

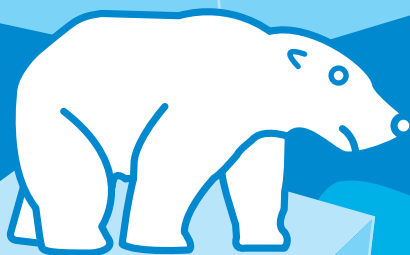
Melt down

Get COOL in
2007!

Polar plight



Mari Boine –
singing nature



Warming
ice



Ice explorers



Tara – riding high

TUNZA

the UNEP Magazine
for Youth. To view current
and past issues of this
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Partners for Youth and the Environment



UNEP and Bayer, the German-based international enterprise involved in health care, crop science and materials science, are working together to strengthen young people's environmental awareness and engage children and youth in environmental issues worldwide.

A partnership agreement lays down a basis for UNEP and Bayer, who have collaborated on projects in the Asia and Pacific region for nearly 10 years, to step up current projects, transfer

successful initiatives to other countries and develop new youth programmes. Projects include: TUNZA Magazine, the International Children's Painting Competition on the Environment, the Bayer Young Environmental Envoy in Partnership with UNEP, the UNEP Tunza International Youth/Children's Conference, youth environmental networks in Asia Pacific, Africa and Latin America, the Asia-Pacific Eco-Minds forum and a photo competition, 'Ecology in Focus', in Eastern Europe.



CONGRATULATIONS to Charlie Sullivan (11) of the United Kingdom, global winner of the 16th annual International Children's Painting Competition on the Environment (www.unep.org/tunza/paintcomp/), themed on climate change. The joint second prize went to Catherine Nishchuk of the Russian Federation (see image on page 15) and Petkova Polina Zdravkova of Bulgaria.

World Environment Day Cool & Cooler

IDEA 1: Empower people to become active agents of sustainable and equitable development.

Cool: Plant a community organic garden at school or in the neighbourhood.

Cooler: Start a group that meets regularly to prepare a special meal with the garden's harvest.

Coollest: Read Barbara Kingsolver's new book, *Animal, Vegetable, Miracle: A Year of Food Life*, and be inspired to eat only home-grown and local produce.

IDEA 2: Promote an understanding that communities are pivotal to changing attitudes towards environmental issues.

Cool: Go for a long walk or bike ride in a local nature area with family and friends.

Cooler: Organize a carbon-free parade, with people using their favourite mode of green transport, eg: walking, jogging, skateboarding, roller-skating, cycling and unicycling, even pushing baby buggies!

IDEA 3: Advocate partnership, which will ensure all nations and people enjoy a safer and more prosperous future.

Cool: Ask your teachers to help set up green pen-pals with a school in a different country, and share ideas on helping the environment.

Cooler: Find an environmental programme in another country that you'd like to support. Organize a local photo exhibition, talent show, concert or play to raise money to help support this cause and spread the word about it.

EDITORIAL

Not long ago, the polar ice caps and the world's mountain tops were thought to be pristine, among the few parts of the planet to have remained unsullied by humanity and pollution. Now we know they are feeling the heat more than anywhere else on the globe. For global warming is having its most dramatic and ominous effects at high altitude and high latitude, with enormous consequences for the rest of the planet. Like the canaries that miners used to take underground, they are providing an early warning of grave dangers to come.

Temperatures are rising faster in these cold corners of the Earth than over the planet as a whole, and the effects are already all too visible. The very atlases are having to be redrawn as great ice shelves collapse on the Antarctic Peninsula, forever changing the shape of its coastline. Arctic sea ice is shrinking much more than ever in recorded history, and may disappear altogether by the middle of the century. Glaciers are retreating at both poles, suggesting that both the Greenland and West Antarctic ice sheets may eventually melt, causing sea levels to rise to cover most coastal cities. And they are also rapidly thawing in mountains across the world, from New Zealand to Alaska, the Himalayas to the Andes, the Alps to Africa's Mountains of the Moon: their disappearance would devastate water supplies worldwide.

So melting ice is a hot topic, one of the hottest there could be. It is also one of the most urgent challenges we face. It demands immediate changes in government policies, in industrial practices – and in all our lifestyles. We must rapidly reduce our emissions of carbon dioxide and other greenhouse gases by reducing our use of polluting fossil fuels and by preserving forests and other key ecosystems. Otherwise we will be the first generation since the start of humanity to witness the vanishing of the Earth's ice and snows. And, like the canaries in the mines, their extinction will presage deadly peril for us all.





HEAT

It may sound like the least likely sales success story in history, but the Inuit are rushing to buy air conditioning as the world warms up. And no wonder. A year ago a heatwave sent temperatures soaring into the low 30s Celsius in parts of the Canadian Arctic, following a winter which saw people basking in February temperatures of 9°C on the Arctic Circle rather than the normal -30°C. Their buildings, designed to be airtight against the cold, are turning into heat traps.

And yet this is perhaps one of the least dramatic of all the changes facing the people of the far north. They are losing their hunting culture as their prey – like polar bears, walruses and seals – flee the warmer temperatures, and as the ice gets too thin for them to travel safely over it. Houses and other buildings are crumbling as the frozen earth beneath them melts: plans are underway to relocate whole villages.

The Inuit are at the sharp end of one of the most ominous changes ever to afflict the planet – the increasing

disappearance of its ice. Arctic sea ice has been rapidly retreating, glaciers are thawing all over the world, and scientists are even beginning to fear that the great Greenland and West Antarctic ice caps are beginning to melt irreversibly – a process that could eventually raise sea levels by 12 metres, inundating vast areas of land and submerging most of the world's great coastal cities.

Sea ice in the Inuit's Arctic is now melting 40 times faster than just two decades ago, and the process seems to be accelerating. Last September it reached its second lowest extent ever – only behind 2005 – and scientists believe it would have set a new record had it not been for an abnormally cool August. And as white ice is replaced by dark ocean, less of the sun's radiation is reflected, and more of its heat is absorbed, causing the region to warm and thaw still more. Some experts predict that the ice will disappear altogether in summer in little more than 40 years; others fear that the massive addition of freshwater to

the North Atlantic may disrupt the Gulf Stream, which makes northwest Europe hospitable to human habitation in winter.

Greenland's glaciers are greatly accelerating their once-slow progress towards the sea as temperatures rise, partly because the melting ice allows pools of water to form on their surface, which then flows down through crevasses to the rock beneath. Once there it forms a liquid layer between the rock and the bottom of the glacier, allowing it to move as if on a conveyor belt.

Much the same is happening at the other end of the Earth, in Antarctica, where the movement of glaciers is being speeded up by similar layers of water: a study of 244 of them found 87 per cent to be retreating. And vast ice shelves have disintegrated, literally changing the face of the maps in a development unprecedented in at least 10,000 years.

Glaciers are melting almost everywhere in the rest of the world, as the map on

TRAP



Fred Bruemmer/Still Pictures

pages 12-13 shows. As they disappear, vital water supplies will be put in danger for perhaps a billion people, from the Chinese and Indian plains, to South America's dry Pacific coast, to the North American West. And as they melt, glacial lakes form high in the mountains, threatening to cause 'tsunamis from the sky' if they burst their banks. When this happened to a lake in the Andes in 1970, some 60,000 people are thought to have lost their lives in what was, perhaps, the first great disaster caused by global warming.

Even more worrying, vast amounts of carbon dioxide (the main cause of global warming) and methane (an even more potent greenhouse gas) could be released by the melting of the permafrost that binds the cold land areas of the world. This would cause the world to heat even faster, greatly accelerating climate change, and threatening to create a vicious cycle that could spin global warming out of control. And that would face all of us, not just the Inuit, with massive threats to our ways of life.



INTERNATIONAL POLAR YEAR

In March 2007, 5,000 scientists from 60 countries celebrated the opening of International Polar Year, a massive two-year research collaboration focused on the effects of global warming in the Arctic and Antarctica – such as melting glaciers and sea ice – and how the poles interact with the rest of the planet. The 220 individual research projects include a census of the marine biodiversity in the Antarctic recently exposed by the collapse of the Larsen B ice shelf, which involved scientists from 18 countries; exploration of subglacial lakes; and astronomical studies.

Many of the Year's projects are part of ongoing research, but it provides a valuable opportunity for individual institutions and nations to pool their resources – both financial and scientific – to explore these remote, treacherous regions. Scientists hope the information gleaned during this international effort will give us a more complete picture of how climate change affects the whole world, as well as increase our knowledge of the poles – conceding that it will still only be the tip of the iceberg.

Pole-pole

In February, US student Michael Agnone joined a UN-sponsored climb of Mount Kilimanjaro in aid of at-risk youth in Africa. Here he describes his experience on Tanzania's 'Rooftop of Africa', just 300 kilometres south of the equator.

'Pole-pole', slowly-slowly in Swahili, was our chant as we climbed. The beauty of the mountain was astounding, as were the sights: the plants, the horizons, the icy blue glacier. The snowy top was the most beautiful thing I have ever seen. But this beauty is fading; the glaciers of Mt Kilimanjaro are slowly melting. I had heard about the effects of global warming around the world, but up there I witnessed it first-hand. It is destroying the mountain's beautiful glaciers – they have shrunk by more than 80 per cent since 1912, the first year they were measured, literally disappearing. According to numerous studies, all ice on the mountain top will be gone in the next 15 years. But I've been there and seen that icy blue from Gilman's Point. I will always remember it as it gives way to the effects of global warming... and not so 'pole-pole'.



Core of the issue

Understanding the present means understanding the past – in climate science as in anything else.

The high levels of atmospheric pollution now being recorded by scientists mean little unless they are put into perspective. We need to understand how they compare with those of hundreds of thousand of years of history, so we must travel back in time to take measurements of the atmospheric conditions of the past. But that's impossible... isn't it?

Actually, it is as simple as drilling a giant tube of ice out of Antarctica or Greenland. The process is called coring, through which scientists can study the composition of past atmospheres.

Ice is made of stacked-up, squished snowflakes; snowflakes contain air bubbles. As snow falls, layers of ice pile up. If you looked at a cross-section of ice that had built up over a week, you would see layers of identical little air samples trapped by snowflakes throughout the seven days. But the scientists are examining a cross-section of ice built up over 400,000 years, with air bubbles at the bottom containing the air that was breathed by Neanderthals. Studying it reveals the temperature, atmospheric composition and precipitation at that time.

A recent study, revealing that current greenhouse gas concentrations are unprecedented in the last 800,000 years, required a sample 3.2 kilometres long, taller than a stack of 126,000 ice cubes.



Left: a slice of shallow ice core through which air can circulate freely. Right: a slice from a depth of 120 metres, in which the trapped air bubbles are clearly visible. Below: scientists in Antarctica remove a 10,000-year-old ice core from a drill.



Photos: Chris Gilbert/British Antarctic Survey

Sniffing

Kim Holmén (pictured below right) stands on top of the world. He spends much of his time at Ny-Ålesund, a science research station on the island of Spitsbergen, deep in the Arctic Circle and surrounded for much of the year by frozen ocean. And from there he travels in the world's most northerly cable car to the top of a mountain.

Mount Zeppelin is named after Ferdinand von Zeppelin, well known as an airship designer, less so as an Arctic explorer. One of his airships flew from Ny-Ålesund to the North Pole in 1931. Today, his name is again at the cutting edge of science in the Arctic; the mountain has some of the world's most sophisticated equipment, sniffing pollutants out of the Arctic air.

Kim and his team call it their watchtower. 'This is the place where humanity will get the first hints of the world's future – of global pollution, or runaway climate change, or a sudden alteration of the ozone layer,' he says. 'For here, in the thin, cold Arctic air, is where much of the world's pollution ends up.'

Spitsbergen is an international island, run by Norway, but under a treaty that allows anyone to come here. Ny-Ålesund, the world's most northerly town, is full of scientists from a dozen countries. Kim comes regularly because he is in charge of many of them. And because he loves it.

It's a weird place. It may be close to the North Pole, but Kim remembers when, in July 2005, a party of politicians and journalists, togged out in their heaviest overcoats and fur hats, 'stepped off the plane to find scientists in t-shirts and shorts. Temperatures had hit 19°C.' Even though the town – which is reached by the Gulf Stream – is warmer than most places in the Arctic, he adds, this was yet another sign that global warming has taken a grip on the frozen north.

Ny-Ålesund stands on a fjord once filled by a huge glacier. Now it has retreated by 5 kilometres. As we watch, huge chunks of blue ice fall off the front of it and float slowly towards the Atlantic. Last winter the fjord remained ice-free. Seals – which usually give birth to their pups on the ice – failed to produce any live offspring.

Kim's ice expert, Jack Kohler, observes that Spitsbergen's glaciers are disappearing fast, raising sea levels right around the world. 'If you want to see the world's climate system change,' he says 'you'd probably better come here to see it first.'

the future

BY FRED PEARCE

But, if you accept his invitation, take care. As the land warms and the sea ice breaks up, polar bears are coming ashore to hunt and getting increasingly aggressive. They break into huts on the island and eat anything that looks like meat – bed mattresses, inflatable boats. And you, if you get too close.

It's a scary 10-minute journey up Mount Zeppelin in a tiny four-person cable car that lurches in the wind. But you are greeted by a magnificent view across the shrinking glaciers looking like giant frozen waves. There are fresh fox prints in the snow, though thankfully no signs of polar bears.

But for the moment, Kim only really cares about his equipment, sensitive enough to sniff out the smoke from a cigarette 2 kilometres away. There is a strict no-pollution policy in Ny-Ålesund down below. Kim says he had a row with Greenpeace when their boat showed up here a few years ago, because the emissions from its engines upset his instruments.

The equipment's job is to measure the world's pollution. The Arctic may seem remote – but find it on a globe and you will see that it is surrounded by great continents. The winter winds bring car exhausts from the United States of America, coal smoke from Europe, methane from leaking gas fields in the Russian Federation and heavy metals from Siberian smelters.

Sometimes the pollution forms a yellow haze over the ice. Sometimes it rains mercury. But even the tiniest, most invisible particles register on Kim's monitors. His team can use computer calculations of where the wind has come from to track back to the source of the pollution – sometimes even to individual factories.

Overhead, this is one of the places where holes form in the ozone layer. By a quirk of atmospheric chemistry, gases like chlorofluorocarbons (CFCs) from old refrigerators destroy ozone only in the freezing air above the polar regions. So at Ny-Ålesund they check for that too. Some nights see a green laser light pointing into the sky as German researchers probe the ozone layer.

Strangely, many of the world's most toxic pesticides also end up here. Though mostly sprayed onto fields far to the south, often in the tropics, they evaporate from the soil and travel on the breezes until they reach the Arctic. In the cold air, they condense out, like a toxic frost. The pesticides end up on the ice, in seaweed, or absorbed by the mosses and grasses of the tundra – to be eaten by insects or fish, and then move up the food chain to mice and birds and seals and polar bears.

Millions of guillemots live on nearby Bear Island, Norway's largest bird colony, eating the fish that eat the seaweed that soaks up the pesticides. 'The birds contain extraordinarily high levels of pesticides,' says Kim. 'And their droppings collect in a big lake on the island, filling it with toxic chemicals

in a place where you might expect to find the cleanest water in the world.'

Scariest of all, Kim gets an early warning of the rising levels of the gases that are warming up our planet, as he and his team measure the amount of carbon dioxide in the air. Strange to say, concentrations here are the highest in the world. During my visit, most other stations around the globe found the air contained about 380 parts per million of the gas. But some days on Mount Zeppelin, the equipment measured 390 parts per million.

Kim thinks this is due to the 'very rapid increase in emissions from the booming economies of Asia'. That pollution, like the pesticides, seems to be getting fast-tracked north. Not for the first time, Kim believes he has caught a whiff of the future at the top of the world.



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Q How much time do we have to bring global warming under control?

A Global warming is going unchecked, more so every year, with increasing impacts around the world. We should have started tackling it seriously years ago. The best current estimate by leading scientists and other experts is that we have only a decade to bring it under control before catastrophic consequences for the world become inevitable. We still have an opportunity to reduce our emissions of carbon dioxide – and dependence on energy from fossil fuels – and at least to pass on to the next generation a planet that is not entirely damaged and polluted. But the longer action is delayed, the more drastic and difficult it will have to be. The situation demands immediate attention. Act, act and take action.

Q What are the consequences of melting glaciers for people and the environment?

A About a billion people worldwide depend entirely on glaciers for their water supplies, including several hundred million people in China and India alone, and scores of millions more in the countries of the Andes in South America. Large parts of developed countries, like the western United States of America, also rely on them. As the world warms up, the meltwater comes earlier and earlier and there are increasing shortages later in the year. In the long run, when the glaciers have gone, there will be no dry-season water at all, with catastrophic consequences for both people and agriculture. Increasing meltwater also threatens to make glacial lakes high in the mountains burst their banks, causing devastating floods downstream. And then there is the contribution of glaciers to sea-level rise as well.

Q What exactly does the human family have to do to stop the polar ice caps melting?

A We have to move rapidly to a low-carbon economy, where we end our reliance on burning fossil fuels (oil, gas and coal), which releases carbon dioxide, the main cause of global warming. It can be done. We are now blessed with unprecedented knowledge, know-how and resources to make cars

that run cleaner and burn less fuel, to generate electricity from wind and sun and other renewable sources, to modernize power plants, and to build refrigerators, air conditioners and whole buildings that use less power. But if we do not act very quickly it will be too late.

Q Will climate change open up the Arctic and Antarctica for some kinds of agriculture, human settlements, etc.?

A It may do. Farmers in Greenland are already beginning to grow broccoli, cauliflower, Chinese cabbage and other temperate area crops. Unfamiliar species like salmon and robins, for which the Inuit people have no names, are beginning to appear in their lands. And oil companies are keeping an eye out for new reserves as ice retreats in Arctic waters. But any 'benefits' from global warming will be far offset by harm in warmer climes, and will disappear even in the polar regions if the world goes on heating up.

Q If the glaciers and ice caps melt, by how much will sea levels rise?

If all the glaciers outside the polar regions melted, sea levels would rise by about half a metre. According to scientists, if the Greenland and West Antarctic ice caps melted, sea levels could rise by as much as 12 metres, changing the map of the world, submerging low-lying islands and coastal cities and vast areas of countries like Egypt and Bangladesh.

Q What are the most important things that governments and people, especially young people, should do?

A Governments need to sign up rapidly to effective treaties, starting with one agreeing on heavy cuts in greenhouse gas emissions from 2012 when the present arrangements under the Kyoto Protocol run out. But they should not wait for these agreements, and should immediately start taking action to cut emissions. People need to remind, pressurize and persuade governments to act – and young people can be particularly effective advocates as it is they who will inherit the warmer world. All of us need to change our way of life, behaviour and attitudes and choose a different path.

Do you have any **QUESTIONS** on environmental issues that you would like the experts at UNEP to answer?
Please send them to unepubb@unep.org, and we will try to answer them in future issues.



Riding high

A little greenery goes a long way in the Arctic winter, so for the eight men of the Tara Arctic expedition, carefully nurtured hydroponic salads are a cause for celebration. Coming from France, Russia and New Zealand, and ranging in age from 26 to 65, they form a tiny international family at the top of the world. 'The working language is French, but we have had moments of being lost in translation,' says expedition chief and lone anglophone, Grant Redvers of New Zealand. 'But it's amazing what we can communicate with stumbling grammar, mime and drawings. And when you're out in a wind of 60 knots and muffled up in heavy clothing, you can't hear voices anyway.'

Drifting in the pack ice – just 520 kilometres from the North Pole – these core members of the team of the Tara Arctic expedition are studying the effects of climate change. The expedition is part of DAMOCLES (Developing Arctic Modelling and Observing Capabilities for Long-term Environmental Studies), a cooperative European contribution to the International Polar Year.

At the centre is *Tara*, a yacht with a difference. She was built by French explorer Jean-Louis Etienne, then taken over by renowned yachtsman Sir Peter Blake, and is now owned by French businessman Etienne Bourgois. Unlike Ernest Shackleton's *Endurance*, she was designed to get caught in the icy polar seas, with special features to keep her from being crushed to pieces. Her hull is shaped like an elongated olive stone, with two retractable centre boards instead of a keel. When the centre boards are pulled up, there is nothing for the pack ice to take hold of, so as pressure on the hull increases, *Tara* just pops up on top of the ice.

'So far we haven't had any serious problems, but it can be quite disconcerting when the ice shifts around the boat,' says Grant. 'Although the ice seems solid, it's floating on dynamic, tidal water. When the water moves or



Tara Arctic

the wind is strong, the ice sheets are forced into each other, like geological plate tectonics, and form pressure ridges. It can sound like crunching – which isn't so bad – or like the roar of a train, which takes a bit of getting used to!

For the next year and a half, *Tara* will be a laboratory for 25 visiting scientists from 10 European countries, the United States of America and Russia. Some will record oceanographic data to find out about salinity levels, temperature, pressure and depth; others, atmospheric data to understand wind speed, direction, temperature and atmospheric pollutants. Others still will assess the thickness and composition of the ice and will study its albedo, or reflective power. As sea ice melts, solar radiation (heat) is no longer reflected into the atmosphere but is absorbed by the darker sea, warming it up.

Tara's crew is already taking scientific readings: drilling holes in the ice is a great way to keep warm when it's -40°C outside. The meteorological readings are also challenging: three specialized masts are mounted on the ice, but have to be rescued when it splits and moves.

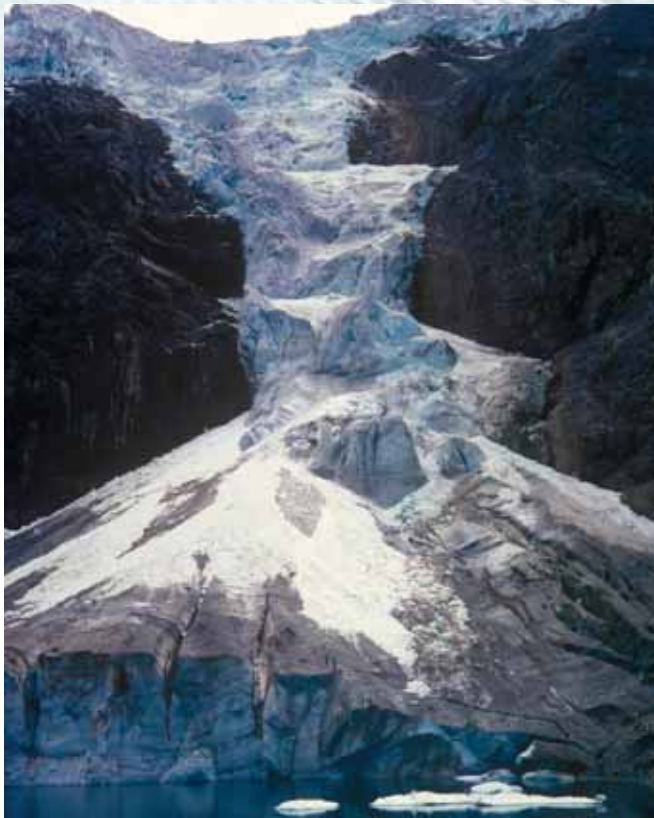
But it's a high-tech life aboard *Tara*. Electricity comes from a combination of

wind and diesel generators, and 40 square metres of solar panelling were rolled out after the Arctic night abated in March. Most scientific data is automatically sent through cables on the ice to computers aboard *Tara*, then emailed to Europe for analysis. Light bulbs and laptops are energy efficient, and satellite telephone calls and emails keep the crew in touch with family and friends. There's even enough hot water for a weekly shower, but it takes a couple of hours each morning to collect the ice slabs that are thawed for washing and drinking water.

Tara is using the Arctic pack ice drift first observed by Fridtjof Nansen (see page 20). Over two years, it will travel, ice-bound, some 2,000 kilometres from north of Siberia, past the North Pole, and along the northeast side of Greenland.

For the moment the crew are looking forward to the Arctic spring and the return of light and wildlife. 'It can be pretty desolate up here,' Grant concedes. 'In October we saw some polar bears, but none over the winter. A couple of days ago an adult male ambled by the boat and we all got very excited. And just this morning we found a small beetle in the flour. It's been a very biologically diverse week!'

Warming ice – and frozen



In 1980 (above) a huge glacier filled Jacobabamba Valley in Peru; by 2003 (below) the effects of global warming had changed the view dramatically.



Bryan Lynas/Still Pictures

Mark Lynas/Still Pictures

In February 2006, Canadian Claire Hastings spent five weeks sailing and hiking around the island of South Georgia, a 100-kilometre-long mountainous island in the Southern Ocean. She climbed up the Heaney glacier on a sunny afternoon, and soon realized that 10 kilometres of glacier is much longer than it looks. Here, she describes her experience and examines how the glaciers of South Georgia and the rest of the world are doing.

‘It’s cold and raw on top of a glacier, as is becoming all too clear to me halfway up the immense Heaney glacier on the remote Antarctic island of South Georgia. As I slip for the fourth time, reacquainting my knees with the ice, the thought crosses my mind that a little global warming might not be a catastrophe. Not a lot, of course: just enough to ease the wind that is biting my cheeks and freezing my fingers into popsicles. At this point it is hard to comprehend that an increase of just 1°C could spell disaster for the ice under my feet.

But it’s true. Despite what my rapidly chilling feet keep telling me, the world is warming up, and glaciers are the first casualties. At the other end of the world from here, Greenland, with its glaciers accelerating, lost 220 cubic kilometres of ice in 2005 (the entire city of Los Angeles only uses 1 cubic kilometre of water each year). Meanwhile, the glaciers of the Andes have shrunk by a quarter in the last 30 years, while scientists predict that the Alps will be almost ice-free by 2050.

Should I – on my Antarctic glacier – be concerned? If Heaney melted away, would anybody be immediately affected? No one lives on South Georgia, after all. ’

As I learned when I got home, the shrinking of the world’s glaciers will have dire consequences. Let’s start with the Alps, where winter sports are a multibillion-dollar industry. Resorts dot the mountains of Austria, France, Germany, Italy and Switzerland, but the skiing season is getting steadily shorter. In December 2006, temperatures there were the warmest in 1,250 years, and snow was nowhere to be seen. The Alps’ glaciers are losing at least 3 per cent of their volume each year. So Europe’s recent hot summers and dry winters could spell economic ruin.

In Tanzania the vanishing ice fields of Mt Kilimanjaro, Africa’s highest peak, will seriously hit both local people and scientific knowledge. Tourism brings in most of the country’s foreign exchange, but much of it could evaporate with the snows that Ernest Hemingway described as ‘wide as all the world, and unbelievably white in the sun’. And the mountain’s glaciers are the sole source of ice core records for Africa – the oldest layers of ice record air and climate information from 11,500 years ago – containing vital data about tropical weather patterns over the past millennia.

In the Andes, even spiritual traditions are under threat. People attending the Qoyllur Rit’I religious festival in Peru, for

feet

example, chip off pieces of the Sinakara glacier believing the ice can cure illness. In 2003, the ceremony's guardians stopped this because of the glacier's retreat. A thousand years of belief are being frustrated by global warming.

❧ *Scrambling up Heaney is getting progressively difficult. I'm reduced to picking my way between deep fissures and crevasses. Torrents of frigid meltwater rush through the cracks in the ice and emerge at the ice front, forming a freshwater river that flows across the plain, through a king penguin colony, and down to the sea. The 250-metre-wide river is the most visible sign that the glacier – despite the chilly air – is actually melting. If the melt rate speeds up, the river would flood the plain, displacing the penguins and a number of breeding elephant seals. The animals would be forced to move along the coast, and elsewhere animals, plants and humans alike face huge risks.* ❧

Glaciers provide vital water supplies, especially where there is little rainfall. Meltwater from Himalayan glaciers, for example, feeds the Ganges, Indus, Mekong, Yangtze, Thanlwin, Brahmaputra and Yellow rivers, which provide water to 2 billion people. But as the melting speeds up, two disasters ensue. First the increasing water makes lakes and rivers overflow, causing floods downstream. Forty-four glacial lakes in Nepal and Bhutan are at risk of bursting their banks, threatening to send devastating walls of water through the valleys below. Many millions of people are threatened.

The second, even greater, disaster comes as the glaciers begin to disappear altogether. After too much water, there is then too little. Water supplies are already under strain in much of Latin America as the glaciers that feed Andean rivers melt. Yet 2 million people in the La Paz region of Bolivia, for example, rely on glacial runoff for their water supplies, while 70 per cent of Peru's electricity comes from hydroelectric dams that depend on it.

The melting glaciers also contribute to increasing sea levels. So far, most of the rise has come from the thermal expansion of the oceans: the seawater expands as it gets warmer. But, if all the world's glaciers melt they will raise the seas by about half a metre, though the melting of the Greenland and Antarctic ice caps would add much more.

❧ *The wind is picking up and I've reached as far up the glacier as I can go by myself. In front of me the luminous ice stretches up the mountain to meet the pewter sky. As I turn around to retrace my steps, I hear a series of pops and then a low rumble. A few seconds later a chunk of ice the size of a small car bobs into view at the mouth of the melt river: a microcosm of global climate change.*

I shove my cold hands into mittens and retract my selfish wish for global warming. The consequences could be beyond my imagining. ❧

Ice rivers

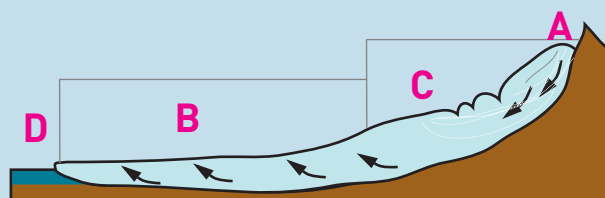
Ice sheets form high in mountains where more snow falls in winter than melts in summer. Over time, the weight of accumulated snow and repeated freezing and thawing change the lowest layers into grainy ice. As more snow falls, more layers are created and eventually, driven by pressure, the frozen mass begins to move, becoming a glacier.

Pressure and gravity help the glaciers on their journey. Pressure builds up as their upper areas continue to accumulate snow, and the bottom layers of ice deform under the weight, enabling them to be slowly pulled downhill by gravity.

Sometimes, glacial advance occurs because the entire glacier slides forward, lubricated by meltwater that has accumulated underneath it, providing a conveyor belt between it and the rock below. Sometimes this happens because pressure on the bottom of the glacier thaws ice, with melting continuing as a result of friction against the rock as it moves. Recently, another process spurred by global warming has been hastening the movement of glaciers in Greenland and Antarctica: pools of water, accumulating on the surface as the ice melts in higher temperatures, rapidly find their way down to the rock below through cracks in the ice.

When glaciers are moving it is best not to be in their way. Acting like giant scouring pads, they erode the landscape, creating long, trough-like U-shaped valleys with flat bottoms and steep slopes.

A series of ice ages over the last 100 million years covered temperate areas in glaciers, which then retreated in the intervening periods of relative warmth. The most recent deep freeze kicked in about 2.5 million years ago and its glaciers covered 32 per cent of the Earth's land. Today's glaciers are remnants of that freeze, and have been melting and shrinking for the past 14,000 years. But as global warming is taking hold, their retreat is accelerating all over the world.



- A** The upper part of the glacier – where the snow still falls – is called the accumulation zone. In a healthy glacier, this covers 60 to 70 per cent of its surface.
- B** At the end of the glacial tongue is the ablation zone. The glacier is melting here, and snow rarely falls.
- C** The equilibrium line is where accumulation and ablation zones meet. Here, the amount of snow accumulated is equal to the amount of ice melting.
- D** The tip of the tongue, where the ice thins to nothing, is called the ice front.

Melt down

The Earth's cryosphere – its frozen regions – is melting fast. According to the 2007 report of the Intergovernmental Panel on Climate Change, 30 mountain glaciers around the world lost more than half a metre of thickness in 2005, resulting from a temperature rise of 0.6°C over the 20th century. This, most scientists agree, is largely due to our greenhouse gas emissions.

Side-effects from the melting itself may now be accelerating the process: when permafrost thaws, for example, it releases methane, a long-lasting greenhouse gas, from the soil; and melting Arctic sea ice also means loss of its reflective qualities, as water absorbs more of the sun's energy than ice and snow. Here are some of the world's shrinking cold spots.



J. Greenberg/Still Pictures

Alaskan glaciers, United States of America

Many of these thinned three times faster in the last decade than in the 40 preceding years, producing an annual sea-level rise of about 0.14 millimetres.

Glacier National Park, United States of America

Two thirds of the Park's glaciers have disappeared in the last century; it may have none left by 2030.



www.reisalbum.de

Chacaltaya glacier, Bolivia

Home to the world's highest ski slope, Chacaltaya lost two thirds of its mass in the 1990s alone, and may disappear by 2010.

Peruvian glaciers

These have lost at least 22 per cent of their area since 1970, and melting is accelerating – threatening the water and power supply for the nation's arid coast, where two thirds of its population lives.

Patagonian ice fields

The Southern Hemisphere's largest non-Antarctic ice masses are the Earth's fastest-retreating glaciers, contributing more than 9 per cent of global sea-level change from mountain glaciers.

Greenland ice sheet

The largest land ice mass in the Northern Hemisphere is losing at least 50 cubic kilometres of ice per year, enough to raise global sea levels by 0.13 millimetres annually.

Breidamerkurjökull glacier, Iceland

The main glacier emerging from the Vatnajökull ice cap – Europe's largest – receded by 2 kilometres between 1973 and 2000. Most of Vatnajökull's glaciers were receding as of 2000.

Quelccaya ice cap, Peru

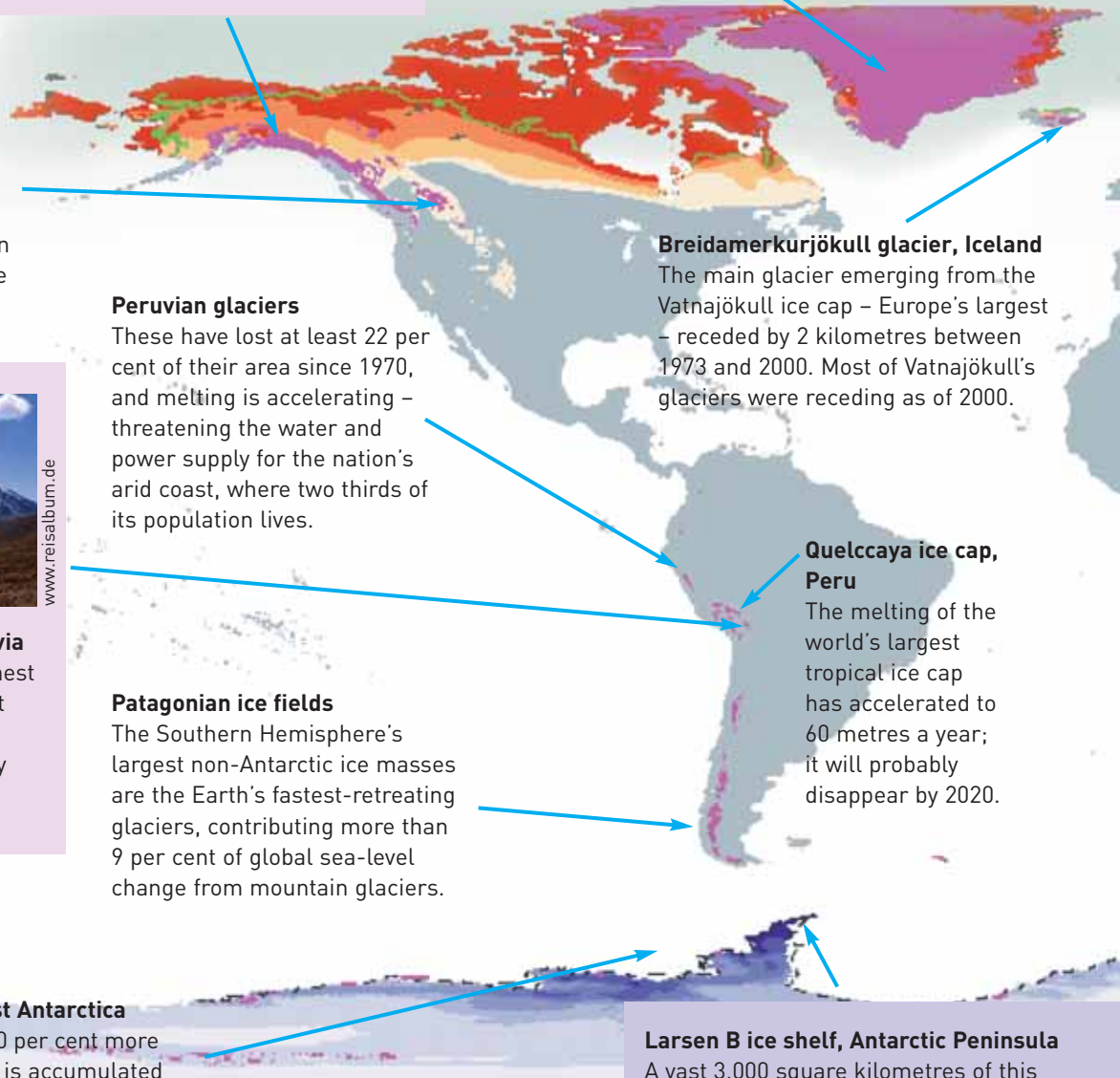
The melting of the world's largest tropical ice cap has accelerated to 60 metres a year; it will probably disappear by 2020.

Amundsen Sea, West Antarctica

Glaciers are losing 60 per cent more ice into the sea than is accumulated through snowfall – this could raise sea levels by around 0.2 millimetres annually.

Larsen B ice shelf, Antarctic Peninsula

A vast 3,000 square kilometres of this ice shelf disintegrated in 2002 (shown right in blue). Since then, local glaciers have been moving faster, releasing more ice into the sea.



Arctic sea ice

Arctic sea ice has been shrinking at a rate of around 9 per cent per decade over the last few decades. All summer sea ice could disappear this century.



September 1979



September 2005

NASA/GSFC



L. S. Eisenlohr/Still Pictures

Arctic permafrost

Permafrost has warmed by up to 2°C since the 1980s. Widespread thawing is predicted, which will release large amounts of methane and carbon into the atmosphere.

Norwegian glaciers

Many of Norway's 1,627 glaciers are expected to melt away within the next century, including a third of its largest and all of its smallest.

Caucasus Mountains, Russian Federation

Glaciers here have shrunk by half in the last century.

Tien Shan Mountains, Central Asia

Glaciers lost nearly a third of their area in the second half of the 20th century, up to 2 cubic kilometres of ice annually.

Tibetan Plateau glaciers

The largest area of ice outside the polar regions, these 46,298 glaciers are disappearing at the rate of 50 per cent per decade, threatening water supplies across much of Asia.

Alps, Western Europe

Alpine glaciers are likely to shrink to 5 per cent of their 1970s volume by the end of this century.

Mt Kenya glaciers, Kenya

The glaciers at this World Heritage site have shrunk rapidly, losing over 75 per cent of their area in the last century. Eight of the 18 ice entities totally disappeared over the same period.

Mt Everest, Himalayas

Everest's glaciers have shrunk by 2 to 5 kilometres in the last five decades, flooding glacial lakes and nearby communities.

Carstensz and West Meren glaciers, Indonesia

Carstensz shrank by 80 per cent between 1942 and 2000, while West Meren melted completely in the late 1990s.

Ruwenzori glaciers, East Africa

These tropical glaciers have melted by 50 per cent since 1987, and could disappear within two decades.

Kilimanjaro, United Republic of Tanzania

The glaciated area shrank by 80 per cent in the last century (the images show the change in the northern ice field between the early 1950s and 1999).



John West



Javed Jafferji

New Zealand glaciers

Glaciers have been retreating since the mid-19th century, and have lost half of their area since then. Breaking glaciers are posing a hazard to climbers.

- Arctic sea ice
- Permafrost extent
- Glaciers and permanent land ice
- Antarctic snow accumulation
- Arctic boundary

Sources: GEO Snow and Ice 2007; IPCC; AAAS; Earth Policy Institute; NASA; Chinese Academy of Sciences.
Map: UNEP-WCMC/National Snow and Ice Data Center.

Changing minds



Mihaela Hristova, TUNZA Youth Advisor for Europe and Assistant Programme Coordinator of the National Association of UN Youth Clubs of Bulgaria, is studying psychology at

Sofia University, trying to bring psychological perspectives to environmental issues. She has focused her studies on finding effective motivational and educational ways of changing the high-consumption behaviour of young people. She explains:

A major difficulty in making progress on environmental issues is overcoming the gap between the environmental values people claim to have and what they actually do. Most people feel that the environment is important but are reluctant to take concrete action to preserve it. And although 'environmentalism' has many good characteristics – such as caring for future generations, notions of fairness, and respect for animals and nature – some perceive it as having bad ones as well, such as dreaminess and extremism.

So how can we square this circle? Maybe environmental psychologists can help, as it may require a shift in the underlying value people place on the environment.

Research in environmental psychology suggests that climate may influence temperament. A cold climate, for example, exposes people to the possibility of freezing, inducing insecurity, and a hostile environment with scarce resources can make people more aggressive. A very warm climate, where seasons do not change much and resources are easily available throughout the year, might promote a more relaxed approach.

Thinking this through, a moderate climate should be the best for the environment, because it provides the most benevolent living conditions, possibly inducing holistic, intuitive and well-balanced approaches to life. But is that so? I would rather leave that question open.

Raw theories are not enough by themselves to deliver a significant change in high-consumption lifestyles. A sustainable planet will not be possible without developing behaviour patterns that value conservation. Resource-costly lifestyles, predominant in some parts of the world, present a challenge. Most techniques used to promote sustainable behaviour seem better at bringing about short-term results than achieving long-term change. Perhaps the urgency of our environmental problems suggests that we should pay more attention to environmental psychology as a way of ensuring that sustainable lifestyle patterns spread and last.

Trying to stay cool

As temperatures rise, animal and plant species are having to migrate, following their food to more favourable conditions in cooler climes. Even slight increases in temperature can force them to move towards the poles and up mountains. Arctic and mountain species, however, have nowhere else to go, and so they are most at risk of extinction from global warming.

In the Arctic, thinning ice and longer summers are shrinking the habitats of polar bears, seals, walruses and other animals. At the same time, species from lower latitudes – like salmon and grizzly bears – are moving north and competing with them for resources.

Much the same is happening in mountain ecosystems, where the only place to go is up. Alpine plant species have been found to be slowly climbing the mountainsides to compete with their loftier neighbours. Gorillas in cloud forests of the Virunga mountains of Rwanda, Uganda and the Democratic Republic of the Congo are making for higher altitudes as their forests shrink through deforestation, and as climate change

takes hold they will eventually run out of road at the top. Ethiopia's gelada baboon, Central America's quetzal and Australia's mountain pygmy possum are under similar threat.

Of course, climate change affects species everywhere. European butterflies are among those moving north. But it is harder for plants that can only 'move' by spreading their seeds. Plants in Canada and Russia, it is thought, would have to migrate at an impossible rate of more than 1 kilometre a year to stay ahead of the warming.

Worse, people – and their farms, cities and paved roads – stand in the path of such migration. It would help a little if humanity made it easier for the hard-pressed migrants, for example by moving the boundaries of nature reserves or establishing wild corridors of land between protected areas. Meanwhile, keeping a close eye on Arctic and mountain species will give an idea of how much climate change is affecting the world's intricately connected ecosystems.



Joseph S Darling/UNEP/Topham

POLAR PLIGHT

The Inuit call them *nanuq*; in Scandinavia they are 'ice bears'. Fewer than 25,000 polar bears patrol the ice and tundra of Alaska, Canada, Greenland, Norway and Russia, and they are becoming ever more endangered.

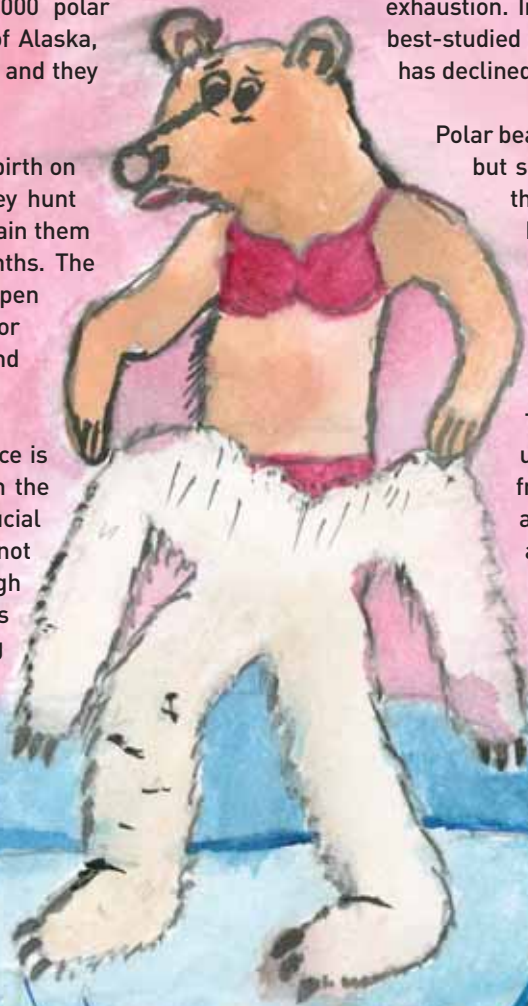
Polar bears travel, hunt, sleep and give birth on Arctic sea ice. In winter and spring they hunt seals, stocking up fat reserves that sustain them through lean, land-bound summer months. The seals swim too fast to be caught in open water, so the bears have to lie in wait for them to surface for air through cracks and holes in the ice.

But as the world warms up, Arctic sea ice is shrinking and, worse, melting earlier in the season – depriving polar bears of crucial feeding time. Underweight females cannot sustain pregnancies or produce enough milk for their cubs. And weakened bears may not be able to swim the increasing

distances between ice floes, succumbing to exhaustion. In Canada's Hudson Bay, home to the best-studied polar bear community, the population has declined by 22 per cent since 1987.

Polar bears have survived for millions of years, but some scientists now believe that, with the way things are going, they may become extinct within the decade.

But in December 2006, the United States of America formally listed polar bears as a threatened species under the Endangered Species Act. That requires the Government to come up with a recovery plan and prevents it from 'enacting, funding, or authorizing actions which adversely modify the animal's critical habitats'. Could this be the trigger for the United States to reduce emissions of climate-changing greenhouse gases?



Painting by Catherine Nishchuk, joint second prize, International Children's Painting Competition on the Environment.

‘Singing called me back’ *Mari Boine*



Tarjei Krogh Eknes

In the title track of her album *Gula Gula* (Listen Listen), Sami musician Mari Boine sings, in her native tongue:

*Hear the voices of the foremothers...
They ask you why you let the Earth become polluted
Poisoned
Exhausted...
They want to remind you
That the Earth is our mother
If we take her life
We die with her...*

Boine grew up in Gamehhisnjarga, a Sami village in northernmost Norway, and her music is rooted in the

joik, a traditional chant expressing a person, animal or landscape's essence.

By turns primal and throaty, ethereal and soaring, Boine's voice bears echoes of a bitterness she experienced growing up within cultures at odds with each other. The spirituality and culture of the Sami – the indigenous people of Arctic Scandinavia and Russia, often nomadic hunters, farmers and reindeer herders – were inextricably tied to the land before colonization by Europeans started to become aggressive in the 17th century.

Boine began performing in the 1970s, but it wasn't until 1989, when British rock star Peter Gabriel started distributing *Gula Gula* on his RealWorld label, that she became one of the best-known ambassadors for her culture.

Countdown → 2008

Gabriele Brennhaugen and Charlotte Fjelltvædt, of Young Agenda 21, report on preparations for the Tunza International Children's Conference for the Environment 2008 and the issues that inspire young people to get involved.

World Environment Day will start the countdown to the next Tunza Conference, to be held in Stavanger, Norway, in 2008. During the celebrations on 5 June, Tunza Junior Board members Helga Anfinssen, Hanna Monslaup Eikås and Håkon Bore Haaland, from around the city, and Kristian Øien, from the more northerly town of Trondheim, will have their first get-together to start planning

it. They are looking forward to welcoming young environmentalists from all over the world – and hoping to inspire new friendships and ideas. It all started when the Young Agenda 21 Foundation – a Stavanger-based environmental organization that collaborates with UNEP – encouraged pupils from local Eco-Schools to attend the last Tunza Conference in Malaysia in 2006. Almost 20,000 such schools worldwide fly the Green Flag of the Foundation for Environmental Education and work to raise awareness among pupils by involving them in environmental activities.

‘We make an effort to recycle waste and plant bushes and herbs in the school yard,’ says Helga. ‘We have also restored a swamp next to a nearby river and given the area back to the salamanders and insects.’

Kristian loves skiing and hiking through the snow. ‘Something's been wrong this year,’ he says. ‘We have never had this little snow before. It would be sad if it stops snowing altogether. Just think about the animals and plants that depend on it.’

Since *Gula Gula*, Boine has recorded seven albums, building on its spare *joik* style, incorporating jazz, rock, electronica and instrumentation from Africa and South America. We spoke to Boine between touring Europe and scoring *Kautokeino Rebellion* – a feature film about an 1852 Sami uprising – to ask her about life and music in the Arctic.

Q: How did the environment shape your life growing up in the Arctic Circle?

A: I grew up in free nature, with big space all around. We weren't nomadic, and didn't herd reindeer, but I grew up on a farm, and we picked berries, fished salmon from the river – nearly all our livelihood came from the land. So I learned very early that we must treat nature well because all things come from her. But when I was 15, I wanted to live in the city like everyone else. In school I was taught that where I came from was nothing. So I wasn't interested in nature for 10 years. When I started to sing, I realized the wisdom in my traditional culture, and I learned to value nature again. Singing called me back.

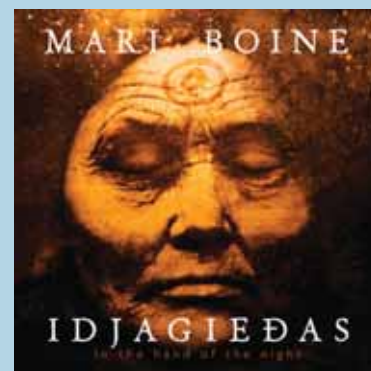
Q: Much of your music deals with the struggle between traditional and modern ways of life. Do you think these tensions affect how we treat the environment?

A: For a long time the modern world has forgotten that everything comes from nature, and has wanted to conquer it, taking as much as it can. Our biggest challenge now is to find a balance between modernity and treating nature with respect, not abuse. I want my music to remind all people of our spiritual link to nature. I can't say music can save the world, but anything that can keep the human flame that's connected to Earth alive is a way to save nature. It may be a naive belief, but I want to keep it.

Q: Tell us a bit about the *joik*. What is its relationship to the environment?

A: Because my people lived so close to nature, following seasons and animals, much of *joik* reflects nature. But

we don't sing *about* nature, we *sing* nature. The song is a way for humans to be part of nature, and deep in the past it was part of shamanistic rituals communicating with nature gods. Many old Sami ways were lost to colonization, but some elements, like *joik*, have survived.



Mari Boine's latest album cover.

Q: What can the world learn from Sami culture?

A: It can learn from all indigenous cultures – not only Sami – that everything is linked. It could learn to live more simply. Sometimes modern people don't see how what we do to nature affects us, and our children. Many aren't aware of the link between nature and humans – which is spirituality. And, as indigenous Canadian folk singer Buffy Sainte-Marie sang, 'Third-Worlders see it first' – people closest to nature see pollution's first effects. Ice is melting. This affects indigenous livelihoods in Greenland, in Alaska. And it affects the Sami – about 20 per cent of us – who still herd reindeer. When temperatures fluctuate, reindeer cannot get food. Normally reindeer migrate to the coast before rivers melt. Now it's melting earlier. It is all confused now.

Q: What is young people's role in the face of climate change and global warming?

A: The world's young people are more aware and awake: I see that children are far more caring about the environment than adults. And when I see young people's wild protests, I feel they're really screaming, 'We don't want money, cars, and things, things, things!' We are drowning in things. Spirituality is the only way for materialism not to win.

Hanna, who cycles to school in all weathers, at first found it hard to pluck up the courage of her convictions. 'But after being interviewed by a newspaper and standing in front of the whole school to report on the 2006 Conference, I've become much braver about talking about environmental issues, and encouraging adults to recycle,' she says.

Håkon says that besides helping to plan the International Children's Conference 2008, the three Junior Board members living in Stavanger meet regularly to work on a competition they started between classes at their schools. Each student is encouraged to report on their personal activities for sustainability, like walking or biking to school, recycling waste at home, turning off lights or buying organic fruit. The most environmentally aware class wins a visit to a recycling plant.

But they keep a worldwide perspective on their local activities. 'In Malaysia we made friends who didn't even have clean water to drink in their homes, or clean air around them,' says Håkon. 'We take all these things for granted in Norway.'



Gaare/Still Pictures

Cold prospect

Cold, empty and very far away, the world's icy regions usually linger at the edges of our consciousness. But curiosity is driving more and more people to see them with their own eyes. The scientists, adventurers and tourists that measure, traverse and snap pictures of glaciers or icebergs are amazed by their natural beauty, but they often damage what they come to see.

Climbers call it the highest rubbish dump in the world. To reach the lofty heights of Mt Everest you almost have to wade through a sea of discarded oxygen canisters, plastic bottles and other waste. More than 2,250 people have climbed the world's highest mountain since Edmund Hillary and Tenzing Norgay first did so in 1953, and have left more than 50 tonnes of rubbish behind them to pollute the snow, water and soil. Several clean-up expeditions have been mounted; the most recent collected 1,600 kilograms of waste over three months.



Tourists are Antarctica's greatest invasive species: almost 30,000 tourists will arrive this year. The majority come in the short polar summer and visit the Antarctic Peninsula, just 2 per cent of the continent's area. Most tour companies enforce strict guidelines and keep interaction with wildlife to a minimum, but icebreakers crashing through the pack ice pollute the ocean and air. To make matters worse, the tourism season coincides with the seal, penguin and albatross breeding season.

Indigenous people have lived in the Arctic for thousands of years, developing strong cultures and sustainable lifestyles. But recent commercial interest has led people and industry to penetrate deep into hitherto pristine wilderness. In an area where a single footprint in the tundra moss can remain for hundreds of years, the effects of new infrastructure are potentially disastrous. Networks of roads and oil pipelines stretch hundreds of kilometres, disrupting and threatening caribou and reindeer migration patterns. In 2006 one of the pipelines leaked a million litres of crude oil near Prudhoe Bay, Alaska.

Relatively accessible icy areas, such as the European Alps or North America's Rocky Mountains, are suffering even more from overuse. Skiing itself damages sensitive ecosystems and, as the winters warm, resorts are diversifying to bring people, and their polluting habits and vehicles, all the year round.

Raising the profile of the world's ice is important, but so is keeping it healthy. We must strive to find a better balance.

UNEP/Topham

Melting lives

Just one degree separates ice and water. If the Arctic's snow and ice represent the barometer of worldwide climate change, its indigenous people are the mercury in it. As the frozen north warms and the landscape changes, so too do the lifestyles of those who have lived, travelled and hunted there for millennia.

And the changes are vast. Permafrost is melting and the coastline is eroding. Glaciers are receding and the sea ice is becoming treacherously thin: hunters now regularly fall through it. In Canada and Alaska the longer, warmer summers lure southern animals like grizzly bears northwards.

Plants move too. The 10,000 strong Nenets people of Siberia are struggling to sustain the reindeer herds that provide their food, clothing, shelter and transport. The animals graze on moss and lichen, but these are now being crowded out by less hardy plants flourishing in the warmer temperatures.

In all, 4 million indigenous people live in the Arctic, spread across Scandinavia, Canada, Alaska, Russia and Iceland. Though their traditions and lifestyles differ, climate change is putting them all under pressure.

'The Inuit are a hunting people of the land, ice and snow,' explains Sheila Watt Cloutier, former Chair of the Inuit Circumpolar Conference. 'Hunting is not just about killing animals. The process of the hunt and

Get cool!



UNEP/Topham

eating of our food personifies what it means to be Inuit. It is on the land that values and age-old knowledge are passed down from generation to generation.'

That knowledge is increasingly being lost. In some areas elders no longer share their hunting and fishing know-how with younger generations because it is no longer needed. Populations of seals, whales and polar bears shift and change as the patterns of ice become unpredictable. Communities rely less on hunting and more on shop-bought, packaged food: in remote regions, food is often flown in from urban centres in the south rather than made or hunted locally.

'The process of the hunt teaches young Inuit to be patient, courageous, reflective and bold under pressure; how not to

be impulsive, to withstand stress, to have sound judgement and ultimately wisdom in order to carry out a plan to achieve a goal.' Cloutier continues, 'Let me repeat – our hunting culture is tied to the land. This is why, for us, climate change is an issue of our ability to exist as a people.'

Adapting is difficult. The Sami people of Scandinavia fight legal battles to keep mining companies from drilling in recently softened permafrost and ice-free sea. Some Inuit hope that the softened permafrost will finally allow them to have basements in their houses; others worry that eroding coastlines will cause their houses to slip into the sea. The unpredictability of future temperatures, and the changing landscape that accompanies them, make sustainable lifestyle choices challenging. The barometer and its mercury are registering alarm.



Michael Sewell/Still Pictures

SO YOU WANT TO KNOW MORE about the Sicy regions? Maybe even head for the high latitudes?

Film it

The 2007 Nordic Youth Film Festival (www.nuffglobal.net) is featuring films on climate change, and the Planet in Focus Film Festival (www.planetinfocus.org) will be spotlighting polar films in October 2007. Get creative and show the world how climate change is affecting your life.

Get the degree

If you are craving a degree in Circumpolar Studies, the University of the

Arctic is the way to study. The only challenge could be deciding where to go: the University is made up of 130 universities, colleges and other organizations from all over the Arctic – including Norway's University of Tromsø, the most northerly in the world. You could also find yourself on a North2North exchange, studying in Iceland, Russia, Canada or Scandinavia (www.uarctic.org).

The online invasion

Harness the power of the internet! The Arctic Youth Network (www.taiga.net/ayn) and Ookpik (www.ookpik.org) connect young people from all over the circumpolar world. Check them

out for Arctic news, art and writing by northern youth, and for upcoming conferences and events.

Hop on board

Nobody knows exactly how many young people visit the polar regions each year, but if all goes according to plan, at least 500 will be chilling out near the poles over the International Polar Year. The organization Students on Ice is mounting Arctic and Antarctic expeditions in 2007, with participants spending two weeks touring, researching and participating in workshops about the polar environment, education and outreach (www.studentsonice.com).

Ice explorers



Fabian Gottlieb Thaddeus von Bellingshausen (1778-1852)

The Estonian is probably the first person to have seen

Antarctica, after being appointed in 1819 to take two ships to find the 'bottom of the world'. On 28 January 1820 he came to within 30 kilometres of the Antarctic mainland, described in his logbooks as a 'great wall of ice'.



Fridtjof Nansen (1861-1930)

In 1882, on a voyage to Greenland, Nansen found a ship's log from a wreck off Siberia

and realized that the ice pack actually drifts around the Arctic Ocean. Eleven years later he deliberately locked his ship, *Fram*, into the pack ice, planning to go with the floes. But after making slow progress for a year, he decided to head north by sledge with Hjalmar Johansen, reaching 86°14'N – the furthest anyone had yet been. The two men had to spend the winter on Franz Josef Land, surviving only on what they could hunt, before rescue came and they returned to *Fram*. It took another year for the ship to get back to Norway.



Roald Engebret Gravning Amundsen (1872-1928)

Norwegian Amundsen, part of the first expedition successfully to

overwinter in the Antarctic, was racing to the North Pole in 1910 when he heard that Robert E Peary had beaten him. Turning south, he determined to be first at the South Pole instead; Captain Scott's ill-fated expedition was heading for it too, but Amundsen won, raising the Norwegian flag there on 14 December 1911.

Not just going with the floe

He seems like a real life Captain Planet. At only 28, David de Rothschild has explored Australia, Antarctica, New Zealand and Greenland, and has now crossed the Arctic. Named one of National Geographic's Emerging Explorers of 2007, his main concern is to use his adventures to mobilize environmental action, and he has now set up a global, interactive web-based youth network of ecological ambassadors – Adventure Ecology. TUNZA caught up with him while he was in London planning his next expedition, and started by asking about the health of the Arctic...

'The Arctic ice is a living puzzle. There is no consistency; the pieces are constantly moving. Surviving there means paying attention all the time!' David de Rothschild knows what he's talking about: from March to June 2006 he hiked, skied, dog-sledded and hopped ice floes from Russia to the Canadian Arctic across the Arctic Ocean – taking in the North Pole on the way.

'I wasn't sure what to expect,' he says. 'I hadn't walked across an ocean before, and, though I'd done a lot of research on climate change and its effects on the Arctic, I wasn't prepared for how much open water and dangerously thin ice there was. Paul Landry, a polar guide who had last been in the Arctic three years ago, was astounded at how much it had changed.'

In a way, it shouldn't have been such a surprise: de Rothschild dreamed up the trip, called Mission 1: Top of the World, specifically to highlight the changes our warming planet has brought to the Arctic. The team of four included two Canadians – Landry, on his fourth trip to the North Pole, and his daughter Sarah McNair-Landry, who at the age of 20 has traversed Greenland, Antarctica and the Arctic Ocean – and photographer Martin Hartley. Sixteen sled dogs rounded it off. Between them they carried 2.5 tonnes of gear and 35 kilograms of chocolate. But the team had no intention of being out of range in the frozen north for months on end: along the way, they used satellite technology to conduct interviews and podcasts, and blog about what they were doing and seeing.

Digital communication comes naturally to de Rothschild – a child of the 1980s, he grew up with computers and the internet – and he was taught about conservation from an early age. 'My father and aunt grew up in England during the Second World War,' he explains. 'Wastefulness and unnecessary consumption were unheard of. They had lived through rationing and real scarcity. They taught me by example to be aware of living within my means and resources. When I was growing up we reused plastic bags, and if it was cold we put on a jumper rather than turning up the heating.'

Cold places don't seem to bother de Rothschild – quite the reverse. In 2004-2005 he traversed Antarctica and then sped off to cross the Greenland ice cap. That's three vast polar landscapes in three years. Could it get a little monotonous? 'Absolutely not. They are very, very different. The Arctic was cold but humid because we were travelling over an ocean, not a continent. It was also noisy because the ice was constantly



Adventure Ecology

moving and cracking... and we had to be aware of wildlife like seals and polar bears: not an issue in Antarctica.

'In the centre of Antarctica it's dry and crisp. When you are skiing along, working up a sweat, it can feel like a pleasant alpine day and you look around and daydream. It's sterile and silent – a frozen desert.

'The scale of the geography in Greenland and Antarctica is immense. These two places fundamentally changed my perception of the natural world: it's not human centred at all, and we are – compared to a glacier or a mountain – minute.'

Before going off to the Arctic, de Rothschild set up Adventure Ecology, an internet portal (www.adventureecology.com) where young people can learn about environmental issues, share their stories, develop their own projects, and follow David's adventures. People all over the world celebrated with the Mission 1 team as they stood at the North Pole on 27 April 2006, and followed an agonizing decision by the team to stop the expedition on 8 June because the ice was rapidly breaking up.

The Arctic sea ice should be a solid, flat plain, but we were dealing with fresh, thin ice that wasn't stable. And it moved so much that there was rarely more than a football pitch's worth of flat ice. It was continually broken up by pressure ridges. There's no doubt in my mind that climate change is causing the changes. We saw open water in the Arctic in March. That's not healthy!

He is now planning his next trip, but this time he's not packing a scarf. Mission 2: Trash Waste will highlight the impact of waste on the planet, and will take him to the middle of the Pacific... on a raft made of plastic bottles. As de Rothschild points out, the health of the Earth is in our hands: 'The planet isn't the problem,' he reminds us, 'It's we who are making the problems for the planet.'



Library of Congress

Matthew Henson (1866-1955)

This black American was Robert E Peary's valet on the 1909 expedition to the North Pole. Henson

was an able hunter, driver of dog sleds and speaker of the Inuit language. His true contribution was recognized in 2000 when the National Geographic Society posthumously awarded him the Hubbard Medal, its highest honour.



UPP/Topfoto

Tenzing Norgay (1914-1986)

In 1953 Tenzing, the most famous of the Nepalese Sherpa people, and Edmund Hillary were the

first to conquer Mount Everest. Tenzing had climbed Everest as a porter on several expeditions in the 1930s, and in 1952 reached a record height as a member of a Swiss expedition, just a year before his historic first.



bancroftarnesenexplore.com

Liv Arnesen (b. 1953) and Ann Bancroft (b. 1955)

In 2001, former schoolteachers Arnesen (Norway) and Bancroft (USA)

became the first women to cross Antarctica's landmass, a 2,747-kilometre, 94-day trek. Each has also broken records on her own: Arnesen was the first woman to ski solo (and unsupported) to the South Pole while Bancroft was the first woman to cross the ice to both poles and the first woman to the North Pole.



www.180degrees.co.uk

Rob Gauntlett (b. 1987) and James Hooper (b. 1987)

Gauntlett and Hooper hope at 20 to be the first to travel from North to South Poles

under their own steam – skiing, sailing and cycling 35,406 kilometres – on their 180 Degree Pole to Pole Challenge. Rob and James want to raise awareness of global warming, and hope the Challenge will set an example by being carbon neutral: not only will they be manpowered; any emissions from support vehicles will be offset.

7 ICED WONDERS

Elusive bird

The Kittlitz's murrelet is a lonely bird. Alone among Arctic seabirds it seeks the protection of isolation, breeding high in remote mountains in Alaska and Siberia, laying only a single egg in depressions on the bare alpine ground rather than in conspicuous nests. After the egg hatches, the chick's parents carry one small fish at a time to their offspring. Only 10,000 of them now remain in the world, and they are threatened by climate change and pollution. As glaciers retreat inland, their summer feeding grounds – in the waters where glaciers meet the sea – disappear; and as the ocean warms the fish they eat decline. They are also vulnerable to an increasing risk of oil pollution.



Stacy Studebaker/USGS

Frozen fish

Antarctic ice fish (Antarctic notothenioids) regularly withstand temperatures as low as -2°C as they swim under pack ice. So why don't they freeze solid? Their secret weapon is glycopeptide – a mixture of sugar and amino acids that works much like the antifreeze humans use to melt ice on windows – which they produce and pump through their bodies. Some species of these eerily pale fish also have no haemoglobin (the red blood cells that carry oxygen), relying instead on the oxygen-rich waters of the Southern Ocean. And some species' large hearts beat just once every six seconds; understanding these cardiac systems could increase survival rates in people who have had heart-lung bypass surgery or are suffering from hypothermia.



Franco Banfi/Still Pictures



Alan Leschinski/UNEP/Topham

Snowy cat

Stealthy, solitary snow leopards are perhaps the least-studied endangered mammal on the planet, and for good reason. Nocturnal, they live 2,000 to 4,000 metres up in the Central Asian mountains, and can evade investigators by leaping 9 metres – six times their body length – in one bound. Though they have few natural enemies, their numbers have declined steadily since the 1970s; now only 4,000 to 8,000 are left in the wild. They are threatened by climate change, farmers trying to protect their livestock, and poaching for fur and traditional medicines. Involving local people in protecting them is the most effective strategy: in rural Nepal, for example, committees of elders, herders, women and village leaders spearhead the movement to conserve them.

Valuing vicuña

This rarest and smallest member of the camel family is adapted to the Altiplano – the Andes' arid, wind-lashed habitat 5,500 metres above sea level. Its large heart lets it survive the thin air, its narrow hoofs help it navigate rocky terrain, and its wool – valued for its extraordinary lightness – keeps it warm. After the Spanish conquest, demand for the wool drove it near to extinction. Conservation efforts since the mid-1960s have included adopting the old Incan practice of shearing and releasing the animals, which have made a dramatic comeback, numbering 200,000 today. However, they are still vulnerable to climate change: vicuña near the Quelccaya ice cap have been observed climbing to cooler, newly ice-free areas.



P Oxford/Still Pictures



A Hartl/Still Pictures

Mass krill

The vast Antarctic marine ecosystem is fuelled by a creature weighing just a single gram. But there are so many of these krill that, put together, they weigh more than all the people on Earth! These zooplankton are crustaceans, and look a lot like shrimp. They are not strong swimmers, so rely on the strong Antarctic currents to take them to their prey, single-celled phytoplankton floating on the ocean's surface. Krill drift around in swarms so massive they can be seen from space: 2 million tonnes of them can cover over 450 square kilometres. But their numbers may have dropped by 80 per cent since the 1970s, probably due to a combination of global warming and the commercial krill fishery.



AK Brian/www.akbrian.net

Wonder worms

Able to live for years without nourishment and thriving in conditions that would turn most organisms into icicles, the ice worm wriggles effortlessly through fissures in glacial ice sheets. It propels itself by secreting an ice-melting, tunnel-burrowing enzyme. Until recently the worm – which lives in glaciers and snowfields in coastal Alaska, British Columbia, Washington and Oregon – has been largely unstudied. But scientists are now keen to find out how enzymes that regulate their energy cycle allow them to thrive at temperatures where most organisms' cell energy runs out. This could be valuable in organ transplants, which depend on preserving tissue at extreme temperatures. But as the world warms up, the worms are under threat.

Cold calling

The Antarctic pack ice seems to stretch unbroken to the horizon, but it is actually dotted with round holes chewed by Weddell seals to give them breathing vents. Named after the British explorer who first documented them, Weddells hunt fish and octopus by diving deep beneath them and spotting them in silhouette against the ice. By collapsing their lungs and lowering their heart rate, they can hunt for up to an hour without breathing, and dive as far down as 700 metres. They are hunted themselves by orcas and leopard seals, but are excellent communicators, allowing them to warn of approaching danger; scientists have classified 34 distinct Weddell phrases and calls.



E Hummel/Still Pictures



ice

ESA/DLR/FU Berlin (G. Neukum)

Mars still has it. Shouldn't we preserve ours?

