

The UNEP Magazine for Youth



TUNZA



for young people · by young people · about young people

“Enjoying the environment is key to its preservation.”



 THE WINTER OLYMPICS **VANCOUVER 2010** 

TUNZA

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ISSN 1727-8902

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Printed in the United Kingdom

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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.

The partnership agreement, renewed to run through 2010, lays down a basis for UNEP and Bayer to enlarge their longstanding collaboration to bring successful initiatives to countries

around the world 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 Africa, Asia Pacific, Europe, Latin America, North America and West Asia, the Asia-Pacific Eco-Minds forum, and a photo competition, 'Ecology in Focus', in Eastern Europe.

Numbers

2°C is the rise in global temperatures (since 'pre-industrial levels') that has been recognized by the Copenhagen Accord as the upper allowable limit.

12 is the number of accredited young people allowed to attend the final session of the Copenhagen Climate Conference (COP-15).

16 is COP-16, the next UN climate meeting, which will be held in Mexico in December 2010. This provides the next opportunity to come to a binding international agreement on climate change.

20 is the percentage of CO₂ emissions that come from forest degradation and loss. Recognition of UN-REDD (a mechanism for reducing these emissions) was one of the achievements of COP-15.

192 is the number of nations attending COP-15.

1,500 + is the number of youth advocates accredited for the COP-15.

1998 is the hottest year on record, but some predict that 2010 will be yet hotter.

2,600 is the number of people evacuated from the Carteret Islands in May 2009 because of rising sea levels.

5,000 + is the number of young people who made their voices heard in Copenhagen.

12,373 is the number of people who will lose their home when Tuvalu becomes uninhabitable as a result of rising sea levels.

45,000 is the number of people accredited to the Copenhagen COP-15. But the Bella Centre, where the Conference took place, had capacity for just 15,000.

15,245,151 is the number of global citizens who signed a petition asking political leaders to sign a climate deal in Copenhagen that was ambitious, fair and binding.

30,000,000,000 is the quantity of US dollars committed by developed countries in the Copenhagen Accord for climate change adaptation and mitigation between 2010 and 2012, with priority given to the most vulnerable nations, such as the least developed countries, small island developing states and Africa.

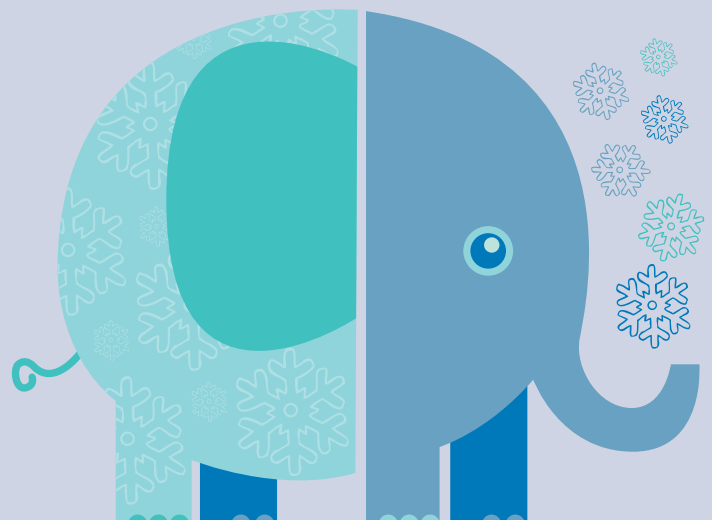
100,000,000,000 is the quantity of US dollars that, by 2020, must be mobilized annually by the developed countries to address the needs of developing countries, according to the Copenhagen Accord.

EDITORIAL

Snow and ice – the very foundation of the glories of the winter Olympics – are the most visible sign, and one of the most sensitive indicators, of climate change. The Arctic ice cap shrank to its smallest ever extent in September 2007, reaching a level not expected until 2050. Though it has slightly recovered since, it is still only about 40 per cent of the size and thickness that it used to be. Antarctic ice shelves are disintegrating and the great ice sheet that covers the frozen continent is showing signs of melting. And everywhere glaciers are retreating, posing an enormous future threat to the water supplies of billions of people.

Faced with this and many other warnings of disasters to come, the world's governments still managed to squander the chance of working out the basis of a new, effective, fair, inclusive treaty at the Copenhagen climate summit, even though, when the meeting opened, it was almost within their grasp. There will be many post mortems on how it could have gone so inexplicably wrong, but we need to look forward, not back, and use the crucial year ahead to ensure that a treaty is agreed and finalized when governments meet again in Mexico in December 2010, if not before.

One benefit from Copenhagen was the emergence of a strong voice from youth, demanding that they should not inherit a planet where it would be hard to live decent lives. Their voice joined with those of the small island states and African countries, who are among those most vulnerable to global warming, to create a new fault line in international diplomacy – between the big polluters and their potential victims. We must not let that momentum be lost, but shame our leaders into action by asking them how they can dare to endanger our future. And we must regulate our own consumption so as to lead low-carbon lives, both to give us the authority to speak, and for the sake of the planet.



Such a vast international event as the Winter Olympics is bound to take a toll on the environment. Venues must be built and race-courses carved out of hillsides, while transporting, feeding and housing the thousands of athletes, spectators and media also makes a big impact.

It would be easy to lose sight of the planet in all the effort and the excitement surrounding the Games. But the Vancouver Organizing Committee (VANOC) has made environmental sustainability a priority, informing every decision, from where to put ski trails to what materials are used in buildings. And it aims not just to make the Games as green as possible, but to contribute to making Vancouver and Whistler – a resort some 125 kilometres to the north where the cross-country, biathlon, Nordic combined and ski-jumping events will be held – more sustainable for long afterwards.

UNEP has provided the environmental perspective to Olympiads since the 2006 Torino Games, and will carry out an environmental assessment of the Vancouver Games, providing details of their environmental impact in a year that will also see the FIFA World Cup, the first ever Youth Olympics and the Commonwealth Games.

Birds and bees

The star attraction of the Olympic redevelopment is a 2.4-hectare green roof covering the newly expanded Vancouver Convention Centre on the city's waterfront, from which 10,000 journalists will cover the games. The living roof – Canada's largest – provides hives for 60,000 bees and is planted with more than 400,000 indigenous coastal plants and grasses from 19 species, designed to attract insects and birds. But it is not all that is green about the building. A marine habitat, complete with tidal zones, is built into its foundations, providing

White and green



the right environment for barnacles, mussels, seaweed, starfish, crabs and fish. And there's more: its use of fresh water has been reduced by up to 70 per cent through rainwater catchment, desalinization and sewage treatment systems. Meanwhile, the constant temperature of sea water is to be used for carbon-free heating and cooling through a heat-exchange system.

Creek check

Madely Creek, home to frogs, fish and other wildlife, runs through the heart of Whistler Olympic Park, so special steps are being taken with the aim of protecting it. The Park's staff only use biodegradable cleaners and soaps, and employ a non-toxic product to melt ice on slippery walkways. Wastewater is treated onsite, including by high-level ultraviolet filtration, and is monitored daily before being returned to the creek, which itself gets further health checks.

No parking

Spectator parking is banned at all venues to discourage car use, and walking, cycling and public transport are being actively promoted instead. Four hundred special buses carry spectators between central Vancouver, Whistler and the Cypress Mountain ski resort, 30 kilometres from the Olympic Village. In Whistler itself, 22 hydrogen-fuelled buses have been put on the streets, another addition to an extensive

public transport system. And a new 19-kilometre Canada Line railway is to connect key places.

Re-heating

Carbon emissions should be cut back and electricity saved by re-using waste heat. At the Hillcrest/Nat Bailey Stadium Park, where curling events will take place, heat generated from keeping the ice rink frozen will be used to warm the swimming pool next door. And heat from the wastewater treatment plant at the Olympic Village Whistler will provide 90 per cent of the energy needed for its domestic heat and hot water.

Relocation, relocation

Twelve locally significant plant species – including the common butterwort, three-leafed goldthread and round-leaved sundew – have been relocated from a small wetland due to be developed as a snow-making reservoir at the Cypress Mountain snowboard venue in West Vancouver. Volunteers dug up plants and replanted them in a similar wetland nearby, and they are expected to bring rare insects and other wildlife to the new site.

Similarly, trees in the way of the Vancouver Olympic Centre were moved to other sites nearby. And when the construction team at the Whistler Creekside alpine skiing venue had to disturb the local tailed frog population, they moved both frogs and tadpoles by hand 40 metres upstream.



VANOC/COVAN/www.vancouver2010.com

Beetle drive

More than 120,000 hectares of commercially valuable lodgepole pine in British Columbia's forests have been stricken by the mountain pine beetle. Now the 2-hectare ceiling of the Richmond Olympic Oval – where speed-skating will take place – has been made from beetle-damaged lumber that would otherwise have been discarded. Using such salvaged wood saves cutting down healthy trees, and, it is hoped, may inspire others to use the material, helping the communities that have been hit by the infestation.

Green backup

Black-outs are unthinkable at such a global event, and VANOC is relying on British Columbia's clean existing hydroelectric power. Each venue is linked with two separate power lines from different substations, so that if one line goes down there's still power from the other. Sometimes generators are unavoidable, so it plans to use low-emission models that can run quietly on biodiesel, and remain off until needed. It is hoped that these measures will reduce greenhouse gas emissions from auxiliary power sources by 90 per cent.

Big footprint

Even with green measures in place, VANOC estimates that the 2010 Winter Games will generate 270,000 tonnes of carbon emissions during the period from when Vancouver won its bid, in 2003, until the end of July 2010 when operations will be wrapped up. Some 120,000 tonnes of these will be direct emissions (such as from venue construction, operations, athlete travel and accommodation, and waste management) and 150,000 tonnes indirect, for example those from spectator and sponsor air travel and accommodation, which are outside VANOC's control.

All in all, the green initiatives aim to reduce the direct carbon footprint of the Games by 18 per cent – saving 57,000 tonnes of carbon emissions. Once the Games are over, VANOC plans to offset the direct emissions with the help of Offsetters, a carbon asset management company. This will work with clean technology companies based in British Columbia, supporting technologies such as cellulosic ethanol production (biofuel made from wood debris), computer-controlled hybrid fossil-fuel and electric heating systems, and other projects that should help reduce future emissions. The firm will also work with Games partners, sponsors and participants who volunteer to offset the Games' indirect emissions.

Ben Hulse/VANOC



VANCOUVER:



Maybe it's the stellar location, nestled between the Pacific Ocean, the mouth of the Fraser River and a snow-topped coastal mountain range. Or perhaps it is its citizens' reputation as gortex-clad outdoorsmen who can harvest tomatoes while the rest of the country is blanketed by snow. At any rate, Vancouver's position as Canada's greenest city is almost unassailable.

Not content to rest on its reputation, the city has embarked on an ambitious green strategy in the six years since it learned it would be hosting the 2010 Winter Olympics. For 16 days in February, the world will be wowed by toned athletes, but the city of Vancouver will be using the opportunity to launch its own gold-medal bid: to become the world's greenest city by 2020.



In February 2009, the newly elected Mayor, Gregor Robertson, announced the Greenest City Initiative, an action plan mapping how the city can achieve its goal. And he also introduced Vancouverites to the Greenest City Action Team – a diverse group including scientist and environmentalist Dr David Suzuki and former provincial Premier Mike Harcourt – which is responsible for leading the city's efforts to enhance sustainability and make concrete progress on greening it.

At 44, the mayor is no stranger to ambitious plans. After finishing university he restored a wooden sailboat and helmed it around the Pacific. At 25 he returned to British Columbia and started an organic farm near Vancouver that grew to include an organic juice company with 50 employees.

Robertson is lucky; his sustainability plans have a strong foundation. Way back in 1990, well before the Canadian environmental movement enjoyed strong popular support, the city commissioned the *Clouds of Change* report to address air pollution in the greater Vancouver area. It recommended severe cuts to CO₂ emissions (20 per cent below 1988 levels by 2005) and forced an evaluation of industrial pollution.

The current jewel in Vancouver's green crown descends directly from the 1990 report. Southeast False Creek – 32 hectares of industrial land bordering a sheltered Pacific inlet which used to be one of the city's most polluted areas – is now to become a futuristic ecovillage. Eventually the community will have 600,000 square metres of LEED-certified (the Leadership in Energy and Environmental Design rating scheme), green-roofed, residential housing and commercial space, a community centre, a school, its own sustainable power generation plant and 10.5 hectares of green space for parks, wetlands and community agriculture. Though construction continues, the shiny new Southeast False Creek will open its doors in February to 16,000 people as the 2010 Olympic Village.

But the greening of Vancouver extends well beyond this. The *Clouds of Change* report suggested planting large trees in city parks and public spaces to offset carbon emissions and to reduce water runoff. With young trees and green roofs, the city's canopy is verdant, and Mayor Robertson has now turned his attention to the city floor. Community vegetable gardens and smaller, flower-filled street gardens have taken root across the city, even at City Hall: in



GREENEST CITY



Photos: City of Vancouver/<http://vancouver.ca>

March 2009, part of its north lawn was dug up to create a community vegetable garden.



'If we want Vancouver to be a truly sustainable city, City Hall needs to lead the way,' Mayor Robertson explains. 'By converting part of the City Hall lawn into a community garden, Vancouver is walking the talk when it comes to producing local food.'

Robertson's concept of sustainability – a marriage of ecological and social benefits – demands citizen engagement. The City Hall garden, tended by volunteers, donates the bulk of its produce to food-banks and soup kitchens in the troubled Downtown Eastside. The website for the Green Streets programme, which encourages people to 'adopt' gardens in traffic roundabouts, suggests they should 'approach a neighbour on the corner and ask to use their hose connection'.



With a growing number of flowering traffic roundabouts, Vancouver now has 2,750 registered community gardens.

And, if all goes according to plan, the aspiring 'Greenest City' will have fewer gas-guzzlers zipping around these carefully tended roundabouts. Vancouver is going electric. In October 2009, the Renault-Nissan Alliance announced it would be the Canadian launch point for the Nissan LEAF, a compact five-door car completely fuelled by electricity.

With an abundance of renewable hydroelectricity generated in British Columbia, Vancouver is developing a sophisticated charging infrastructure for electric vehicles and all new houses must have dedicated car-charging outlets. 'We've moved very aggressively to bring in electric vehicle-charging



infrastructure regulations for Vancouver,' Mayor Robertson points out. 'The city will need electric vehicles to charge on that new infrastructure.'

For those who prefer pedal power to electric or petrol, a bike lane pilot project across the busy Burrard Bridge has made cycling into downtown safer and faster. An average of 4,718 cyclists cross the bridge daily, 25 per cent more than before the lane was opened.

Making a city of half a million people the greenest in the world is neither a quick nor a simple goal, but Mayor Robertson remains optimistic.

Claire Hastings, Canada



Taking part

M. Rennertz/Bayer

Tell me, and I will forget. Show me, and perhaps I will remember. Let me take part, and I will understand.' Ottmar Hartwig likes to quote the Chinese proverb. And, as if to prove its accuracy, he founded the Lumbricus Ecomobile, a brightly painted, solar-powered bus with a built-in laboratory. Usually, the vehicle provides German schoolchildren with hands-on, on-site education about nature. But today, young adult environmentalists – delegates at Bayer's Young Environmental Envoy 2009 conference – were seated at its desks, listening to Hartwig and watching live footage of a magnified woodlouse scurrying about on a TV screen.

He explained: 'If you want to learn to swim, you go to water. We take children out to forests and fields where they make close observations of natural processes, examine, identify and record plants and animals, and present their findings to each other.'

But what does this have to do with sustainable development – the main theme of the BYEE conference? 'The pupils of today are the homeowners, car builders and business people of the future,' he explained. 'So we aim to give children a love of nature, which they will have all their lives.'

This was the final day of the week-long event, hosted annually by Bayer in partnership with UNEP. It brings together 50 young people (chosen from 1,300 applicants) from 19 countries across Asia, South America, Africa and Europe who have demonstrated extraordinary commitment to environmental protection, giving them a front-row perspective on how Germany's people, government and industry cooperate to protect the environment.

During the week, delegates pulled sediments from the bottom of the Rhine on a state water-monitoring laboratory ship, visited a waste incineration plant to learn how toxins are scrubbed from flue gases, and observed German citizens sorting waste at a municipal recycling facility.

They also made biodiesel at BayLab Plants – Bayer's educational labs where pupils get a taste of the practical work involved in finding innovative solutions to global problems.

Johannes-Rudolf Jansen of Bayer CropScience showed them how to add methanol and a catalyst to rapeseed oil, heating the mixture and stirring it to create biodiesel. The lesson was not just about understanding the chemical process, but illustrated a problem with biodiesel: as the golden fuel rose to the top, it left a clear by-product, glycerol, in the bottom half of the flask. 'If you produce 1 billion tonnes of biodiesel, you wind up with 2 billion tonnes of this waste, which must be disposed of,' said Jansen.

In fact, BYEE Alfredo Díaz from Colombia is already looking for a solution to this. His idea is to transform glycerol into ethanol, which could either be used as a substitute for gasoline or to produce hydrogen for fuel cells. 'I work with microorganisms which ingest glycerol and produce ethanol,' he says. 'We're still at the experimental stages, but the goal is to be able to scale the process up to industrial level, in any climatic condition, and to close the cycle of biofuels.'

If such practical experiences showed the 'how', workshops led by environmental monitoring experts, conservationists, scientists and other experts helped explain 'why'. A panel discussion on sustainable development at the former German parliament building in Bonn, for example, covered such subjects as population growth, energy, agriculture and sustainable building.

Most exciting, however, were the Envoys' own environmental innovations, which Bayer Management Board Member Wolfgang Plischke acknowledged and welcomed in his opening address. 'You have all demonstrated your passion in qualifying for this trip,' he said. 'Climate change is a global challenge; we are all called to take part in the discussion about the best ways to tackle it. I strongly believe that innovation is the only way forward.'

Satinder Bindra, UNEP's Director of Communications and Public Information, also expressed admiration for their vision and hard work. 'Combatting climate change is one of the biggest challenges facing humankind, requiring the responsibility, dedication and action shown by all the Bayer Young Environmental Envoys,' he said.



Karen Eng

M. Rennertz/Bayer

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Tell me, and I will forget. Show me, and perhaps I will remember.

Let me take part, and I will understand.



M. Rennertz/Bayer

Green shoots

It's called *die Sprösslinge* – German for 'shoots' – and it's a zero-emissions kindergarten for 60 children of Bayer employees at the company's Monheim site.

It's also the first building to be completed under Bayer MaterialScience's EcoCommercial Building initiative, combining the company's materials expertise with the know-how of architects, developers and partners in constructing energy-optimized commercial buildings tailored to their environments. The kindergarten's bright, 1,267-square-metre structure has flat photovoltaic panels on the roof, thick polyurethane insulation in the walls and around window frames, a geothermal heat pump, and skylights to make good use of daylight. The initiative's next eco-building is to be in New Delhi.

Other Bayer programmes now include developing efficient, high-yielding rice and vegetable cultivation; creating tools for measuring industrial emissions and energy efficiency; and providing drugs – such as medicine for Chagas disease and contraceptive pills – free of charge to developing countries.

'For us, innovations are the driver of sustainability,' says Werner Wenning, Chairman of the Bayer Board of Management. 'And we are aiming for sustainability in everything we do. We are investing in the future – for our own benefit and that of society as a whole.'

Big feet, big ideas

At every Bayer Young Environmental Envoy conference, Envoys share ideas. Some are still on the drawing board; others have already been implemented. Imaginative solutions abound.



Water wise

Alperen Dülge, Bahçeşehir University, Istanbul, Turkey

Seventy per cent of wastewater worldwide is 'grey' water – the water we use for washing dishes and bathing – and only 30 per cent is 'black' water, or sewage. Yet it is all collected and treated with the same processes.

I propose separating black water and grey water at the point of contamination – buildings – and piping them separately to the water treatment plant. The grey water would be treated lightly and pumped back for showering and gardening, while the black water would be given more treatment and pumped back for toilet flushing, car washing, and other applications that don't require human contact. Fresh water would then only be used for drinking and cooking.

This system would save at least 70 per cent of water use, doesn't require building new treatment plants, and would cost extra only for piping, pumps and labour, which would be balanced by the water savings.

Of course we can't retrofit entire cities, but such a system could easily be implemented when buildings and infrastructure need replacing. For newly built communities in remote regions, it could easily be put into place and would contribute to substantial water savings.



Trees and lavatories

David Osiany, University of Nairobi, Nairobi, Kenya

Since 2006 I've planted trees like crazy. I've personally planted more than 2,000 (perhaps 1,100 have survived) and am aiming for 5,000 at the start of 2010. Whenever I travel, I carry trees: I buy them in Nairobi or in the village, and plant them by the wayside. If I see someone nearby, I offer a few shillings, and say: 'Why don't you take care of this tree?' When I can, I go back and check on them.

My biggest challenge is funding: I set aside 10 per cent of my earnings to pay for the trees. Sometimes I want to take 100 seedlings with me but can only afford 10. I also worry that my trees will die. Maintenance is important.

As president of my university's student body, I started a programme to fund a youth tree-planting project by using campus toilets as advertising space. Companies targeting students pay monthly to advertise in the stalls, and 70 per cent of this will be used to buy seedlings for primary and secondary school environment clubs who will plant the trees. Twenty per cent of the money will be used to maintain the toilets – eco-friendly ones – and 10 per cent will be kept in reserve to reward students who show they have kept the trees alive.

The way is long, the time is short. But we must do it.

E.A. Antunes/UNEP/Topham



Joerg Boethling/Still Pictures



M. Rennertz/Bayer



Dandee Bitancor



Daniela Jaramillo Troya





Retreads

**Riska Mirzalina, Prasetya Mulya
Business School, Bogor City,
Indonesia**

I didn't intend to start a green fashion business. But, a year ago, I decided to design and make myself shoes, partly because I have big feet. I found a shoemaker who, over the course of a month, taught me how to craft a pair. My classmates liked them and put pressure on me to make shoes for them, too.

I researched recycled materials, and discovered a glut of discarded textiles destined for incineration in my area. Indonesia is the second largest exporter of textiles, after India, and there are many garment manufacturers in Western Java, but factories are closing because the recession is slowing demand. Lower grades of fabric get dumped too. I began gathering this discarded material, hired shoemakers in a village, and gave them my designs.

Funded with a loan from friends and relatives, I started a business and began selling ready-made and custom-made shoes online. Magazines and newspapers covered the story, and I now have customers in Indonesia, the Philippines and the United States of America.

I aim to make the business green and sustainable throughout: we use up to 70 per cent recycled materials in the shoes, recycled corrugated cardboard box packaging, and dark browser colours on our website to minimize energy waste, and our web server is powered by wind energy. The money I save by using locally sourced, recycled materials I channel to the shoemakers' wages. I also market my shoes at WWF and Earth Day events. <http://klassamirza.multiply.com/>



Lung Walls

**Dandee Bitancor, Bicol State
University, Legazpi City, Philippines**

My passion for environmental protection is rooted in my upbringing, but I was inspired to create the Lung Wall while climbing the Mayon Volcano, near my city, and finding that people burn the forests and vegetation on its slopes to grow vegetables, making them vulnerable to flash floods. Many lives have been lost. I thought: 'Why burn the forest if you can have your own vegetable production in the heart of the city, using a tiny strip of land?'

The Lung Wall – built along the concrete perimeter of my university campus – is a vertical garden, where climbing vegetables form wall-like canopies of leaves that filter pollutants from urban air while producing food. The garden is composed of ten 4-by-4 metre trellises made of steel tubing tied with nylon string, on which grow cucumber, squash, string beans, and so on.

The first step was to dig a long trench. With the help of classmates, I collected plant waste from around campus, such as dry leaves which are normally burned, market waste like fruit peelings, and food waste from the canteen. All this organic material went into the trench, forming a compost pit. I positioned the trellises over these pits and planted my vegetables in the compost. Just before leaving for the Bayer conference, I harvested three pumpkins and a couple of kilos of cucumbers.

When I return to the Philippines, I will visit farming communities where I have started to help build Lung Walls. There has been resistance. They say: 'You have grievances against us because we burned the forest.' I politely and humbly tell them: 'No, I am also a farmer. I'm just giving you a choice that is less hazardous to the environment.'



Women's worth

**Daniela Jaramillo Troya, Universidad
San Francisco de Quito, Quito, Ecuador**

My project (the Youth Group Network for Leaders in Responsible Sexuality) promotes peer education as a solution for overpopulation, an issue not discussed as often as CO₂ emissions and renewable energy.

Most people in Ecuador, regardless of socioeconomic status, know about HIV and contraception, but only 4 per cent of those aged 15 to 30 protect themselves. Why? Culturally, women come second to men, and feel uncomfortable with their sexuality. This is why some young women don't go to the doctor for contraceptives or to look after their reproductive health. But it is only when people accept and take charge of their sexuality that they can engage in family planning.

With the support of Fundación Nahuel, a non-governmental organization, I have so far trained 10 youth leaders – volunteers from universities – to facilitate self-esteem workshops. We visit schools and lead activities that help girls feel better about themselves. They stand in front of a small group and state their own opinions, for example. Once they are comfortable, we get them talking about sexuality and self-acceptance. So far we have reached about 60 girls between the ages of 13 and 18. In 2010, we plan to train 60 leaders and to reach 300 girls from poor areas in and around Quito.

We do discuss the environment and why it's important not to have too many children, but poor people mainly think about survival. So we put it in such terms as: 'How will you feed your children?' It's still about saving resources.

Population has an effect on climate change, and we must also consider how people will adapt to changing conditions. My aim is not to tell women how many children to have, but to empower them to make informed decisions, while considering their own well-being.

SHIFTING GROUND

Land across the Arctic is held up by permafrost, layers of permanently frozen subsurface soil varying in thickness from a few metres to a kilometre deep. The frozen layer holds moisture near the surface, forming Arctic lakes and streams, important habitat for wildlife. But the Arctic is warming at almost double the global average rate, and the permafrost has begun to thaw.

Inhabitants of the coastal Inupiat village of Shishmaref **(1)**, Alaska, are planning to evacuate their tiny island composed of sand and permafrost. The sea ice that once protected the island from storm surges has disappeared, and thawing permafrost makes the island more vulnerable to erosion.

When permafrost thaws, its solid foundation melts away: a difference of 3°C reduces the capacity of the ground to support heavy structures by 70 per cent. More than 500 tall buildings have been reported damaged due to melting permafrost in Norris and Yakutsk **(2)**, Alaska, and thaw-related damage already costs Alaska about \$35 million per year, particularly in road repair.

In Canada, a recent government report warned that the country is ill prepared for thaw-induced damage to roads, runways, buildings, and energy and communications infrastructure.

In Siberia **(3)**, where indigenous nomadic peoples like the Nenets still herd reindeer, melting tundra disrupts traditional migration paths and times, and changing vegetation affects animal health.

Thaws cause the Arctic lakes to drain, so that some can disappear altogether. Indigenous Arctic peoples in Alaska and Siberia, who rely on fish from these lakes for food, are reporting a shrinking catch.

DRYING UP

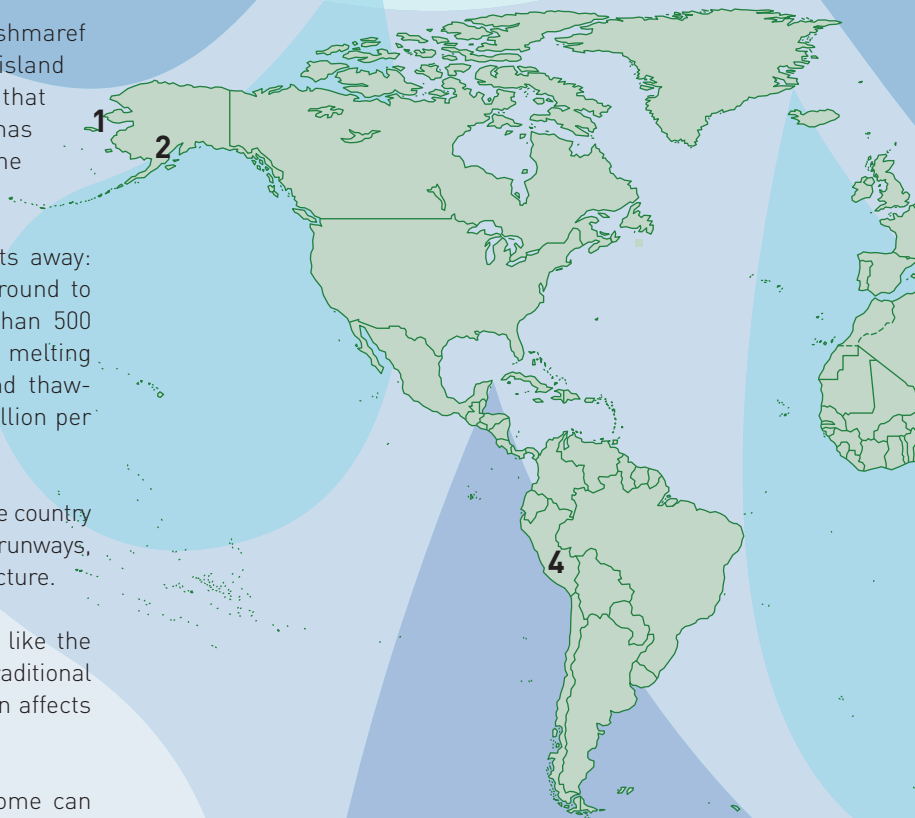
Glaciers in the tropical Andes provide fresh water for millions throughout Bolivia, Peru and Ecuador. The Quelccaya ice cap in Peru **(4)**, the largest ice cap in the tropics, is melting so quickly that scientists believe it will disappear by 2100. Farmers in Pucarumi, at the foot of the retreating Ausangate Glacier, are planting potatoes ever higher where water still flows. But as soil is less plentiful and rich, they must use chemical fertilizers; meanwhile their alpacas are feeding on thinning pastures and providing less wool.

Communities downstream of Tanzania's Mount Kilimanjaro **(5)** are experiencing reduced flows in rivers and wells, and are beginning to compete for fresh water and productive pasture and farmland.

Photos: **1** Still from the documentary *The last days of Shishmaref* by Jan Louter/www.thelastdaysofshishmaref.net; **2** Fred Bruemmer/Still Pictures; **3** Julia Vishnevets; **4** Lattes Emmanuel/BIOS/Still Pictures; **5** McPhoto/Still Pictures; **6** <http://pamirtimes.net/2008/06/page/3>; **7** Matthieu Paley/www.paleyphoto.com; **8** Brent Olson/brent@geoex.com; **9** Abir Abdullah/Still Pictures; **10** Kobeh Pascal/Biosphoto/Still Pictures; **11** Toby Parkinson/Oxfam.

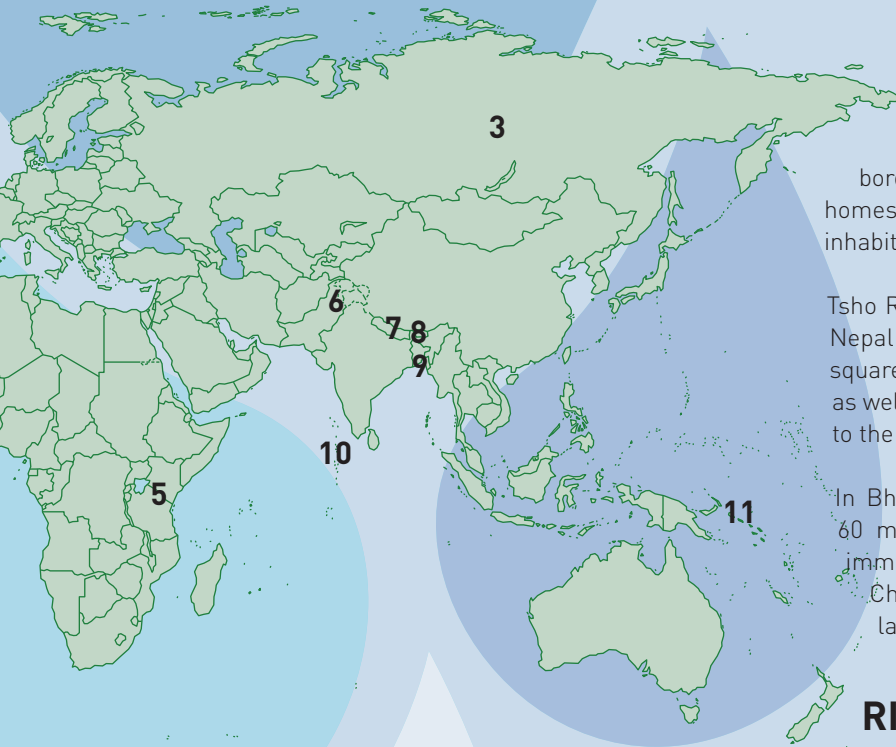
The hum

People often dismiss the impacts of melting ice as being tomorrow's problem...



an crisis

...but for many people all around the globe, the crisis has already begun.



GLACIAL LAKE OUTBURST FLOODS

Runoff from retreating glaciers forms glacial lakes, but rapid melt is overloading the lakes, which can cause them to break through moraines (the masses of rock and sediment that contain them), releasing catastrophic floods.

Glaciers in the Himalayas are retreating more quickly than anywhere else in the world. According to UNEP, at least 50 glacial lakes in Nepal and Bhutan are susceptible to outburst floods, while those in Pakistan, India and China have yet to be counted.

In summer 2007, four floods hit the small village of Chut Ghush, in the Hunza Valley (6) near the border between Pakistan and China. The floods damaged homes, agricultural land and power supplies, and the inhabitants had to be evacuated.

Tsho Rolpa glacial lake, considered the most dangerous in Nepal (7), has grown from 0.23 square kilometres to 1.4 square kilometres in half a century. It threatens 10,000 lives as well as farmland, livestock and infrastructure, all the way to the village of Tribeni, 108 kilometres to the south.

In Bhutan (8), glaciers are melting at the rate of up to 60 metres per decade, and 25 swollen lakes pose an imminent threat to the country's Punakha-Wangdi and Chamkhar valleys, where a tenth of Bhutan's population lives.

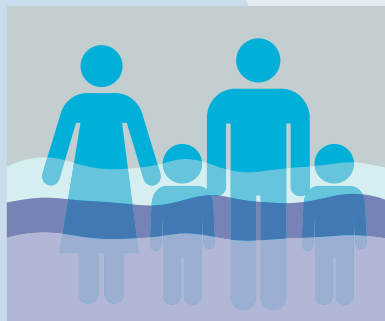
RISING WATERS

Global sea level rose by an average of between 1 and 2 millimetres annually over the last century. Since 1992, the rate has increased to 3 millimetres a year due to glacial melt and thermal expansion (the increase in water volume as it warms). Coastal floods salinate agricultural fields and freshwater supplies, killing trees, harming rice crops and forcing people to drink contaminated water.

Bangladesh (9) often floods due to its many rivers, but sea-level rise and melting Himalayan glaciers make matters worse. In 2004, floods swamped two thirds of the country. The region is also experiencing increasingly violent storms, such as cyclone Sidr, which killed 3,500 people and displaced 2 million in November 2007, followed by more deadly floods.

Sea-level rise and storms are eroding the Indian Ocean's Maldives islands (10), which stand only an average 1.5 metres above sea level. Citizens are shoring up beaches with stone and sand and building brick sea barriers to keep buildings from washing away.

In early 2009, the inhabitants of Papua New Guinea's Carteret atoll (11) in the South Pacific began evacuating to Bougainville, an island 80 kilometres away. For 20 years, islanders had planted mangroves and built sea walls against storm surges and high tides. Experts estimate the atoll will be submerged by 2015.



Racing downhill

Two Canadian winter sports activists – an Olympic contender and a young Olympic hopeful – describe what is happening to the snow they know so well.

Snowboarder **Justin Lamoureux** competed in men's Halfpipe at the 2006 Winter Olympics with the Canadian Olympic Snowboard Team, and will do so again in this year's Games.

I learned how to ski when I was one, almost as soon as I learned to walk. I started snowboarding at 12 but didn't start competing seriously until I was 19.

As a snowboarder I've visited Europe, Australia, New Zealand, Japan, Korea, Chile and other parts of North America, but Alaska is the most awe-inspiring place I've ever been. A few years ago, I was asked to snowboard there for a TV show and found everything about it – the grandeur of the mountains, ocean, massive glaciers – just incredible.

My sport means I need to keep a constant eye on weather, and sadly, I've already seen signs of climate change – particularly glacial melt – that make me worry for the future of snow sports. Competing in the same places year after year for over a decade, I have photos and memories of where glaciers used to be, and they've definitely retreated. Winter weather patterns are more

erratic, too: I've seen only a few centimetres of snow in the high Swiss Alps in February.

As for the impact of the sports themselves, I find those who visit wilderness areas are careful to minimize their footprint. Ski areas make an impact crossing alpine terrain, but many animals abandon high mountain areas during winter, heading for valleys. Most wintertime recreation takes place on the snow, and doesn't damage fragile ground vegetation. Besides, enjoying the wild is key to preserving it. It's easy to stay in the city and ignore nature, but getting out and having fun helps people to remain aware of the environment, and makes them want to protect it.

It was amazing to represent my country in the 2006 Olympics, and being an Olympic athlete puts me in a good position to campaign for environmental protection. Last winter, more than 70 of us wrote to VANOC, the Vancouver Organizing Committee, asking them to follow through on the promise they had made to offset carbon emissions in their bid for the games. One of VANOC's climatologists told me our letter was 'instrumental' in pushing the Committee to start working in partnership with a provider of carbon offsets. And we ask our fans do their best to learn about the issues and reduce their carbon footprints, whether travelling or at home.

I am a spokesperson for the David Suzuki Foundation, a Canadian environmental organization, and a member of its Play It Cool programme. Athletes – including skiers, snowboarders, rowers and more than half the National Hockey League – offset all their travel emissions. I've taken it a step further and offset my whole life, while minimizing my carbon footprint and taking every opportunity to get people to think about the environment. So I'm mostly trying to lead by example.



Phil Tifo

Phil Tifo

I belong to the Wet'suwet'en nation, from Moricetown, a small reserve in British Columbia. My grandparents were fluent in Wet'suwet'en, and at school we learned our culture's songs, stories and prayers.

It is true, as they say, that 'it takes a village to raise a child'. If it were not for my background, I wouldn't be where I am today. The First Nations Team gave me my opportunity, and my community is unconditionally supportive. So having the chance to serve as a mentor, role model and ambassador for First Nations youth is even more important for me than competing. That is my passion, and where I find success.

The community still holds ceremonial feasts, our way of governing. Trapping and hunting are still traditional practices: everything that's caught is used, we only take what is needed, and we're thankful for what the creator gives us.

Moricetown has long winters. When I was a little girl, the plough would pile snow high by the roadside, perfect for skiing and snowboarding: locally, we call it champagne powder because it's so soft. But the winters are getting warmer: I remember having to incorporate snowsuits into our Hallowe'en costumes, but in the last two years, snow hasn't come until Christmas.

So I'm glad to know my peers around the world are taking climate change seriously. I encourage everyone to do at least one thing, whether it's cycling to school or not wasting food. We can only do this together; if we all take small steps, there will be huge results. *Sne kal yëgh* (thank you)!



cb6379/flickr

Chelsie Mitchell launched her snowboarding career at 16, joining the First Nations Snowboard Team, a Canadian initiative for indigenous youth. At 22 she became the first indigenous woman to join the British Columbia team. She will be a torchbearer in this year's Games and is training to compete in the 2014 Olympics.

VANOC/COVAN/www.vancouver2010.com





Daughter of necessity

Imwriter/Flickr

Winter sports often originated in necessity. Skiing, for example, is thought to have begun thousands of years ago in Arctic Europe and Asia when people strapped animal bones to their feet with leather to hunt and travel. Similarly, scholars believe the first ice skates, also made of bone and leather, originated at least five millennia ago in southern Finland, where the terrain included many small lakes. Other games rooted in traditional Arctic activities such as racing sled dogs or playing ancient games of endurance have become popular in the last three decades.

A dog's life

The Canadian Inuit dog, or *qimmiq* – whose coarse hairs cover a thick undercoat that provides natural insulation from cold and wet – has lived in the Arctic for at least four millennia, as long as the Inuit people have lived there themselves.

The dogs have helped people survive in the harshest of environments by tracking prey and serving as guardians, and even providing an emergency food supply. No one is sure when they were first harnessed to sleds to pull food, fuel and people across snow and ice, but archae-

ologists have found remains of sleds from nearly a thousand years ago.

Dog sleds were later adopted by European trappers and gold prospectors in Arctic North America. The Norwegian explorer Roald Amundsen even used them on his 1910-1912 expedition to the South Pole. In winter 1925 a sled relay – of 20 drivers and over 100 dogs – famously brought medicine over many kilometres from Anchorage to the ice-bound town of Nome to treat a diphtheria epidemic.

Sled dogs are now commonly used for transport only in Greenland,

having mostly been replaced by snowmobiles. But racing has become a big sporting event in Canada's Yukon Territory and Alaska, with two major races a year. One, Iditarod, commemorates the Nome rescue, running more than 1,850 kilometres from Anchorage to the town. It typically takes a team of 12 to 16 dogs with their musher between 10 and 17 days to complete, but the record, set in 2002, is under nine days. The other, the Yukon Quest, covers 1,609 kilometres, following a historic Gold Rush and mail delivery route from Whitehorse through Dawson City in the Yukon to Fairbanks, Alaska.

Hands, ears and feet

But it's not all about whizzing across ice and snow. Indigenous North American games also test strength, agility and endurance, and prove fitness for life in the Arctic.

Historically, they would be played on celebratory occasions and would test fitness for joining whaling and hunting crews. Today, they are featured in large, sometimes international events. Among the most popular is the Two Foot High Kick, in which the athlete launches himself off the floor and, feet together, kicks a sealskin ball suspended as high as 2.4 metres off the floor, then lands on both feet. The game originated in coastal Arctic communities, where messengers would run to within view of villages and kick like this to indicate a successful hunt.

The Indian Stick Pull tests hand strength and grip – needed to grasp live fish – while the Toe Kick exercises the ability to balance on bad ice: players jump forward with both feet, trying to land beyond a stick while kicking it backwards. Other games are about tolerating pain: in the Ear Pull, two people face each other, each pulling at a twine looped behind the other's ear, until one gives in.

Traditional sports have been played every summer since 1961 at the World Eskimo-Indian Olympics (WEIO). And more than 2,000 athletes gather every two years for the Arctic Winter Games, hosted in cities in Arctic North America and providing an opportunity for indigenous peoples from Alaska, Canada, Russia and Greenland. Traditional games provide the biggest draws at the events, though there is also ice hockey, curling, skiing and snowboarding. Traditional arts demonstrations – such as Russian folk singers, Inuit throat chanters and Dene totem-pole carvers – round out the celebration.



AlaskaTeacher/flickr

Early learning

The Kalaallit, an Inuit people from Greenland, train their boys to balance on kayaks from infancy. When a baby boy is big enough to sit, his mother plays 'kayak games' with him, holding his hands to make a paddling motion, while chanting:

**'Little kayak
paddling toward seal
throws his harpoon
Tik!
Avatarsi
avatarsi!'**



During the rhyme the mother makes the boy mime throwing a harpoon, then rocks him from side to side to imitate the bobbing of the boat. Later, young boys receive a balancing board, which is easily overturned, and eat their meals on it so that they will have learned to balance by the time they get into their first kayaks.

Source: *Eastern Arctic Kayaks: History, Design, Technique*. J.D. Heath, E.Y. Arima



Red nose day

Reindeer racing isn't exactly traditional, as the Sami people didn't start it until a few decades ago, but it is the only sport specific to them that is now practised. Taming reindeer for transport fell out of use with the arrival of motor vehicles, but the races, held every year, help keep taming traditions and knowledge alive.

Lea Simma, Sweden

Keep winter white

BY LEA SIMMA, SWEDEN

My name is Lea Simma and I am a Sami, belonging to the indigenous peoples of the part of the Arctic that covers northern Sweden, Norway, Finland and Russia's Kola Peninsula.

Sami peoples are already seeing changes in the climate, which are damaging reindeer herding, a fundamental part of our culture. We used to have snow for about two thirds of the year, but now it comes later and melts earlier. It is

now common to have rain in winter and this can cause a layer of ice to form on the snow when it freezes, making it impossible for reindeer to reach their food. Meanwhile the ice on lakes and rivers is thinner than it used to be, so the reindeer's traditional migration paths are no longer safe.

Despite these drastic changes, most Sami herders believe that they will be able to adapt to climate change as long as we have grazing lands: but these are threatened by the



Q Does climate change in cold climates endanger tourism, now the world's largest industry?

A Most winter tourism focuses on sporting activities, and we are witnessing changes in snow conditions as a result of climate change: less snow, receding glaciers, melting permafrost and more extreme events including landslides or avalanches. These changes put one of the fastest-growing tourism industries in danger and threaten flora and fauna, patterns of agriculture, drinking water supplies, vital energy sources for hydropower and the ways of life of many mountain peoples.

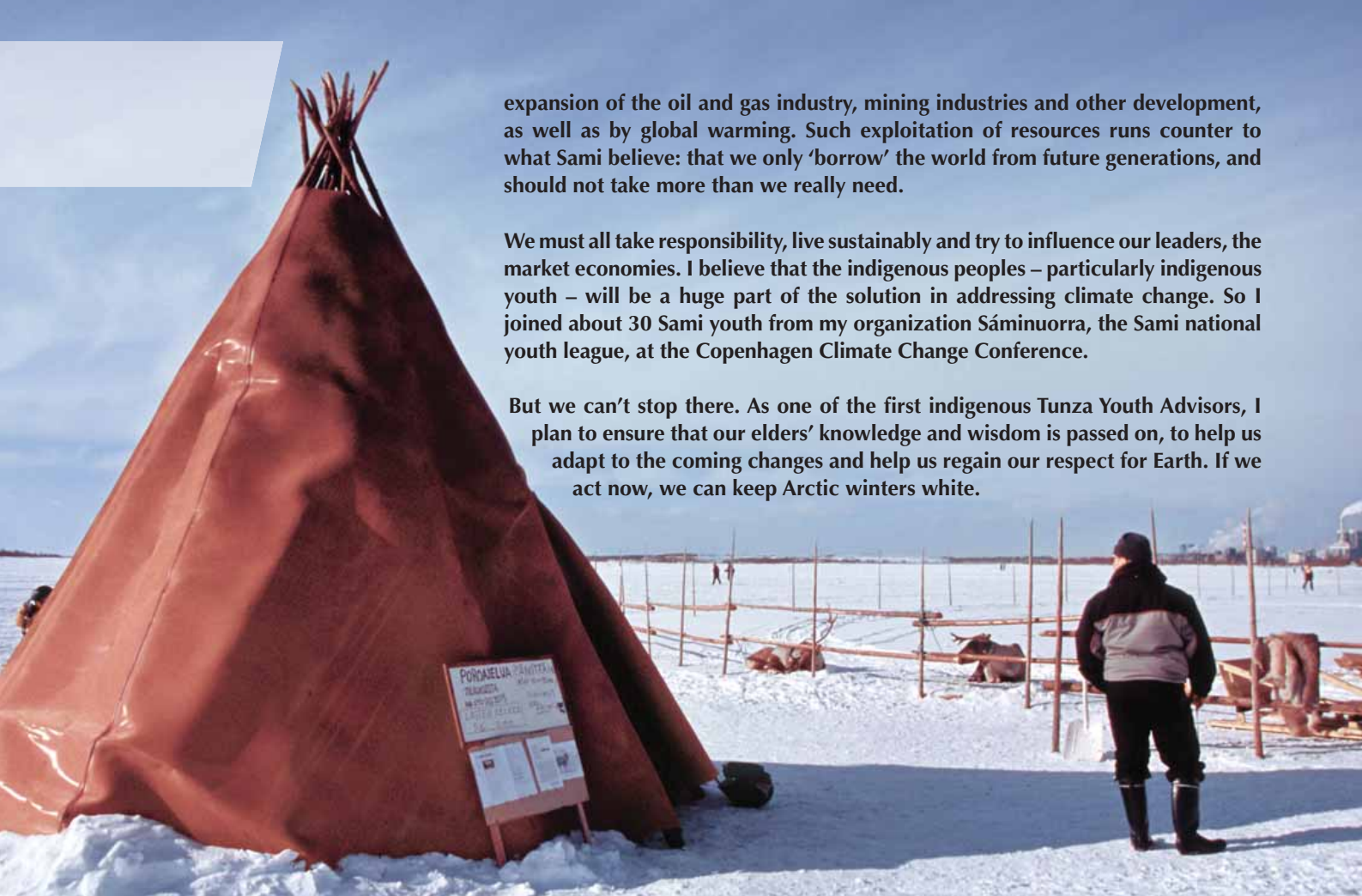
Q Can winter sports be eco-friendly?

A Today, sporting events not only focus on what goes on during the games but also the build-up and what happens afterwards, aiming to produce lasting benefits both locally and globally. The events are embracing a new wave of sustainable practices ranging from the use of wind-generated electricity, sustainable waste management, and biodiversity and habitat protection to improvement in water and air quality, urban regeneration and green architecture. As many winter sports take place in very fragile ecosystems, environmental stewardship and impact reduction must be at the heart of major sporting events.

Q Governments are always encouraging people to keep fit and stay active. How can we balance these needs with environmental ones, particularly in colder climates?

A Regular exercise and physical activity benefit our health and reduce the risk of cardiovascular disease, diabetes and osteoporosis. Like our body, the natural environment needs regular care and attention. We can enjoy winter sports provided we don't cut down trees to make trails or block the natural flow of streams or interfere with sensitive habitats. And getting out and enjoying the natural world can also sensitize us all to looking after it.





D. Galehr/Still Pictures

expansion of the oil and gas industry, mining industries and other development, as well as by global warming. Such exploitation of resources runs counter to what Sami believe: that we only 'borrow' the world from future generations, and should not take more than we really need.

We must all take responsibility, live sustainably and try to influence our leaders, the market economies. I believe that the indigenous peoples – particularly indigenous youth – will be a huge part of the solution in addressing climate change. So I joined about 30 Sami youth from my organization Sáminuorra, the Sami national youth league, at the Copenhagen Climate Change Conference.

But we can't stop there. As one of the first indigenous Tunza Youth Advisors, I plan to ensure that our elders' knowledge and wisdom is passed on, to help us adapt to the coming changes and help us regain our respect for Earth. If we act now, we can keep Arctic winters white.



Q Can the 2010 Winter Olympics be used to raise awareness of the effects of climate change in cold regions?

A Yes. The 2010 Olympic and Paralympic Winter Games start just 57 days after the crucial UN Climate Change Conference in Copenhagen came to an end. For the duration of the Games the world's attention will be on winter sports, and this presents a golden opportunity not only to showcase best practices in the planning, staging and hosting of the Games, but also to promote sustainability, the only way to ensure our long-term future.

Q What can winter sports stars do to encourage people to reduce their carbon footprints?

A At a time when there are many climate change sceptics, winter sports stars can provide personal testimony about shorter, warmer winters and diminishing snowfalls. They are not the climate experts, but snow and ice are their environment and they have a lot to say about them. And they can be great advocates for protecting sensitive habitats, promoting car sharing or taking public transport to ski areas.

Q What can be done to lower the impact of climate change on the world's snow and ice? What can individuals do?

A There is a lot we can do. We all have a responsibility to ensure that our lifestyles are not threatening the future of our planet and of the following generation. We all can play our parts in everyday life, by walking, biking or taking the bus, turning off our appliances rather than leaving them on standby, and really thinking before making any purchase. And if you are lucky enough to go skiing, stay on designated trails, avoiding areas where skiing could damage habitats in which animals or plants need to be protected. You could also pick your holiday destination based on a resort's green credentials.

The snowball effect

By Fred Pearce

What picture comes to mind when you think of the Winter Olympics? Snow, of course. And ice. Most of the sports involve them. But across the world, snow and ice are getting more scarce. The air is becoming too warm, so we get rain instead. Soon, finding enough snow to hold the Winter Olympics could be much harder than it is today.

What's going on? Global warming. The world has warmed by more than 0.5°C in the past 40 years. And scientists say the warming is happening faster in the snowy parts of the world than anywhere else. This is because when ice melts, less heat is reflected and more is absorbed at ground level – causing even more melting (see panel, below).



Dsearls/Flickr



Ashley Cooper/Still Pictures

Thanks to global warming, most of the world's glaciers and snow fields are getting smaller – at least 90 per cent of them are thinner and retreating up their valleys, according to UNEP.

As a result, one of the most amazing features of our planet is fast disappearing. It may not be long before snow at the equator is a thing of the past. For now, even in the hot tropics, the air on the tops of mountains can be cold enough for snow to fall and for there to be permanent ice. Some of these tropical mountains have had glaciers on them for thousands of years. One example is Mount

Why do cold places warm fastest?

There is a reason why cold places warm the fastest. It is because whenever ice and snow melts, it speeds up the warming. How? Snow and ice are white, and anything that is white reflects the sun's rays. That is how wearing white clothes helps keep you cool. But if the white disappears, less of the sun's energy is reflected and things warm up quickly.

For instance, when a mountain is covered in snow, the snow itself helps keep the mountain cool by reflecting the sun. But if the air around the mountain warms a bit, and some of the snow melts, then it exposes a darker surface of rocks or vegetation. That darker surface captures more of the sun's heat and the whole mountain heats up further.

So a bit of warming makes more warming, which causes melting and even more warming. It's like a runaway effect, and it's melting the world's glaciers in double-quick time.

Runaway warming is particularly happening in the Arctic, where the ocean round the North Pole is warming twice as fast as the rest of the planet. As ice melts, it exposes dark blue sea water, which absorbs more heat and melts more ice, and this happens every summer. We can see the result. Satellite pictures taken over the past 30 years show that at the end of each summer there is less floating ice on the Arctic Ocean. Today, in high summer, there is not much more than half as much ice as there used to be.



meL_jp_05/Flickr

Kilimanjaro, the highest mountain in Africa at nearly 6,000 metres. But 80 per cent of the ice on Mount Kilimanjaro has melted away in the last 90 years.

Nearby Mount Kenya has lost seven of its 18 glaciers since 1900. Most of the ice on the Rwenzori Mountains between Uganda and the Democratic Republic of the Congo, known as 'the mountains of the moon', has gone too. And across the Indian Ocean, on the island of New Guinea, the West Meren Glacier vanished altogether in the late 1990s.

In Europe, the Alps have lost half their glaciers in the last century, and a fifth of their ice in Switzerland has gone over the past 15 years. Ski slopes have been abandoned at 57 of the 666 skiing areas in the Alps. Forecasters say almost all the ski resorts will be snow-free by 2050, including famous sites of past Winter Olympics like St Moritz in Switzerland and Garmisch in Germany.

At the Pitztal Glacier resort in Austria, they now cover their ski slopes with plastic in summer to keep the sun off and try to stop the glacier melting. But you can't protect a whole mountain, still less a whole planet.

Today, large areas of the Earth are still covered in ice for at least some of the year. But, like the ice disappearing from Kilimanjaro, it could soon be just a memory. And without the ice, where would we hold the Winter Olympics?



Ashley Cooper/Still Pictures

C. Keller/MISUM/Still Pictures

Man of the mountains: Lonnie Thompson

There are two special things about Lonnie Thompson. First, his doctors reckon that, at past 60 years old, he has spent more time on high mountains than any other lowlander on the planet. And second, in his deep freeze back home in Columbus, Ohio, he has the world's most amazing collection of ice: 6,000 metres of 'cores' of ice, each about as thick as your arm, that he has drilled from glaciers in all the big mountain regions of the world. The ice represents the most detailed record anywhere of the climate of planet Earth over the past 20,000 years. And it shows the world's ice is melting away.

Thompson is as much an adventurer as a scientist. He has spent half a lifetime taking his ice pick, crampons and drilling gear to the Andes and the Himalayas, Tibet and the Russian Arctic, Alaska and East Africa. He measures how the ice is retreating, and he drills ice cores so that he can analyse the air bubbles trapped inside. These ice cores are like time machines. By doing chemical tests on the ancient air, Lonnie discovers what the world was like back on the day the air was trapped in the ice.

It's dangerous work. Lonnie has found himself in New Zealand dangling on a rope above 600 metres of empty space. 'On one trip we were up on Quelccaya mountain in Peru for three months,' he says. In order to bring the long cores back home, 'we had to cut the ice by hand into 6,000 samples, take them downhill on our backs and then melt them and put the water in bottles sealed with wax. By the end, the place looked like a mining camp from the 1800s.'

Despite that, Quelccaya is Lonnie's favourite ice mountain. But for how long? Its largest glacier is retreating by around 150 metres a year and has lost a fifth of its area since 1963. Across Peru, says Lonnie, a quarter of the ice surface has disappeared in 30 years. Venezuela has lost four of its six glaciers since 1975. Glacial retreat, he says, 'is happening at virtually all the tropical glaciers. There is no other explanation except global warming.'



Thomas Nash

Seven **ICY** wonders



Ashley Cooper/Still Pictures

Going green

Drilling 2 kilometres down into the Greenland ice cap, scientists found the DNA of plants, butterflies and spiders, suggesting that the country was indeed green over half a million years ago. Now it seems to be heading that way again, as global warming hauls it out of the deep freeze of history. Its vast ice cap is beginning to melt, particularly around its edges. And its great glaciers are starting to retreat rapidly: the biggest of all, Sermeq Kujalleq, by 16 kilometres a year, five times as fast as just a decade ago. Greenland's Government looks forward to the revelation of mineral riches as the ice retreats, but its Inuit people are suffering the loss of their way of life, and if it all eventually melts, global sea levels will rise by a disastrous 7 metres.



Ron Gilting/Still Pictures

Ice dam

Patagonia's Perito Moreno Glacier can lay claim to being the world's most intriguing river of ice. For a start, the glacier – on Argentina's largest lake – is advancing by about a metre a day as the world gets warmer, even as the vast majority of glaciers around the world are retreating. But it is what happens as it advances that is really unusual. At 5 kilometres wide and up to 750 metres deep, it gradually pushes out across the Lago Argentino until it reaches the further shore, forming a complete dam of ice. The water on the upstream end of the lake cannot get out and can rise up to 30 metres higher than on the other side of the glacier. Eventually the pressure gets too much and the dam ruptures, starting the process all over again.



Peter Rejcek/S Antarctic Program, National Science Foundation

Cold bugs

Is this the oldest, coldest life on Earth? Five hundred metres beneath the Antarctic ice, a diverse colony of bacteria has lived, isolated from the rest of the world – and deprived of light and oxygen – for up to 2 million years. Some 17 different types of marine microbes have so far been found in the iron-rich outflow from a briny pool, four times saltier than sea water, beneath the Taylor Glacier on the east Antarctic ice sheet: scientists suspect there may be as many as 30 there. The microbes are thought to 'breathe' iron leached from the rock beneath the glacier, using sulphur as a catalyst, and live off organic matter trapped with them. They may provide a clue to how life survived 'Snowball Earth', a time when the planet was entirely encased in ice.



Peter Frischmuth/Argus/Still Pictures

Water beds

It is the ultimate in recycling, a hotel built of ice every winter that melts and returns to the nearby river every spring. For the past 20 years, builders and designers have gathered in November in the village of Jukkaskarvia (its name means 'meeting place') in Swedish Lapland, to start building the Icehotel – complete with 60 guest rooms, a bar and a church – out of crystal-clear blocks of ice from the Torne River, carving it to create windows, doors, pillars, desks, chairs, lamps and statues. Complete by New Year's Day, the Icehotel closes in the spring as it begins to melt. Indoor temperatures vary from -4 to -9°C depending on the number of people staying, while outside it can fall to -40°C . There are plans for the Icehotel to become carbon negative, producing more renewable energy than it consumes, by 2015.

Blooming frost

When the first frosts arrive some plants produce strange but beautiful flowers – delicate ribbons and whorls of ice – from their stems. It happens when water in the stalks of a few plants – such as the North American *Verbesina virginica*, commonly known as white crownbeard, and *Helianthemum canadense*, nicknamed frostweed – begins to freeze, expanding and splitting the stem, and producing the ice flower as water reaches the freezing outside air. And there are also ice flowers at sea, formed by a different if not entirely dissimilar process: water seeps through cracks in new layers of sea ice, freezing in the cold air, and causing salt on the surface to crystallize around them.

D. Bruce Means



EURAC

Long-lost cousin

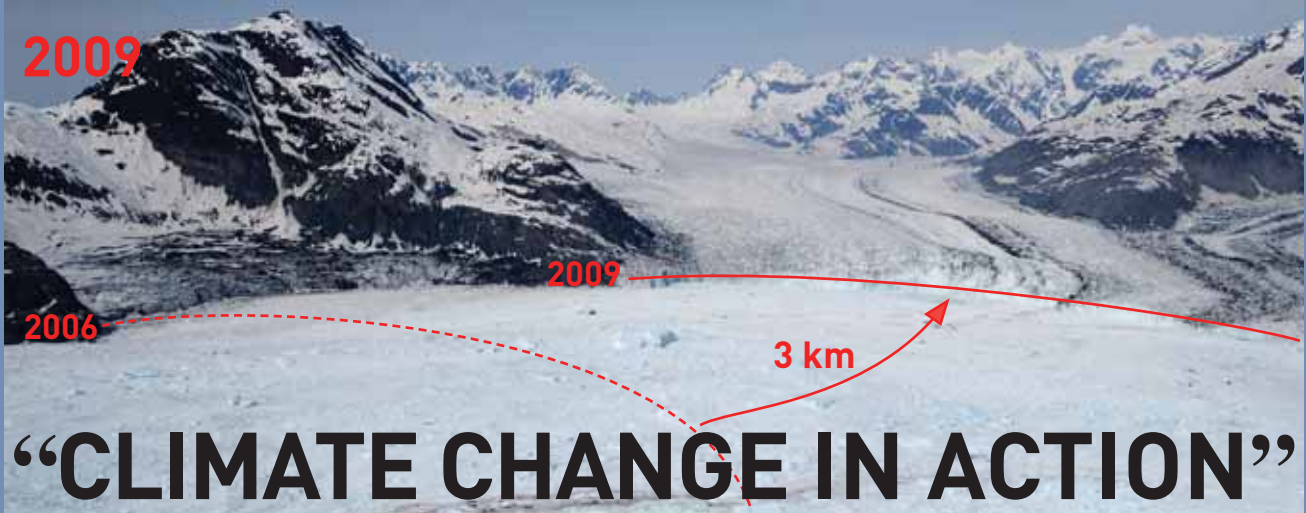
Otzi's cause of death, his approximate age, and the contents of his last meal were all determined by autopsy. Nothing unusual about that, right? Except that he died 5,730 years ago. He was preserved in a gully in the Alps in South Tyrol, Italy, as ice piled up over his snow-covered body. But as the world warmed and the ice started to melt, he was spotted by two German hikers. He is believed to have been 46 years old when he died – a considerable age during the late Neolithic period – after being shot in the back with an arrow. Bryan Sykes, Professor of Human Genetics at Oxford University, compared Otzi's mitochondrial DNA with that of his secretary, and found the two to be related, even though they were born almost six millennia apart.

Mammoth discovery

Woolly mammoths went extinct 15,000 years ago as the world emerged from the last ice age, but they are still telling us about themselves. A hundred or so have been unearthed, mainly from thawing permafrost from Alaska across to Siberia, and they build up a remarkable picture – of whale-like blubber up to 20 centimetres thick, metre-long hair and long curved tusks. In 2008 scientists used computer tomography to take pictures of a perfectly preserved 37,000-year-old baby mammoth found in the Russian Arctic, showing the most detailed image ever of a prehistoric animal's internal organs. They even saw what appeared to be silt in its airways, suggesting that it died by drowning.

Ullstein bild - Insadco/Gaertner/Still Pictures





James Balog

For years, nature photographer **JAMES BALOG** was a climate-change sceptic. He finally changed his mind when he discovered that the Earth's climate trajectory is not just based on a computer model, but written in the Earth itself: measured and recorded in ancient ice, deep-ocean sediments and tree rings. Now Balog wants to bring such physical evidence of global warming to the world, and has found his subject in the cryosphere. 'Ice is the canary in the global coal mine,' he says. 'It's the place where we can see and touch and hear and feel climate change in action.'

Balog has been photographing the world's melting glaciers for the Extreme Ice Survey since December 2006, primarily using solar-powered, computer-controlled time-lapse cameras drilled into bedrock, where they take photos at regular intervals during the day. Balog's team currently has more than 25 cameras stationed in Alaska, the Rockies, Greenland and Iceland, and annually visits spots in British Columbia, the Alps and Bolivia. When the images gathered over years are retrieved and played together, they show something we could not have otherwise seen with our own eyes: footage of vast sheets of ice, which took hundreds of thousands of years to form, disintegrating at an alarming rate, all over the world.

The images shown here are of the Columbia Glacier, in Prince William Sound on the south coast of Alaska. The first (below) was taken in June 2006, and the second (above) in May 2009. In the 2006 photo, the calving face, which is about 80 metres high (higher than a 25-story building), curves in front of the black mountain towards the front of the image. In the second photo, the line of the ice face has receded into the distance, running between the foot of the mountain and the right edge of the image. The glacier had receded more than 3 kilometres over the three-year period – a length equivalent to that of 295 buses lined up.

The Columbia Glacier has retreated more than 17 kilometres since 1984 and, according to some researchers, is North America's largest contributor to sea-level rise. It is also an example of how quickly tidewater glaciers (those that touch the ocean) melt once local conditions become unstable. Similar processes are now also accelerating in Greenland's tidewater glaciers.

To see the Columbia Glacier and others retreating via time-lapse video, visit www.extremeicesurvey.org



James Balog