation. The practice of life storytelling gives a voice to marginalized knowledge-holders, promoting interdisciplinarity, reflexive interaction, and their

1. To Florence Piron, instigator of the Yanayi Project and pioneer of committed open science

2. These include the science shops in Ngaoundéré (Cameroon), Conakry (Guinea), Bobo Dioulasso and Ouagadougou (Burkina Faso), Port-au-Prince (Haiti), Abidjan (Ivory Coast), Bambey (Senegal), Abomey-Calavi and Parakou (Benin), and Niamey (Niger).



**Figure 1.** Schematic representation of the approach used in the Yanayi project

recognition as knowing, sensitive and active actors, and therefore as agents of change (Piron, 2019). This capacity for empowerment offered by life stories, based on the voices and lives of participants, proves crucial in the light of conventional—mostly quantitative—research on climate change in Africa and Haiti, which usually shows rural communities as passive or, on the contrary, co-responsible for disasters.

As the fight against climate change requires that we take into account the local and global dimensions, as well as the individual and collective scales, this new co-constructive and intrinsically formative method also meets this requirement, with the unusual feature of including and valuing local knowledge. In this case, it relies on their potential to illuminate the complexity surrounding climate change and to offer an alternative to hegemonic knowledge, which is often inadequate for the needs and aspirations of local communities, for “whether we seek to value it, despise it, or ignore it, the fact remains that local knowledge exists and it is this knowledge that primarily guides interactions between social actors and their living environment” [Translation] (Piron and Ringtounda, 1994).

## Stories of Adaptation and Resilience Strategies from Yanayi

A total of 478 stories of local and endogenous knowledge of climate change was collected in geolocated sites over the course of 2020 (Figure 2).

Structured around six story typologies, the information gathered from older men and women spans ten different rural territories in eight countries. Each interview was conducted by the students in the local language, to enable the interviewed actors to use their own referents and facilitate the restitution of their knowledge. The stories were then translated into French by the same student story collectors. Thus, in the Epicollect database, it is possible to listen to people tell various stories, their life, observations, consequences, resiliencies, recommendations, and a message to Africa, both in the local language and in French. For the most part, the episodes recounted are accompanied by photographs that help illustrate the narrators’ words according to each type of story (Figure 3).

With 478 stories collected from coastal, desert, mountain, agricultural, forest, and pastoral environments, the Yanayi project brings together an array of local realities facing

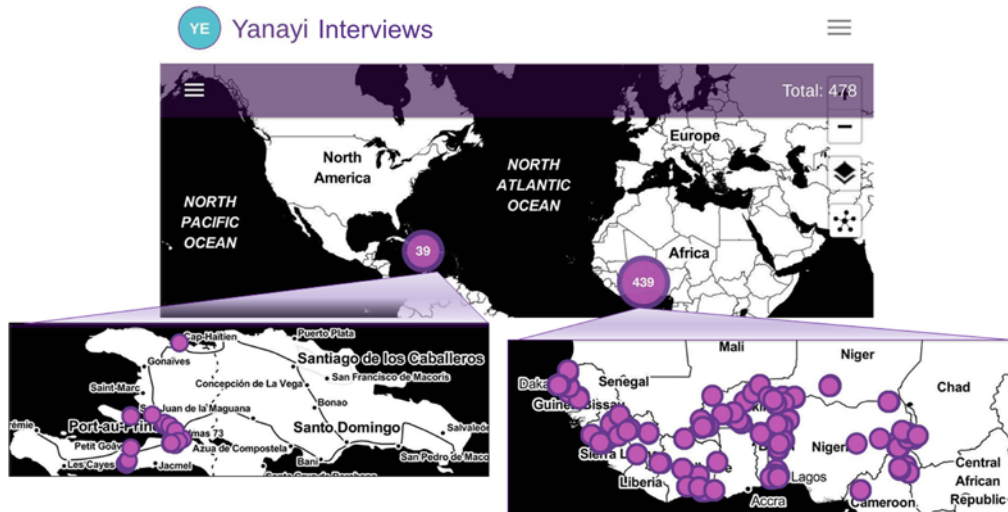


Figure 2. Geographical distribution of the 478 stories stored in the Epicollect5 database



Figure 3. Schematic representation of the different stories collected during the Yanayi project. These photos were taken during an interview with Mrs. Rokhaya Diagne, a fisherwoman living in the Guet Ndar district of Saint-Louis, Senegal. Contextualized in a coastal environment where rising sea levels are increasingly felt, her story recounts the social impacts of climate change on her community, as well as the adaptation measures put in place in the face of growing fish scarcity. Photo credit: Florence Piron, Laval University (2020).

highly variable climate change impacts. This is reflected in the wide variety of adaptation measures implemented by local populations. These strategies include (1) processing fish into salted, dried, and fermented products for resale during the wintering season; (2) setting up local cooperatives; (3) switching to short-cycle seeds to overcome harvest shortages; (4) modifying the agricultural calendar; and (5) diversifying subsistence-economy activities. These adaptation strategies, developed locally by and for communities, deserve to be disseminated to a wider public to enable them to be reapropriated.

In addition, given the massive amount of data collected, there is a real need to bookmark the content of the stories in order to highlight the most knowledge-rich passages and associate them with evocative key words, to guide database readers immediately to the files that will be most useful to them. Following this tagging job, data restitution and sharing could be implemented, both at the local stakeholder level—in particular to raise awareness among local players of the various adaptation measures available to them—and on a more global scale, by sharing the results of the Yanayi project in the scientific and political spheres.

# The Contribution of Local Knowledge to Climate Change Adaptation Science and Policy

**T**oday, the scientific community recognizes the inescapable contribution of local and endogenous knowledge to combating climate change and preserving biodiversity (Ogar, et al., 2020; IPCC, 2022). The effects of climate change are highly variable spatially, and they therefore impact ecosystems, regions, and localities differently. The knowledge of local communities is qualitative, linked to specific localities or cultures, and bears witness to a long history of interaction with the natural environment (Nkoudou, 2015). It is also intimately linked to a set of practices, stories, and beliefs, which distinguishes it from scientific knowledge. Scientific knowledge, however, has demonstrated its frequent inability to account for territorial realities, and in some cases, its inability to lead to effective and sustainable solutions.

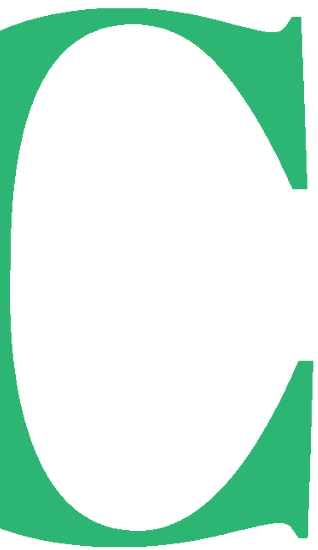
Thus, the combination of local and scientific knowledge should enable a better understanding of the complex impacts of climate change, facilitate the identification of adaptation solutions in line with the needs and aspirations of local communities, and ultimately facilitate the implementation of mitigation and adaptation policies. The development of collaborative or participatory approaches, at the interface between the natural and social sciences, must be encouraged in order to make the most of all the scientific content included in local knowledge. This type of approach involves local players in the co-production of knowledge and the development of solutions for adapting to climate change, and it must respect the dignity and autonomy of Indigenous peoples.

## Conclusion

**P**rojects such as Yanayi enhance local climate knowledge, build resilience and capacity to adapt to climate change, and improve education on and awareness of adaptation strategies. As a follow-up to this project, a campaign to popularize its results will be carried out in 2023–2024 in Benin, Cameroon, and Senegal. In the current climate emergency, it is and will be crucial to ensure collaborative, equitable, and respectful inclusion of local knowledge to identify and implement effective mitigation or adaptation solutions adapted to different realities.

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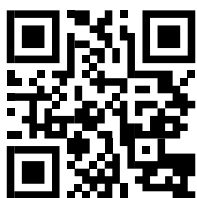
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