Latinoamérica21

Climate Change Impacts in Latin America and the Caribbean

Editorial coordinators: Jerónimo Giorgi (L21) and Irene Torres (IAI)

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Design and layout: estudio di candia | www.estudiodicandia.com

Cover image: iStock/WhitcombeRD

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The Inter-American Institute for Global Change Research (IAI) is an intergovernmental organization with 19 Parties in the Americas that promotes transdisciplinary research and the enhancement of capacities to improve public awareness. The IAI also provides information to governments for the development of public policy, which is relevant for a global environmental change based on scientific excellence, international and intersectoral cooperation, and the open exchange of knowledge. As part of its strategic plan 2019–2044 (Strategic Plan: http://www.iai.int/pdf/en/Strategicplan-en.pdf), the IAI Directorate also hosts the Belmont Forum Secretariat.

Climate change impacts in Latin America and the Caribbean [ebook] / coordinators Jerónimo Giorgi, Irene Torres. -- Rio de Janeiro, RJ : Maria del Carmen Villarreal Villamar, Leonardo Magalhães Firmino, 2022. PDF

Many Authors.
ISBN 978-65-00-54980-5

1. Latin America - Climate conditions 2. Caribbean - Climate conditions 3. Environment-Social aspects 4. Climate change - Socialenvironmental aspects I. Giorgi, Jerónimo. II. Torres, Irene.

22-133072 CDD-363.73874

1. Climate change : Environmental problems 363.73874

Eliete Marques da Silva - Librarian - CRB-8/9380

Content

Foreword

Scientists have been warning about the causes and impacts of climate change for decades. Human activity now affects most ecosystems on Earth and our actions continue to modify the functions of the Earth's systems globally. To support governments in mitigating and adapting to global change, the Inter-American Institute for Global Change Research (IAI) is supporting scientific endeavours by using a transdisciplinary approach that brings together diverse perspectives. The aim is to generate the best possible scientific information and tools for the development of public policies.

Thirty years ago, twelve countries came together in Montevideo, Uruguay, to establish the IAI with the aim of achieving regional coordination of scientific research on the extent, causes, and consequences of global change in the Americas, as a means to expand the frontiers of knowledge and serve as an effective interface between science and the policy-making process.

The Montevideo Agreement showed great foresight because it understood that the complexity of global change requires multinational transdisciplinary collaborations to find solutions that cannot be pursued by one country or one discipline alone. It created the opportunity for a region as culturally and biologically diverse as the Americas to collectively conduct research and share best practices on policy formulation and implementation. At the moment, there are 19 IAI member states.

During this time, the IAI has followed the principles of scientific excellence, international cooperation, and the full and open exchange of scientific information relevant to global change in the Americas. The goals of the IAI strategic plan revolve around eight main areas: Poverty and Equality, Food security, Water security, Energy security, Climate action, Human health and wellbeing, Biodiversity and ecosystem services, and Clean air, water, and soil.

The IAI's science program has pushed the boundaries of science to better understand the drivers of global change and their impacts, and to seek solutions. Priority societal issues are addressed through the co-creation of knowledge with natural and social

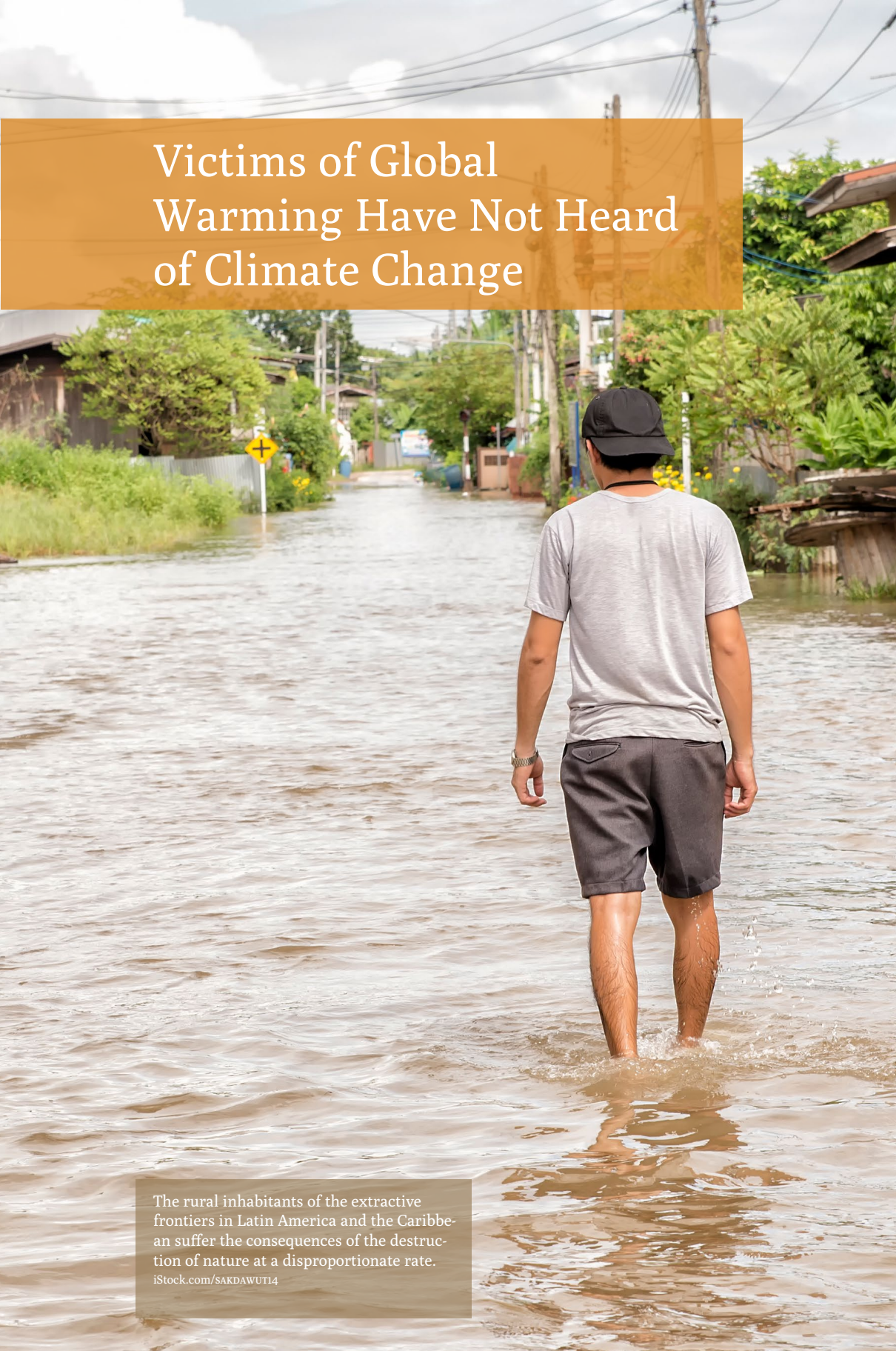
scientists, policy practitioners, and other stakeholders who collaboratively propose research questions, conduct transdisciplinary research, and ensure that the resulting information is useful, timely, and can be readily applied to address the needs of society.

The capacity-building program has contributed to strengthening research institutions, individuals, and networks across the Americas, particularly in Latin America and the Caribbean. As part of its efforts to promote equity, diversity, and inclusion (EDI), special attention has been given to supporting early career researchers and individuals from countries with limited scientific production. The IAI's EDI policy is aimed at mainstreaming scientific research and science-policy initiatives regionally and at increasing the leadership of people from underrepresented groups in scientific activities. The policy contemplates reducing imbalances and biases across gender, age, and underrepresented groups.

This compendium captures many of the results of climate change research in the region and implications for public policy, through the voices of the IAI's Small Grants Program scientists and Science, Technology and Policy (STeP) fellows. The commentaries have been published in diverse national prestigious newspapers reaching broad audiences, including civil society, and the public and private sectors. We hope the information shared here will help to inform public opinion and inspire others to support these collaborative regional endeavours to address the challenges of climate change for a healthier Americas.

Anna Stewart-Ibarra
Scientific Director
Inter-American Institute for Global Change Research (IAI)

Victims of Global Warming Have Not Heard of Climate Change



The rural inhabitants of the extractive frontiers in Latin America and the Caribbean suffer the consequences of the destruction of nature at a disproportionate rate.
iStock.com/SAKDAWUT14

- Duvan Caro — Audiovisual Communicator of the Institución Universitaria de Bellas Artes y Ciencias de Bolivar (Colombia). Researcher in conservation and environmental issues in rural territories of Montes de María in Colombia.
- Olga L. Hernández-Manrique — Biologist and researcher with a PhD in biodiversity: conservation and management of species and their habitats, University of Alicante, Spain. Specialising in inter/transdisciplinary and socio-ecological approaches.
- Diana Moreno — Adjunct Researcher at the Alexander von Humboldt Biological Resources Research Institute, Colombia. D. in Environmental Studies from the National University of Colombia.
- Matías Mastrangelo — Biologist and PhD in Environmental Studies, Victoria University of Wellington, New Zealand. Assistant Researcher at the National Council for Scientific and Technical Research (CONICET), Argentina.

Over the last decades, the Indigenous and peasant communities in the tropical forest of Montes de María (María La Baja, in the Colombian Caribbean) have been witnesses to the changes in their once diverse crops, which have now become monocultures of African palm and rice; the decrease in water flowing from the mountain, the disappearance of medicinal plants, and the increasing irregularity of rainfall. The increasingly frequent overflowing of rivers causes floods that bring with them a slew of diseases, while wildfires not only devastate subsistence crops–crops that meet part of the food needs of a given population–but also the rainforest, which provides the inhabitants with access to water.

However, for Duvan Andrés Caro, who is dedicated to communicating the problems of these impoverished, racialised and forgotten communities, climate change 'is a story of scientists, of NGOs, of cities. Of another world.'

For decades, scientists have hoped that the evidence would help policymakers make decisions that reduce social vulnerability and

environmental conflict. Public and private sector 'decision-makers' are increasingly heard talking about environmental change and sustainability. But as international conferences on climate change multiply, the number of people leaving rural areas, displaced by the destruction of nature and their livelihoods, is rising exponentially. The disconnect between the international forums where solutions are sought, the territories, and their inhabitants is evident.

All is not lost, though. New ways of connecting science with the territories and decision-making centres are now emerging. If scientists really want to contribute to finding solutions to environmental problems, they must begin to take into account the voice of the inhabitants of these areas and open up to their knowledge.

Joint production, or 'co-production,' between inhabitants, scientists, decision-makers, and other social actors linked to the territory is a way to reconnect these distant and different worlds, to generate spaces for the dialogue of knowledge, and to generate spaces for negotiation between the parties.

Furthermore, if the data generated in the research centres were

The Montes de María tropical forest in the municipality of María La Baja in the Colombian Caribbean suffers from increasingly erratic rainfall. iStock.com/ThCh

> If scientists really want to contribute to the search for solutions to environmental problems, they must begin to take into account the voice of the inhabitants of these areas and open up to their knowledge.»

to be adapted to languages coherent to the communities, a 180-degree turn could be made in the decision-making processes that affect these territories and their inhabitants. This would make the processes of restoration and conservation of biological corridors, which is becoming increasingly urgent, easier as the communities' food sovereignty and security depend on them.

In this context, both the inhabitants of the Colombian community of María La Baja and those of the small village of Sachayoj ('lord of the forest' in Quechua) in the Argentine Chaco–which has gone from being one of the largest forested regions on the continent to one of the largest deforestation frontiers on the planet in only 30 years–have participated in a scientific project that has had promising results in terms of 'co-production' of knowledge and capabilities.

The 'Socio-ecological resilience in the face of global environmental change in heterogeneous landscapes' project brought together inhabitants, producers, scientists, and other social actors to jointly identify the main threats and opportunities for local development. In Sachayoj, due to the demand of the stakeholders of the territory, a monitoring plan of environmental indicators is being implemented to correct harmful practices and avoid greater risks and vulnerabilities. Pollinator monitoring, for example, is reducing the use of agrochemicals and favouring biological pollination.

In María La Baja, on the other hand, the local community, together with scientists, co-designed communication pieces about life and diversity in the territory, memory and food, and actions for the well-being and revitalization of the territory in the context of tropical dry forest conservation. The project has also promoted and strengthened the socio-ecological dynamics of monitoring fauna and flora and of agricultural production to overcome the region's vulnerabilities.

The advances in these two marginalised communities in Latin America show that carrying out processes of co-production, co-cre-

ation, and calling for community work when conducting environmental research in specific territories is of utmost importance. The achievements made through greater rapprochement and participation between researchers, community members, and research centres also helps to make the future of natural resources the focus of the discussion, which is essential when making decisions about policies that affect biologically relevant areas.

While in the centre of the big cities and in the most powerful countries of the world people temporarily seek to 'isolate' themselves from environmental conflicts, families and rural communities in Latin America and the Caribbean live permanently exposed to their consequences. Therefore, according to Duvan, 'the inhabitants of the communities urgently need their ancestral practices of conservation, care and understanding of nature to be endorsed and taken into account when producing information about the territory.'

It is time to consolidate change. While scientists have opted for an ineffective and naive strategy to contribute to the solution of environmental problems, rural dwellers on the frontiers of extractivism in Latin America and the Caribbean suffer the consequences of the destruction of nature at a disproportionate rate.

There is still time to change this situation. But instead of continuing to pin our hopes on influencing decision-makers, we must commit ourselves to work as equals with all the social actors who live and act on the ground In order to address the environmental crisis, which is manifesting itself more and more strongly in the poorest regions, we need to carry out more democratic processes that take into account the different forms of knowledge.

Ocean Warming Is Already Affecting the Lives of Many Latin Americans

Artisanal clam fisheries in the region are particularly vulnerable to rising ocean temperatures.
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- Gabriela Jorge-Romero — Marine biologist. Professor and researcher at the Marine Sciences Laboratory of the Faculty of Sciences, University of the Republic (Uruguay). Master's degree in Ecology from the same university.
- Ignacio Gianelli — Biologist, collaborating researcher and PhD student in Marine Science, Management and Technology at the University of Santiago de Compostela, Spain.
- Jeremy Pittman — Associate Professor and PhD in Social and Ecological Sustainability at the University of Waterloo, Canada. Specializing in environmental policy and governance in the Anthropocene.
- Omar Defeo — Professor and researcher at the Marine Science Laboratory of the Universidad de la República (Uruguay). PhD in Marine Sciences from the Centro de Investigación y Estudios Avanzados (Mexico).

'When they closed the fishery, I wanted to die because that's what I knew how to do. I knew how to work the clams. That's all I knew,' recalls Arturo Agüero, a fisherman from La Coronilla, a small fishing village in Uruguay. It was 1994 and, faced with the massive die-offs that decimated the populations of the yellow clam (Mesodesma mactroides), the Uruguayan authorities opted for the total closure of this fishery in the department of Rocha to prevent its local extinction. This reduction was nothing more than a direct consequence of the systematic increase in sea surface temperature recorded for several years, particularly after the transition from a cold to a warm period during the 1990s.

The warming of the oceans results from, in part, the increase in greenhouse gas emissions, especially carbon dioxide, which retains solar energy within the atmosphere and thus generates a tropical expansion driven by temperature gradients, moving poleward in mid-latitudes. This temperature increase alters the intensity and direction of winds, which subsequently affects ocean circulation and currents. These long-term changes have caused losses in polar ice sheet mass, altered precipitation regimes, and led to an increase in sea level.

The warming of the oceans results, in part, from the increase in greenhouse gas emissions, especially carbon dioxide, which retains solar energy within the atmosphere.»

The South-West Atlantic

Ocean warming is apparent in the South-West Atlantic, particularly over the continental shelf of southern Brazil, Uruguay, and northern Argentina, one of the world's largest marine hotspots. The adjacent Rio de la Plata basin is also subjected to intense warming. The Brazil current shows a consistent poleward shift, and the advection of warm waters towards the north-eastern Uruguayan slope has been intensified by the increase in the speed and frequency of winds blowing towards the coast.

Artisanal fisheries in developing countries are particularly vulnerable to the effects of climate change. Ocean warming has been responsible for mass mortality in species with an affinity for cold water, the increasing occurrence of red tides (harmful algal blooms), and a species shift from cold to warm water. Hence, fishing communities that depend on marine resources are increasingly threatened by rising ocean temperatures.

In the case of the La Coronilla yellow clam, massive die-offs caused fisheries to close, forcing fishers to diversify their livelihoods into local sectors of the economy, such as construction, agriculture, and logging, or to migrate. This shows that the socio-ecological system of the area as a whole, including governance, society, and economy, was not prepared to cope with this kind of drastic change.

In the summer of 2009, after 14 years of closure, fishing families resumed clamming on La Coronilla beach, a tradition passed down for generations. But due to the small volume of clams, the fishery was reopened with a catch of only three tons. Priority was then given to product quality over quantity and a co-management regime was implemented whereby fishers were part of the discussion about fishery management measures.

This time, in a joint effort by the fishers, the government, and academia, the Rocha family, with a long-standing tradition in fishing that has spanned generations, embarked on marketing the clam based on higher value-added products. Therefore, thanks to

Red tides on the Uruguayan ocean coast have been increasing, particularly since the early 2000s. iStock.com/ FernandoPodolski

this family's drive and government support, the first processing and purification plant for the product was built to meet the standards for human consumption.

This milestone made it possible for the product to start being sold at a higher price in restaurants in tourist resorts along the Uruguayan coast, therefore positioning it as a gourmet product. However, despite the efforts of the fishers, and due to changing weather conditions, supply cannot yet be assured. The supply is not only affected by the scarcity of the resource, but it is also diminished by the constant onslaught of red tides (largely caused by the warming of the water), which force the fishery to close due to the risk of intoxication.

The Rise in Red Tides

The number of days when shellfish harvesting is banned because of red tides on the Uruguayan ocean coast has been increas-

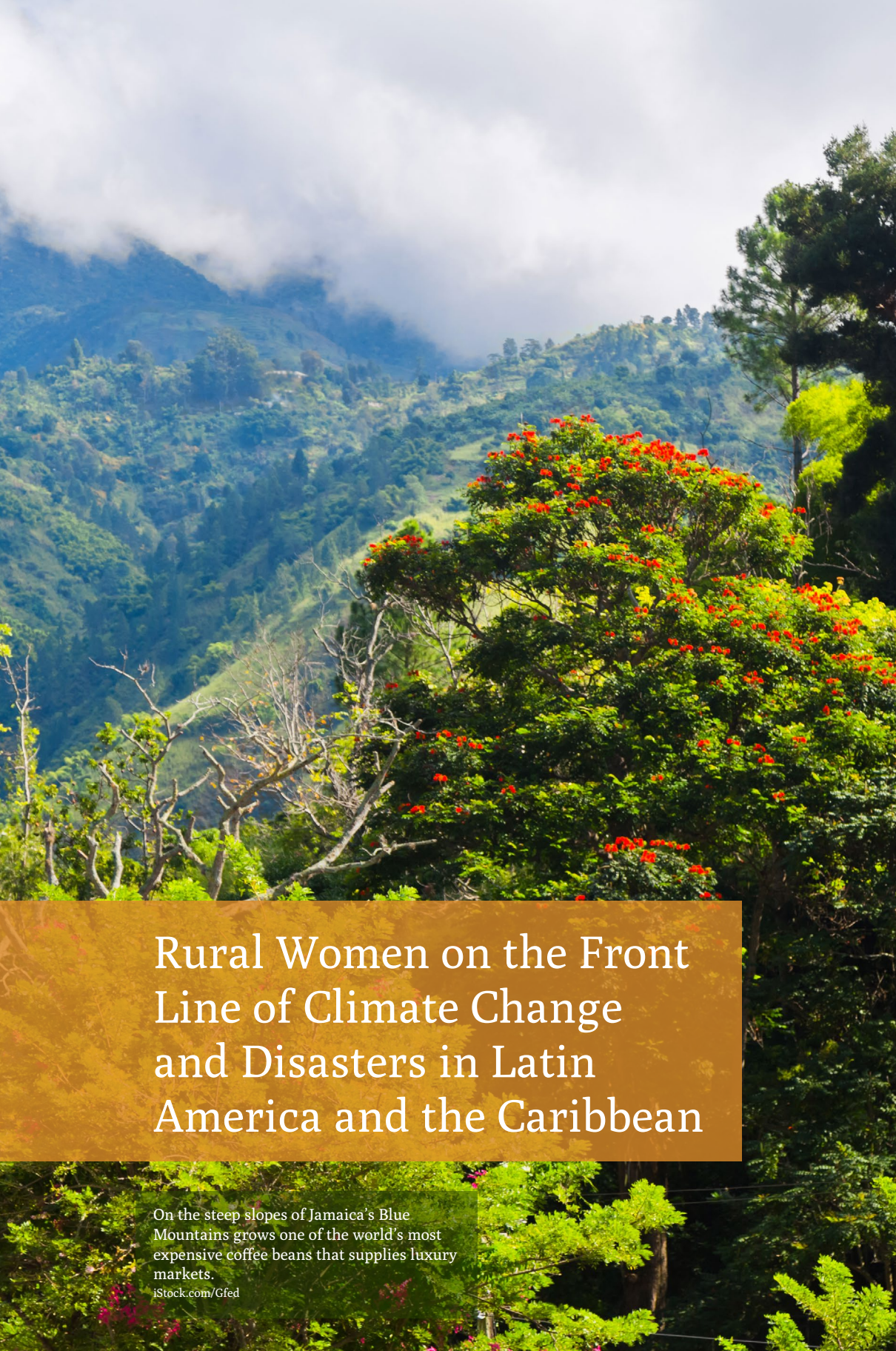
ing, particularly since the early 2000s. This has affected coastal fisheries and has severely limited the yellow clam fishery in La Coronilla. 'When a red tide occurs, we have to stop fishing and request an extension of the fishing season. This is a partial solution, because sometimes we end up working in winter, when only twenty kilograms of clams can be sold. That's not worth it,' says one of the fishermen.

This problem, however, is not limited to Uruguay. Similar fisheries have been affected in Latin America, including the Mesodesma donacium clam on the Peruvian and Chilean Pacific coasts. The effects of climate variability generated by El Niño events decimated the Peruvian clam, whose fishery has been closed since 1999 and has led to socio-ecological collapse. In the case of the clam exploited in Chile, the El Niño of 2015-2016 decimated stocks and also led to the closure of the fishery for several years.

While analysis of the effects of uneven ocean warming has garnered attention in the last ten years, the lack of data in developing countries often does not allow us to adequately size the damage. Nevertheless, it is clear how sea level rise and onshore winds cause erosion, beach retreat, and loss of dunes. By 2100, up to 70 per cent of beaches in southern California will have eroded; and El Niño events have already eroded areas on the Pacific and the Atlantic coasts.

Intensifying changes in climate, alongside other anthropogenic impacts, will increase the vulnerability of coastal systems, thereby reducing their capacity to provide services and benefits related not only to fisheries, but also to recreation, tourism, a habitat that supports a rich biodiversity, and coastal storm protection. This has had and will have increasingly profound socioeconomic consequences for the communities that inhabit Latin America's coasts.

Rural Women on the Front Line of Climate Change and Disasters in Latin America and the Caribbean



On the steep slopes of Jamaica's Blue Mountains grows one of the world's most expensive coffee beans that supplies luxury markets.
iStock.com/Gfed

Anne-Teresa Birthwright

PhD. in Geography from the University of the West Indies (Jamaica). She is currently an STeP Fellow at the IAI and serves on the board of directors of Jamaican Women in Coffee (JAWiC), the national chapter of the IWCA.

'(...) There is no social sector more invisible, more misunderstood, and more underserved than that of rural women, despite the vital role they play in our rural communities...'

Former President of Costa Rica, Ms. Laura Chinchilla

Blue Mountain Coffee is one of the most expensive specialty coffees in the world, and it caters to a hyper-niche market of luxury coffees, costing over $58/lb. Its prized berries grow on the cool steep slopes of Jamaica's Blue Mountain range above 3000ft where it fuels the livelihood of over 4,000 smallholder farmers. However, this area of luxury coffee production has not escaped the far-reaching effects of climate change.

The livelihoods of Jamaican women coffee farmers have been particularly affected by variable rainfall, extended dry seasons, reduced yields, and increased pests and diseases. Such conditions have led to inconsistent production and poor coffee quality, which in turn has resulted in financial losses.

Moreover, the unpredictability and inconsistency of weather conditions have also increased the cost of maintaining coffee farms, as the farm inputs required to increase yield and treat diseases such as the coffee leaf rust are often expensive.

Rural women are greatly impacted by climate change, as they are usually more dependent on natural resources for their livelihoods, therefore, this is not an isolated case. Their maintenance is often disrupted by hydro-meteorological events such as hurricanes, storms, floods, droughts, and landslides, among others.

Unfortunately, even though the Latin America and Caribbean (LAC) region contributes less than 10 per cent of global emissions, their economies, sectors, infrastructure, and people have been feeling their impact and adverse effects at a disproportionate rate. According to the State of the Climate in Latin America and the Caribbean 2020 report, Hurricanes Eta and Iota wreaked havoc in Guatemala, Honduras, Nicaragua, and Costa Rica; Brazil, Bolivia, Paraguay, and Argentina's Pantanal region experienced an unprecedented drought and fire season. The glaciers in the Chilean

> [...] ignoring women's contribution to rural livelihoods and limiting opportunities to access resources not only lowers a nation's economic potential, but it also weakens its resilience to climate change impacts.»

and Argentine Andes continue to retreat and the Caribbean region continues to face rainfall deficits.

Moreover, considering that many economies and livelihoods within the LAC region are dependent on climate-sensitive sectors such as agriculture, food and nutrition security are also in the crosshairs of being adversely affected. It is expected that by 2050, Central America and the Caribbean will experience a one-fifth reduction in agricultural yield for beans and maize.

Other areas that remain highly exposed and vulnerable include human health, water resources, settlements, and biodiversity. Economically, the combined annual damages for Latin America and the Caribbean due to climate change are estimated to be at $100 billion by 2050, which is almost as much as Ecuador's GDP.

Particularly for the Caribbean region, approximately $ 22 billion in losses are projected. Therefore, the devastating impacts on the economic, cultural, environmental, physical, and social fabric of said countries will erode any gains and progress made in terms of development.

However, amidst these threats, the gendered face of climate change remains a critical area, as the difference in the capabilities of men and women to adapt to changing weather conditions continues to cause concern. The recent IPCC assessment reported with high confidence on the unequal impact of climate change on men and women. This is primarily due to the gender inequality and inequity that influences the control of and access to assets, resources, services, and the decision-making processes.

ECLAC acknowledged that 'women and children are 14 times as likely as men to die during a disaster.' Rural women, particularly in the Latin America and Caribbean region, are expected to face the brunt of climate change impacts and disasters.

Rural women play a critical role within the food system, where on average they comprise 43 per cent of the agricultural labour force; they contribute to the food security of households and com-

munities as producers, planters, harvesters, farmworkers, rearing livestock, and doing housework.

However, despite their contribution, the work of rural women often goes unrecognised. Their reality is persistently characterised by poverty and structural inequalities, particularly since they have less access to productive resources. Climate change impacts and disasters tend to exacerbate these pervasive challenges, thus increasing their vulnerability.

According to Oxfam, around 30 per cent of rural women in Latin America own agricultural land, while access to technical assistance is only available to less than 5 per cent. For example, in Brazil and

The livelihoods of Jamaican women coffee farmers have been impacted by erratic rainfall, longer dry seasons, and increased pests and diseases.
iStock.com/chang

Guatemala rural women have more restricted access to credit, technology, mechanization, land, and other assets, thus limiting their ability to adapt and make decisions. In Colombia, climate change has affected women coffee producers by exacerbating the spread of the coffee berry borer. Their ability to successfully control this pest has been hampered by their lack of access to technical expertise, information, and decision-making power. Similar experiences are also found in Haiti and other smaller Caribbean islands, where rural women face socio-economic barriers rooted in gender inequality, increasing their vulnerability, and heightening their risk in the face of climate disasters.

For Jamaica's women coffee farmers in the Blue Mountains, the impacts of climate change have also been fuelled by the disparity in receiving advisory services. Based on a pilot survey conducted by IWCA Jamaica (JAWiC), a woman coffee farmer for over 10 years perceived that, 'people [wider industry stakeholders] want to help men or look to men more' with regard to farm management.

Women also pointed out that there are barriers to access resources, technical training, and to engage in opportunities which allow upward mobility in the coffee value chain, as well as the ability to occupy leadership spaces within their communities.

This gender dynamic and uneven power relation illustrates that some women perceive their contribution to the coffee industry as 'lesser than,' compared to men.

However, ignoring women's contribution to rural livelihoods and limiting opportunities to accessing resources not only lowers a nation's economic potential, but it also weakens its resilience to climate change impacts. For women coffee farmers in Jamaica, there have been efforts to effect change by providing access to opportunities such as training, technical knowledge, financing, and productive resources. Empowering rural women to tackle the impacts of climate change not only requires a gendered lens in reforming institutions and investment in services, but also tackling deep-seated cultural, socio-economic, and patriarchal norms that limit the full expression of women's productive capacity and decision-making power. Additionally, this will allow humankind to continue to enjoy one of the best coffees in the world.

We Underestimate the Impact of Climate Change on Education

In 2016, Hurricane Matthew damaged 300 schools in Haiti and in 2021, Hurricanes Eta and Iota affected 76 schools in Nicaragua and 340 in Guatemala.
iStock.com/Robert_Ford

■ Irene Torres — Science and policy advisor at IAI (Inter-American Institute for Global Change Research) and member of the International Council of the Global Society on Migration, Ethnicity, Race and Health.

■ Carole Faucher — Anthropologist at the Moray House School of Education and Sport, University of Edinburgh. She is a research affiliate of the UNESCO Chair in Global Health and Education and a member of the Advisory Board of the Nordic Center for Conflict Transformation.

On top of wiping livestock, crops, homes—in essence, people's sources of income and well-being—hurricanes are especially cruel to education. They damage and destroy school infrastructure, equipment and teaching materials, and ensuing flooding and mudslides prevent teachers and students from accessing school facilities. In the aftermath, schools are often used as shelters, bringing lessons to a further halt. The numbers are staggering: in 2016, hurricane Matthew damaged 300 schools in Haiti; in 2021, Eta and Iota impacted 76 schools in Nicaragua and 340 in Guatemala.

Climate change is causing more frequent and more severe weather events, and 2022 is no exception. As an example, 2020, the most active Atlantic hurricane season on record, featured 30 named storms, including 14 hurricanes of which seven became major hurricanes. Storms never come alone; that same year, they clashed with the peak of the COVID-19 pandemic, which reduced active school days by 50 per cent for 170 million for more than two years. The impact on attendance and, therefore, learning achievements, are unprecedented, as is the increase in desertion rates. The estimated loss adds to 1.5 years of learning.

Slow climate change related events such as an increase in surface and ocean temperatures, and in the frequency and intensity of heatwaves and droughts are also expected to continue to unfold in Latin America and the Caribbean. But decision-makers are grossly unaware of the repercussion of extreme heat on children's development from the time they are in their mothers' wombs and, during school years, on their ability to concentrate in class and their general wellbeing. All this means that completing secondary education, a key factor when it comes to finding subsequent opportunities in life, has become more challenging.

School should be more than a place of learning; it must provide space for students to develop social and emotional connections.»

Concurrently, we must consider that school should be more than a place for learning; it must provide space for students to develop social and emotional connections, as highlighted in the recently published International Science and Evidence Based Education (ISEE) Assessment. However, although this UNESCO report states that climate change has the potential to corrode social cohesion and interaction, it fails to explicitly identify how. In light of this, it is crucial that we all agree on the fact that, without school infrastructure or physical access to schools, students have fewer opportunities to develop the relationships through which they can flourish.

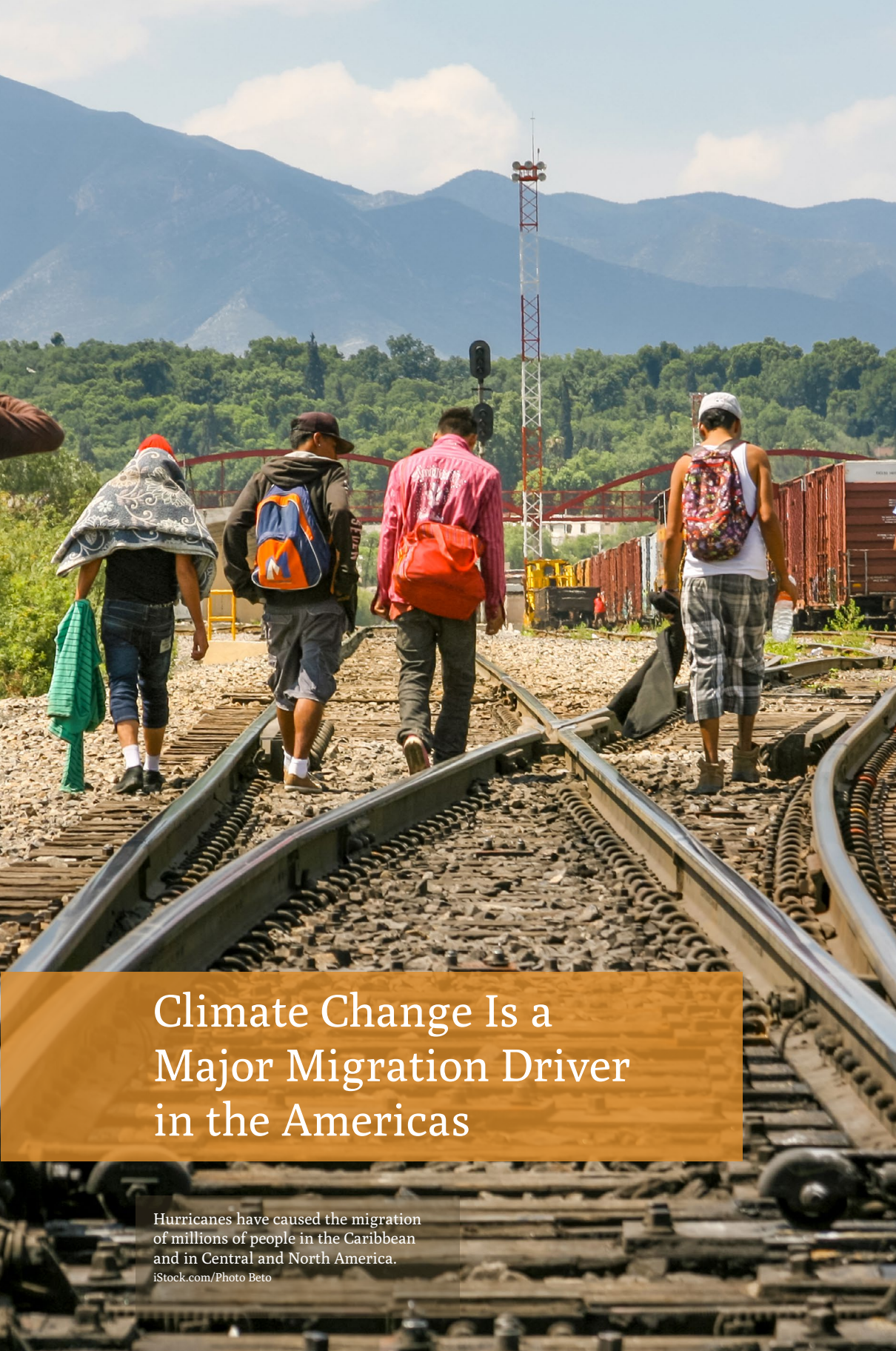
The WHO's Health Promoting Schools (HPS) framework aptly advanced the notion that educational policy and programmes must pay attention to the school's physical environment. Sadly, the HPS approach never really took off in Latin America and the Caribbean, despite the fact that in a large number of schools, access to the most basic necessities, such as safe drinking water, sanitation, and hygiene remains extremely limited.

Furthermore, although HPS provides a useful theoretical approach, its assumption is that there is a school infrastructure—albeit basic—where a single teacher or a team of principals, staff, and teachers can work to create a sense of community and empowerment towards bringing about change. But there is little evidence that the region is having at least a discussion on what the future of schools looks like in the current climate change emergency.

As in a war, while the region still struggles to recover from the COVID-19 pandemic, roads and footpaths, and small and large school buildings will continue to be wiped out together with livelihoods and sources of income. After witnessing Latin American and Caribbean governments struggle tremendously to adapt to the change brought on by the pandemic (for example, in that they failed to come up with alternative ways to access learning or to socialise), how can we expect policy and decision-makers to imagine a different, viable future for schools that would seriously consider the climate change crisis unfolding right before our eyes?

Schools face a variety of challenges in the region, but climate change may represent the greatest of them because it threatens the very foundations of what we think a school should be. A building that is at the heart of a community, invested in the new generations, one where parents want their children to be safe and happy. Indeed, one of the bravest acts of resistance in Latin America and the Caribbean will increasingly involve protecting the right of students to physically remain in school.

There is not a vaccine or a face mask, or a similarly concrete measure, to help students continue their education when schools must confront the extraordinary magnitude of events caused by climate change. Revistalised visions of education require crossing the more traditional boundaries of educational understanding and planning. Are governments and key actors in the field of education across Latin America and the Caribbean ready to take a step forward?



Climate Change Is a Major Migration Driver in the Americas

Hurricanes have caused the migration of millions of people in the Caribbean and in Central and North America.
iStock.com/Photo Beto

- Irene Torres — Science and policy advisor at IAI (Inter-American Institute for Global Change Research) and member of the International Council of the Global Society on Migration, Ethnicity, Race and Health.
- Anna Stewart-Ibarra — Scientific Director of the Inter-American Institute for Global Change Research (IAI). Ph.D. in Ecology from SUNY College of Env. Science and Forestry, Syracuse Univ. (USA). Assistant Prof. in the Department of Medicine at SUNY College.

'I risk everything because I have already lost everything,' a migrant woman once said on the migrant trail in Oaxaca, Mexico. Indeed, if poverty, marginalization, violence, and political turmoil were not enough, extreme climate-related events—such as droughts, heat waves, and heavy rainfall—are making life even more precarious for many people living on the edge in Latin America and the Caribbean. Although the connection between climate change and migration is not deterministic, contingent upon vulnerability factors, 17 million people are projected to migrate within Latin America due to climate change by 2050.

The Impacts of Climate on Migration

Hurricanes have triggered the mobilization and migration of millions of people in the Caribbean and in Central and North America. Over a period of twenty-two years (1998-2020), more than 277 million people were directly affected in Latin America and the Caribbean by climate-related and geophysical events, which accounted for 312,000 lives. The consequent rises in food insecurity and poverty have been major drivers of mobility. Increasingly, Central America is also suffering from floods and storms, mudslides, and landslides, while arid areas are affected by droughts. In South America, disasters are significant drivers of internal displacement, with both rapid and slow-onset disasters, such as floods, landslides, and droughts having widespread impacts.

In 2020, new internal displacements in the region were triggered by disasters: the number of displaced people reached 937,000 in Honduras, 639,000 in Cuba, 358,000 in Brazil (75 per cent of them due to the extreme rainy season), and 339,000 in Guatemala. In 2021, after the rainy season in Brazil had begun ahead of time, a subtropical storm in Bahia resulted in floods and ensuing land-

« People in Latin America and the Caribbean are already experiencing the impacts of climate change on their health, and as these impacts grow, there will be more climate incentives to migrate.»

slides and rockslides, leading to at least 27 people dying and 523 becoming injured. The cyclone affected more than 950,000 people and resulted in 155 of Bahia's 417 municipalities declaring a state of emergency.

Historically, migration in the region has flowed from South and Central America, and Mexico, to cities in the United States, such as Miami, New York, Houston, and Los Angeles. However, U.S. cities that receive migrants are also exposed to the mounting impacts of climate change. More extreme drought, wildfires, destructive storms and rising seas in U.S. territories are resulting in increased injury, death, and economic damages. Vulnerable communities, such as that of undocumented migrants, are at risk of damage due to exposure to these extreme climate events.

Climate Change, Migration, and Infectious Diseases

People in Latin America and the Caribbean are already experiencing the impacts of climate change on their health, and as these impacts grow, there will be more climate incentives to migrate. A recent study in the region found that rising temperatures will increase the risk of heat-related deaths, mostly linked to heat stroke, and predicted that this trend will continue into the future. Extreme climate events have been found to trigger outbreaks of climate-sensitive infectious diseases, such as vector-borne diseases like dengue fever and malaria, and water-borne diseases like cholera. With large-scale human displacements, such as the recent massive Venezuelan migration, these diseases can spread across ecological and political boundaries, making the containment of outbreaks even more difficult to manage in migrant and local populations.

Who Migrates?

People whose livelihoods depend on water and soil, such as small-scale fishers and farmers, may be the most likely to migrate due to climate causes. They also bear the impact of other climate-associated changes, as is the case of Uruguayan fishing communities who are reliant on clam harvests, which have dramatically reduced as a result of rising ocean temperatures.

An increase in temperature and a decrease in rainfall in the Amazon region is displacing Indigenous populations away from land that is part of their cultural identity, land which is already under pressure from industry and urbanization. Less access to basic services, such as health care, clean piped water and education, and jobs further compels them to mobilise. By 2010, at least 50 per cent of the Indigenous population (approximately 50 million) in the region had been forced out of their lands or intentionally migrated to urban areas, where they are vulnerable to discrimination and marginalization while striving to enter the formal economy.

Between 1998 and 2020, more than 277 million people in Latin America and the Caribbean were directly affected by climate and geophysical events.
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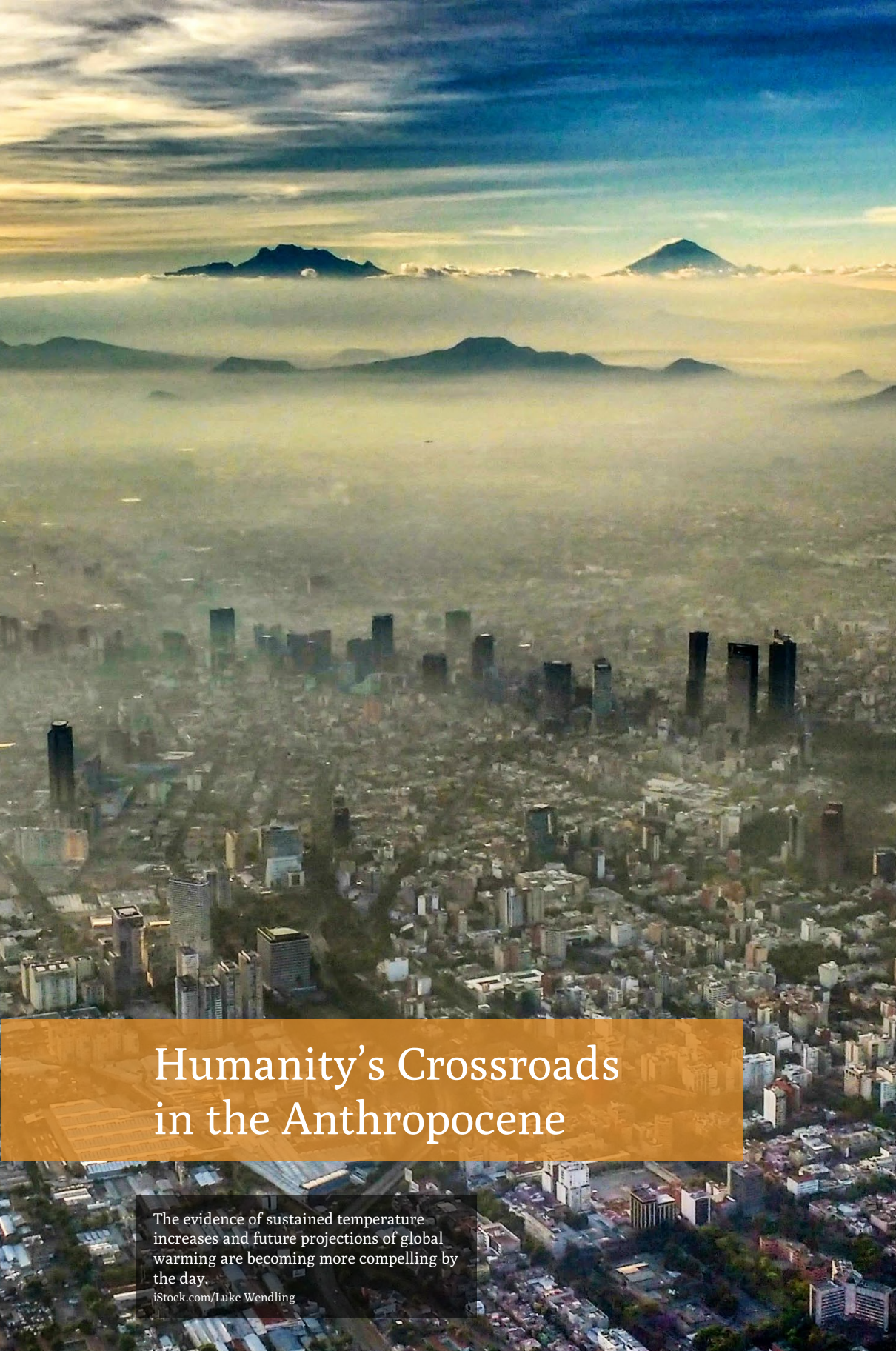
Responding to Climate Change and Migration

Migration in Latin America and the Caribbean will continue to rise under the dual pressures of climate change and dire social inequities. Governments need information and tools that allow them to predict and respond to internal and international migration events and adapt to changing climate conditions. Climate information, such as forecasts of extreme climate events, can be used by migration specialists to plan actions to prevent and respond to humanitarian crises. This will require bringing the migration and climate sectors with other relevant sectors together.

To address the need for climate-informed tools, the Inter-American Institute for Global Change Research (IAI), the US Global Change Research Program (USGCRP), and AmeriGEO have partnered with countries in the region to co-design an Initiative for Enhancing Capacity for Climate Risk Assessment and Catalyzing Partnerships to Inform Decisions in Latin America and the Caribbean (LACI). Representatives from ministries of environment and other sectors are working to develop national climate impact assessments and to identify strategic climate change adaptation actions, such as early warning systems.

Finally, countries should join forces to seek ways to reduce greenhouse gas emissions, particularly by the highest emitting countries, while addressing the underlying causes of migration, that is, deep social inequity and fractured governance.



Humanity's Crossroads in the Anthropocene

The evidence of sustained temperature increases and future projections of global warming are becoming more compelling by the day.
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María Inés Carabajal

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We are in a time of crisis and uncertainty. It would seem that the organisation of life and the representation of the future as we imagine it are being challenged by global dynamics that transcend our understanding and drag us towards unimagined and even dystopian situations. The emergence more than two years ago of a virus of presumed zoonotic origin—an infectious disease transmissible from vertebrate animals to humans—such as COVID-19 is proof of this process. Since then, our lives have been completely disrupted. The same could be said of anthropogenic climate change, brought on by human behaviour and impacting on nature.

Although the scientific community has been raising the alarm on this subject for more than 30 years, evidence of a sustained increase in temperature and global warming projections are becoming increasingly conclusive, as confirmed by the Sixth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) between 2021 and 2022.

COVID-19 and climate change share several aspects. Both are global in scale and local in impact, no country can tackle them alone, and addressing their complexity requires the inclusion of different types of knowledge and experience implementing transdisciplinary approaches.

In this regard, COVID-19 and climate change are far from being strictly scientific issues, they are political and social problems. Therefore, they challenge us to think about the multiple aspects involved, from production and consumption patterns, the perception of risk and its ethical-political aspects, the current and desirable development models of society, to the relationship that humans have with nature.

Changes in Ecosystems and the Emergence of New Viruses

This last aspect is crucial and is becoming increasingly relevant in scientific debates, the media, and civil society. Indeed, a

study recently published in the journal *Nature* suggests that abrupt changes in ecosystems and the destruction of habitats, in addition to the continuous rise in global temperatures, may generate an ideal environment for the emergence of a 'network of new viruses' and the transmission of diseases that can potentially affect humans.

The study indicates that the migration of wild species due to the loss of their natural habitats and anthropogenic climate change could create the conditions for viral exchange among species that have not had previous contact, which would facilitate zoonotic contagion.

In that same regard, other studies have postulated that COVID-19, as a zoonotic virus, could be classified as a disease of the Anthropocene, the product of complex processes involving the extinction of species and loss of biodiversity, deforestation, and changes in land use for arable land and intensive livestock production, and the alterations that these processes entail for human and planetary health.

Habitat destruction and high temperatures in the future could create an ideal environment for the emergence of new viruses.
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In Latin America, for example, illegal deforestation rates have continued to grow in both the Amazon region and the Argentine Chaco. In the latter case, between 2000 and 2019, 5 million hectares have been deforested, 40 per cent of which was illegal and resulted in the loss of the native forest.

This and other symptoms of our time would indicate that we have entered the 'Anthropocene,' a new geological age in which human beings have become a force of global and planetary transformation.

The Anthropocene: The Irruption of Humankind as a Geological Force

One thing is certain: changes in the world have accelerated uncontrollably. Human intervention on the planet has been of such magnitude that scientists, on an international scale, are discussing our possible entry into a new geological age which they have called the Anthropocene.

Coined by Nobel laureate in chemistry Paul Crutzen and biologist Eugene Stoermer in 2000, the concept accounts for human domination of the planet, insofar we have ceased to be merely biological agents and have become geological agents with the capacity for global stratigraphic transformation.

In a seminal article, Crutzen proposes that the Anthropocene may have begun at the time of the Industrial Revolution and the change in the energy matrix towards a fossil economy at the end of the 18th century. This first article was so influential in scientific circles, that in 2009 the Anthropocene Working Group (AGW) was created under the International Union of Geological Sciences with the aim of searching for stratigraphic evidence, possible markers, and periodisation in the geological record.

This working group has already submitted a formal proposal, but it has not yet been endorsed by geological experts. However, regardless of whether it is accepted or not, discussions surrounding the Anthropocene have gained unprecedented significance within the field of geology and also in the environmental humanities, the arts, and the media.

Taking up discussions on the possible beginnings of the Anthropocene, a group of scientists from the Stockholm University Resilience Center led by Will Steffen have shown how certain socioeconomic and Earth system parameters have had exponential growth since 1950 with the so-called 'Great Acceleration.'

Evidence of a sustained increase in temperature and global warming future projections are becoming more convincing every day.»

Indeed, socioeconomic parameters such as increased production and consumption, energy and water use, population growth, migration to cities, and even telecommunications and tourism have expanded significantly since 1950. These trends are reflected in the dynamics of the Earth System through the increment in greenhouse gases (GHG) (carbon dioxide, methane), the rise of the Earth's temperature, the loss of tropical forests, and the degradation of the terrestrial biosphere. Furthermore, after 1954, nuclear weapons tests are also a possible marker of the Holocene epoch end and the socio-environmental conditions that allowed the development of humanity as we know it.

The Responsibility of the 'Anthropos'

The Anthropocene is debated extensively by scholars working in fields ranging from geology to social and human sciences, where they problematise the responsibility of the 'Anthropos.' Is it possible to speak of the human species as responsible for the current environmental and ecological crisis conditions, or should we speak of an economic system, an ideology, fostered by the capitalist system of production and consumption?

As with anthropogenic climate change, we cannot attribute the same responsibility for this crisis to sustainable communities living in harmony with nature as to certain socioeconomic sectors that plunder it to generate greater profitability. For this reason, it has been proposed to call this epoch the Capitalocene.

The complexity of naming this current epoch has led to important terminological debates. In this sense, a number of terms have been proposed. The term Occidentalocene highlights the responsibility of Western countries for the current situation; the term Technocene emphasizes on technology, and Plantationocene refers to the how intensive forms of agricultural production and monocultures are responsible for social and environmental transformations.

The idea of the Anthropocene has become a nucleus of inter and transdisciplinary debate on how human beings cohabit with other species on the planet, and, fundamentally, their interdependence. Therefore, in light of the major crossroads we are experiencing amidst climate change and COVID-19 as symbols and symptoms of this current epoch, we need strategies for collective action.

We can no longer expect solutions to arise only from the techno-scientific fields. We need to include civil society in both debates and actions to rethink the current and desirable development models of society together, and how to reconnect with the terrestrial ecosystem of which we are a part.

Let Us Put Out Wildfires to Stop Climate Change

Each year fires destroy more than 8,000 km^2 of forest, reducing the Amazon's carbon stock, one of its greatest means to mitigate climate change.
iStock/SPmemory

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- Celso H. L. Silva-Junior — Environmental engineer and postdoctoral researcher at the Institute for Environment and Sustainability at the University of California, Los Angeles | UCLA, USA.
- Marcus Vinicius Silveira — Forestry engineer. Ph.D. student in remote sensing at the National Institute for Space Research (INPE), Brazil.
- Liana Anderson — Biologist and researcher at the National Center for Natural Disaster Monitoring and Alerts (Cemaden), Brazil.

When Yara de Paula, a resident of the Raimundo Irineu Serra Environmental Protection Area in the Brazilian state of Acre, came home with her newborn baby girl one day in early August 2015, the sky was grey with soot. Within minutes, the wildfire would be just metres away from her house. To stop the smoke from coming in, she covered the holes in the windows and doors with wet towels, while her husband contained the flames with buckets of water. Fortunately, the blaze did not burn their house, but since then, Yara and her daughter have suffered from chronic asthmatic bronchitis. This forest fire in the Amazon is not an isolated case. In June 2022, in the state of Acre alone, 196 km^2 of burned areas were mapped in already deforested areas, a number that has been increasing recently.

These fires in the Amazon rainforest have caused a surge in hospital admissions for respiratory diseases. In fact, life expectancy in the western Amazon region is up to three years lower than that of people living in other parts of the country, even compared to large urban centres.

In addition to health issues, these forest fires not only lead to a loss of agricultural production, but also wipe out more than 8,000 km^2 of forest per year, thus eliminating one of the greatest means to mitigate climate change: the carbon stock in the Amazon basin. In other words, the capacity to contain this greenhouse gas is being

« Fire and deforestation are wiping out the world's largest rainforest. This is accelerating climate change, making the climate in this region drier and hotter, and making forests more vulnerable to fires.»

lost. But there are other impacts: these forests are impoverished in terms of biodiversity and cannot fully recover in the long term.

A Vicious Circle with Catastrophic Consequences

Fire and deforestation are wiping out the world's largest rainforest. This is accelerating climate change, making the weather in this region drier and hotter, and making forests more vulnerable to fires. This has created a vicious circle where climate change makes tropical forests more vulnerable to wildfires, and this ever-present fire increases CO2 emissions, which translates into the worsening of local and regional weather and, subsequently, climate change.

Forest fires in the Amazon are breaking records every year. Between 1985 and 2020, approximately 16 per cent of the biome was burned. On average, more than 65,000 km^2 per year are burned in the Brazilian Amazon, an area larger than Costa Rica. Moreover, a large part of these blazes reaches native forests—surprising, considering that the Amazon Basin is mostly covered with rainforest, where forest fires would hardly start naturally, let alone spread.

However, climate change has hit the region hard, and temperature rise in some regions such as the southwestern Amazon reach 2.5 °C during the dry season months. In the eastern region, on the other hand, rainfall has decreased by more than 30 percent during the driest months of the year. In addition, extreme droughts are becoming more frequent (in this century they have occurred every five years), causing larger areas of forest to be burned, and the remaining healthy forest is increasingly vulnerable to forest fires.

In the past, Brazil has demonstrated that it is possible to reduce deforestation in the Brazilian Amazon, through the implementation in 2004 of the Action Plan for the Prevention and Control of Deforestation in the Amazon (PPCDAm). However, it has also shown that progress on the environmental agenda is fragile and

highly vulnerable to the political scenario. In fact, setbacks have recently led to the highest rate of deforestation in the Brazilian Amazon in the last 15 years in 2021.

Forest Fires Contribute to CO_2 Increase.

Of all the negative impacts, perhaps the most concerning is the contribution to the increase of CO_2 in the atmosphere by forest fires, which has a direct impact on climate change. Unlike deforestation, fire does not necessarily lead to land use change. The forest can burn and remain, but without the characteristics of a healthy forest and emitting carbon into the atmosphere for decades.

Another effect is that the ability to pump water into the atmosphere that these forests have is reduced. This is an important part of the hydrological cycle, as it contributes to the rain that is essential for both the agricultural areas of Brazil, Uruguay, and Argentina, and for the generation of hydroelectric energy.

This emission, which is not directly associated with deforestation, may represent more than half the amount produced by deforestation of primary forests during drought years. Therefore, the increased susceptibility to drought-generated forest fires and the projection of drier future conditions means that carbon emissions in the Amazon are dominated by forest fires. In addition, once the environment becomes more flammable, intentional fires (traditionally used in a controlled manner by local communities) are more likely to reach adjacent forests.

Changing this trend is critical to mitigate and adapt to climate change on a global scale. But the search for solutions must consider the main reasons that lead to the intense use of fire in the region: illegal deforestation and pasture management.

Therefore, investing in resources to promote alternatives to fires in agriculture is essential to prevent forest fires in the Amazon. It is estimated that, on average, one-third of the total area burned annually in the Amazon corresponds to agricultural areas. In the Brazilian Amazon, the vast majority of agricultural areas correspond to grazing areas managed with low technology and expertise, which means that fire is often used for the renewal of degraded pastures, and with it, the risks of forest fires increase.

In Brazil, the use of fire in agriculture is prohibited by law, except in cases of subsistence farming, where approval from the environmental agency is required. In 2020, despite the government establishing a decree prohibiting agencies from authorization for

Deforestation and fire are destroying the world's largest rainforest, accelerating climate change, and making forests even more vulnerable to fire.
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120 days, fires remained at the highest levels of 2019. This shows that fire use in the region is mostly illegal and is not monitored. Therefore, the fight against illegality must align with broadened assistance to rural producers in order to encourage sustainable practices that boost productivity so as to replace the use of fire.

Brazil must take urgent action to break the vicious cycle in which fire is transforming the environment into its own fuel. The socioeconomic and environmental impacts of forest fires are widespread, and failure to change this situation is contrary to what is expected of a nation committed to sustainable development.

Is There a Choice between Energy and the Environment?

The Paraná River basin is the second largest in Brazil, the main hydroelectric power generator, with more than 60 hydroelectric dams.
iStock.com/Cristian Lourenco

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The Paraná Basin, the second largest in Brazil and the main hydroelectric power generator, has more than sixty hydroelectric dams that hold 40 per cent of the country's electricity production capacity and account for half of the water storage capacity. But the operation of the reservoirs, necessary to control the generation of hydroelectric energy, affects the reproduction, feeding, and refuge systems of different aquatic species. This loss of diversity has been harming not only the fishers, who see their livelihoods reduced, but also the basin as a whole since the impact on biodiversity affects the aquatic ecosystem of the Paraná River.

The Paraná Basin presents a certain vulnerability to guaranteeing water, energy, and food security, something that has been evidenced by the drought that has plagued the basin recently. As our demand for water, energy, and food increases, water becomes scarcer, and meeting society's needs without compromising the quality of the environment for future generations becomes more difficult.

Meeting—and overcoming—this challenge depends not only on the more efficient use of water, but above all, on how we share this resource with the various existing demands, including the environment itself. Water in rivers, lakes, and reservoirs is also necessary to keep ecosystems that provide valuable resources for society alive: from food, such as fish, to recreational activities and even the cleaning of the water itself, which is carried out by the organisms that live in it.

On the other hand, for communities living near the rivers, the importance of these resources goes much further, as the river is a source of livelihood and cultural identity that is passed down from generation to generation.

Much of our development process uses natural resources with still limited knowledge of how the ecosystems could be affected.»

However, much of our development process uses natural resources with still limited knowledge of how the ecosystems could be affected. In several regions of Latin America and the world, this process has been accumulating impacts that already compromise the environment. Water is polluted, fish stocks are declining, and the ability of the environment as a whole to sustain life is at risk.

In this context, the fishing communities of the Paraná Basin have been calling attention to the reduction in the quantity of fish and how this impacts the livelihoods of the families that have made their living from this activity for years. Fishers report that it is often necessary to fish in more distant areas to supplement their income, which also ends up increasing fuel costs and physical exhaustion of the fishers.

Conditions such as the aforementioned cause many families to abandon fishing and seek livelihoods in other activities. From nearly 1,200 members reported by the fishermen's association in the Paraná town of Puerto Rico in 2010, that number has dropped to just 384 members in 2019.

The Most Important Mission of Water Resource Management

It is up to water management agencies, planning bodies, and basin committees to involve society to discuss, negotiate, and reach a consensus in order to seek solutions and to achieve common objectives. The result of this participatory work is the basis on which effective public policies should be created.

In this sense, the transdisciplinary research project 'Improving the governance of the floodplain in over-built river basins,' coordinated by the Federal University of Rio Grande do Sul in Brazil, has identified an extensive chain of causal relationships between the water resources of the Paraná basin and the multiple energy, ecosystem, fishing, and recreational uses, and created methods and solutions that will help to conceive adaptation paths, thus reconcil-

Water from rivers, lakes, and reservoirs is also needed to keep ecosystems that provide valuable resources for society alive.
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ing the different uses of water and the environment for the benefit of society.

These water uses have a positive impact on society: from the local communities that depend on fishing for their livelihoods to the millions of people in Brazil and Paraguay who consume energy thanks to a nationwide interconnected energy production system.

The results of the study show that in complex systems such as Paraná's there is no single solution, but a universe of possibilities and different results. It is possible to combine different flow patterns released by the reservoirs and still meet the demands of the fish, thus reducing the impact on them.

As each combination also reflects the amount of energy produced by the reservoirs, it is possible to exploit this result to find alternative water allocation solutions that meet both local demands for fishing, tourism and recreation, biodiversity protection needs in the Paraná Basin, and national needs for clean and affordable energy.

Moreover, with a higher number of alternative solutions available, the negotiation process becomes less contentious, which increases the chances of reaching effective solutions for the environmental recovery of the basin without a high energy cost.

The solutions to these problems are urgent and require long-term strategies for the basin to adapt. In fact, according to the same study, possible climate change scenarios indicate an average reduction in flows of between 7 per cent and 40 per cent, which

would also reduce energy generation, resulting in less water available for fish demands.

The 2020-2021 drought in the Paraná basin corroborated this concern to the extent that flows released from some reservoirs were reduced to preserve storage and maintain hydropower generation in a period of low power stock in the country.

However, if the operation of the system were adjusted to follow the results of the studies, fish populations would be able to recover in the long term, making the ecosystem more resilient to withstand the impact of the next drought, once the operation of the reservoirs is modified to maintain the country's energy security (which is the main priority).

These results could also be used to support energy policies that explore other sources of energy generation and storage, thereby reducing pressure on river basins.

In conclusion, reservoirs are key infrastructures for our adaptation to climate and human-induced changes. Although their construction and operation have led to environmental impacts, many of which are yet to be mitigated, they provide a significant water storage capacity that will be critical in helping us protect ecosystems from the effects of climate change that make water more scarce, uncertain, and variable.

It is possible to optimise the operation of reservoirs to reduce risks to energy production and create opportunities to maintain the flows required by fish during important spawning months.

However, this process requires coordination of water, environmental, energy, and social policies, as we need water to sustain life in rivers, generate electricity, and supply food to cities and local communities. We also need the energy to produce food and expand development opportunities for economically and socially vulnerable regions.

This strong interweaving of the different factors makes it clear that a policy is to succeed in one of these areas only if integrated to succeed in the others as well.

Global Challenges Are Changing the Paradigms of Science

The loss of fresh water and the acidification of the oceans are some of the consequences of the environmental changes in our environment.
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Fany Ramos Quispe

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'We cannot solve our problems with the same thinking we used when we created them.' A century ago, Albert Einstein pointed out with these words that humanity should be critical of our way of thinking, which was already creating problems for ourselves and for life on Earth itself.

We constantly see and hear news about environmental changes occurring in our environment and in different parts of the world such as climate change, loss of biodiversity, chemical pollution, land degradation, loss of fresh water, ocean acidification, and ozone depletion.

In 2019, hurricanes caused 465,000 displacements in seven Caribbean countries, according to the World Health Organization and the Internal Displacement Monitoring Center (IDMC). At the same time, floods and landslides displaced 295,000 people in Brazil.

More than 50 million people, slightly more than the population of Colombia, have suffered food and water insecurity due to climate-related disasters such as floods, droughts, and storms, especially in Africa, Asia, and Central and South America. In this regard, it is estimated that by 2050, some 30 million people will migrate from Central America to North America due to food issues related to the climate crisis.

As if that were not enough, greenhouse gas (GHG) reductions to limit global warming to 1.5 °C are out of reach, according to the United Nations Intergovernmental Panel on Climate Change (IPCC).

It seems that these changes are being caused by the prevailing economic development model of which modern science is part, and contrary to what we might like to believe, to which modern science has also helped develop and give rise to. Therefore, we, as inhabitants of the Earth, must strive to change this image of science and economic development to an alternative that aims to sustain life.

During 2019 hurricanes caused 465,000 displacements in the Caribbean while floods displaced 295,000 people in Brazil.
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It Is Time for Science to Evolve

Today's environmental problems have multiple scales and dimensions and occur simultaneously, making addressing their effects increasingly complex. Current science aims to develop knowledge and high technology to better 'manage' the Earth and its resources. However, it would seem to be more worthwhile to focus on assessing our own behaviour towards humans and the Earth.

At present, science tends to develop in isolation from society and, in some cases, scientific advances are driven solely by private interests. By using methods that are difficult to understand and

by addressing limited and specialised communities, science seems to turn its back on populations and their realities and is no longer trusted to solve real-world problems.

On the other hand, there is also growing isolation of disciplines and the relationships between academia, governments, and other actors in civil society are fragile and running out.

The Transdisciplinary Approach, an Evolving Idea

One of the solutions being discussed in academia is that of building scientific knowledge with the participation of different actors in society through a collaborative learning process.

The scientific community is often seen as an elite that develops and owns knowledge exclusively. However, due to the current gaps between scientific knowledge and everyday life practices, community leaders advocate for opening science to other forms of knowledge. Also, among climate change researchers and experts, there is a growing consensus on the importance of traditional knowledge and practices of Indigenous peoples and local communities in tackling climate change.

This cooperation clashes, however, with the fact that there are insufficient means and incentives for academia, governments, and civil society to work more closely with communities on the ground. Moreover, this should be a never-ending collaborative learning process, rather than a simple step to 'include' other forms of knowledge. Therefore, what is the solution?

Open Science to Other Forms of Knowledge and Promote Cooperation

It is hard to find a single solution to all facets of this issue, but oftentimes complex problems may require a complex set of solutions. In this context, a fuzzy concept has emerged: 'transdisciplinarity,' which is not yet fully defined but evolving. However, several of its characteristics can be observed in the daily practices of academic and non-academic communities, while reinforcing its essence.

One example of the international community's efforts around 'transdisciplinarity' in science is the Inter-American Institute for Global Change Research (IAI), committed to promoting regional cooperation for transdisciplinary research. This organization brings together governments and institutions in the Americas to conduct

> We, as inhabitants of the Earth, must strive to change this image of science and economic development to an alternative that aims to sustain life.»

research at a regional scale, which is necessary and appropriate when addressing environmental issues.

Another broader international initiative that promotes transdisciplinary research on global environmental change issues is the Belmont Forum. Projects conducted under this initiative integrate the social and natural sciences as well as the humanities. In addition, projects must be co-designed and co-implemented by diverse stakeholders (academia, the public and private sectors, intergovernmental, local communities, and Indigenous peoples, and more) in a collaborative manner. Projects are developed within the framework of international consortia of at least three countries and are funded by national and international partners.

There are still challenges to overcome such as national and international institutional agreements, and economic and funding systems, which among others are designed for the existing economic development and science models. As inhabitants of the evolving earth who want to remain in harmony with the planet, it is our obligation to join efforts to achieve a renewed collective imaginary in line with the challenges we face.

Scientists Can Help to Rebuild Confidence in… Science!

In the last 34 years, the Amazon has lost almost 200,000 square kilometres of forest, an area larger than that of Uruguay.
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Laila Sandroni PhD in Social Sciences from the Federal Rural Univ. of Rio de Janeiro with a post-doctorate in Applied Ecology from the Univ. of São Paulo. Specialising in transdisciplinary research practices and inclusive processes of biodiversity conservation.

In the 1990s, the Tupinambá people of Olivença in southern Bahia, Brazil, filed a claim for ethnic recognition which was only officially granted in 2001. The land demarcation process, however, never materialised. Simultaneously, a group of scientists and NGOs began to pressure the government to expand protected areas in the same region from deforestation. In 2007, conservationists succeeded in establishing a Wildlife Refuge in part of the Indigenous lands which, without the approval of the Ministry of Justice, lacked legal security. As a result, the Tupinambá's lands adjacent to the biological reserve became a refuge, especially for the golden-headed lion tamarin, a primate species, and the ancestral practices of cultivation through slash-and-burn began to be fined by the authorities. At the same time, a few kilometres from the reserve large companies continued to open huge craters in the jungle for sand extraction.

Most of the data used to support decisions such as the creation of a Wildlife Refuge comes from the use of satellite imagery and Geographic Information Systems (GIS). These new technologies have provided detailed images of changes in land use, allowing humanity to become more aware of deforestation processes.

In the Amazon, while the climate emergency calls for increased conservation efforts, the rainforest is being devastated. The Xingu+ network proved there was an 1,857 per cent increase in deforestation between 2020 and 2021 in the Ituna-Itatá Indigenous land in the country's northern state of Pará.

Additionally, the Mapbiomas initiative, a group of scientific institutes, tech companies, and civil society organizations that analyses data on land cover in Brazil, shows that the Amazon has lost almost 200,000 square kilometres of forest in the last 34 years, an area larger than that of Uruguay.

It is clear that the degree and pace of destruction of ecosystems such as the Amazon is accelerating despite countless warnings from the academic community about the catastrophic effects of deforestation on the economy, livelihoods, and climate. The problem is that this data has been used to unfairly recommend and imple-

ment policies, as the case of the Tupinambá's land clearly demonstrates.

But this is not an isolated case. In the Colombian municipality of Guasca, some 60 kilometres from Bogotá, conservation policy decisions influenced by private foundations, NGOs, and scientists based on ecological data, have resulted in the prosecution and economic punishment of farmers for carrying out traditional farming and ranching activities.

The Distance between Machines and Humans

There is an incredible disconnection between the machines that fly over hundreds of thousands of kilometres to take photographs and the territory inhabited by people, which sometimes materialises in dehumanised policies. This has created an enormous distrust of science in broad sectors of society.

We should add that in this era of 'post-truth' the scientific interpretation of reality is being so questioned, that obvious facts such

The destruction of ecosystems such as the Amazon is accelerating despite countless warnings about the catastrophic effects of deforestation on the economy, livelihoods, and climate.
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The degree and pace of destruction of ecosystems such as the Amazon is accelerating despite countless warnings from the academic community about the catastrophic effects of deforestation.»

as the high-speed deforestation that is occurring throughout the Brazilian rainforests are being disputed.

From academia, the tendency is to point the finger at those who actively seek to delegitimise science through the dissemination of fake news, the formulation of conspiracy theories, disinformation, and misleading information. But would it be appropriate to point the finger at those on the 'other side' of the barricades of truth as solely responsible for the mess we have gotten ourselves into?

A less visible part of the problem is that those who question science base their claims on a quite real flaw in the production of knowledge itself. Scientists tend to consider themselves the owners of the truth, recurrently presented to the public as an inviolable 'black box.'

In biodiversity conservation, decisions on where and how to install protected areas are usually based on scientific ecological data, which, although rigorous, does not represent the whole reality. Such decisions often ignore the perspectives of those who live in the areas to be protected, including the Indigenous populations who have lived in these ecosystems for centuries and who do not have access to institutional tools, unlike environmental agencies, to protect their own rights.

This arrogance often causes real problems for the communities that inhabit the territories. As a result, environmental policies and actions based solely on scientific recommendations tend to be met with resistance and to arouse a feeling of exclusion in those affected. This repeated scenario, in turn, strengthens the questioning of scientific institutions, and in this way, the scientific community as a whole is also affected.

The Need for a 'New Transdisciplinary Science'

In view of the aforementioned situation, how can we, scientists, help to regain trust in science? How can we use the enormous

amount of data offered by technology to try to curb biodiversity loss and climate change, but also to improve people's lives? How can science contribute to building a more socially and ecologically fair world?

To find a way out of the post-truth problem, science must begin by questioning itself. And while the rigour of scientific analysis and the pursuit of objectivity are crucial to moving towards a more sustainable future, shouting and screaming that scientists own the truth or continuing to insist that science is the only legitimate source for environmental decision-making will not help us.

The environmental challenges we face today are full of risks and uncertainties that need to be addressed from different perspectives that compose a broader picture and leave room for dialogue. A transition is needed towards a more open science that learns to relate to other types of knowledge such as the practice of policy making and Indigenous knowledge.

This new perspective on how to do science, called 'transdisciplinary science,' is a process of knowledge production and dissemination that in turn brings together diverse worldviews and aims to arrive at dialogical solutions to real problems at different scales. The promotion of this type of science can help us to regain legitimacy and confidence in scientific endeavours, not through technocratic, but democratic commitments.

Scientists have to learn to work through difference and recognise our place as brokers of diplomacy and critical thinking about complex problems to build solutions together with the people and for the people.

Towards a New Water Policy in Latin America?

Many countries have established basin committees and similar bodies in their legislation to manage water resources.
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Almost two decades ago, a constitutional reform was approved in Uruguay through the water plebiscite promoted by civil society organizations that came together in response to the threats of a growing wave of privatization of water supply services. This reform not only determined the provision of public sanitation and water supply services for human consumption, but also the human right to water, and the participation of the users and the civil society in all the instances of planning, management, and control of hydro resources, establishing the hydrological basins as basic unities.

In Latin America, as in the global context, there is a trend of change in water management and governance, which implies a transition from centralised and technocratic to decentralised, integrated, and participatory models. However, while regulatory frameworks play an important role in the transition to a new governance model, they are not sufficient.

Water resources have historically been managed through a technocratic approach from the central governments' spheres, based on forecasting and control. This approach, still predominant in several contexts, has led to many consequences for ecosystems and the societies that depend on them, giving rise to alternative approaches in recent decades.

The Laguna del Cisne Basin

Laguna del Cisne is an important source of water in Uruguay and supplies some 30,000 residents and 70,000 visitors during the summer months. Between 2008 and 2010, a socio-environmental conflict in connection to the first transgenic soybean crops and other crops that required pesticides in the basin arose. Thus, civil society groups and users undertook actions to pressure public institutions into implementing measures to protect the basin from contamination, therefore stopping crop spraying and ensuring water quality.

Environmental conflicts are common in the region and are connected to the spraying of pesticides on crops that contaminate water sources.
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Finally, in 2014, against the backdrop of the National Water Policy, the Laguna del Cisne Basin Commission was formed (made up of government, users, and civil society groups), which became an important platform to coordinate and discuss to ultimately offer advice on management. Based on the work done by the commission, the departmental government has drafted regulations that include measures to prohibit land spraying with self-propelled sprayers, the transition to sustainable production models, watercourse protection strips, and the establishment of a water quality monitoring plan.

This model, as well as other alternative management models, tends to recognise the variability, dynamics, and uncertainty of watersheds; to accept the validity and contributions of local

knowledge acquired from exercise and the close link with the environment, as a supplementary source for scientific and technical knowledge. Another tendency of these models is to encourage the participation of different actors, governmental and non-governmental, creating spaces for interaction among them with the aim of making contributions to water management.

In this context, the GovernAgua Project, led by the SARAS Institute, seeks to understand and promote adaptive and anticipatory water governance in South America through a transdisciplinary approach. In fact, the transition from a centralised governance model to a participatory or networked form of governance implies several challenges. One of them is to overcome the fragmentation of functions of management between public institutions for the environmental protection and agricultural production in countries such as Argentina or Uruguay.

Another important challenge has to do with implementing relevant participatory processes and making decisions collaboratively among the different actors involved, in a way that their voices are truly considered. Oftentimes, problems occur because of prevailing models of centralised governance or market governance, as in the case of Chile, where there is a market to allocate the resource, leading to substantial inequalities in access to water.

A New Form of Water Management in the Region Makes Headway

At the regional level, many countries have opted to establish the creation of basin committees and other similar bodies to support the management of water resources in their legislation. But the characteristics of these forums and bodies vary from one country to another, and even within the same country.

In Argentina, for example, each province has its own legal framework for the management of water resources, and the composition of the committees varies from one to the other. Some provinces do not even have a committee. In Brazil, among the responsibilities of the basin committees are to coordinate and deliberate with the different participants, to arbitrate in water conflicts, and to approve the Water Resources Plan. In Uruguay, the basin and aquifer commissions collaborate in formulating and implementing local management plans, articulating different actors, supporting resource management, and more.

In short, participatory governance implies participants be directly involved with water and watersheds, making it more dem-

The transition from a centralised governance model to participatory or networked governance involves several challenges.»

ocratic than other types of governance. In addition, the areas of articulation involving several actors allow different types of knowledge to be brought together for decision-making and are therefore more in line with the realities of the territories. Participation in the management process is also associated with greater acceptance of the proposed measures.

The combination of many of these aspects implies that these governance systems are better prepared to deal with unpredictable changes and to adapt, as there is interaction between organizational levels, different actors, and various sources of knowledge, and also, they offer a broader panorama of actions.

Managing Water in the Face of Climate Change

These characteristics are especially relevant in a context of global environmental changes and climate emergency that intensify the water crises the region is going through. Droughts, floods, and loss of water quality due to excess nutrients or sediments arise as a result of interactions between social, political, economic, and climatic factors. In addition, water crises (which not only concern water but also land use) are also known as 'governance crises.'

In order for basin committees and other similar bodies to play an important role in this governance in the context of water crises, it is necessary to strengthen their functioning. This may imply the institutionalisation of these committees with specific rules on their composition, competencies, work dynamics, and more, as well as also the allocation of the necessary resources so that they can fulfil their competencies.

Public institutions are often limited as to the extent that they can advance in this transition towards participatory models, and this is reflected in the lack of compliance with the so-called quality markers of participatory processes. In this sense, and because they are consultative or advisory spheres, it is essential that public institutions consider the contributions and proposals that emerge from

the committees. Not doing so leads to their erosion and ultimate dissolution.

Latin America must continue to make progress in the transition from centralised to participatory water governance, but there is a long way to go. And, among other issues, Academia must promote the development of transdisciplinary research that brings together non-academic actors directly involved in watersheds and their management, in the search for solutions in different contexts.

Preparing the Americas for the Next Pandemic

New approaches conceive health as the result of interlinked social and ecological systems.
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The Growing Threat of Emerging Infectious Diseases

COVID-19, monkeypox, dengue fever. Headlines today make no room for doubt that new viral diseases will continue to emerge and threaten our health. Infectious diseases are emerging at a greater rate than ever before, as a result of global changes over the last century that favour disease transmission and because there are better technologies to detect and diagnose them. Global social-ecological changes include rampant deforestation in highly biodiverse tropical regions, increasing temperatures, more frequent extreme weather events, and the rapid global spread of people and viruses. This scenario is ideal for the emergence of diseases, as the increasing contact between people, animals, and viruses amplifies the likelihood of new and old viruses being transmitted from animals to people and vice versa.

Climate change and deforestation (changes in the use of the land) are shifting the geographical distribution of people, animals, viruses, and disease vectors like mosquitoes. We are now witnessing dengue fever outbreaks in places previously too cool for mosquito-borne disease transmission, such as mid-elevation areas in the tropical Andes or cities in the temperate Southern Cone of South America like Córdoba, Argentina. As species migrate to new geographic locations, they come into contact with many more species than before.

A recent study predicted that these geographical shifts would result in over 300,000 'first encounters' between mammal species, doubling the current rate of encounters. As new mammals come into contact, it becomes more likely for viruses to spread from one species to another, including people. The authors found that these new encounters tend to occur in mountainous tropical regions with high biodiversity and high human population density. They also found that bats are one of the most critical mammal species to spread new viral diseases due to their unique ability to fly long distances.

Dengue outbreaks are increasingly common in places that were previously too cold for mosquito-borne disease transmission.
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Notably, the current and future burden of endemic and emerging viral diseases is not equally shared across wealthy and less wealthy countries. The so-called Global South is most impacted by disease outbreaks and lacks equitable access to vaccines and other public health solutions, as painfully apparent during the COVID-19 pandemic. Colonial legacies have left profoundly entrenched poverty, social inequalities, and weak governance, increasing the population of highly vulnerable people. However, global health research and funding priorities continue to be driven by the Global North.

Building the Capacity of the Public Health Sector to Respond to the Next Pandemic

Doctors, nurses, and frontline public health practitioners are now faced with responding to this increasingly complex public health scenario. The traditional biomedical model—checking

the patient, identifying physical symptoms, and recommending medical treatment—is no longer sufficient. The WHO and other global health actors have proposed integrated approaches like One Health, which brings together human health, animal health, environmental health, and Planetary Health, and focuses on 'addressing the impacts of human disruptions to Earth's natural systems on human health and all life on Earth.' Programmes like this conceive health as the outcome of interconnected social and ecological systems. Most medical schools and public health programmes, however, are not preparing their workforce for this paradigm shift.

Clinical and public health solutions to emerging infectious diseases must be addressed in the context of rapidly changing, interconnected social and ecological systems. An essential first step is to build the capacity of the health sector to understand and respond to these changes. To respond to this need, the Global Consortium on Climate & Health Education (GCCHE) has established a fast growing global network of schools of health professions, health societies, and regional health organisations to 'create a global climate-ready health sector, prepared to mobilise and lead health promotion and response in the era of climate change, while restoring the health of the planet.'

In April 2022, the Inter-American Institute for Global Change Research (IAI), the Pan American Health Organization, and the GCCHE partnered to launch a virtual course entitled 'Climate & Health Responders for Latin America.' The response was overwhelmingly positive. For over five weeks, more than 1,500 people from across the Americas and beyond participated in live sessions with experts from Latin America. Similar courses were conducted in North America and the Caribbean, reaching thousands of professionals across the continent.

This course revealed there is high demand for climate and health training from diverse sectors, including government ministries, academia, and civil society. Some ministries of health reported that this course allowed them to address their training needs as part of their commitment to the UNFCCC international climate change agreement. To continue to support this effort, a regional (Americas) community of practice will be launched in September 2022. A virtual platform will bring together policy practitioners, researchers, and civil society to share knowledge and best practices to combat emerging infectious diseases and other health issues affected by climate and the environment.

Infectious diseases are emerging at a greater rate than ever before, resulting from global changes over the last century that favor disease transmission.»

Co-Designing Solutions through Equitable Transdisciplinary Partnerships

Fundamentally, a One Health or Planetary Health approach requires a shift in the way that scientists, health professionals, and civil society work together. Equitable collaborations and trusted partnerships are essential and should be built by parties committed to a long-term engagement process. Health practitioners, civil society, and stakeholders from other key sectors should identify their communities' priorities and solutions. Professionals and scientists from diverse disciplines can collaborate with these partners to co-design evidence-based solutions for their communities. This transdisciplinary approach is a best practice to develop tools and information that can be used by the health sector to make informed decisions about how, when, and where to intervene to prevent an epidemic.

Solutions include improved surveillance systems to detect emerging disease threats, new vaccines and therapeutics, innovations to control mosquito-borne diseases, and early warning systems to predict disease outbreaks. This requires a long-term funding commitment from the most significant global health funders, like the Wellcome Trust and the Gates Foundation, to support One Health teams led by investigators in the Global South.

This also requires training for early career researchers and practitioners in collaborative leadership skills such as listening, facilitation, diplomacy, communication, and personal self-reflection. Addressing emerging infectious diseases requires a radical transformation of the systemic oppressions—colonialism, racism, sexism, classism—that continue to shape how we work together and the health of our current and future generations.

Communicating Science to Save the Planet

The COVID-19 pandemic, caused by SARS-CoV-2, has been responsible for multidimensional impacts of political, economic, and social nature. Among other effects, this phenomenon has led to the world's worst economic downturn since the Great Depression and to an unprecedented increase in poverty and inequality.

The pandemic, the result of a zoonosis, becomes even more relevant if we consider that we are living in a new geological period: the Age of Humanity, the Age of Humankind, or the Anthropocene. This is a phase that replaces the Holocene, in which human action has drastically altered Earth's functioning and natural flows, promoting intense global changes.

The adoption of the Anthropocene approach has led to a profound transformation in science, allowing a reformulation of its conceptual, methodological, and political bases. As a result of this process, scientific research is becoming more global and adopting an inter- and transdisciplinary character. At the same time, it puts nature as a central axis and sees environmental problems, such as the reduction of biodiversity, extractivism, climate change, socio-environmental conflicts, and forced displacements, as intimately connected to our production and consumption model.

In this context, it is key for researchers not only to analyse the impacts and challenges of this new epoch, but also to seek solutions to our common problems. In addition, an increasingly important objective is to know how to communicate the results of their work and how to generate a broad dialogue with governments, civil society, the private sector, and individuals directly affected—the protagonists of changes and decisions that can save the planet. It is here that scientific dissemination becomes relevant, considered a communication process through which scientific discoveries are presented to the non-specialised population so that they can be understood and assimilated.

The idea of disseminating scientific discoveries to the public is not new and it can be traced back to important work such as that of magazines like *American Science* and *National Geographic*, both

created at the end of the 19th century. Throughout the 20th and 21st centuries, the transmission of scientific knowledge popularised and managed to position itself as one of the main challenges to forming better-informed audiences.

From Latinoamérica21, our desire is to join this collective effort to disseminate science and spread its beneficial effects over society as a whole. We are a plural media content platform, developed by a team of journalists, academics, and professionals from different areas. We have a network of more than 500 researchers and experts from various fields of knowledge that produce analysis, opinion, and scientific dissemination articles from Latin America or with a Latin American perspective. Our texts, including those that can be read in this compendium, are published on the Latinoamérica21 website in Spanish, Portuguese, and English, and through a media network that includes around 20 of the main Latin American newspapers.

In this context, our collaboration with the Inter-American Institute for Global Change Research (IAI), and the book you are holding, is just one example of this effort to contribute to the dissemination of scientific knowledge, to debate global problems that affect us and to seek solutions that will guarantee life in our shared home. We are counting on you as readers and disseminators of knowledge for our work to multiply and produce the best outcomes.

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The articles collected in this compendium were published in Latinoamérica21 in Spanish, Portuguese and English, and in its associated media network that includes *Folha de São Paulo* (Brazil), *Clarín* and *Perfil* (Argentina), *El Universal* and *SinEmbargo* (Mexico), *El Espectador* (Colombia), *El Nacional* and *Tal Cual* (Venezuela), *El Universo* (Ecuador), *El Deber* and *Página Siete* (Bolivia), *El Observador* and *La Diaria* (Uruguay), *El Mostrador* (Chile), *Última Hora* (Paraguay), *El Faro* (El Salvador), *Confidencial* (Nicaragua) and *La Revista CR* (Costa Rica).