THE UNESCO
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Vanishing glaciers

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IDEAS

Why primates must be saved

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and
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THE UNESCO Courier

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Editorial

According to Amerindian legend, the highest peaks of the Merida mountain range in Venezuela owe their snow-covered summits to the beating wings of five white eagles. But over the last few decades, the birds of prey seem to have deserted the cordillera, which is now covered in stony soil. In 2023, the country lost its last glacier, La Corona.

The Andes are not the only mountains the white eagles no longer visit. Glaciers are retreating everywhere, from the Alps to Mount Everest to Kilimanjaro. More broadly, it is the entire cryosphere – all the masses of ice, snow and frozen ground – that is being reduced by climate change. Over the last two years, this process has accelerated at an unprecedented rate.

The International Year of Glaciers' Preservation declared by the United Nations and coordinated by UNESCO and the World Meteorological Organization (WMO) provides an opportunity to analyze the consequences of this major phenomenon, which can only be curbed effectively by a significant reduction in greenhouse gas emissions.

Raising public awareness of the effects of global warming is another key focus of the International Year. But we have far to go in this domain. According to several recent UNESCO studies, less than 40 per cent of teachers feel capable of explaining the impact of climate change to students, and 70 per cent of young people admit they have a poor grasp of the subject.

Yet there is an urgent need to act. The melting of glaciers has far-reaching consequences: disruption of the water cycle, rising sea levels that threaten coastal areas, and increased risk of flooding are just some of the already visible manifestations. It is also a source of disruption for many indigenous communities living at high altitude, for whom glaciers have a cultural dimension, as shown by recent developments in the pilgrimage to the shrine of the Lord of Qoyllurit'i, which was inscribed on UNESCO's Representative List of the Intangible Cultural Heritage in 2011.

The changes that are taking place on mountain peaks today, in areas often remote and difficult to access, may seem distant and local. Quite the opposite is true. What is happening today in the mountains, the veritable sentinels of climate change, will affect the quality of life in the valleys, coastal areas, and cities. In a word, our future is at stake.

Agnès Bardon
Editor-in-Chief

Vanishing glaciers

The Perito Moreno Glacier in Patagonia, Argentina.

Agnès Bardon
UNESCO

Glaciers are melting at an alarming rate. This is anything but good news for our planet. The influx of water from melting glaciers is disrupting the water cycle and raising sea levels, threatening coastal areas. The International Year of Glaciers' Preservation, declared by the United Nations for 2025, is an opportunity to reflect on the consequences of this phenomenon. It is only through a significant reduction in greenhouse gas emissions that this major issue can be effectively addressed.

There are approximately 1,400 glaciers in Switzerland. But how many will still exist tomorrow? The question might have seemed absurd just a few decades ago, but this is no longer the case. A study by the Swiss Academy of Sciences published in September 2023 paints a pessimistic picture. Scientists are alarmed not only by the predicted melting, but also by its dramatic acceleration. The figures are staggering. According to experts, Swiss glaciers have melted more in the last two years than between 1960 and 1990. High temperatures and low snowfall have reduced their volume by 10 per cent between 2022 and 2023.

Switzerland is not an isolated case. For several decades now, the cryosphere – the part of the planet containing masses of ice, snow and frozen ground, whether permafrost (permanently frozen ground), sea ice, glaciers, ice caps (Greenland and Antarctica), seasonal snow or lake and river ice – has been under threat.

All over the world, glaciers – huge masses of slowly moving ice that cover around 10 per cent of the Earth's surface – are retreating. In the tropical Andes, between 78 and 97 per cent of their volume could be lost by 2100, according to UNESCO data. La Corona, the last glacier in Venezuela, now only exists in memory. In Central Asia, the glaciers in the Tian Shan and Pamir, the two main mountain ranges in the region, have lost up to 30 per cent of their volume over the last 60 years, according to a study by the Eurasian Development Bank. As for the last glaciers in Africa, notably Kilimanjaro, it is estimated that they will have disappeared by 2050.

A state of emergency

The accelerated melting of glaciers is a dramatic illustration of the impact of climate change. It demonstrates the need to accelerate and strengthen climate action to preserve human livelihoods and wellbeing and secure ecosystem integrity, as well as to draw the attention of the general public and decision-makers to this major phenomenon. This will be the focus of the International Year of Glaciers' Preservation, proclaimed by the United Nations for 2025, and coordinated by UNESCO and the World Meteorological Organization (WMO). This initiative will be an opportunity to highlight that the most effective way to stop glacier melting is to reduce greenhouse gas emissions to limit the rise in temperature to 1.5 degrees, in line with the commitments made by the signatory parties of the Paris Agreement in 2015.

To better apprehend the complex phenomenon of melting ice, and to try to limit its effects, we must first understand it. Observation in the field, combined with techniques such as satellite imagery and aerial photography, has already made it possible to gather a wealth of data from around the world. But monitoring glaciers remains tricky, not least because they are difficult to access. Although scientists have been examining them for almost 130 years, there is still much to discover about these giants of nature and the impact rising temperatures are having on them as well as on the downstream communities and ecosystems.

> **"According to UNESCO, glaciers in the tropical Andes could lose between 78 and 97 per cent of their volume by 2100**

First and foremost, there is an immediate, direct and well-documented consequence: the threat to biodiversity. Many plant species – such as mosses and lichens – and animal species – including the emblematic polar bear – are already suffering from changes to their →

environment. But the consequences go beyond glacial ecosystems.

A chain of consequences

Snow, permafrost and glaciers play a key role in the functioning of the climate system and the hydrological cycle. Around 70 per cent of the planet's freshwater exists as snow or ice, making glaciers essential to the water supply of millions of people.

Water from melting glaciers also causes increased risks of flooding by outburst of glacial lakes. According to UNESCO, nearly a thousand of these lakes in Central Asia are considered a threat to the population. Conversely, other regions located downstream of glacier-fed rivers are experiencing water shortages.

In addition, the influx of water coming from melting glaciers is contributing to the sea level rise. This increases coastal erosion and puts many islands at risk of submersion, threatening the livelihoods of coastal communities. Since 2006, over half of the rise in sea level has been attributed to the melting of glaciers and ice sheets in Antarctica and Greenland.

The west coast of Greenland, one of Earth's main incubators for icebergs. Image captured by NASA's Terra spacecraft.

Increased freshwater influx from arctic glacier melt is also identified as a cause for the weakening of the Atlantic Meridional Overturning Circulation (AMOC), the main ocean current system in the Atlantic Ocean. This could lead to severe impacts on global and local climates still during the 21st century.

An International Year to raise awareness about glacier melt

The United Nations has designated 2025 as the International Year of Glaciers' Preservation. UNESCO and the World Meteorological Organization (WMO) are the key implementing partners of this global effort to raise awareness about the critical role of glaciers, snow and ice in the climate system and the hydrological cycle. Additionally, starting from 2025, March 21 is recognized as the World Day of Glaciers.

The stakes are high: glaciers support the livelihoods and economies of millions globally and play an essential role in environmental sustainability. However, they are shrinking rapidly. The International Year of Glaciers' Preservation presents an opportunity to draw the attention of the general public and decision-makers to this major phenomenon and its consequences, as well as mitigation and adaptation strategies.

As part of the International Year of Glaciers' Preservation 2025, a high–level event of the World Day for Glaciers and World Water Day will be organized on 21 March in Paris to highlight the accelerating threat of glacier melt and its impact. This will also mark the launch of the 2025 World Water Development Report, themed "High Mountains and Glaciers".

> **"The most effective way to stop glaciers melting is to reduce greenhouse gas emissions**

Another consequence is that the melting could lead to the release of pathogens previously trapped in the ice, with unknown consequences for biodiversity and human health. Many species of virus, bacteria and sometimes even small organisms have managed to stop their vital signs for long periods in order to resist extreme environments. There have been examples of species being reanimated after very long periods, up to 750,000 years, spent in glaciers or permafrost. This is the case for certain

viruses, but also for a recently discovered species of worm that spent 36,000 years in the Siberian permafrost.

The tears of Hine Hukatere

Glaciers are crucial ecosystems for the planet's equilibrium, but they also have a cultural and spiritual significance for many indigenous peoples and local communities. In New Zealand, the Franz-Josef Glacier is called Ka Roimata o Hine Hukatere, or "the tears of Hine Hukatere", the name of a Maori demigod overwhelmed by grief after the death of her great love in an avalanche. The glacier is said to have been born from her tears.

In Peru, the pilgrimage to the sanctuary of the Lord of Qoyllurrit'i, inscribed on UNESCO's Representative List of the Intangible Cultural Heritage in 2011, attracts around 90,000 people from the Cuzco region every year. The highlight of the event is an evening walk to the summit of the glacier, which rises to an altitude of 5,200 metres. Ukukus, the spiritual leaders, used to cut blocks from the glacier and share them with the pilgrims, as the meltwater was said to have healing powers. But this ritual is no longer practiced because of the rapid retreat of the glacier.

"Last chance tourism", a growing trend where travellers rush to visit places doomed to disappear, is certainly not going to reverse the trend. On the contrary, the influx of visitors only serves to further weaken ecosystems that are already in danger.

Rather, it is awareness of the issues at stake and the urgent need to act that will at least enable measures to be taken to mitigate the effects of melting glaciers. In this fight, education has a key role to play in raising awareness among future generations. Yet climate change education remains a major challenge. According to a UNESCO study conducted in 2021 in around a hundred countries, almost half (47 per cent) of school curricula make no reference to climate change. The International Year of Glaciers' Preservation could be the opportunity to kick-start a change. The clock is ticking. ■

Climate change at school: we can do better

Teaching about climate change in schools is not yet a matter of course. According to a UNESCO study carried out in 2021 in around a hundred countries, 47 per cent of school curricula made no reference to climate change, and fewer than 40 per cent of teachers felt confident discussing the impact of climate change in their classes. Another UNESCO study from 2022 found that 70 per cent of young people feel unable to explain climate change.

To meet this challenge, UNESCO has launched the Greening Education Partnership, which brings together more than 80 Member States and some 1,300 organizations, including UN agencies, civil society organizations, youth organizations and the private sector. The aim is to provide countries with tools to strengthen the role of education in the fight against climate change.

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◥ *Date markers indicate the retreat of the Athabasca Glacier in Jasper National Park in Canada.*

Interview by
Katerina Markelova
UNESCO

Douglas Hardy: "Kilimanjaro is a compelling place from both aesthetic and scientific perspectives"

Despite predictions by many 20th century scientists, the glaciers of Kilimanjaro in Tanzania still exist. However, their surface area has decreased by 91 per cent since 1912, when they were first mapped. According to Douglas Hardy, glacier and climate specialist at the University of Massachusetts Amherst (United States), their disappearance is inevitable.

◥ *The Northern Icefield, Kilimanjaro's largest body of ice.*

© Douglas Hardy

You've made over twenty expeditions to Kilimanjaro's summit and even call it your 'home away from home'. What first drew you to study Kilimanjaro's glaciers?

Initially it was really luck. I was collaborating at the time with Lonnie Thompson from Ohio State University on tropical glacier research, and in 1999 he obtained permission and funding to drill ice cores at Kilimanjaro's summit. I was invited to install meteorological instrumentation to support the ice core interpretation. Typically, such a project would last 3-4 years. Yet, 24 years later, I have logged 82 nights in the crater – far more than I ever imagined.

Kilimanjaro is indeed an incredibly compelling place from both aesthetic and scientific perspectives. Once you reach the summit, you're struck by the contrast between bright-white vertical walls, and fins of ice sitting cleanly on dark volcanic sand. The whole scene up there is unlike anything I've ever seen.

From the scientific perspective, these glaciers are fascinating because they exist in a desert environment, sometimes without any snow in sight, on the African continent, at an altitude halfway through Earth's atmosphere. Throughout the 20th century, scientists consistently predicted their demise, but have been uniformly wrong.

What preparation is required for a high-altitude research expedition?

Kilimanjaro rises 5,000 metres above the surrounding landscape. Because it's relatively easy to climb, the most important preparation is to bring patience along. By ascending slowly, most people can adapt to the altitude and the tremendous change in oxygen concentration. This is why we usually camp about five nights on the way up, even though the entire ascent can be completed in six hours. We also try to keep in mind that we're not just climbing; we're going to the summit and then we're setting up camp and we're starting to work. It's different from a typical climb where one races back down.

Going up the mountain is a tremendous number of rapid transitions. You start on the plains, where there's a lot of villages and small farms. Then you go through the rainforest above which the environment begins drying out. By the time one reaches the summit, there's virtually no vegetation. However, it's not devoid of life, and increasingly, we're seeing birds and insects at the top.

© Douglas Hardy

The Rebmann Glacier near the summit of Mount Kilimanjaro in 2011. The vegetation in the foreground is characteristic to East African mountains.

> **"Kilimanjaro's climate is closely linked to sea surface temperatures in the Indian Ocean**

How have the glaciers changed since you began your research in 2000?

The most obvious change is in the ice's extent and thickness. Since Kilimanjaro's glaciers were first mapped in 1912, 91 per cent of their area has disappeared. There have also been more subtle changes. For example, when I first visited, sharp ice features with spires and narrow fins were common. While these textures can still be found, the ice has changed. With higher humidity caused by climate change, it becomes more rounded.

What makes Kilimanjaro's glaciers so fragile?

The summit elevation is warming. However, with collaborators in Austria and Germany we've shown that increasing temperature is not the main reason for the glacier retreat. Kilimanjaro's glaciers lack an accumulation zone, and with reduced precipitation, they are really doomed.

At a much larger scale, the ocean stores a tremendous amount of heat, warming the global atmosphere. Kilimanjaro's climate is closely linked to sea surface temperatures in the Indian Ocean and elsewhere. The strong correlation between the annual mean temperature at the summit and sea surface temperatures demonstrates the importance of the global climate system as a whole.

When did the first signs of fragility in the Kilimanjaro glaciers begin to appear?

Scientists have known about their retreat for a very long time. The German geographer Hans Meyer, who first reached the summit in 1889, noted significant ice loss by his return in 1898. He predicted they'd disappear within 20-30 years! However, his prediction was premature. →

A 2002 article published in the academic journal *Science* suggested that if climate conditions didn't change, Kilimanjaro would likely lose all its ice between 2015 and 2020.

Despite this, although the glaciers have shrunk dramatically, with the larger Northern Icefield now more fractured, ice is still there. The glaciers' persistence is part of Kilimanjaro's mystique, although their eventual disappearance is inevitable.

What are the connections between these glaciers and the nearby communities?

The glaciers – and the people who are living and farming at lower levels of the mountain – are actually victims of the same problem, which is decreased regional precipitation. This is having serious implications for humans and ecosystems, creating drier conditions with more fire risk.

Kilimanjaro is Africa's highest point, which makes it a symbolically important landmark. It's no surprise that in 1962, Julius Nyerere, the first prime minister of independent Tanganyika, sent a torch to the top to spread light and hope throughout all of Africa. This sentiment still resonates with locals and visitors alike.

As a result, Kilimanjaro attracts a tremendous number of climbers. Many are people who don't normally spend time in the mountains, who just view the climb as a 'bucket list' accomplishment. However, these visits bring employment to local people and foster cultural exchanges.

To preserve Kilimanjaro's unique environment, the National Park closely monitors ascents of the mountain. People who climb the mountain are required to bring along certain local personnel: a guide, an assistant guide, a cook, porters. Scientific research at the summit relies on this essential support.

What insights have the ice cores drilled from Kilimanjaro's glaciers in 2000 provided?

It was a difficult project, involving challenges such as transporting tons of equipment up 5,000 meters, working at nearly 6,000 meters for a month, and carrying heavy ice cores down

© Douglas Hardy

"Kilimanjaro's glaciers are retreating due to reduced precipitation

© Douglas Hardy

A fragment of the Furtwängler, the last glacier within the summit caldera.

Ice texture formed by sublimation – the transition from a solid to a gaseous state – on the Decken Glacier near Uhuru Peak.

© Douglas Hardy

Douglas Hardy prepares the installation of a stake to measure height changes in the ice.

challenging terrain into tropical heat. In 2002, we published a paper suggesting the glaciers were almost 12,000 years old, though, if we are being honest, we knew that subsequent research was likely to modify the story. This is the normal process of science, yet today it remains the only publication on the history of Kilimanjaro's current glaciers.

Planning for a new drilling project began in 2019 by the Ice Memory Foundation, an international initiative to obtain and preserve ice cores from the world's key endangered glaciers. But the effort was halted due to permitting issues, leaving the project unrealized. With unrelenting ice loss it's now virtually impossible that any new ice core record will ever be recovered from Kilimanjaro's summit.

Is there hope for preserving Kilimanjaro's glaciers?

Optimism sprung from 2003 speculation by the Zimbabwean scientist Euan Nisbet who suggested covering the glaciers with three square kilometers of tarps, and removing them during the wet season. However, based on experience with this idea in the Alps, where ski areas on glaciers have used the same approach for decades, we know that it isn't viable at such a scale.

Kilimanjaro glaciers will disappear. But along with them, glaciers in the Alps, Andes, and elsewhere; even glaciers in the Himalaya ultimately will disappear, with tremendous implications for water resources and flooding events. In the end, Kilimanjaro will assume new symbolism, emblematic of the myriad implications of global climate change. In the short term, I think the most important message from the glaciers is that humanity must drastically reduce our consumption of fossil fuels. That is absolutely the only solution. ■

World Heritage glaciers under threat

Around 18,600 glaciers have been identified in natural World Heritage sites, spanning about 66,000 km^2, or almost 10 per cent of the glaciers on Earth. Like everywhere in the world, these glaciers have been retreating at an accelerating rate. They lose on average some 58 billion tonnes of ice every year and contribute to almost 5 per cent of global sea-level rise.

These findings are published in *World Heritage Glaciers: Sentinels of climate change* (2022), a report by UNESCO and the International Union for Conservation of Nature (IUCN). Projections indicate that glaciers in around half of all World Heritage sites could almost entirely disappear by 2100 with the current emissions scenario.

However, if emissions are drastically cut to limit global warming to 1.5°C (relative to pre-industrial levels), glaciers in two-thirds of World Heritage sites could be saved. Measures that could be taken at sites include improving monitoring, implementing early warning measures, and making glaciers a focus of targeted policies.

Alister Doyle

Freelance journalist and author of The Great Melt *(2021)*

Glaciers under close surveillance

Scientists are increasingly turning to satellites, robot submarines, hot water drills, and drones to monitor the cryosphere since collecting samples is becoming more costly and dangerous.

Scientists using satellites to study Antarctica and global sea level rise were recently surprised to discover that the surface of a vast, remote glacier 1,000 metres thick was rising and falling like clockwork, twice a day.

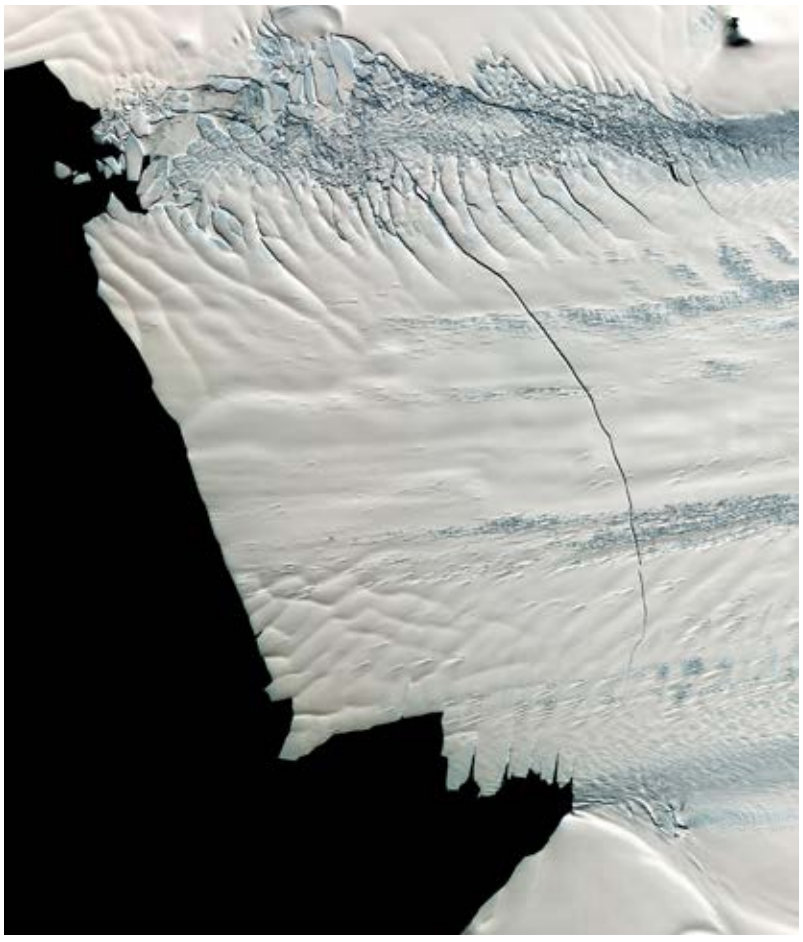
They concluded in 2024 that the ebb and flow of tides were heaving the Thwaites glacier, which rests on the bed of the Amundsen Sea off West Antarctica, up and down from below by tens of centimetres. The tides were pushing warmer, salty seawater far beneath the underbelly of the glacier and causing "vigorous melting".

The findings add to evidence that climate change could weaken the Thwaites and accelerate global sea level rise from the glacier, which covers an area the size of Florida or Great Britain and is sometimes dubbed the "Doomsday Glacier" because of its vulnerability to thaw. Other glaciers flowing into the oceans from Greenland to Antarctica may also be at risk from water seeping underneath.

The Achilles heel

"It's mind-boggling to think that a little change in water pressure from the sea is lifting up a kilometre of ice, lifting up the whole glacier," says Eric Rignot, a professor of Earth System Science at the University of California–Irvine, and lead author of the Thwaites study. Rignot, who also works for the United States' space agency NASA's Jet Propulsion Laboratory, called the zone where ice rests on the seafloor "the Achilles heel of the glaciers" in a warming world.

> **"In 2023, the warmest year on record, glaciers collectively lost 600 billion tonnes of water**



This image captured by NASA's Terra spacecraft shows a massive crack across the Pine Island Glacier, one of the largest ice streams in Antarctica.

NASA researchers using a hot-water drill at the Juneau Icefield in Alaska, in 2023.

A special focus is currently being placed on glacier monitoring due to climate change, but scientists have always been interested in them. Among the illustrious examples is the creation in 1894 of the International Glacier Commission to monitor glaciers and study how ice ages occur. Today, scientists continue to carry out *in situ* monitoring, visiting the ice to measure surface temperatures or inserting long metal stakes into glaciers and returning months later to see whether ice has thinned or thickened.

But the dangers and costs of visiting heavily crevassed glaciers are spurring ever more use of technology. Scientists are enlisting technologies including satellites, robot submarines, hot water drills, ice cores, and aerial photography by drones and planes.

These techniques are effective, but they are also expensive. The United States and the United Kingdom invested US$50 million from 2018-25 to study the Thwaites, whose total collapse would add 65 centimetres to sea levels. The remoteness of Antarctica and bone-chilling temperatures makes such projects hugely challenging.

Impressive technological equipment is deployed to examine this ice giant. Scientists camped on the glacier and worked from ships, deployed robot submarines, sonars, radars, and even tagged seals with high-tech sensors. They used a hot water drill to open a hole 600 metres through the ice, and lowered a torpedo-shaped robot known as Icefin to study seawater beneath the ice shelf, the tongue of ice floating at the end of the glacier.

Race against time

In Norway, drones and laser scanners are used to monitor small glaciers. "In the north of the country, there were record glacier ice losses this year. It was a bit shocking to see how negative the numbers were," explains Liss Marie Andreassen, research professor at the Norwegian Water Resources and Energy Directorate.

Scientists are racing against time. Global warming has already led to the disappearance of thousands of glaciers worldwide. The Copernicus Climate Service, a European initiative providing information about the past, present and future climate, reports that in 2023 – the warmest year on record – glaciers collectively lost 600 billion tonnes of water, equivalent to about 1.7 mm of sea level rise. In some parts of the world, glacier monitoring is going out of business as whole countries are losing glaciers.

In Slovenia, a camera that monitors ice below the summit of Triglav, the nation's highest peak at 2,864 metres, shows mere remnants. Temperatures there are now sometimes above freezing for six months a year, against just four months in the 1950s.

"There are just two small patches of ice – the leftovers of the former real glacier… they don't have crevasses and don't really move any more," laments Miha Pavšek of the Anton Melik Geographical Institute in Slovenia. ■

Technology to combat glacier melting in China

In the race to save melting glaciers, China has come up with creative solutions – such as nanomaterial blankets and artificial snow systems – to slow the melting process, and they are yielding promising results.

A section of Ürümqi Glacier No. 1 covered with a protective textile in 2022.

Like everywhere in the world, as the melting of glaciers accelerates, protecting the cryosphere – and glaciers in particular – is an urgent priority in China. Using thermal blankets and artificial techniques for making snow are among the innovative experiments conducted to combat melting. These efforts are in line with the global initiatives of the United Nations' designation of 2025 as the International Year of Glaciers' Preservation, and its approval of the Decade of Action for Cryospheric Sciences (2025-2034).

The use of such techniques to preserve ice sheets is not new. Since the early 21st century, an increasing number of countries, including Austria, France, Germany, Italy, and Switzerland, have started to protect glaciers by covering them with geotextiles. Such coverings aim to increase surface albedo – reflection of light – and reduce its absorption of solar radiation, thereby slowing down glacier melting.

China has also adopted the method. The Key Laboratory of Cryospheric Science and Frozen Soil Engineering in Lanzhou in northwestern China has conducted a series of experiments on the Dagu Glacier in the Hengduan Mountains in the southwest, and Ürümqi Glacier No.1 in the eastern Tian Shan Mountains in the northwest. Some exciting progress has been made. At 4,830 metres above sea level on the Dagu Glacier, a 500 square metre trial area was selected and covered with specially designed geotextiles.

Kang Shichang

Ph.D., Professor, and Vice-president of the Northwest Institute of Eco-Environment and resources, University of Chinese Academy of Sciences in Beijing, China.

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These "glacier blankets" not only provided excellent thermal insulation but also effectively suppressed the absorption of shortwave radiation, increasing the albedo of the glacier surface. As a result, the melt rate was reduced by approximately 34 per cent between August 2020 and October 2021.

Nanomaterials

Meanwhile, more advanced nanomaterials were used to cover a section of the glacier surface at elevations between 3,740 and 3,990 metres above sea level on Ürümqi Glacier No.1. This technique allows the glacier to be "dressed" in a layer of "high-tech protective gear", which significantly slows down the melting process, particularly during hot seasons. These nanofiber materials, with their remarkable optical and electrical properties, have helped reduce the melting rate by as much as 70 per cent during the summer.

> **Nanofiber materials helped reduce the melting rate of the Ürümqi Glacier No.1 by 70 per cent during the summer**

Nevertheless, more work is needed to see how this technique can be expanded and made more environmentally friendly. Covering glaciers with blankets has mainly been adopted for small glaciers that have been developed for tourism and are on the brink of disappearing. While this has proven effective in slowing down glacier retreat, it does present environmental risks, high costs, and can only be applied to small areas. The current rapid and large-scale shrinking of glaciers cannot be addressed by nanomaterials alone.

Snow and algorithm

Making artificial snow is another glacier protection method. Simply put, it works by increasing precipitation in mountainous areas to supply more mass to the glacier. At the same time, it helps to clean the glacier surface, enhancing its albedo, which reduces the absorption of solar radiation and thus slows down the rate of glacier melting.

In mid-August 2018, a week-long artificial snowfall conducted by a smoke generator on the Muz Taw Glacier, in the Sawir Mountains in the northwest, resulted in precipitation accounting for 42 to 54 per cent of the total glacier meltwater during that period. From April to May 2023, the Key Laboratory of Cryospheric Science and Frozen Soil Engineering conducted a three-dimensional operation (smoke generators, rocket launches, and aircraft operations) to make artificial snow in the Bailanghe Glacier basin in the Qilian Mountains. The view of snowflakes abundantly falling across the glacier landscape was truly breathtaking.

After completing the operation, we developed an innovative algorithm that improves traditional evaluation methods by separating fixed-region analysis from meteorological interference. The results showed that the operation of making snow contributed to a 5.9 per cent gain in glacier mass, and helped reduce glacier melt by increasing surface albedo over the following 1-2 days.

Reducing greenhouse gas emissions

The rapid shrinking of glaciers is mostly driven by global warming due to human-related greenhouse gas emissions since the industrial revolution. So, to effectively curb the process, greenhouse gas emissions must be reduced on a global scale. Dust and black carbon emitted by human activities should be decreased at the regional level, because these light-absorbing particles can accelerate the melting of ice and snow by reducing albedo.

> **Covering glaciers presents environmental risks and involves high costs**

Other measures can help to rapidly reduce the rate of glacier melt. Ground-based cloud seeding operations, which improve a cloud's ability to produce rain or snow, could be strengthened in glacier basins. Alpine precipitation methods could be further investigated, and more systematic artificial snowing programs implemented in glacier areas. By integrating glacier melt models, a comprehensive system that assesses artificial snowing, glacier melting, and runoff changes can be developed.

Green electricity could be used more effectively to power the artificial snowmaking using glacier meltwater to reconstitute glacier mass. Green electricity can also drive meltwater pumps to clean glacier surfaces by flushing light-absorbing particles away. These techniques allow surfaces to be supplied and treated in a green, efficient, and cost-effective manner. Meanwhile, drones can enhance snow supply and replenish glaciers.

Monitoring the different glacier mitigation solutions is also essential. Given the complex terrain and unpredictable cloud or rain conditions in glacier regions, ground-based observation methods, such as drones and 3D imaging, must be combined with monitoring technologies. That way, more accurate data will help further improve glacier protection measures. ■

Amir Ismailov

Journalist in Central Asia

Central Asia, a region of high priority

In Kyrgyzstan, as in the rest of the region, the melting glaciers are having a substantial impact on mountain populations facing water scarcity.

"The irrigation channels are drying up and in the mountain pastures where I used to water my cattle, some of the springs have dried up," says Urmat Omurbekov, a farmer in the village of Kochkor in central Kyrgyzstan.

On his farm in the heart of this mountainous agricultural country, he continues to cultivate five hectares of cereals, mainly barley and wheat, despite the harsh climate and lack of water. "Before, you had to cross the rivers on horseback because of the strong currents when the glaciers were melting. Now you can cross on foot," continues Omurbekov, who is 59.

The retreat of the glaciers in Central Asia has had very direct consequences for the inhabitants, who have been facing water shortages for some years now. This arid, landlocked region, thousands of kilometres from the sea, is particularly exposed to the vagaries of the climate.

With peaks approaching 7,500 metres, Kyrgyzstan and neighbouring Tajikistan are among the most mountainous countries in the world, each boasting between 10,000 and 15,000 glaciers. These glaciers are veritable water towers for the region, providing vital water reserves for the food security of the 80 million or so inhabitants of Kazakhstan, Kyrgyzstan, Uzbekistan, Tajikistan and Turkmenistan. When they melt in summer, they supply the population with water during the months when there is no precipitation, before regenerating by accumulating snow and ice in winter.

Glaciologist Gulbara Omorova takes samples from a glacial lake in the Tian Shan mountain range.

© Amir Ismailov

> **"Glaciers in the region are not regenerating and are melting faster**

But over the last few decades, the mechanism has come to a halt. In 70 years, Kyrgyzstan has lost 16 per cent of its glacial mass, and over a thousand glaciers have disappeared in Tajikistan in the last three decades. As glaciers melt, they leave behind stony ground that absorbs more solar radiation, further amplifying the process.

Accelerated melting

From the highest scientific station in Central Asia, perched at an altitude of almost 3,600 metres in the heart of the Tian Shan (Celestial Mountains), Gulbara Omorova, a researcher at the Institute of Water Problems of the Kyrgyz Academy of Sciences, is on the front line to observe the glaciers' retreat. "What we can see is

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The highest scientific station in Central Asia is located at around 3,600 metres above sea level in the Tian Shan mountain range in Kyrgyzstan.

that they have deteriorated considerably under the impact of climate change and rising temperatures," she explains. The glaciers no longer have the necessary mass, they are not regenerating and they are melting faster.

Despite the lack of resources, her work is crucial for quantifying this phenomenon, which is still insufficiently documented. "To measure melting, we install stakes on the glaciers. For example, the Adygene glacier has lost an average of 16 metres a year since the 1960s, which means more than 900 metres," adds Omorova, who notes that the melting has "intensified over the past year".

Forecasts are alarming: the acceleration in the melting of Central Asian glaciers is expected to peak between 2035 and 2055, according to a study published

UNESCO supports glacier monitoring in Central Asia

The shrinking cryosphere is of particular concern to Central Asia, as the region's main river systems are dependent on the seasonal melt of snow and ice. The intensive melting of glaciers and the associated formation of glacial lakes poses a threat to mountain populations. UNESCO is implementing several projects in the region to help monitor these developments and to provide adaptation strategies for vulnerable communities.

Within the five-year project Reducing vulnerabilities of populations in the Central Asia region from glacier lake outburst floods in a changing climate, the Organization is putting early warning systems in place to alert people to any impending threat. Another project enables Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan to share their experience of monitoring the cryosphere, including information on the impact of melting glaciers on the availability of water. This knowledge will then help design national and regional strategies for adapting to climate change. The project is being implemented in the framework of UNESCO's Intergovernmental Hydrological Programme, in collaboration with the United Nations Development Programme (UNDP) and the Global Environmental Facility.

in 2023 in the leading scientific journal *Science*. The Kyrgyz and Tajik authorities agree that by 2050, a third of the glaciers in Central Asia could disappear. And all of them could disappear by the end of the century, which could cause tensions between the countries of Central Asia over control of water resources.

> **Veritable water towers, glaciers provide vital water reserves for Central Asia**

Artificial glaciers

In this context, the region's inhabitants are being forced to adapt. Urmat Omurbekov is well aware of this. "We have to take climate change into account and modify our practices. Kyrgyzstan is a rural and agricultural country, so we can't survive without raising livestock and growing crops."

In recent years, experiments have been conducted to deal with shortages, including the use of artificial glaciers. "We have built a fountain that is supplied via underground pipes with water from a spring at the top of the mountain. In winter, the water gushes out under pressure and freezes on contact with the air. In spring, the glacier melts and the cattle can drink. And so can we," explains the farmer.

"This two-hectare artificial glacier gives us 20 per cent more water and feeds around a thousand people. It's not enough, but it covers part of our needs."

Still not widely used, this method has the advantage of being simple and inexpensive. Since 2020, some 30 of these artificial glaciers have been built across the country.

© Amir Ismailov

The Adygene Glacier, located at an altitude of around 4,000 metres in the Tian Shan mountain range, has retreated by more than 900 metres since the 1960s.

Drip irrigation

Water stress is also forcing local people to turn to more appropriate activities. This is the case of Taalai Malabayev, a livestock farmer in Kara-Jygach, a village at the foot of the Tian Shan mountains in northern Kyrgyzstan. He has given up raising livestock and growing clover to plant berries, which require less water.

Drip irrigation is also developing in this region, where water shortages are exacerbated by dilapidated infrastructure. "It saves time, effort and water," sums up the 40-year-old.

"With conventional watering, a lot of water is wasted, whereas drip irrigation only waters the roots of plants, which is much more effective," he continues. This technique also saves time. "It used to take me a whole day to water a hectare. Now, it can be done in three hours," he says.

The only problem with drip irrigation is its cost. This watering system requires significant investment on the part of farmers with modest incomes.

These initiatives are beneficial in that they help alleviate water shortages and improve living conditions for local populations. But they cannot counter another consequence of melting glaciers: the bursting of glacial lakes, whose fragile structure can break up and submerge entire territories by suddenly releasing huge masses of water. ■

Lars Pilø

Glacial archaeologist and editor of Secrets of the Ice, *website of the Glacier Archaeology Program, a joint initiative by Innlandet County Council and the Museum of Cultural History in Oslo, Norway.*

Melting ice reveals the past

By restoring objects that are sometimes thousands of years old, melting ice is a gift for archaeologists: these relics from the past provide unprecedented information about the lives of prehistoric humans. But it's a race against time to collect these objects before they disappear.

Ötzi, the iceman – or ice mummy – was discovered in the Tisenjoch pass in the Alps between Italy and Austria in 1991. He remains the most famous glacial archaeological find, and thanks to radiocarbon dating, we know that he and the artefacts found with him were 5,300 years old. Among these artefacts are his clothing, a bow and quiver filled with arrows, an axe with a copper blade and a flint dagger. Due to the exceptional preservation of his body, extensive information has been gained about Ötzi's health, diet and his final days.

Ötzi is an example of such frozen relics from our ancestors' lives in the high mountains, now emerging from the retreating ice. As glaciers and ice patches worldwide retreat, a new archaeological frontier has opened. Under the right conditions, glacial ice acts like a giant deep freezer, preserving artefacts in a pristine condition, frozen in time.

The mountainous regions across North America, the Alps, Scandinavia, and Mongolia have provided the most discoveries. They offer an invaluable new source of historical information, and shed new light on how humans adapted to climate change in the past.

As the ice retreats, the finds are getting steadily older. In a way, we are melting back in time, gaining a deeper understanding of human history with each discovery. At the same time, there is →

◥ *A 1,500-year-old arrow, discovered in the Jotunheimen Mountains, Innlandet County, Norway.*

> **"As the ice retreats, the finds are getting steadily older**

great urgency in recovering the finds from the ice. Once out in the open and exposed to the elements, the clock starts ticking fast, and the objects will be lost forever if they are not recovered quickly.

Tools, bones, and darts

The discovery of a lost mountain pass at Lendbreen ice patch in Innlandet County, in the south-east of Norway, has yielded over a thousand archaeological finds, revealing continuous use from around 200 to 1500 CE, with peak activity around year 1000. The pass connected farms and their summer pastures, and facilitated long-distance trade routes to the Sognefjord. Finds include clothing, tools, remains of sleds, and bones from packhorses and a dog. Many of these finds are exhibited in the Norwegian Mountain Center in Lom.

The earliest artefact from mountain ice is a more than 10,000-year-old spear-thrower dart, found near melting ice in the Rocky Mountains in the United States. A similar, slightly younger dart was found in the Yukon, in Canada. Radiocarbon dating reveals a transition in hunting technology from spear-thrower to bow-and-arrow around 1,200 years ago.

> **“The best preserved pair of prehistoric skis in the world was discovered in Norway**

The best preserved pair of prehistoric skis in the world was discovered at the Digervarden ice patch in Innlandet County, the first ski in 2014 and the second in 2021. The skis have preserved bindings, which is exceedingly rare, and this has allowed for experimental Iron Age skiing on replicas.

High-altitude archaeology

Glacial archaeology takes place in a very different environment than traditional archaeology. The survey areas, situated at altitudes of 1,800-3,000 metres above sea level, are rugged, rocky slopes. Most artefacts are found near the edges of the retreating ice, but sometimes, when the melt is particularly severe, they can also be recovered from the surface of the ice. Fieldwork in these remote high-altitude

A fragment of birch bark found at the Lendbreen ice patch in central Norway.

© James H. Barrett

Reindeer antlers found at Trollsteinhøe, Innlandet County, Norway.

regions often resembles expeditions, with basecamps for extended stays.

The best preservation conditions occur in stationary ice, particularly ice patches – smaller bodies of ice frozen to the ground. Ice patches can preserve artefacts in organic materials, such as wood, leather and textiles, for thousands of years.

> **Ice patches can preserve artefacts in organic materials for thousands of years**

These finds reveal that human activity in the high mountains was more extensive than previously believed, even during the wintertime. In Scandinavia and North America, hunters pursued reindeer, which sought refuge on the ice during the summer to avoid pestering insects. The hunters left behind arrows, spear-thrower darts, and other hunting tools as well as a broad array of everyday items such as clothing, tools, fodder and sometimes even pack animals and sleds. Such transport sites are especially common in the Alps, although they also occur in Norway.

Accelerating retreat

Rising global temperatures are causing glaciers and ice patches to retreat at an accelerating rate. Even if greenhouse gas emissions ceased today, the slow response of mountain ice to warming means significant future ice loss is inevitable. In Norway, for example, 60 to 80 per cent of mountain ice is projected to disappear by the end of the century, even if greenhouse gas emissions are completely stopped now. Under current climate pledges, ice loss could reach 90 per cent. Only two regions – the Yukon and Innlandet County – have permanently funded rescue programs. Elsewhere, efforts are sporadic and limited by short-term funding, if any work is done at all.

Beyond artefacts, ice patches contain environmental records, including ancient DNA, volcanic dust, pollen and climate indicators. These fragile materials are far more vulnerable than bones or artefacts; they are lost forever when the ice around them melts. To meet this challenge, glaciologists have started collecting ice cores from mountain ice to meet this challenge.

Glacial archaeology is currently in an intensely active field phase. After this phase – perhaps as soon as the end of this century – this branch of archaeology is expected to shift from a fieldwork-focused discipline to one centred on a museum-based study of recovered artefacts. In the meantime, archaeologists, environmental scientists and local communities must work together to salvage as much of the emerging histories from the ice as possible before it is too late. ■

Traditions shaken by global warming

Scientists are not the only ones concerned by the melting of the glaciers. The cultural and spiritual life of indigenous mountain populations is also impacted.

Elizabeth Allison

Professor of Ecology and Religion at the California Institute of Integral Studies in San Francisco (United States), she leads their graduate programme in Ecology, Spirituality, and Religion. For more than 20 years, Dr Allison has studied spiritual ecology among indigenous communities affected by climate change.

"I remember my grandfather used to tell me 'Boy, these snowcapped peaks you see won't exist years from now.' I thought he was exaggerating and I didn't believe him… How did he know that the snowfall would stop existing, that someday it would end? Thinking about that still surprises me." Recalling a prophecy from his childhood, a young man from the indigenous Aymara population in Bolivia shared his memories in 2022 with Wilson Poma, an Aymara researcher, for the study entitled *Vanishing Ice, Vanishing Cultures?* carried out in the Milluni valley, near the Chacaltaya glacier.

This glacier, once the site of the world's highest lift-served ski resort, had vanished in 2009, six years ahead of scientists' predictions, leaving the former ski lodge marooned like a beached ship atop the craggy peak. It comes as no surprise that local indigenous people were alarmed. The global intergovernmental biodiversity monitoring group – known as IPBES – reported in 2019 that much of the world's remaining biological diversity is in lands owned, managed, or cared for by local, native, and indigenous peoples. For the continuation of indigenous cultures and lifeways, the preservation of the landscapes from which these cultures cannot be separated is imperative.

Tropical glaciers – a disappearing world?

Tropical glaciers are sentinels of climate change – and they are disappearing at an alarming rate. By 2050, these ice giants, which are found in 11 countries in Latin America, Africa and South-East Asia, will have lost around 90 per cent of the surface area they occupied before the 20th century. Many will have completely disappeared. This loss not only threatens local ecosystems, but also deprives indigenous peoples of an essential part of their spiritual belief and cultural heritage.

In a book published by UNESCO and IRD Éditions in 2025, entitled *The Voices of Glaciers: Stories of Grief and Hope Among Fading Glaciers in the Tropics*, the climate crisis is presented through the lens of personal life stories, like that of an ice harvester from the Ecuadorian Andes still carrying on a fast-disappearing tradition.

The book also highlights initiatives that aim to preserve glaciers and their memory. These include the opening of a new climbing route on Margherita Peak, the third highest mountain in Africa, now deprived of its glacier, and a new musical composition that gives emotional expression to the complexity of scientific knowledge.

Blending glaciology, anthropology and visual art, *The Voices of Glaciers* explores the emotions aroused by melting glaciers and the role they can play in mobilizing action. Can we touch hearts where figures fail? This book's response offers a glimmer of hope.

© Danielle Villasana

Pilgrimage to the sanctuary of the Lord of Qoyllur Rit'i in southeastern Peru.

"A Quechua prophecy asserts that a new epoch will begin when the Ausangate glacier disappears

The feeling of loss

Glacier decline has significant cultural and spiritual effects for high mountain communities, initiating transformations in the ways that local people understand themselves and make meaning in relation to their surroundings. Local communities express feelings of loss and culpability as their home landscapes are irrevocably altered. Traditional prophecies depict ultimate ruin in the event of the glaciers' disappearance.

In the high Andes of Peru, snowy mountains are turning brown as their glacier caps melt. The highest summit of the Cordillera Vilcanota range, Mount Ausangate, is worshipped as a powerful *Apu*, a god of the landscape overseeing the local plants and animals. The local Quechua people understand the mountain deity to be a manifestation of Pachamama or Mother Earth.

As the indigenous Quechua have observed the decline of the glacier on Ausangate, they have adjusted aspects of their annual pilgrimage ascent, known as *El Señor de Qoyllur Rit'i* (Lord of the Snow Star). Previously, ritual leaders who mediate between the mountain gods and the villages would cut large blocks of ice from the glacier to be carried down the mountain. This healing elixir of the *Apu* promoted vitality and agricultural fertility.

Concern for the receding glacier has prompted adaptations in the ritual, with →

guards preventing damage or removal of ice, and only small bottles of meltwater allowed as relics. Extending care and concern for the landscape and mountain deity that sustain their lives, villagers have decreased the size of the votive candles they light along the edge of the glacier to carry their prayers. Local prophecy asserts that a new epoch will begin when the glacier disappears.

Mountain deities

Mountaineering is banned in Bhutan to protect the abodes of deities believed to inhabit the glaciated high peaks of the eastern Himalayan Mountain range of Nepal and Bhutan. Morality and harmony with protector deities is connected with maintaining the environmental quality of the region.

Local custom and religion prohibited travel to the high reaches of the Nepal Himalayas prior to the arrival of European mountaineering expeditions in the early twentieth century. But the economics of mountaineering, through which locals could earn more in a few weeks than they would earn in an entire year of farming, incentivized locals to join the expeditions.

Members of the Sherpa ethnic community, many of whom live within Sagarmatha National Park – called Chomolungma in Sherpa and Tibetan, and known to the rest of the world as Mount Everest – are well adapted to the rigors of high elevation and have become excellent mountaineers. In advance of mountaineering expeditions in Nepal, appropriate prayers and offerings to the mountain deities are required to ensure safe passage.

> **“Mountaineering is banned in Bhutan to protect the abodes of deities believed to inhabit the glaciated high peaks**

© Kondoruk / Shutterstock

The Puja ceremony involves prayers and offerings in honour of the mountain deities on the Nepalese side of Mount Everest.

◥ *Khawa Karpo, a sacred mountain in the Meili Xue mountain range, in northwestern Yunnan, China.*

© FS11 / Shutterstock

> **“In local understanding, the community’s existence is intertwined with that of the sacred Mingyong glacier**

Warming temperatures have made mountaineering more difficult and dangerous, as ice softens and shifts, unleashing avalanches of rock and ice. Sherpas perceive mountain disasters, such as the 2014 Mount Everest tragedy that killed sixteen climbing Sherpas, to arise from disrespectful conquering attitudes of many mountaineers, as well as uncouth practices like fighting, littering the mountain with human waste and spent climbing gear, and buzzing it with helicopters.

The holy glacier

To avoid the dangerous displeasure of mountain deities, local people living near Mount Khawa Karpo, a sacred mountain in the Meili Snow Mountains of northwest Yunnan, China, prohibit foreign scientists from treading on the sacred Mingyong Glacier. They are only allowed to monitor it from afar through repeat photography. In the local understanding, it is impossible for the glacier to die because the community’s continued existence is intertwined with that of the glacier.

Glacier decline and extinction reveal cultures metabolizing loss, reckoning with culpability, and adapting practices and spiritual rituals. Indigenous, traditional, and local lifeways elevate values beyond the efficient, materialist, and economic. Mountain peoples extend an ethic of care to their biophysical surroundings, recognizing the necessity of reciprocal relations and responsibilities with a living landscape for maintaining well-being and livelihoods. The rest of the world would be wise to heed their example. ■

Ásgeir H. Ingólfsson

Journalist based in Akureyri (Iceland) and Prague (Czech Republic)

Iceland: see Vatnajökull and die?

Tourism in Iceland faces an uncertain future as the country's iconic glaciers melt. The Nordic island is striving to find the right balance between preservation and profit in an era of "last-chance tourism".

> **97 per cent of tourists said Icelandic nature was the main reason for their visit**

Tourist boats in the Jökulsárlón glacial lagoon in southeastern Iceland.

© Giacomo G / Shutterstock

During her guided tours on the glaciers, Icelandic tour guide Íris Ragnarsdóttir Pedersen sometimes feels a pang of sadness. "I am little by little losing my place of work and I don't know if the generations after me can continue doing this," she says.

She grew up surrounded by glaciers and has seen them retreat in only a few decades, stories she shares with her guests. "I've been doing this for a decade and when I started, it was more common for people to be skeptical about climate change. Now they are surprised to see how quickly it's happening."

If the current trend continues, all Icelandic glaciers will disappear in the next 200 years. And some of them are much closer to their expiration date, such as Snæfellsjökull, which served as the setting for Jules Verne's *Journey Into the Center of the Earth*. It probably only has some 25 years left.

This is a gloomy perspective for ecology, but also for the economy of the island. Iceland's glaciers may be melting, but tourism thrives on the country dotted with both glaciers and volcanoes. 97 per cent of tourists cited nature as the main reason for traveling there in a survey conducted in 2022 by the Icelandic Tourist Board.

In the last 15 years, the country has seen a massive tourism boom, partly due the successful PR campaign Inspired by Iceland launched in 2011, which helped increase the number of visitors from half a million to over two million per year.

Last-chance tourism

As controversial as it sounds, the melting of the glaciers might also motivate "last chance tourism" – a trend where travelers rush to visit places before they disappear, which may in some cases make them disappear faster.

Nonetheless, Edward H. Huijbens, a geographer specializing in tourism, believes the threat posed by last-chance tourism is negligible in Iceland because the glacier melt is primarily caused by rising temperatures. "However, this is generally long-haul tourism," he says. The long distances needed to reach the island →

The world's first artificial ice cave in Reykjavik's Perlan museum.

© Marco Zorzanello

Writer and ecologist Andri Snaer Magnason holds a plaque commemorating Okjökull, the first Icelandic glacier to disappear in 2014.

result in a larger carbon footprint. After that it doesn't really matter much if you see a glacier or just buy a hot dog.

But how do you strike a balance between economy and ecology? "We need to learn to appreciate things differently," he says, preaching the beauty of slow travel, "but under the current consumptive ethos it is to tick the Box, take the selfie and move on to the next wow thing to be 'done'. But do we really all need to see a glacier before we die?"

White gold rush

Regulations and infrastructure have struggled to keep up with the new Icelandic "white gold rush". A tragic demonstration of this occurred in August 2024, when an American man died and his partner was seriously injured after ice collapsed while he was on a group tour to a glacier ice cave in Breiðamerkurjökull.

Breiðamerkurjöll is part of the Vatnajökull National Park, named after the second largest glacier in Europe that covers 10 per cent of the country. When trips to the ice cave resumed, park manager Steinunn Hödd Harðardóttir questioned the responsibility of certain tour operators in a Facebook post. She also claimed that companies had been caught digging new ice caves and tunnels in the park under the pretense of improving accessibility.

> **"The carbon footprint of tourists visiting Iceland is high**

This accident served as a lesson, however. "The government has realized something needs to be done," Íris Ragnarsdóttir Pedersen says and adds: "Now the safety of all caves is evaluated on a weekly basis. If companies break the rules, they simply won't get a license to work within the national park anymore."

Edward H. Huijbens is more skeptical. "No, I cannot see much change there as well. I guess at the end of the day, a glacier is worth dying for."

Glacier cemetery

Five years ago, writer and environmental activist Andri Snær Magnason served as an undertaker during a memorial service – for a glacier. The idea was to raise awareness by creating a sense of mourning for the first Icelandic glacier to be declared dead. A memorial plaque has been set up. The headline is "A letter to the future," and the rest reads: "In the next 200 years all our glaciers are expected to follow the same path. This monument is to acknowledge that we know what is happening and what needs to be done. Only you will know if we did it."

To ensure that glaciers continue to exist elsewhere than on tombstones in the future, pedagogy can be a useful tool. Ecological awareness is gradually increasing among tour operators. "Most tour companies have an environmental policy," Íris Ragnarsdóttir Pedersen says and adds that "a large part of my job is to educate tourists about the glaciers and the impact of climate change on them. This is a prime opportunity to see that up front." ■

Interview by
Anuliina Savolainen

UNESCO

Zaria Forman: "I draw to portray the sublime beauty and vulnerability of polar ice"

American artist Zaria Forman has accompanied NASA, the United States' space agency, on missions documenting changes in Earth's polar ice. Her large scale pastel drawings complement scientists' observations by bringing to life the fragile beauty of icy landscapes.

In 2016 and 2017, you traveled alongside NASA scientists on several airborne missions. Did you observe any effects of climate change during these travels?

Flights were 12 hours on average, and we flew only 1,500 feet above glaciers, sea ice, and mountain ranges. For most of us, the polar ice sheets are just giant white spots on a map. (And indeed, they sometimes look like that from the air!) But the IceBridge scientists and engineers know that there's rapid change occurring beneath the surface – a complex interplay of freshwater rivers, valleys of bedrock, and warmer ocean waters eating away at glaciers from beneath.

The rate at which the whole of Antarctica is shedding ice has tripled over the past decade. These IceBridge missions are collecting critical information that can tell us how this ice loss is occurring.

Some of the drawings in this series were born from photographs taken from the window of NASA's flying laboratory. But other material came from cameras that are fixed to the belly of the plane, pointing downward.

My proximity to NASA scientists allowed me to ask endless questions about what we were seeing and how they were measuring it. This experience informed and elevated my own practice of observing ice, and in turn, my drawing technique evolved toward heightened precision and nuance.

Unlike a straight-on iceberg or glacier, the subjects of these drawings aren't widely recognizable. To bring people closer to the sublime beauty and vulnerability of polar ice, I needed to zoom in. There are so many stories and clues in the geometric patterns of cracked sheets, and in the texture of wind-blown snow. The range of blues, from inky to electric, are a visual language of time and pressure.

◥ Jakobshavn Glacier, Greenland, 69° 4'51.58N 49°28'24.41W, *a pastel drawing by Zaria Forman from 2018.*

Artist Zaria Forman reproduces in pastel the Jakobshavn Glacier on the west coast of Greenland.

What do you see that maybe scientists can't?

The sometimes dizzying perspective of the imagery from this series nods to the impossibility of grasping the size of these places. Even after logging 40,000 miles over 95 hours in the air, it's still difficult to comprehend the vastness of polar ice and the rate at which it is disappearing. Climate change, too, can feel like an overwhelming abstraction. While it is arguably the biggest challenge of our time, it's also one of the hardest stories to tell. The NASA drawings are a portrait of accelerated loss—and a clarion call for faster action against that loss.

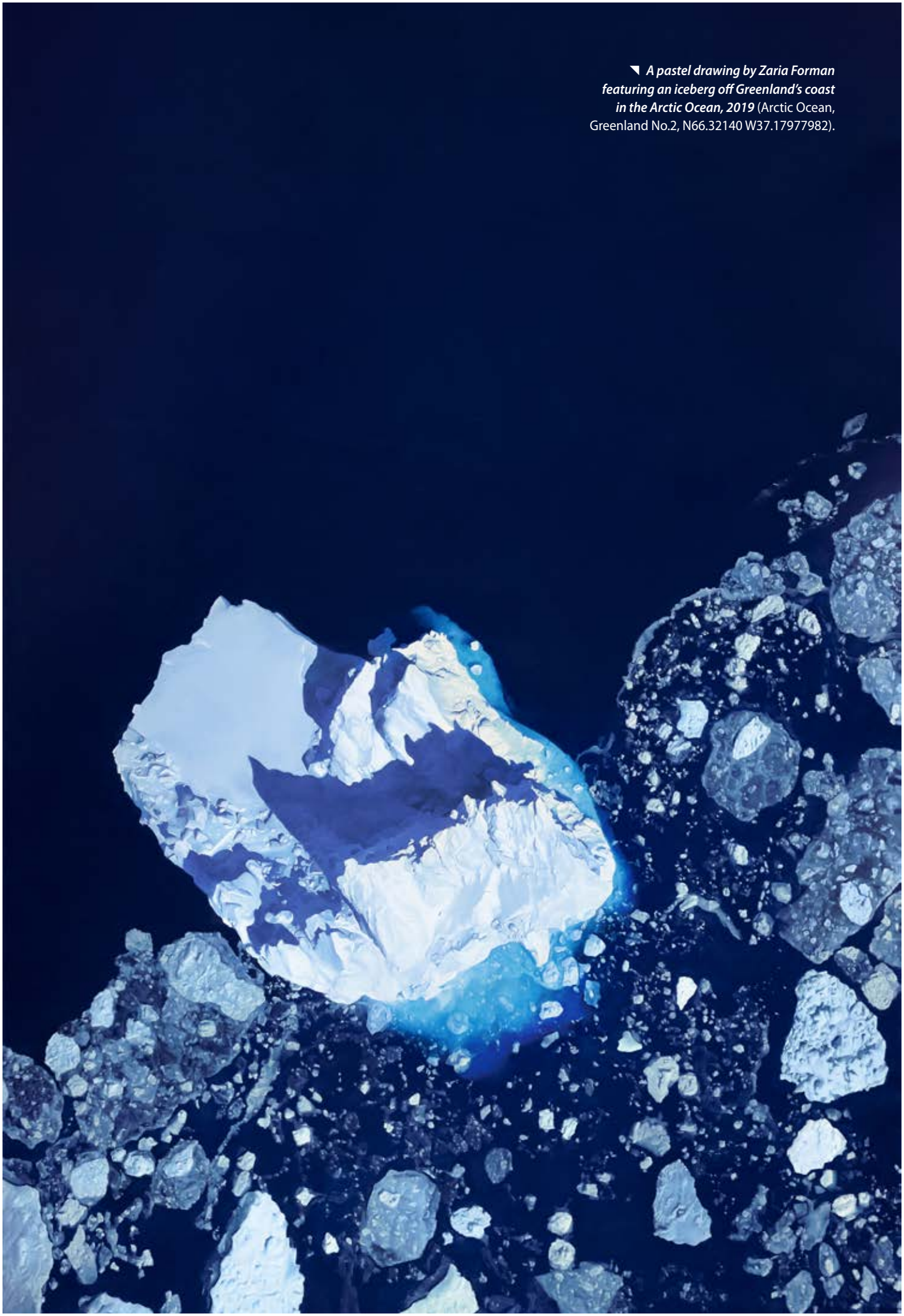
I rely on other specialists to make rational, data-driven arguments for why we must take action to preserve our ecosystems. But through my work, I'm trying to make the appeal on a more elemental level. Art has a special ability to tap into emotions – something scientific data cannot do. This is the very reason why NASA invited me to fly with them. Human beings take action and make decisions based on our emotions more than anything else – this has been scientifically proven.

> **"There are so many stories and clues in the geometric patterns of cracked sheets, and in the texture of wind-blown snow**

You have been drawing icy landscapes for almost two decades. What makes these places so attractive from an artist's point of view?

I actually grew up spending a lot of time outdoors in far-flung places, and those experiences instilled in me a love of landscape. My mother, Rena Bass Forman, was a fine art landscape photographer. She traveled a lot. My family and I were fortunate to join and support her on those adventures, from riding camels through Northern Africa to mushing near the North Pole. My motivation as an artist has always been to evoke an emotional connectedness to these dramatic and fragile places and to forge a sense of stewardship. When you love something, you want to protect it! I want to bring people closer to the sublime beauty and vulnerability of polar ice. My hope is that my drawings spark curiosity, inviting people to drop into these environments and spend time exploring their intricacies.

My work has focussed on conveying the urgency of climate change. Most people can't access many of these remote and extreme places that I draw, so in some ways the environmental issues there may seem remote, disconnected from their lives. That's why I work on such a large scale, to recreate the wonder of witnessing an iceberg up close. If you can fall in love with these places as I have, perhaps you will be inspired to protect and preserve them. ■



◥ ***A pastel drawing by Zaria Forman featuring an iceberg off Greenland's coast in the Arctic Ocean, 2019*** (Arctic Ocean, Greenland No.2, N66.32140 W37.17977982).

Jesse Marlow – the unexpected is just around the corner

Photos:
Jesse Marlow

Text:
Laetitia Kaci,
UNESCO

Anything Can Happen and Probably Will – it would be hard to find a better title for Australian photographer Jesse Marlow's series of images gleaned from his wanderings around Melbourne and Sydney. Indeed, each image is the beginning of a story, a sketch to be continued from the viewer's imagination. A distracted passer-by, a few leaves stranded on the pavement, a silhouette bent over by the wind – all turn the city into a short-lived stage-set, where the incongruous vies with the poetic for a place.

Originally destined for a career as a graphic designer, Jesse Marlow takes his inspiration from geometric shapes and architecture, developing a style marked by bold compositions, occasionally flirting with abstraction. Inspired by the New York street art of the 1980s, he plays brilliantly with colours, transforming ordinary scenes into stills from the cinema.

The Australian photographer has established himself as a major figure in street photography, winning several awards for his singular vision. In 2011, he won the International Street Photographer of the Year award at the London Street Photography Festival. In 2012, he received the Bowness Photography Prize, one of Australia's most prestigious awards, for Laser Vision, a chromogenic print from his series *Don't Just Tell Them, Show Them*.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Jane Goodall watches young Gaia and her mother Gremlin in Gombe National Park, Tanzania.

Jane Goodall: "We've sent a rocket up to Mars, yet we're not intelligent"

Globally renowned British ethologist and anthropologist, Dr Jane Goodall is known for her pioneering research into the relationship between humans and animals, chimpanzees in particular. The influential environmental activist spoke at UNESCO Headquarters in Paris on 19 October 2024. Below are excerpts from her speech, in which she talks about her long fight to preserve wild animal life while conveying a message of peace and hope.

I went to a conference in the middle of the 1980s. We had a session on conservation, and it was shocking. I learned that right across Africa, wherever chimps were being studied, forests were being destroyed. They were losing their habitats, and their numbers were decreasing. So, I went to that conference as a scientist and left as an activist.

…

I visited the study sites around Africa to learn more about the plight of the chimpanzees. Of course, there was the commercial hunting of wild animals for food. Hunters were setting snares to catch antelopes, bush pigs, and so on. A chimpanzee can get caught in the wire snare, and although they can break the wire, they can't get the snare off. They will either lose a hand or a foot or die of gangrene.

In addition to habitat loss, mothers are shot so that babies can be stolen and trafficked around the world to be sold as pets or for some kind of entertainment, like circuses. As people move further and further into the forest, they take with them human diseases. Chimpanzees share 98.7 per cent of our DNA, so they are able to catch our diseases, and this can have a devastating effect on a chimpanzee community.

Save the forest

But at the same time as I was learning all this about the chimps, I was learning about the plight of some of the African people living in and around chimp habitats.… It came to a head when I flew over the tiny Gombe National Park in the mid-1980s. In 1960, when I began, it was part of the equatorial forest belt that stretched from western East Africa right across to the West African coast. But now, to my horror, I looked over a little island of forest that was the national park, and all around, the trees were gone. The hills were bare. There were more people living there than the land could support.

Why were they cutting down the trees? Because they were struggling to survive, they had to try and get some money from charcoal and timber, or to clear land to grow more food to feed their families. It hit me then, as I flew over that little Gombe: if we can't find ways of helping these people make a living without destroying their environment, we can't save chimpanzees, the forest or anything else.

Animal intelligence

Today, we're leaving a flawed world for our children. This is where I come to the biggest difference between humans and other animals. We know today that animals are way more intelligent than we used to think – and not just the great apes. We now know that pigs are very intelligent. Birds are very intelligent, particularly crows and parrots. I know a parrot who knows 1,500 words, and a word is only counted in his vocabulary if he has said it twice, unprompted, in the right context.

…

An experiment was conducted in China in which three goldfish were placed on one side of the tank and three on the other side, and they learned to play football! Bumblebees can be taught to drop a little marble into a hole, and then they get a nectar reward. Other →

bumblebees who have not been trained can do the same just by watching the trained bumblebees. And we know the amazing intelligence of the octopus. So yes, animals are very intelligent.

> **If we were intelligent, we wouldn't be destroying our planet, our only home**

© The Jane Goodall Institute / Chase Pickering

Jane Goodall scans the treetops looking for chimpanzees in Gombe National Park in 2010, 50 years after her arrival at Gombe.

But think about what we humans have done. We've sent a rocket up to Mars with a little camera; we now know what the surface of Mars looks like. We've got the Internet. These are feats that no animal, however intelligent, could do. But we're not intelligent, are we? If we were intelligent – Homo sapiens, the wise creature – we wouldn't be destroying our planet, our only home. What have we done to it? Think of the problems that we've created, we've got global warming, we've got loss of species, loss of biodiversity around the world. We've got pollution of air, water, and land!

A sparkle of hope

We've got industrial agriculture poisoning the soil with chemical pesticides, herbicides, and fungicides. We're polluting the water of the ocean with runoff from agriculture, from industry, and from household waste. We've got the terrible problem of plastic. All of us have plastic in our bodies – plastic is everywhere.

We've got the problem of poverty because, living in poverty, people may destroy the environment to survive, as it happened around Gombe. And on the other hand, we've got to do something to curtail unsustainable lifestyles. Some people have so much more than they need, and I feel this very much from growing up in World War II when everything was rationed, when you didn't take any mouthful for granted.

...

People are asking me, "Jane, do you really have hope?" I know the problems that the world faces, but I do have hope.

I see human beings standing at the mouth of a very long, very dark tunnel, and right at the end, there's a little star, and that's hope. But it's no good sitting at the mouth of the tunnel and waiting for that star to come. No! We have to roll up our sleeves; we have to climb over, crawl around, and crawl under all the problems that lie between us and the star.

The good news is that there are groups of people tackling these problems. But they are so often working in their own narrow little tunnel, in their own silo. They may solve one problem, but solving one problem may lead to another.... If we'd thought holistically in the beginning, we'd work together. And that's the answer for the future: no organization can do it alone. We need more collaboration; we need more partnerships; we need to collaborate to make the world a better place.

The resilience of nature

My reasons for hope: first of all, the young people. Around the world they're making a huge difference. Secondly, there's the resilience of nature. If we give nature a chance, it will come back and again make beautiful places in areas we've totally destroyed.

If you fly over Gombe today, there are no more bare hills. The trees have come back, and with them, various animals, birds, insects, and so on. Animals on the very brink of extinction can be given another chance.

Then there's the human intellect. We are beginning to come to our senses and try to find ways of living in greater harmony with nature. Science is coming up with renewable energy and so on, and we are beginning to think about our own environmental footprints every day....

And there's what I call the indomitable human spirit—the people who tackle what seems impossible and won't give up, and so often succeed.

> **My reasons for hope: first of all, the young people**

One of the worst things that we're facing today is war.... But there is hope for people living in war. In Roots & Shoots[1], we try to bring young people together from different parts of the world. As they get together, differences between nations fade away.... It's the fact that we're all human beings. We all laugh, we all cry, we all have love. What I hope the young people are helping us to do, is to fight the fact that we can all hate.

So those are my reasons for hope. ■

1. Jane Goodall Institute's global youth programme

Inza Koné

Primatologist, Director General of the Swiss Centre for Scientific Research in Côte d'Ivoire (CSRS)

Primates, indispensable inhabitants of the African forest

Sanctuaries of biodiversity, the African forests are home to the greatest diversity of primates in the world. But these intelligent, social creatures are under serious threat from deforestation and poaching. Therefore, we must step up conservation efforts to protect these natural treasures – forests and their emblematic inhabitants.

Inza Koné and his colleagues set camera traps to monitor animals living in the canopy of the Marais Tanoé-Ehy forest, in Côte d'Ivoire.

Inza Koné (on the right) close to the nursery for local trees. Saplings are distributed to farmers to reduce deforestation.

African forests, the green lungs of our planet, cover millions of hectares. They harbour a multitude of plant and animal species that represent a quarter of the world's biodiversity. Africa is home to no fewer than nine of the world's thirty-six biodiversity hotspots and three mega-biodiversity countries: the Democratic Republic of Congo, South Africa and Madagascar. These forests play a crucial role in maintaining the world's climatic and ecological balance.

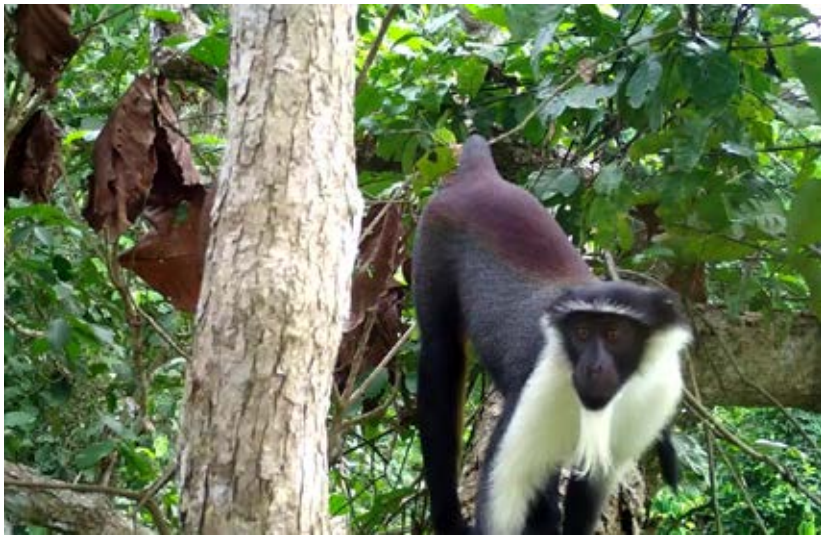
Among the most emblematic inhabitants of these forests are non-human primates. Africa has the greatest diversity of primates, with 43 per cent of the world's 701 species. Five of the twelve countries with the highest number of primate species are in Africa: Madagascar, the Democratic Republic of Congo, Tanzania, Cameroon and Nigeria.

The inextricable link between these animals and the fate of the forests often goes unnoticed. By dispersing seeds they play a key role in the regeneration and diversity of forests. In addition, their proximity to humans, the place they hold in many African cultures, and their appeal to tourists make them important species from a scientific, cultural and economic perspective.

Deforestation and poaching

But deforestation, caused by commercial logging, urbanization, infrastructure expansion, and the development of extractive industries, is increasingly reducing their natural habitats. According to the United Nations Food and Agriculture Organization (FAO), Africa lost around 3.9 million hectares of forest per year between 2010 and 2015. Wildlife is also threatened by poaching. Elephants and rhinoceros, coveted for their ivory and horns, are particularly at risk.

Non-human primates are also under serious threat, with 62 per cent of the world's species endangered. The situation in Côte d'Ivoire is a good illustration of this crisis. The West African country is home to 22 species of non-human primates, 55 per cent of which are threatened with extinction due to the rapid loss of their habitat and illegal hunting. It has lost 67 per cent of its forest cover since the 1960s, making it the country with one of the highest rates of deforestation in the world. In addition, 90 per cent of its



@RASAPCI/CSRS

A Roloway monkey in the Marais Tanoé-Ehy forest in Côte d'Ivoire. This primate species is critically endangered.

chimpanzee population has disappeared in the last 30 years and several other primate species have been exterminated from most of the forests they historically inhabited.

Some species are already critically endangered. This is the case of the red-capped mangabey, the Roloway monkey, Geoffroy's black and white colobus and Miss Waldron's red colobus, which has not been seen in the wild since 1978. The Marais Tanoé-Ehy forest in south-east Côte d'Ivoire is one of the last refuges for these species. In 2000, a Miss Waldron's red colobus was shot by a hunter in this forest, and the calls of these monkeys were heard there by a research team in 2008. Since 2019, scientists have made an increased effort to locate them.

Wildlife inventories

In this context, the scientific study of primates is more crucial than ever for preserving tropical ecosystems. By studying their behaviors, social interactions, and ecological adaptations, we can retrace evolutionary paths and understand how biodiversity has evolved.

Non-human primates play a central role in maintaining the structure and function of tropical forests. A better understanding of their behaviour and ecological needs means these habitats can be better protected. A study carried out in the Taï National Park in Côte d'Ivoire showed that the West African red colobus is particularly noisy and uses the lower strata of vegetation during the rainy season, a period when poaching intensifies. The observation has led to a recommendation to increase surveillance patrols during this period.

Wildlife inventories also help identify the actions needed to preserve primate species. Ethno-zoological studies published in 2008 document the issues involved in their conservation and highlight the cultural dimension of their cohabitation with humans. By analyzing the genetic diversity of primate populations, it is possible to assess their resilience in the face of environmental disturbances. This information is essential for identifying the most vulnerable populations and directing conservation efforts towards priority areas.

Difficult terrain

But carrying out primate conservation work in the field is very challenging. One of the main obstacles is access to research sites. Getting around tropical forests can be complicated due to their dense vegetation and remoteness. Researchers have to navigate through difficult terrain, crossing rivers and swamps. Transporting equipment and ensuring the safety of the teams requires rigorous preparation.

Researchers face a range of risks, including confrontation with potentially dangerous wild animals such as poisonous snakes. In addition, local conflicts, whether due to land disputes or poaching, can complicate their work.

Communities living near research sites often have in-depth knowledge of the local environment and species. Their involvement is crucial to the effective implementation of conservation strategies. An example of this approach is the community conservation project in the Tanoé-Ehy Swamp Forest in Côte d'Ivoire. It aims to protect the habitat of threatened non-human primates while integrating the needs and knowledge of local communities.

Community involvement

Participatory conservation strategies include training local people to monitor wildlife, raising awareness of the importance of biodiversity and developing sustainable, alternative economic activities. By strengthening the link between conservation and community well-being, these initiatives contribute to an environment that supports habitat protection. The results are encouraging: local populations have become active partners in reducing deforestation and poaching. In return, they benefit from sustainable development programmes that improve their quality of life.

> **“Non-human primates play a central role in maintaining tropical forests**

The community conservation project in the Tanoé-Ehy Marsh Forest in Côte d'Ivoire, and many other projects of this kind, demonstrate the effectiveness of community involvement in protecting habitats and improving local living conditions. These research and conservation efforts must be continued to preserve the unique biodiversity of African forests. Everyone can support these initiatives at their own level, whether through public policy, funding or raising awareness, to ensure a sustainable future for these vital ecosystems and the communities that depend on them. ■

Interview by **Lucía Iglesias Kuntz**
UNESCO

Selva Almada: "My writing is influenced by what I hear, what I see in the street, but also by memories and reading"

In a country where the literary scene is concentrated in the capital, writer Selva Almada claims to belong to the "interior" of Argentina, the province where she grew up. A finalist for the prestigious Booker Prize in 2024, she is one of the most powerful voices in Argentine literature, translated into many languages. She is also one of the region's most influential feminist intellectuals.

You often call yourself a provincial author. Why is this important to you?

In the early 2000s, I had a blog called 'A provincial girl'. It was also the title I gave to one of my first books, a collection of autobiographical stories. I was 30, I had just arrived in Buenos Aires, and in it I recounted the life of a provincial girl who has moved to the capital. Today, many years later, I still feel a very strong sense of belonging to what we call the 'interior' here in Argentina, and I define myself as a provincial writer, attached not only to the province where I grew up, Entre Ríos, on the border with Uruguay, but to the whole territory. In my work, both as a writer and in the projects I'm involved in, I try to refute the idea that literature in Argentina doesn't exist outside the capital.

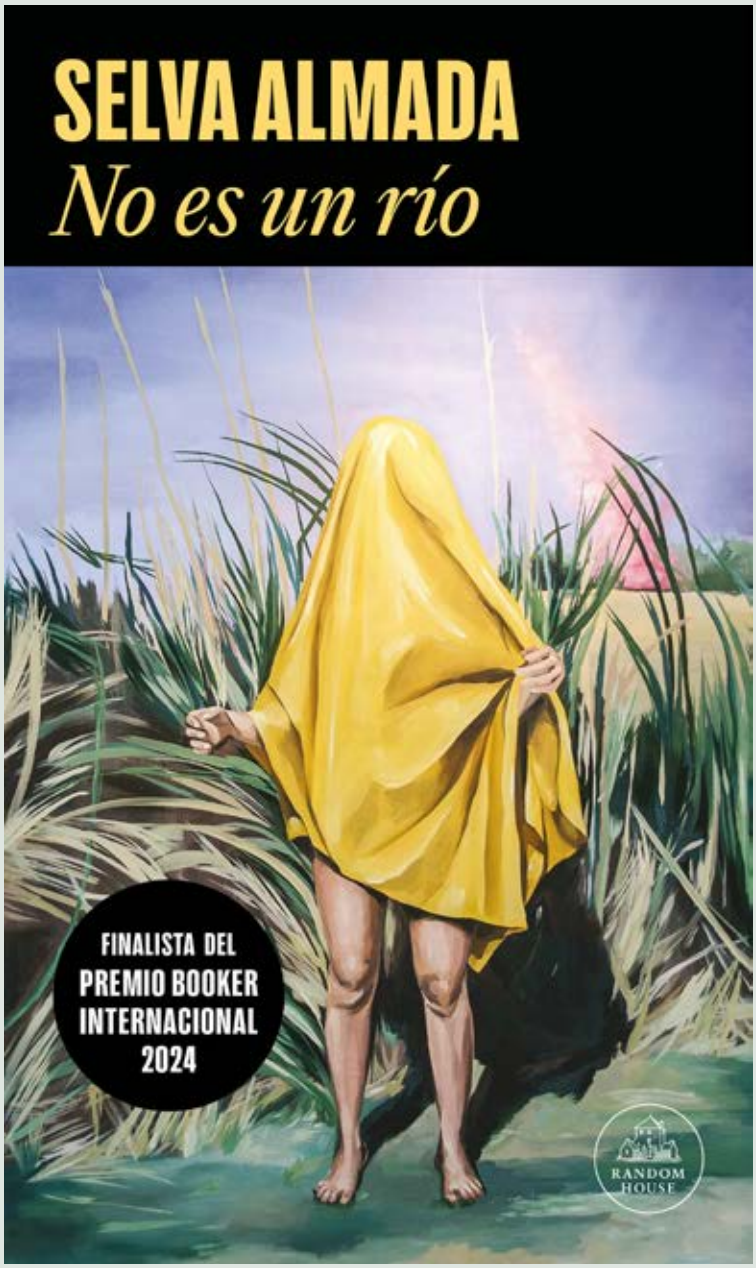
This desire to showcase literature produced throughout the country is also reflected in the choice of authors available in the bookshop you own in Buenos Aires.

Yes, I've called it 'Salvaje Federal' [Federal Savage]. It's an online bookshop, but we also have a physical space in the Almagro district of Buenos Aires. We inaugurated it at the end of 2020, during the COVID-19 pandemic, which is why it existed online first. It features works that don't usually circulate outside the provinces where they're published. The project gradually gained momentum, and two years ago we organized our first festival in the city of Rosario, some 300 kilometers north of Buenos Aires, and we plan to launch one in Neuquén, in Patagonia. The idea consists of a travelling festival that would take place every year or two in a different region of Argentina. We're also working on a number of projects, including an artists' residency, always with a view to showcasing Argentine literature from all over the country.

What are your sources of inspiration, the themes that are closest to your heart?

I don't like to talk about 'themes' in literature. We don't write about themes, but starting from little scenes, situations, atmospheres or characters that we find suggestive, at least as far as I'm concerned. These triggers can emerge from what someone tells me, what I hear, what I see in the street that catches my attention, but also from memories or something I read. Certain subjects recur in the plots of my stories and novels: broken or decaying family relationships, sexist culture, underground violence, the world of physical labour, alcoholism, religion and a set of beliefs specific to the region of Argentina where I grew up.

> **"I'm not one of those writers who can write anywhere. I need to feel peaceful at home**



Cover drawing: © Ornella Pocetti

◥ *Cover of the book* Not a River *by Selva Almada, illustrated by Argentinian artist Ornella Pocetti. Argentinian edition published by Literatura Random House.*

In 2024, you were a finalist for the very prestigious Booker Prize for your latest novel* No es un río *[Not a River]. What is it about? Are literary awards important to you?

The plot of *No es un río* is quite simple: two friends take their deceased friend's teenage son fishing and catch a giant manta ray for sport, only to throw the dead creature back into the water. This leads to a series of conflicts with the locals, who have an almost sacred relationship with their environment. This is a novel in which the world of the living and the world of the dead intertwine and merge, and where unsettled accounts between the living and the ghosts resurface. Being nominated for the Booker Prize was very important for me; it's a very prestigious international prize that opens doors for nominated books, particularly for translation.

You've taken part in literary workshops. Did they play a role in your writing process?

I actually started writing on my own, but with a group of friends who also wrote, and we would get together to read, correct and critique each other… It was a sort of spontaneous workshop. Then, in 1999, when I moved to Buenos Aires, I started attending the workshops of the novelist and poet Alberto Laiseca, and I took part in them for seventeen years, until his death in 2016. They brought me a lot: Laiseca helped me find my voice, he was my guide in writing. Besides what I learned in his workshops, he was for me a teacher in the full sense of the word.

You've run workshops yourself.

For ten years, workshops were part of my daily activities. This is no longer true, except very sporadically. In fact, the figure of Alberto Laiseca was so important to me

that I never felt like a teacher, but rather a workshop coordinator. I was there to accompany, to share with others the problems the writing process can pose, its discoveries… From my point of view, it's obviously not necessary to attend workshops to be a writer, but they are useful spaces for raising the questions we always ask ourselves about our own writing.

You declare yourself a feminist. What does that mean in Argentina today?

True, I do feel feminist. Today, as in the past, being a feminist in our Latin American countries, which are so steeped in a sexist culture, still means having to fight, take to the streets and constantly demand our rights. We have to be permanently on alert, always ready to take to the streets to demand something and claim a right we haven't yet obtained.

Your childhood was spent under the military dictatorship. What role does this chapter in Argentina's history play in your life and work?

Yes, I was born in 1973 so I was three years old when the dictatorship was established. I grew up in a small town where people didn't talk much, and where school was under military control, as in the rest of the country. It was something under the surface: we knew that things were happening, that there was a darkness, but I was small and in my family, the subject didn't come up. When democracy returned, news suddenly flooded into my life: democracy with the first president, Raúl Alfonsín, the trial of the members of the Military Junta, the *Nunca más* [Never Again] report documenting the repression that plagued the country during the dictatorship… In fact, this isn't represented very much in my books. My work explores a later historical period, the 1990s. Many Argentinian authors have chosen to focus on the dark years of the dictatorship in their fiction, but I haven't.

When and where do you write?

Mostly at home. I have an office in a room with a large window overlooking a garden. It's the part of the house that gets the most natural light, which is why I chose it. To tell the truth, I'm rather a creature of habit. I'm not one of those writers who can write anywhere, in any medium, in any café… I need to feel peaceful at home.

Cover drawing: © Ornella Pocetti

◥ *Cover of the book* Ladrilleros *(English edition:* Brickmakers*) by Selva Almada, illustrated by Argentinian artist Ornella Pocetti. Argentinian edition published by Literatura Random House.*

"In my work, I try to refute the idea that literature in Argentina doesn't exist outside the capital

You often say you don't like to travel. Why?

My work involves a lot of travel, but I don't really have a taste for it. I'll never get used to it. I have to, as part of my job as a writer, mostly to support the distribution and promotion of my books, but if I had the choice, I'd be happy not to.

Are you concerned about the invasion of artificial intelligence in literary creation?

It's an issue that doesn't interest me much. To be honest, I've never felt inclined to learn more about the subject. Certainly, artificial intelligence can write a novel, but I don't think it could ever surpass the writing of a human being, even of a bad writer. No computer programme, no machine, will ever be able to rival what is uniquely ours: humanity.

You've been involved in writing film scripts. Since you're used to working alone, how do you adapt to this more collective undertaking?

I worked with Argentine director Maximiliano Schonfeld on the screenplay for the film *Jesús López*, released in 2021, but I had no part in the filming. We found a way of working together: I would write the most narrative parts, which he would then adapt to the screenplay format, and then we would spend a long time working together on the dialogue. I have fond memories of the experience, but I feel I'm primarily a writer of stories and novels.

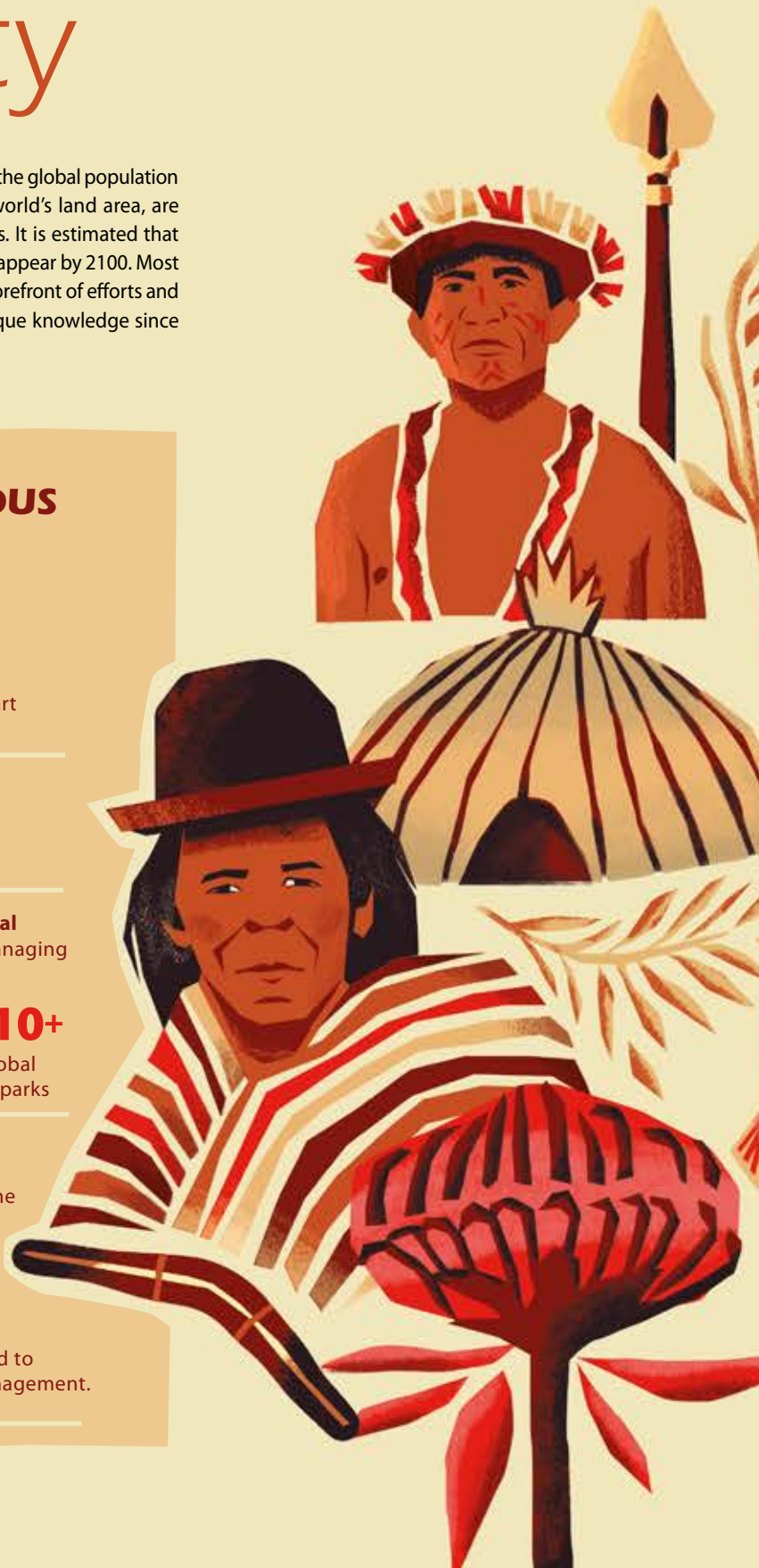
Are you in contact with other Argentine or Latin American writers of your generation?

Yes, I am, fortunately! Especially with women writers, in fact: we read each other's work, we meet at festivals and fairs, and we're very close friends. Gabriela Cabezón Cámara, here in Argentina, but I'm also very fond of Fernanda Melchor from Mexico, and Liliana Colanzi, whom I met at a fair in Bolivia, Alejandra Costamagna and Nona Fernández in Chile… All are writer friends whose work I appreciate. ■

Chen Xiaorong
UNESCO

Indigenous cultures: At the heart of diversity

Indigenous peoples, who make up just about 5 per cent of the global population yet own, occupy and use more than a quarter of the world's land area, are essential for cultural diversity but face increasing threats. It is estimated that half of the world's approximately 7,000 languages will disappear by 2100. Most of these are Indigenous languages. UNESCO has been at the forefront of efforts and initiatives to protect Indigenous communities and their unique knowledge since the last century.



THE POWER OF INDIGENOUS PEOPLES IN FIGURES

Over 370 million
Indigenous people, with unique traditions and characteristics, represent the greater part of the world's cultural diversity.

70+ countries
are home to Indigenous communities.

UNESCO puts Indigenous peoples and local communities at the heart of identifying, managing and safeguarding:

750+	1,220+	210+
Biosphere Reserves	World Heritage Sites	Global Geoparks

183 states
have ratified the UNESCO Convention on the Intangible Cultural Heritage of Humanity, respecting all forms of living heritage.

196 States Parties
to the World Heritage Convention are urged to consider Indigenous aspirations in site management.

PRESERVATION MILESTONES

1948

Universal Declaration of Human Rights – Underlines that all people are free and equal in dignity and rights.

1971

Launch of the Man and the Biosphere (MAB) Programme by UNESCO – Seeks to improve the balance between people and the planet, including by promoting Indigenous knowledge.

1995

The first International Decade of the World's Indigenous People (1995-2004) begins.

2002

Creation of LINKS programme – UNESCO launches Local and Indigenous Knowledge Systems (LINKS) to bridge Indigenous and scientific knowledge, **which has been active for over 20 years.**

2007

UN Declaration on the Rights of Indigenous Peoples – Formally acknowledges Indigenous rights to culture, land, and identity.

2022

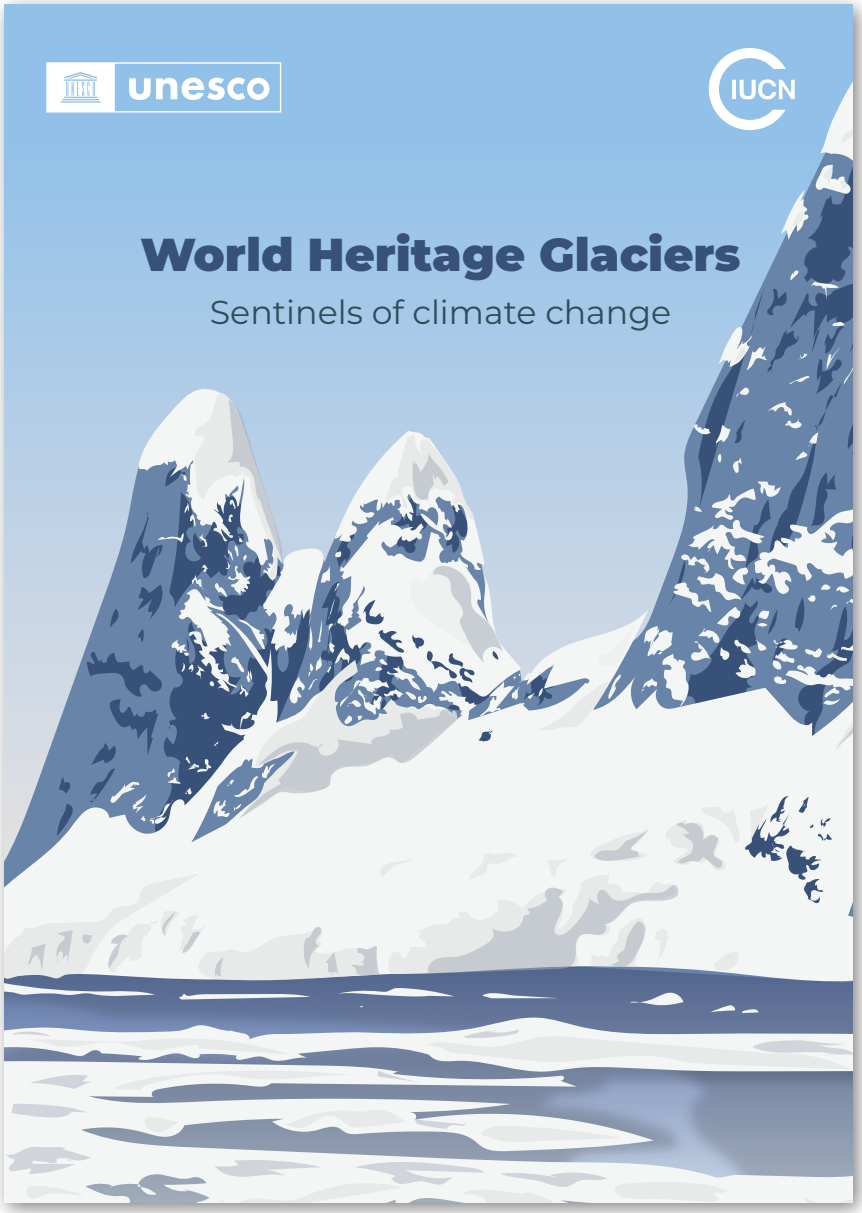
International Decade of Indigenous Languages (2022-2032) – A global initiative to revitalize Indigenous languages.

AN EXAMPLE FROM PERU

Kusi Kawsay School, located in the Peruvian Andes, is an alternative school with 100 students. Its unique curriculum incorporates ancestral Andean knowledge: Indigenous music, dance, weaving, art and gatherings. The school was awarded the UNESCO-Japan Prize for Education for Sustainable Development in 2021 for its commitment to human dignity, community-based approaches, and its action to respond to global challenges.

Source: *Languages, cultures, knowledge: UNESCO's action for Indigenous Peoples*, UNESCO, 2024

World Heritage Glaciers
Sentinels of climate change



Glaciers are crucial sources of life on Earth as they provide vital water resources to half of humanity for domestic use, agriculture and hydropower. They are some of the most valuable indicators for understanding climate change.

Projections indicate that glaciers in one-third of World Heritage glacierized sites will disappear by 2050 regardless of the applied climate scenario. By combining satellite data and projections at the site level, this study quantifies the extent of World Heritage glaciers' retreat and its impact on global sea-level rise.

Read the publication

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