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EEA SIGNALS 2010

BIODIVERSITY, CLIMATE CHANGE AND YOU

European Environment Agency

Front cover image: 'Mother and child', East Greenland, courtesy of John McConnico. The EEA would like to acknowledge the photographers — listed at the back of this publication — who have made their work available for use in Signals 2010.

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2010 International Year of Biodiversity

WHAT IS SIGNALS?

The European Environment Agency (EEA) publishes Signals each year, providing snapshot stories on issues of interest to the environmental policy debate and the wider public in the coming year.

At EEA, we monitor the environment across our 32 member countries in partnership with our network. From researchers up to their knees in water to satellite imaging from space, we work with a huge amount of environmental data.

Finding, reading and understanding the range of 'signals' regarding the health and diversity of our environment is at the heart of what we do. Signals respects the complexity of the underlying science and shows awareness of the uncertainties inherent in all of the issues we address.

Our target audience is broad, ranging from students to scientists, policymakers to farmers and small business people. Signals, which will be published in all 26 EEA languages, takes a story-based approach to help us communicate better with this diverse group of people.

Signals uses several approaches to tell its stories. While each story has specific points to make, as a collection, they also illustrate the many interrelations between seemingly unconnected issues.

We would appreciate your feedback on Signals. Please submit your comments through the EEA public enquiry form: www.eea.europa.eu/enquiries. Remember to write 'Signals' in the subject field.

Key systems under pressure
At the EEA, we are busy working on one of our most important tasks: a detailed review of the European environment, referred to as our 'State and outlook' report or SOER. We publish this report every five years.

SOER 2010 is nearing completion. As well as a survey of the 'state' of the environment across all 32 EEA member countries, the report looks ahead to the future. SOER 2010 sums up some of the key issues driving environmental change in Europe. It also looks at Europe's impact on the rest of the world.

Already, we can see some common themes affecting the key systems underpinning our society: finance and economy, climate and energy, and ecosystems and biodiversity. Just as our financial system is imperilled by the accumulation of huge debts, the failure to protect our environmental capital jeopardises our wellbeing and that of future generations.

Signals 2010 and Signals 2011 will act as bookends to the next SOER, pulling out some of the key themes and conveying the messages through the stories of ordinary people.

EDITORIAL

This year, Signals takes us on a journey, following the course of water from the glaciers of the Alps to the permafrost of the Arctic and the delta of the Ganges. Along the way, we discover how climate change is affecting the ancient water cycle in the mountains with repercussions for millions of people. We hear a mountain guide describe how the very make-up of the rock is changing as temperatures increase and the frozen core crumbles.

We travel to familiar and far-flung places, looking at how we can rebuild our relationships with the crucial elements of everyday life: water, soil, air and the animals and plants that make up the tapestry of life on earth.

We get our hands dirty and rediscover soil. Without healthy soils we will not be able to feed ourselves or regulate the carbon dioxide balance in the atmosphere. Learn from a family business in Italy how farming can be carbon positive as well as sustainable when built around stewardship of the soil.

We go to the Arctic, where climate change is already having a dramatic impact, and see how important it will be to protect one of the last great wilderness areas on the planet. We will hear from the Sami reindeer herders and Inuit hunters of the vast arctic region about how they are already adapting to winters that are no longer consistently cold.

We travel from the Arctic Ocean to the Aegean Sea to find out why fisheries are in danger of collapse not only from overfishing but also from the growing threats of ocean acidification and invading species from other parts of the world.

Our eyewitnesses are real people telling real stories of change, impacts and adaptation. These are not simply anecdotes. The wisdom of ordinary people, such as hunters and farmers, bee keepers and energy producers, hill walkers and sports enthusiasts, offer an untapped information resource to complement and ground our monitoring, modelling and satellite imaging of the world. They form the core of the EEA Global citizen observatory, helping the Agency to speak in a clear language about the complex causes of environmental change.

Pulling all the threads together, we enter the future world of cities. Living in a city or urban area offers many untapped possibilities. City dwellers use less land than their rural counterparts and generally consume less energy and pollute less. In the future our cities will need to become even more effective to meet the challenge of climate change. We will need to make sure that city living is as healthy as possible, with more local food production and smarter solutions for mobility. Adapting to climate change does not have to be a negative experience. Quiet vehicles, vertical gardens, energy efficient buildings and floating cities have a beauty and logic that can help us rethink and redesign how we live, work and play and make the transition to a more secure and sustainable world.

2010 is the United Nations ‘International Year of Biodiversity’ and Signals begins with that very subject. What better place to start our journey than by re-examining our everyday surroundings. Let’s look afresh at bees and flowering plants and the meadows that constitute their shared home. Most importantly in 2010, perhaps, let’s look at ourselves. Let’s review our role in the wide-screen, technicolour, surround sound that is nature’s bigger picture.

Professor Jacqueline McGlade,
Executive Director

A TAPESTRY OF LIFE

> ‘Nature uses only the longest threads to weave her patterns, so each small piece of her fabric reveals the organisation of the entire tapestry’
>
> Richard P. Feynman, Physicist and Nobel Prize Winner

Biodiversity — our life support ‘eco-system’
Commenting on the disappearance of song birds, plant species and insects from the landscape in the early 1960s, writer Aldous Huxley said that we ‘were losing half the subject matter of poetry’.

Huxley had just read a powerful new book, ‘Silent Spring’ by American biologist Rachel Carson. First published in 1962, the book was widely read and reviewed and helped raise public concern over the use of pesticides, pollution and the environment in general. Rather than trivialising what was happening, Huxley’s reference to cultural loss captures the essence of biodiversity, a word and a concept that we often struggle to explain.

Biodiversity comes from two words: ‘biological’ and ‘diversity’. It captures the variety of all living organisms within and across species. In the end, biodiversity is nature in all its forms.

An ecosystem is a community of plants, animals and micro-organisms and their interactions with the environment. From the fleeting meeting of a bee and a flowering plant in a summer meadow to the great and continuous interactions of air, water and soil — ecosystems embody the foundations of life on earth.

As bees gather nectar, they also collect pollen from one flower and deposit it on others, pollinating as they do so. New flowers result and they interact with the air above and the soil and water below. Take trees for example. Their leaves clean our air and their roots purify our water by sucking nutrients out. The roots also anchor and nourish the soil — even when they die. Remove trees from an ecosystem, and soon air, water and soil quality will be affected. Add trees, even in a city, and they will have an effect, cooling the air and improving it.

We are all part of this ‘system’ but we often forget it. Ever since our first ancestors began to harness the bee, the flowering plant and the meadow to produce food through what we now call agriculture, we have been shaping and changing biodiversity. Farmed species and plants became products whose intrinsic value was monetary. From agriculture, we moved on to industrialisation, and where we go, nature must follow — no matter how reluctantly.

Did you know?
Biodiversity is nature in all its forms.

An **ecosystem** is a community of plants, animals and micro-organisms and their interactions with the environment.

We have come full circle: by industrialising our lives, including agriculture, we have industrialised nature. We breed insects, animals and plants for market, choosing characteristics that suit us and our needs. Biological diversity is under threat at the grand and the molecular level.

Nature is often perceived as a luxury: preserving species might be very desirable, losing them might be tragic but ultimately it seems a price worth paying if it allows humans to protect jobs and raise our incomes.

The reality, of course, is very different. Take bees. Wild bee species are already extinct in many parts of Europe. Surviving bee populations are often new varieties gone wild. Now their populations are being devastated across the globe. Bees face a number of serious problems from pesticides to mites and disease to weakened genetic make-up. A survey of British Beekeepers' Association (BBKA) members found honeybee numbers declined by 30 % during winter 2007–2008. That represents a loss of more than 2 billion bees at a cost of GBP 54 million to the economy.

The point, as this example and others to follow demonstrate, is that losing biodiversity does not facilitate economic development, it undermines it.

2010 — biodiversity in the spotlight

In 2002, governments around the world committed to reduce the rate of biodiversity loss by 2010. The European Union went one step further and pledged to halt biodiversity loss completely in Europe by 2010. However, an assessment by the European Environment Agency (EEA) [1] shows that, despite progress in some areas, the EU target will not be achieved. Indeed, biodiversity is being lost at an unprecedented rate.

2010 has been declared the UN International Year of Biodiversity and the subject will be the focus of intense scrutiny and debate throughout the year. The fact that the target has been missed has already started serious discussion within the EU on what actions are needed to save biodiversity.

What is happening to our biodiversity?

Europe has made some progress in terms of protecting biodiversity. Over the last 30 years the European Union has built up a network of nearly 25 000 protected areas [2] across all Member States in an attempt to protect our biodiversity. This adds up to around 880 000 km^2, representing 17 % of EU territory. This vast array of sites, known as Natura 2000, is the largest network of protected areas in the world.

Legislation on atmospheric emissions (air pollution), freshwater quality and wastewater treatment has had positive results, benefiting biodiversity. Acid rain, for example, which devastated forests in northern Europe, is no longer a major issue. Agriculture is becoming more attuned to the surrounding landscape, although there is still a lot to be done. Water quality has generally improved in fresh waters.

However, biodiversity continues to be lost at all scales. Arctic summer sea ice is receding and thinning faster than ever. In 2007 the extent of sea ice was half that measured in the 1950s. This has consequences for all the living inhabitants there — from the microscopic life within the ice to polar bears and humans. As will be explained, glaciers are also melting in Europe's mountain ranges with serious consequences for tens of millions of Europeans.

Around the world, more than a billion people rely on fisheries for their food and livelihoods. However, half of all wild fisheries have been fully exploited. The majority of today's commercial fisheries are likely to have collapsed by 2050 if current trends are not reversed. Back on land, rainforests are being decimated for food (e.g. soy and beef production) and agrofuels (e.g. palm oil) — developments that take no account of the many valuable ecosystem services the forests provide.

An **'ecosystem service'** is a resource or process provided to us by nature. Examples of ecosystem services include the provision of food and drinking water, the pollination of crops and cultural aspects such as the recreational and spiritual benefits nature provides us [3].

Over the past 20 years, butterfly populations in Europe have dropped by 60 % [3]. Butterflies are valuable environmental indicators because they are sensitive to the most subtle habitat change. Their disappearance points to a much broader environmental change that we are only beginning to comprehend.

Why is biodiversity so important for us?
Biodiversity provides a vast range of 'ecosystem services' that we take for granted. Think of the insects pollinating our crops; the soils, tree-root systems and rock formations cleaning our water; the organisms breaking up our waste or the trees cleaning our air. Think of the value of nature, its beauty and the use we make of it for leisure purposes.

These are just some of the 'ecosystem services' that make life on earth possible. However, we have lost our links with many of these basic life support services and rarely even see them, or value them, for what they are. This fact alone has huge implications for our natural world.

The changing nature of environmental challenges
During the 1960s, 70s and 80s the environment was sometimes understood as a collection of separate systems. Policy and campaigning often focused on specific problems: smog in the air, chemicals pouring into rivers from factories, destruction of the Amazon, the plight of tigers, CFCs in aerosol cans. The causes were understood as linear or specific and dealt with separately.

Today, we understand the pressures on our environment differently. They are not uniform, or held in place by geography. What they do share is that they generally result — directly or indirectly — from human activity. Our patterns of production, trade and consumption are immensely strong driving forces, simultaneously underpinning our societies and determining our lifestyles, our quality of life and our environment.

Joining up the dots
Think of a child's drawing book. A child creates a picture by joining dots — beginning at number one and ending at the highest number somewhere else on the page. At the start, the image makes very little sense but slowly something coherent appears. Our grasp of the key issues facing society has developed from isolated dots to the outline of an image. We have not got the full picture but we are beginning to see the pattern.

Biodiversity is vanishing at an alarming rate largely because we have misused nature to sustain production, consumption and trade in our globalised economy. Our failure to put a value on our natural capital means that the prices for our trees and forests, our water, soil and air are low or non-existent.

In an economy where national wealth is gauged by how much a country produces and where increasing quarterly profits are more important than the seasons, it is often difficult to even see nature. Often, our natural capital is not even one of the dots on the page.

Managing the future
We are again in a time of reflection and opportunity. The pressures we face — whether economic or related to energy, health or the environment — can be fixed. We owe that to future generations. We will achieve most if we admit that we still know very little about our natural environment, its complexity and the affects we are having on it. We must rediscover our humility and look again with a sense of wonder at what is around us.

For more information visit the EEA web page on biodiversity: www.eea.europa.eu/themes/biodiversity.

In focus: climate change and biodiversity
Ecosystems are generally quite resilient. However, beyond certain thresholds, known as 'tipping points', ecosystems may collapse and transform into distinctly different states with considerable potential impacts on humans. Climate change threatens to undermine vital ecosystem services like clean water and fertile soils, which underpin both quality of life and the economy. We do not know what the full impacts of climate change will be on biodiversity. But we do know that tackling biodiversity loss and tackling climate change must go hand in hand, if we are to protect our environment. Ecosystem services which at present help to limit climate change, such as absorption of CO_2 from the atmosphere by soils, oceans and forests, are seriously threatened.

A recent EEA report assessing the status of biodiversity in Europe shows that climate change is having a noticeable effect on biodiversity. The report, 'Progress towards the European 2010 biodiversity target' [(4)], studied 122 common European bird species and found that 92 were negatively impacted by climate change, while 30 were positively affected. This indicates that huge changes in biodiversity and ecosystems can be expected in Europe as a result of climate change.

The report also shows that grassland butterflies are declining severely; their populations have fallen by 60 % since 1990 and there is no sign of levelling off. The main driver behind this decline is thought to be changes in rural land use — primarily intensified farming and abandonment of land by farmers. As the majority of grasslands in Europe require active management by humans or their livestock, butterflies also depend on the continuation of these activities.

EYEWITNESS: BEES

Marking the seasons in a natural way
'What I most like about bee-keeping is that the bees are still free and we do not need to kill them to harvest honey from colonies,' says Nicolas Perritaz *, who keeps three hives as a hobby in the Geneva countryside.

'I also like the fact that bee society is complex. The interactions between the queen (the only breeding female in the colony), the female workers and the male drones are fascinating. An individual bee could not survive alone!'

'The development of a bee colony follows an annual cycle, which also appeals to me. It marks the year and the seasons in a very natural way. There is growth from spring to autumn and then a quieter period. In bee-keeping you have to follow this cycle carefully through the year. You also have to look after the surroundings.

Bees are under threat
'Bees could be seen as the "sentinels of the environment". They are very sensitive to what is going on around them. The honeybee is under threat from mites, from viruses and from pollution. Another threat we see is the general weakening of the constitution of the honeybee. Are honeybees not adapted to their environment? Have they become genetically weak because of our breeding practices? Is the "sentinel" showing us the level of contamination in the environment?'

'Remember, at least every third mouthful of human food depends on pollination. The vast majority of this pollination — maybe 80 % — is carried out by the honeybee. We must preserve natural, widespread pollination in order to safeguard our food.'

* Nicolas is a senior scientist with the Department of the Environment, Energy and Communication in Geneva, Switzerland. He also acts as National Focal Point (NFP) between the EEA and the Swiss Government and as such is part of Eionet, a network of institutions and organisations through which member countries cooperate with the EEA to enable it to carry out its work.

ALPS

The impacts of climate change in Europe today

'Yesterday, I came back from leading a climb on the Matterhorn in Switzerland. We used the Hornli ridge, the famous route first climbed in 1865. I go there every summer. These well-used routes are becoming dangerous and several have been shut. The permafrost, which has held the rock together for hundreds or thousands of years, is melting. It melts during the day and freezes at night and this is causing the rock to crumble. This is happening at higher altitudes every year — it's moving up the mountains.'

Sebastian Montaz lives in Saint Gervais, a village in the Chamonix region of France. A mountain guide and ski instructor, he grew up in the French Alps but guides climbers and skiers across the Alpine region.

'Mountains normally change slowly. But here in the Alps we see the changes almost as each season changes. It has altered dramatically since I was a boy and who knows what the Alps will be when my daughter is grown up.'

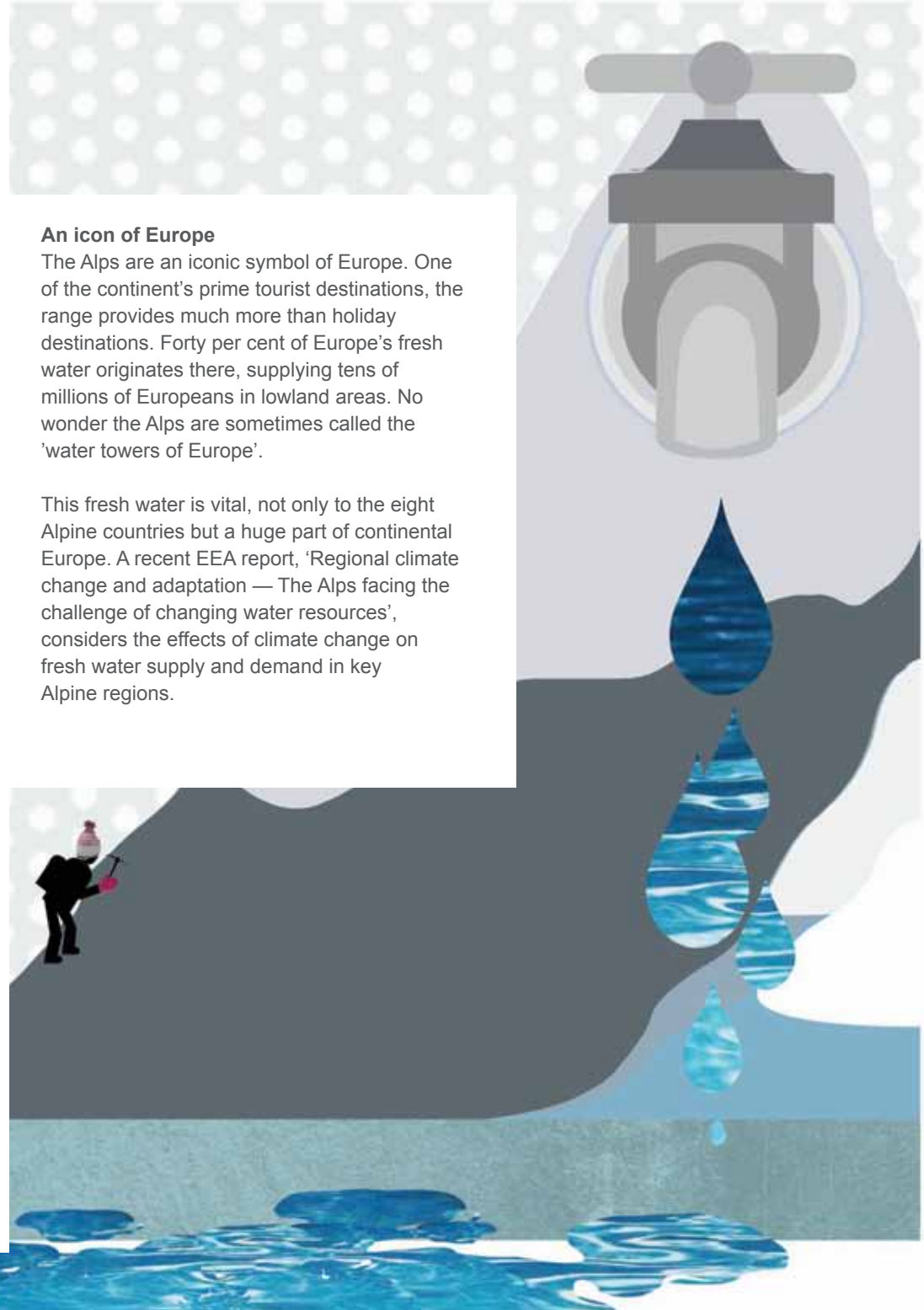
'For the past five years, from June to July, it has not been possible to carry out mixed climbing where you climb on snow and ice. Now it's not safe from June until the end of September. Last winter we had the best snow in nine years but winters like that are now the exception,' says Sebastian.

Climate change is affecting the Alps from the composition of the permafrost that holds the rocks together, to the volume and quality of snow. Glaciers are retreating and ice and snow bridges are disappearing. The art of guiding in the mountains is changing as traditional routes become unsafe. Some glaciers, that could be traversed five years ago, have changed. The ice is gone and the rock underneath is exposed.

An icon of Europe

The Alps are an iconic symbol of Europe. One of the continent's prime tourist destinations, the range provides much more than holiday destinations. Forty per cent of Europe's fresh water originates there, supplying tens of millions of Europeans in lowland areas. No wonder the Alps are sometimes called the 'water towers of Europe'.

This fresh water is vital, not only to the eight Alpine countries but a huge part of continental Europe. A recent EEA report, 'Regional climate change and adaptation — The Alps facing the challenge of changing water resources', considers the effects of climate change on fresh water supply and demand in key Alpine regions.



Focus: climate change impacts on the Alpine ecosystem
Climate change impact on Alpine ecosystem services is not limited to its effect on drinking water supplies. For every 1 ºC increase in temperature, the snowline rises by about 150 metres. As a result, less snow will accumulate at low elevations. Nearly half of all ski resorts in Switzerland, and even more in Germany, Austria and the Pyrenees, will face difficulties in attracting tourists and winter sport enthusiasts in the future.

Plant species are also on the move northward and uphill. So-called 'pioneer species' are moving upwards. Plants that have adapted to the cold are now being driven out of their natural ranges. European plant species might have shifted hundreds of kilometres northwards by the late-21st century and 60 % of mountain plant species may face extinction.

Observed and projected reductions in permafrost are also expected to increase natural hazards and damage to high altitude infrastructure. The 2003 heatwave across Europe demonstrates the potentially severe impacts of higher temperatures and drought on human wellbeing and water-reliant economic sectors (such as power generation). Melting reduced the mass of the Alpine glaciers by one-tenth in that single year and tens of thousands of people died across Europe.

The Alps provide a preview of the challenges ahead for ecosystems, habitats and populations across Europe and the world. In a story on the Arctic, which follows, we will hear from people living in Arctic Europe about the impacts climate change is already having on their lives.

The Alps — a changing ecosystem
Mountains normally change slowly, as Sebastian Montaz observes. But the Alpine climate has changed significantly in the last hundred years, with temperatures increasing 2 °C: twice the global average. And Alpine glaciers are melting as a result. They have lost about half of their ice volume since 1850 and loss rates have accelerated strongly since the mid-1980s.

The snowline is also rising and patterns of precipitation (rain, snow, hail and sleet) are also changing. A large number of medium-size and small glaciers are likely to disappear within the first half of the century. It is estimated that regions currently receiving snowfall will increasingly experience winter rain instead, leading to fewer days with snow cover. This is affecting the way the mountains collect and store water in winter and distribute it again in the warmer summer months. Thus run-off is expected to increase in winter and decrease in summer.

The cycle of water and climate change
Water is collected and stored as snow and ice in glaciers, lakes, groundwater bodies and soil in the Alps during winter. It is then slowly released as the ice and snow melt throughout spring and summer, feeding rivers such as the Danube, Rhine, Po and Rhone, all of which have headwaters in the mountains. This makes water available when supply is dropping in the lowlands, and when demand is highest.

The delicate interactions that underpin this ancient process of storage and release are now under threat from climate change. How will the Alpine ecosystems be affected by climate change? How will ecosystems services change? What can we do?

An ecosystem service under pressure
The Alpine 'water towers' are extremely sensitive and vulnerable to changes in meteorological and climatic processes, landscape and human water use. Alterations can affect the quality and quantity of water supplied to tens of millions of Europeans.

Did you know?
A **river basin** [5] refers to the area of land from which all surface run-off flows through a sequence of streams, rivers and, possibly, lakes into the sea at a single river mouth, estuary or delta.

Climate change threatens to alter the Alpine 'water cycle' drastically. Changes in precipitation, snow-cover patterns and glacier storage are expected to alter the way water is transported. That means more droughts in summer, floods and landslides in winter, and greater variability in the water supply throughout the year. Water quality will also be affected.

Water shortages and more frequent extreme events, combined with ever increasing water demand (for irrigating agriculture or tourist influxes, for example), are likely to hurt ecosystem services and economic sectors. Households, agriculture, energy production, forestry, tourism, and river navigation will all suffer. This may exacerbate existing water resource problems and could lead to conflict between users both in the Alpine region and elsewhere. Southern Europe, in particular, is likely to face more frequent droughts.

Water, a resource often taken for granted, is taking on a new value in the context of a changing climate.

On the streets of Vienna
'The water we get in Vienna travels at least 100 kilometres from the springs in the mountains,' says Dr. Gerhard Kuschnig, head of Spring Protection with the City of Vienna Waterworks. Dr. Kuschnig is several hundred kilometres away from the Alpine home of Sebastian, the mountain guide. But climate change is on his mind too.

'For now, there are no real problems with the quantity or quality of the water but the future is uncertain. Managing climate change means managing uncertainty. We want to make sure we are asking the right questions,' Dr. Kuschnig adds.

Two million people in the cities of Vienna and Graz and the surrounding areas depend on one section of the Austrian Alps for water. Therefore fresh water springs in the region are legally protected. The water aquifers (a body of saturated rock through which water can easily move) in these mountainous areas are extremely vulnerable due to the geological make-up of the rock, the climate and land-use activities, which together substantially influence the quality and quantity of the water available.

River basin management [6] means protecting a river, from spring to sea, and it's surrounding landscapes. This often involves different sectors and authorities but is key to securing water resource, quality and quantity.

In adapting to climate change, one of the key challenges for this region is protecting the quantity and quality of fresh water. High-quality water can only be assured in the long term by protecting the land through which water travels. Changes to the land, including new farming practices and construction, for example, all affect water quality and quantity. Vienna has been protecting the nearby mountain springs for more than 130 years, gradually gaining ownership of vast territories in the water protection and sanctuary areas. The water protection zone covers an area about 970 km² located in Styria and Lower Austria.

The water cycle
'The water runs through the surface layers of the rock, circulates inside the mountain and after reaching impermeable layers drains to springs, whereby it returns to the surface,' explains Dr. Kuschnig.

‘The time span between infiltration (entering the ground) and discharge (returning to the surface via a spring) of water after a rainfall event is very short. Extreme events, such as heavy rainfall or rapid snow melting, mobilise large amounts of sediment which affect the water quality. Large amounts of sediment often cannot be filtered out within the short time before discharge. The likelihood of extreme weather events increases with climate change.’

Climate change
Changing climate conditions in the region, such as rising temperature, will influence the availability and quality of water directly through enhanced evaporation and changes in precipitation. Climate change is also causing indirect effects on water resources by altering vegetation.

Two-thirds of the protection zone is covered with forests. Like agriculture, the region’s forests are managed with the aim of protecting drinking water in mind. ‘Our biggest threat at the moment from climate change is increased erosion as it threatens the forests. Without trees and proper foliage the soil will be washed away and it’s the soil that cleans the water. Temperature increases will mean new types of trees. Climate change equals uncertainty, new factors — and that is always a risk,’ says Dr. Kuschnig.

Adaptation activities and experiences
In the meantime, education is an important task for the water authority. A water school has been teaching local children for the past 13 years about the importance of water and the landscape that provides it. Regular trips are offered to the mountain springs so that students can better understand where their water comes from. Information is also important for the farming community high up in the Alpine pastures. They also have a responsibility to protect land around the springs, especially from animal effluent.

Vienna Water is already involved in projects that bring together other actors in the water world to discuss impacts and adaptation to climate change. For example, a project called CC-WaterS brings together 18 organisations from eight countries to share experiences and discuss common adaptation approaches.

Adaptation policy
‘Policy measures related to climate change adaptation are often drafted in response to extreme weather events that motivate demand for action,’ says Stéphane Isoard, from the Vulnerability and Adaptation team at the EEA.

‘The heatwave of 2003 is a case in point. However, strategies for adaptation that are based on more systematic analysis of vulnerable regions, sectors and people must be thought of now and implemented soon, if they are to be robust and effective in the future for coping with unavoidable impacts of climate change. Adapting to climate change and water-resource issues requires local management within a larger regional, national and EU context,’ he says.

A key element will involve effective river-basin management across national boundaries. For instance, there has been very little cooperation so far between countries in managing water shortages along river basins originating in or fed by the Alpine region. The EU is in a strong position to assist this process by improving the conditions for cooperation.

Climate change **mitigation** means cutting emissions of ‘greenhouse’ gases, i.e. avoiding unmanageable impacts of climate change. However, even if emissions stop today, climate change will continue for a long time due to the historical build-up of greenhouse gases in the atmosphere.

We must therefore begin to adapt. Climate change **adaptation** means assessing and dealing with the vulnerability of natural and human systems to impacts such as floods, droughts, sea-level rise, disease and heat waves. Ultimately, adaptation means reconsidering where and how we live now and in the future. Where will our water come from? How will we protect ourselves from extreme events?

For more information on the topics covered in Signals, visit our website: www.eea.europa.eu.

EYEWITNESS: CLIMATE REFUGEES

The Sundarbans, part of the world's largest delta, lie at the feet of the Ganges river. Spreading across areas of Bangladesh and West Bengal, India, they form the seaward fringe of the delta. Sundarban means 'beautiful forest' in Bengali as the region is covered in mangrove forests.

The Sundarbans are severely affected by climate change. Extreme weather events such as shorter but heavier monsoons and increased tidal surfs, combined with rising sea levels, put the region under huge pressure. In the past 20 years four islands have disappeared, leaving 6 000 people homeless. Most fled to neighbouring islands, which are also under threat.

Many poor communities around the world are already feeling the real impacts of climate change. Helping these communities adapt is a global responsibility. It means transferring knowledge and assisting financially.

SOIL

The forgotten resource

Soil is a limited resource
Pretend that this apple [7] is the planet Earth. Cut the apple in quarters and throw three of them away. The quarter apple left represents dry land.

Fifty per cent of that dry land is desert, polar or mountains * — where it is too hot, too cold or too high to grow food. Cut the dry land quarter in half. Forty per cent of what remains is too rocky, steep, shallow, poor or wet to support food production. Cut this away and you are left with a very small piece of apple.

Notice its skin, hugging and protecting the surface. This thin layer represents the shallow cover of soil on earth. Peel it and you have some idea of how little fertile soil we depend on to feed our entire population. It must compete with buildings, roads and landfills. It is also vulnerable to the pollution and the impacts of climate change. Soil often loses out.

* As you will read, much of the land that is not suitable for food production is important in terms of soaking up CO_2.

Why should I care about soil?
Dirt, mud, clay, earth, soil: we have many words for it but few do it justice. In today's virtual world many of us have, literally, lost our connection with the soil. But soil is the earth's living skin, overlying the bedrock below and making life on earth possible. Like air and water, soil is part of our life support system.

Our ancestors had a much closer relationship with soil. Many of them would have worked with it every day. Then, as now, soil played a crucial role in supplying food. What was not understood in the past is the crucial role soil plays in climate change, serving as a huge, natural store of carbon.

Soil and carbon
Soil holds twice as much organic carbon as vegetation. Soils in the EU contain more than 70 billion tonnes of organic carbon or around 7 % of the total global carbon budget [8]. More than half of the ground-stored carbon in the EU is held in the peat bogs of Finland, Ireland, Sweden and the United Kingdom.

> 'Soil is a crucial link between global environmental problems such as climate change, water management and biodiversity loss'

José Luis Rubio,
President of the European Society for Soil Conservation

Did you know?
Soil is formed from rocks and decaying plants and animals [9].

This figure is put in context when you think that EU Member States emit 2 billion tonnes of carbon every year from all sources. So, soils play a decisive role in climate change. Even a tiny loss of 0.1 % of carbon from European soils emitted into the atmosphere is equivalent to the carbon emission of 100 million extra cars on the road. That is an increase of about half the existing EU car fleet.

Soil organic matter (SOM)
The key substance in the relationship between soil and carbon storage is 'soil organic matter' (SOM). This is the sum of living and dead matter in soil and includes plant residues and microorganisms. It is an extremely precious resource that performs essential functions for the environment and for the economy, and it can do so because it is a whole ecosystem at a microscopic scale.

SOM is a major contributor to soil fertility. It is the elixir of life, particularly plant life. It binds nutrients to the soil, storing them and making them available to plants. It is the home for soil organisms, from bacteria to worms and insects, and allows them to transform plant residues, and hold on to nutrients that can be taken up by plants and crops. It also maintains soil structure, thereby improving water infiltration, decreasing evaporation, increasing water-holding capacity and avoiding soil compaction. In addition, soil organic matter accelerates the breakdown of pollutants and can bind them to its particles, so reducing the risk of run-off.

Soil and the plants growing there capture about 20 % of global CO_2 emissions [9].

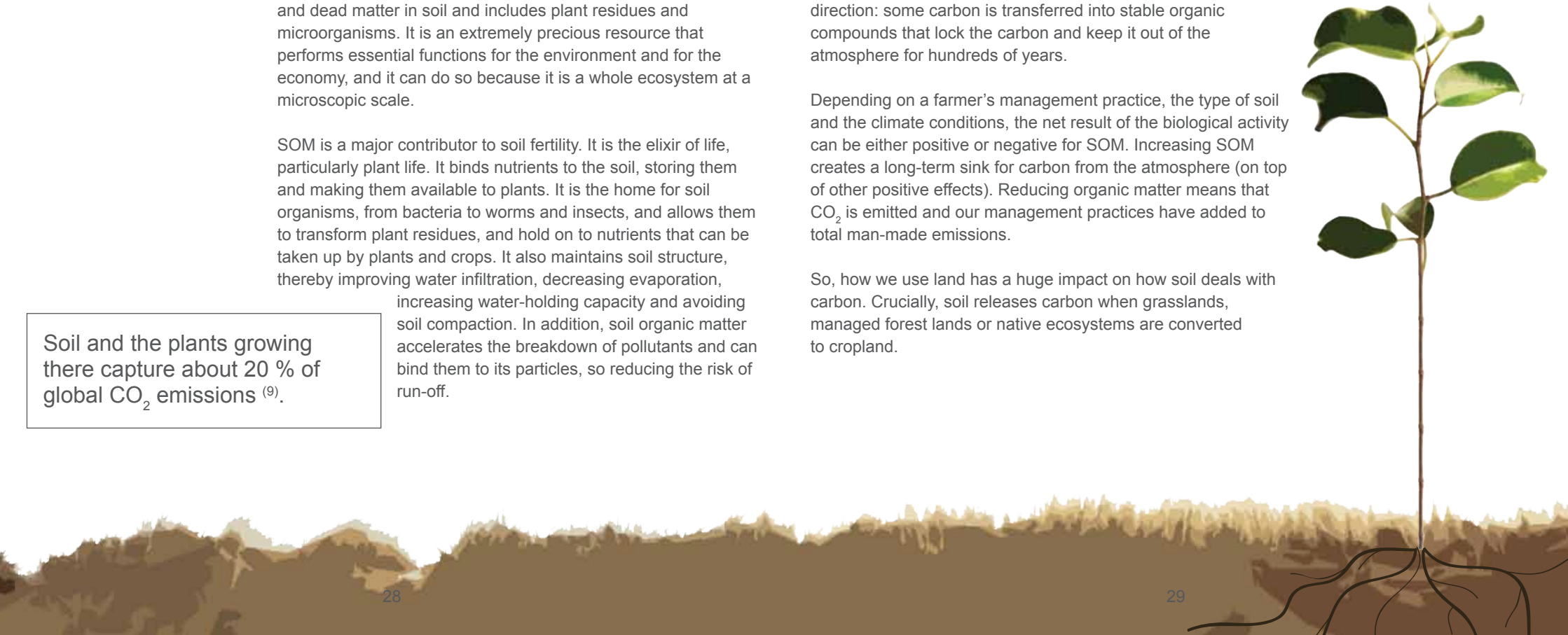
Soil, plants, carbon
By photosynthesis, all growing plants absorb CO_2 from the atmosphere to build up their own biomass. However, just as we see the plant grow above the ground, a hidden growth of similar magnitude takes place beneath the surface. Roots release various organic compounds continuously into the soil, feeding the microbial life.

Soil helps clean the water we drink and the air that we breathe – for free [9].

This increases the biological activity in the soil and stimulates breakdown of SOM, so that mineral nutrients are released, which the plant need to grow. It also works in the opposite direction: some carbon is transferred into stable organic compounds that lock the carbon and keep it out of the atmosphere for hundreds of years.

Depending on a farmer's management practice, the type of soil and the climate conditions, the net result of the biological activity can be either positive or negative for SOM. Increasing SOM creates a long-term sink for carbon from the atmosphere (on top of other positive effects). Reducing organic matter means that CO_2 is emitted and our management practices have added to total man-made emissions.

So, how we use land has a huge impact on how soil deals with carbon. Crucially, soil releases carbon when grasslands, managed forest lands or native ecosystems are converted to cropland.



As much as five tonnes of animal life can live in one hectare of soil [9].

Deserts move to Europe
The process of 'desertification' — whereby viable, healthy soil is drained of nutrition to the extent that it cannot support life and may even blow away — is a very dramatic illustration of one of the issues facing soil across Europe.

'The natural conditions: aridity, variability and torrential nature of rainfall, vulnerable soils, together with the long record of past and present human pressure, mean that large parts of southern Europe are being affected by desertification,' says José Luis Rubio, President of the European Society of Soil Conservation and head of a soil research unit run by the University of Valencia and Valencia city.

In southern, central and eastern Europe 8 % of the territory, about 14 million hectares, currently show high sensitivity to desertification. This increases to more than 40 million hectares if moderate sensitivities are also taken into account. The countries in Europe most affected are Spain, Portugal, southern France, Greece and southern Italy [10].

Healthy soil reduces the risk of floods and protects underground water supplies by neutralising or filtering out potential pollutants [9].

'The gradual degradation of soil by erosion, loss of organic matter, salinisation or destruction of its structure is transmitted to the other ecosystem components — water resources, vegetation cover, fauna and soil microorganisms — in a spiral mechanism, which eventually creates a desolate and barren landscape.

'It is often hard for people to understand or even see the consequences of desertification because, in general, these occur hidden and unnoticed. However their environmental impact on agricultural production, increased economic costs by floods and landslides, their impact on the biological quality of the landscape, and the overall impact on the stability of the terrestrial ecosystem, means that desertification is one of the most serious environment problems in Europe,' Rubio says.

Protecting Europe's soil
Soil is a key and very complex natural resource yet we are increasingly ignoring its value. EU law does not address all the threats in a comprehensive way and some Member States lack specific legislation on soil protection.

The European Commission has been developing proposals for soil policy for many years. Several Member States regard them as controversial, however, and the policy development has stalled. As a result, soil is not protected in the same way as other crucial elements such as water and air.

Focus: For peat's sake
Peatland ecosystems are the most efficient carbon store of all terrestrial ecosystems. Peatlands cover only 3 % of the world's land area but contain 30 % of all global soil carbon. That makes peatlands the most efficient long-term carbon store on earth.

However, human interventions can easily disturb the natural balance of production and decay, turning peatlands into carbon emitters. Current CO_2 emissions from peatland drainage, fires and exploitation are estimated to be at least 3 000 million tonnes a year — equivalent to more than 10 % of global fossil fuel emissions. The current management of peatlands is generally unsustainable and has major negative impacts on biodiversity and the climate [11].

EYEWITNESS: FARMING WITH NATURE

The integrity of our rural landscapes, communities and the biodiversity living there depend on the continuation of farming. Low intensity farming respects and protects the countryside and is opening new business opportunities as consumers embrace 'slow food' and organic movements.

Organic farming — Tuscany, Italy
'My parents bought the farm and the house, "Casa Loro" in 1978 and started to farm. They didn't even know they were organic. They just started to make agriculture the only way they knew, from the father of my father and from the grandmother of my father. And this agriculture was organic. It's not only our job, it's something we do for our children,' says Antonio Lo Franco, whose family run an organic farm and food company in Tuscany.

Feeding the soil and the insects — Tuscany, Italy
'We grow certain crops simply to feed the soil organic nourishment without make use of any chemical product. These methods establish and nurture biodiversity. We even nourish the insects who, in turn help us out,' says Alceo Orsini, Agronomist, Tuscany, Italy.

Community farming — Tipperary, Ireland
'A group of people came together 10 years ago to try to reduce their carbon footprint by building an ecological community. We looked at how we build our houses, how we earn our living, how we grow our food and how we move around,' says Iva Pocock, a member of Ireland's first eco-village project at Cloughjordan in the Tipperary midlands.

'We have about 67 acres, about 30 hectares. We also have allotments — land for growing food — and a community farm. We aim to reduce our carbon footprint substantially by eating locally produced food,' Iva says.

These eyewitness accounts are taken from the 'Environmental Atlas' project, which tells real life stories using film, photographs and satellite images. Co-produced by EEA, the United Nations Environment Programme (UNEP) and the European Space Agency (ESA), you can visit the 'Environmental Atlas' here: www.eea.europa.eu/cop15/bend-the-trend/environmental-atlas-of-europe.

MARINE

Marine biodiversity under pressure

The province of Canakkale lies on both sides of the Dardanelles, connecting the Sea of Marmara to the Aegean Sea: its shores touch both Europe and Asia. It is here that Homer described the mythical wooden horse of Troy in his Illiad, and 130 000 soldiers died at Gallipoli during World War I. Today, the Canakkale marina hosts many colourful yachts, making a stopover in this historically and mythologically rich area.

Just a few kilometres along the coast in Behramkale, we meet Saim Erol. He is one of the few active fishermen left in this small fishing village founded on the site of famous Temple of Athena and with breathtaking views of the Gulf of Edremit.

'Yesterday I set more than 700 metres of nets. All I caught was four red mullets. Not even worth the diesel I used!' says Saim, who has been fishing in these waters for more than 20 years.

The fact that there are fewer fish to catch and more boats chasing them is a sore point. Looking at his six-metre boat and then at the larger vessel out in the sea, he adds, 'I knew everything about this coast, where to fish and when. But things have changed. What I knew seems no longer valid. The sea has changed.'

Over the past 20 years, as the area has turned into a tourist hot spot, most of the fishermen have given up and now earn their living taking tourists to remote beaches only accessible by boat. 'At least that gives them some money to put aside for the winter,' says Hasan Ali Özden, retired teacher and amateur fisherman. 'About five miles to the west, the fishermen in Sivrice are luckier. Once in a while they hit the migration path of swordfish. And that's good money. But it has been many years since a year of plenty.'

The triple impacts of climate change, invasive alien species and acidification
Fisheries are heavily dependent on healthy marine ecosystems but climate change is altering how things work.

Professor Nuran Ünsal from Istanbul University points to alterations in migration patterns and their impacts on fish stocks. Migratory species with high economic value, such as Atlantic bonito, blue fish or mackerel, migrate south to the Mediterranean in the autumn and north to the Black Sea in the spring, where they breed. Year after year, however, steadily fewer fish have been migrating through the Turkish Straits.

‘Changes in water temperatures and seasonal winds, crucial for the necessary currents, have disrupted their migration patterns,’ says Professor Ünsal. ‘Such species need a very specific setting with the right water temperature and amount of food, as well as enough time to breed.’

‘Twenty years ago, they migrated south in September. With warmer water temperatures in the Black Sea now, they do not need to migrate south until mid-October or early November. This means they stay shorter in the Mediterranean and as a result they are fewer and smaller when they return north.’

Fish in warmer water are caught in a bind: as they adapt, their metabolism speeds up. They grow more quickly, although often to a smaller adult body size, and they need more food and more oxygen to support their higher metabolism. At the same time, as the water temperature increases, the amount of oxygen it contains decreases. Many fish experience what is called an ‘oxygen squeeze’: their need goes up and supply goes down.

Climate change is also altering the salinity and acidity of sea water and the way it forms layers. The impacts could be catastrophic. They include the collapse of coral reefs, the spread of invasive species and diseases, the loss of top predators and ultimately the whole structure of the marine food chain.

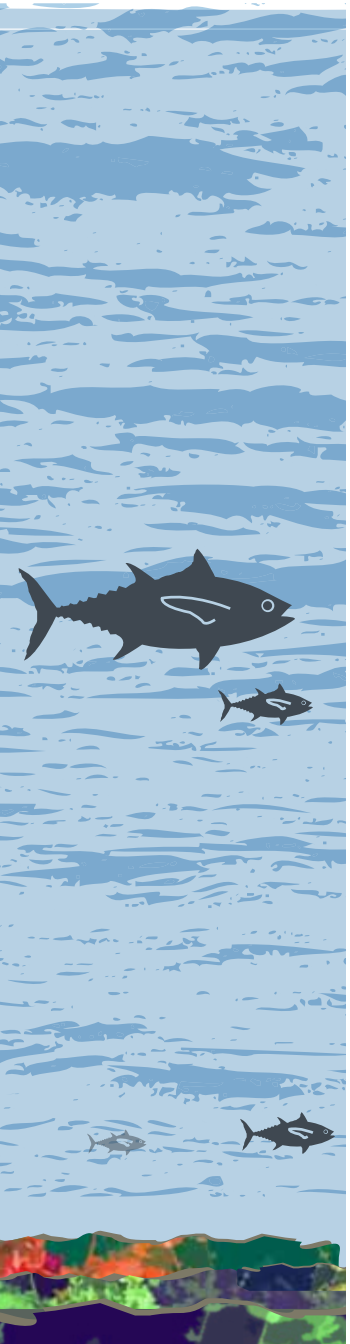
Invasive species

In the late-1980s, the anchovy stocks in the Black Sea collapsed due to a combination of factors. These included overfishing; nutrient enrichment (especially from the Danube river); warmer water temperatures due to climate change; and the invasion of a new species to the region, *Mnemiopsis leidyi*, a combjelly originally from the north-western Atlantic.

Introduced in the Black Sea, most likely via ballast waters of cargo ships, *Mnemiopsis leidyi* feeds on fish larvae as well as organisms that would otherwise feed the anchovy. In the 1990s, another combjelly species *Beroe ovata* from north-western Atlantic and preying almost exclusively on *Mnemiopsis leidyi*, was also accidentally introduced in the Black Sea ecosystem. The introduction of this predator for *Mnemiopsis leidyi*, cooler temperatures from 1991 to 1993 and a decrease in nutrient flows, alongside reduced fishing during the collapse, lessened some of the pressures on the anchovy stocks. Since, the Black Sea ecosystem has shown some signs of recovery.

A similar ecosystem shift has also been observed in the Baltic Sea. Overfishing and climate change has altered the Baltic fish community from a cod-dominated one to one dominated by herring and sprat.

Whether introduced deliberately or accidentally, invasive alien species can cause havoc to people, ecosystems and native plant and animal species. The problem of invasive species is expected to worsen in the coming century due to climate change, increasing trade and tourism.



Blue carbon: the acid test

The Earth's oceans are an immense, 'blue' carbon sink (or store of carbon dioxide). In fact, they are the largest store of carbon on the planet, with the terrestrial counterpart, including forests, a distant second. These natural sinks have functioned effectively for millennia, buffering the planet from the abrupt climatic changes due to greenhouse gases. But today, the carbon dioxide is increasing in the atmosphere faster than the land and oceans can absorb it.

Enhanced uptake of carbon dioxide from the atmosphere has increased the average acidity of the ocean. By 2100 the ocean is likely to be more acidic than at any time during the last 20 million years. Acidification is driving a decline in the amount of carbonate ion, which is needed to make aragonite and calcite — two forms of calcium carbonate that many marine organisms use to build their shells and skeletal material.

In Europe, researchers have begun to observe changes in the shells and skeletons of the microscopic organisms that form the beginning of the marine food chain. The falling rate of calcification is likely to have an immediate negative effect on their ability to survive and on the wide number of species that feed on them.

Corals are particularly at risk because they use calcification to create their skeletons, which make up what we see as coral reefs. Coral reefs are also home to as many as two million marine species and the source of a quarter of the global fish catch in developing countries around the world. The consequences of acidification go well beyond direct effects on calcification by marine organisms. More acidic water can have a major impact on respiration in some non-calcifying species such as squid. While the full consequences of ocean acidification have not yet been fully determined, it has been estimated that up to seven per cent of these 'blue carbon sinks' are being lost annually — seven times the rate of loss of 50 years ago.

Just like forests on land, marine ecosystems have a crucial role to play in the fight against climate change. Losing either would be catastrophic but we still do not fully understand just how quickly life under the surface of the oceans is likely to change.

Chasing the few fish left in our seas

Overfishing is the main culprit for the lack of fish in our seas. In Europe the picture looks very bleak: almost nine out of ten commercial stocks in the north-east Atlantic, Baltic and Mediterranean Seas are overfished. About one-third of those are so heavily overfished that the stock risks losing its reproductive capacity.

In the last decade alone, total landings in the European Union have declined by one-third [(12)] and aquaculture in Europe has not been able to compensate. Global fish consumption per person has more than doubled since 1973, with Europeans consuming on average 21 kg of fishery products annually, slightly more than the global average of 17 kg, but below the USA, Chinese and Canadian consumption levels of around 25 kg. There is a wide variation within the EU, ranging from 4 kg per person in Romania to 57 kg in Portugal.

To meet Europe's demand for fish, about two-thirds of the fish are imported [13]. Europeans therefore have an impact on fish stocks and aquaculture production all around the world. Today, consumers, processers and retailers are increasingly concerned about overfishing and often require guarantees that the fish they consume and sell originate from well-managed and sustainable fisheries. But such assurances are difficult to give for most fish stocks in European waters.

In Europe, current re-evaluation of the Common Fisheries Policy [14] is taking a fresh look at fisheries from a broader maritime and environmental perspective [15]. There will be a far greater emphasis on the ecological sustainability of fisheries outside Europe and the need to manage and exploit natural resources responsibly without jeopardising their future. It will be important to see just how this new approach to securing Europe's fisheries will fit into the existing international regime and the proposed regular process for assessing the global marine environment.

Towards a global assessment of the marine environment
In 2002, the World Summit on Sustainable Development's Johannesburg Plan of Implementation contained specific targets for fisheries management, including restoring fish stocks to maximum sustainable yield by 2015. It also identified the need to establish a 'regular process' under the United Nations for global reporting and assessment of the state of the marine environment, including socio-economic aspects, both current and foreseeable, and building on existing regional assessments.

This important step recognised the need for concerted international efforts to protect and manage the global commons sustainably. It marked the beginning of a concrete, action-oriented process to ensure that countries sign up for sustained, long-term and targeted efforts.

The United Nations General Assembly endorsed the proposal in 2005 [16] and in 2009 recognised the work of the Group of Experts on the scientific basis of the global assessment. As with all international processes, however, implementing the Regular Process for Global Reporting and Assessment will take some years [17].

ARCTIC

Dines Mikaelsen steadies his rifle against the bow of the gently bobbing boat, loads the chamber and signals to his companions to keep quiet. The Inuit hunter has already missed a couple of times. He squeezes the trigger. A loud crack echoes off the icebergs and a football field away a seal collapses.

Dines' four companions — tourists — are stunned. This is what they came to see but it still shocks them a little. Dines and the tourists he now depends on for a large percentage of his earnings are still quite new to each other. While other cultures subsist almost entirely on neat cuts of meat wrapped in cellophane, hunting and traditional forms of animal herding are still central to cultures across the Arctic.

Arctic culture and landscapes, just like Dines' small tourist business, are being shaped by two powerful forces: globalisation and climate change. Globalisation has brought MTV, iPods, state-of-the-art navigation systems and greater exposure to the outside world.

Climate change is transforming the frozen landscape, melting glaciers and opening seaways. This offers some new opportunities. Cruise ships have started showing up for the first time in Tasiilaq, Dines' village on the island of Ammassalik on Greenland's bleak east coast. In 2006, four cruise ships arrived; the following year it was eight.

'Five years ago, there weren't any flies in the North of Greenland. Now they have them. Here the flies arrive a month earlier than they used to,' says Dines. It's also noticeably warmer. Summer temperatures in Tasiilaq have reached as high as 22 degrees in recent summers — shattering previous records.

Pollution and breastfeeding [18]
Numerous dangerous pollutants, including agricultural chemicals, flame retardants, heavy metals and radioactive materials, have been impacting the Arctic and the people who live there for decades.

Pollution from elsewhere is carried to the Arctic by wind and sea. Because of the low temperatures, pollutants such as DDT fail to break down and instead remain in the water. As they are absorbed by fatty tissue, such as seal flesh, these chemicals are carried to the local population. In some parts of the Arctic breastfeeding mothers are therefore advised to supplement young babies' feeding with powdered milk to reduce exposure.

What is the Arctic?
The Arctic is an enormous area, sprawling over one sixth of the earth's landmass; twenty-four time zones and more than 30 million km^2. Much of the Arctic region is covered by ocean, up to 4 km deep, but large land areas are also found there.

The Arctic is inhabited by some 4 million people, including more than 30 indigenous peoples. Eight states (Canada, Denmark/Greenland, Finland, Iceland, Norway, the Russian Federation, Sweden and the United States) have territories in the Arctic region. Five of these are member countries of the European Environment Agency, of which three are EU Member States.

What is happening in the Arctic?
Climate change is having a greater impact on the Arctic than elsewhere. Temperatures in the Arctic have increased by twice the global average over the past 50 years [19]. The Catlin Arctic Survey, carried out in spring 2009, surveyed ice over a 280-mile route along the Beaufort Sea, located at the northern ridge of the Arctic. The ice was six feet deep and only one year old, on average. Older, thicker, more stable sea ice is disappearing. In 2008 the North-West and North-East Passage shipping routes through the Arctic were briefly navigable by boat in the summer for the first time since records began.

The impacts threaten to destroy the delicate network of Arctic ecosystems, which are already changing rapidly. Arctic sea ice in particular is causing concern. The ice and the sea below it are home to a tapestry of life — all at risk from global warming.

Polar bears are starving to death because the ice closest to the sea, the preferred resting place of seals, is too thin to support them. Migrating birds that spend the summer in the Arctic are missing the most plentiful spring blossoming season, because it occurs three weeks earlier — before they arrive.

Why should I care about the Arctic?
For many of us, the Arctic may seem very remote in terms of geography and relevance. However, the region plays a key role in regulating the world's climate. If climate change continues at predicted rates, it will have profound consequences for us all.

The north and south poles play a vital role in regulating the Earth's climate — acting as our cooling system. Reduced snow cover will mean that the Earth absorbs more heat from the sun and ocean currents shift. The Arctic Ocean, a mixture of fresh melt water and seawater, influences ocean currents around the globe. Some scientists believe that too much fresh melt water could actually 'switch off 'some of these sea currents, which play a crucial role in the climate further south.

The Arctic region is also home to millions of people, many from unique, indigenous populations. These people and their cultures are also at risk.

New economic activities in the Arctic
Melting Arctic sea ice and glaciers will open up new areas for human exploitation. It is likely that many economic activities in the Arctic will increase in coming decades. Fishing will occur further north when the ice retreats; oil and especially gas resources in the Arctic will be exploited; tourism is already expanding; shipping will most likely grow in line with exports of Arctic resources.

Intercontinental transport of goods may come with more open water and thinner ice, but requires development of ships and infrastructure. The extraction of minerals, timber and other resources may also increase. The various Arctic nations could begin to compete with each other for control of resources, territory and shipping routes.
Balancing the potential that a warmer Arctic offers against the risks (such as oil spills and environmental impacts) represents a significant challenge — one that requires changes to the way the Arctic is governed.

Environmental governance
In other parts of the world, the environmental challenge is to restore damaged ecosystems. In the Arctic, we still have the chance to protect what is, for the most part, a unique environment. The current Arctic governance system is very fragmented. While a broad range of international agreements apply to the Arctic, they were not made specifically for the region and their implementation and enforcement is uneven, even among the Arctic states.

In November 2008 the European Commission presented a paper outlining the EU's interests in the region and proposing a set of actions for EU Member States and institutions. It is the first step towards an integrated EU Arctic policy. The EU's main objectives are:

- to protect and preserve the Arctic in unison with its population;
- to promote sustainable use of resources;
- to contribute to enhanced multilateral governance of the Arctic.

Polar bears on involuntary diets
Climate change is causing weight loss among polar bears as the ice starts to thaw earlier and earlier each spring, according to 'Signs of Climate Change in Nordic Nature', a new report by the Nordic Council of Ministers. The earlier thaw restricts the number of seals that the bears can hunt. In certain parts of the Arctic the average female now weighs only 225 kg, which is 25 % less than two decades ago. If the trend continues there is a risk of the polar bear disappearing completely from parts of the Arctic.

The report identifies indicators that will help quantify the impact of climate change and follow developments in Nordic eco-systems. The 14 indicators describe the impact of global warming on, for example, the growing and pollen seasons, and fish and plankton stocks. Pollen seasons are starting earlier and earlier, making life more difficult for allergy sufferers. In parts of Denmark, Norway and Iceland, the birch pollen season now starts a month earlier than it did in the 1980s, for example.

EYEWITNESS: ARCTIC

Indigenous knowledge
Indigenous peoples have a long history of living in the same area. Understanding the environment is essential for their survival. Knowledge and the skills required to observe nature have been transferred from generation to generation, encoded in stories and tales. Indigenous hunters, fishers and gatherers possess special skills and unique understanding of nature. Today, this special knowledge can provide an insight into the past that lies outside the grasp of conventional science.

In northern Finland, Norway, Russia and Sweden, the Sami people — who have herded reindeer for centuries — are facing new weather patterns that threaten their culture and their livelihood.

Niklas Labba, Sami person, reindeer herder.
'Climate change is having an impact in an unusual way. In the past, the winters were cold and snowy. The deer survived by scraping snow away to uncover the grass below. However, the temperatures now go up and down in winter causing the snow to melt or rain to fall. This water then freezes as ice during the night. The deer cannot dig through the ice layer to the grass. They lose weight and in some cases starve.'

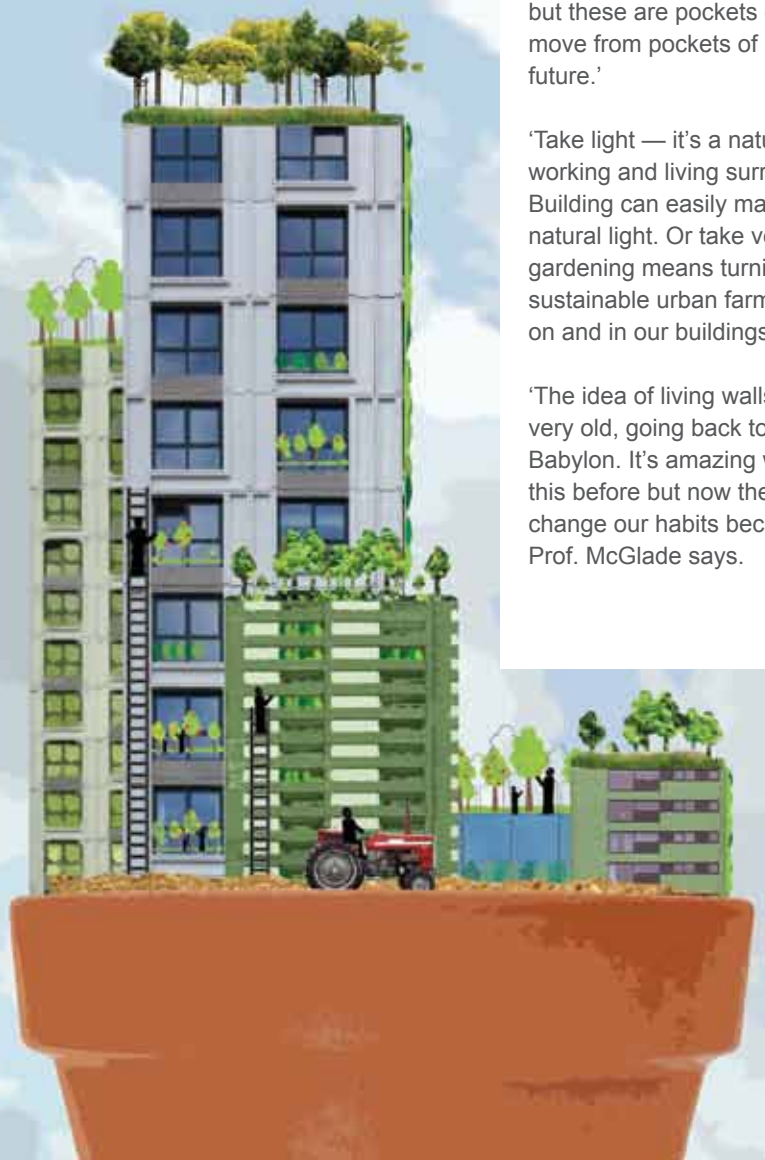
'When we have thawing and freezing, thawing and freezing, then we get ice layers,' explains Niklas Labba a Sami reindeer herder from northern Finland. 'The losses during winter with no access to the soil… It can be catastrophic. You can have 10 000 reindeer in an area and during that winter you can lose up to 90 % of them.'

Bruce Forbes, Research Professor at the Arctic Centre, University of Lapland, Rovaniemi, Finland.
'The things that the climate scientists predicted in the 80s are now normal. Fall comes later, the permanent snow on the ground is coming later each year and the springs are coming earlier. That means snow is melting out sooner and it also means the temperatures aren't as cold in the winter.'

'Tree line advance would be one of the strong signals that scientists have predicted of climate change. Trees are moving higher in elevation onto the mountains. There have been tree line advances of some tens of metres just in a couple of decades. So the trees are advancing into tundra areas.'

URBAN

From urban spaces to urban ecosystems



'Instead of damaging ecosystems, why not start creating them?' says Prof. Jacqueline McGlade. 'We have the technology and the design skills. There are examples of the future all over Europe but these are pockets of innovation. We have to move from pockets of innovation to cities of the future.'

'Take light — it's a natural resource. People like working and living surrounded by natural light. Building can easily make much better use of natural light. Or take vertical gardening. Vertical gardening means turning our cities into sustainable urban farms where crops are grown on and in our buildings.

'The idea of living walls and vertical allotments is very old, going back to the Hanging Gardens of Babylon. It's amazing we haven't done more of this before but now there is a new urgency to change our habits because of climate change,' Prof. McGlade says.

Higher temperatures in cities, caused by concrete and tarmac absorbing heat and releasing it slowly, would mean a longer growing season and improved yield. Rainwater could be harvested on roofs and networks of pipes would allow it to drip through each level. The plants would also have an insulating effect, keeping the living space inside the building cool in summer and warm in winter.

Populations on the move

The global population is congregating in our cities. Eighty per cent of the world's estimated nine billion people in 2050 are expected to live in urban areas. Many of our cities struggle to cope with social and environmental problems resulting from pressures such as overcrowding, poverty, pollution and traffic.

The trend towards urban living is set to continue. Around the world, cities occupy 2 % of the earth's surface but account for half of the global population [20]. In Europe, 75 % of us live in cities. This is likely to rise to 80 % by 2020. Europe's cities and towns currently account for 69 % of our energy use and thus most greenhouse gas emissions.

'Instead of damaging ecosystems, why not start creating them?' says Prof. Jacqueline McGlade

‘There are examples of the future all over Europe but these are pockets of innovation. We have to move from pockets of innovation to cities of the future.’

The environmental impacts of cities spread far and wide as a result of their reliance on outside regions to meet demand for energy and resources and to accommodate waste. A study of Greater London [21] estimates that London has a footprint 300 times its geographical area — corresponding to nearly twice the size of the entire United Kingdom. Pollution from cities also often impacts areas outside the city.

Climate change is a new and ominous threat to city living. Some cities will suffer considerably as a result of climate change. This could aggravate social inequalities: the poor are often most at risk and do not have the resources to adapt. Climate change will also affect the urban environment: air and water quality, for example.

From adaptation to new thinking

So, our cities and urban areas have many problems ranging from social to health to environmental. However, the proximity of people, businesses and services associated with the very word city, means there are also huge opportunities.

Urban settings offer important opportunities for sustainable living. Already, population density in cities means shorter journeys to work and services, greater use of public transport, and smaller dwellings requiring less lighting and heating. As a result, urban dwellers consume less energy per capita than rural residents [22].

Our cities also exist in a unique position with regard to climate change mitigation and adaptation. Physical characteristics, design, governance and location of a city are just some of the factors that can contribute to or alleviate both.

Clearly, engineering approaches — such as flood barriers — are only a part of the solution. Adaptation also calls for a fundamental rethinking of urban design and management, and it should be ‘mainstreamed’ in all related policies, including land use, housing, water management, transport, energy, social equity and health.

Rethinking urban design, architecture, transport and planning we can turn our cities and urban landscapes into ‘urban ecosystems’ at the forefront of climate change mitigation (better transport, clean energy) and adaptation (floating houses, vertical gardening). Better urban planning will improve quality of life across the board and create new employment opportunities by enhancing the market for new technologies and green architecture.

The key lies in planning cities in ways that facilitate lower per capita energy consumption, using means such as sustainable urban transport and low-energy housing. New technologies for energy efficiency and renewable resources, such as solar or wind energy and alternative fuels, are also important, as is providing opportunities for individuals and organisations to change their behaviour.

Designing the future

'The future will turn out different than we expect — that is all we can be certain of. We are planning for that uncertainty,' says Johan van der Pol, deputy director of Dura Vermeer, a Dutch construction company currently designing and building IJburg, a new floating district in Amsterdam.

IJburg is one of the most ambitious projects the municipality of Amsterdam has ever undertaken. An expanding population and rising water levels have forced the heavily populated city to be creative: experimenting with novel types of architecture on the water itself. The new houses are 'docked' to floating walkways and hooked up to electrical, water and sanitation services. They can easily be disconnected and moved somewhere else — bringing a whole new meaning to 'moving house'. The developing town includes eco-friendly floating greenhouses where all manner of fruit and vegetables are growing.

The floating houses of IJburg are just one example of a new movement in architecture and city planning. Climate change impacts range from drought and heatwaves in southern Europe to flooding in the north. Cities must adapt. Rather than simply strengthening flood barriers or shipping in water, some architects, engineers and city planners are looking at a whole new approach to urban and city living. They are approaching urban landscapes as urban ecosystems of the future.

Exchanging knowledge and good practices

'European cities face different challenges which demand different responses,' says Ronan Uhel, head of the Natural Systems and Vulnerability programme at the EEA.

'Those cities initiating measures early on are bound to see the best returns on their adaptation investments. Yet to date, only a few European cities have developed strategies enabling adaptation to the "new" climate change conditions — and actual implementation of measures is, as yet, mostly limited to small scale projects,' he says.

Other cities may not be so fortunate in terms of knowledge and resources and will require ongoing support and guidance. At this stage, improvement in the exchange of experience and best practices among cities would be most valuable.

'Thisted is a small community in western Denmark that provides all of its energy itself. Sometimes, it even feeds energy in to the national grid. This community is reclaiming its destiny. It sounds philosophical but that's what we're talking about: reclaiming who we are,' says Ronan Uhel.

'We have created societies of assisted people. We often only have a virtual connection to our natural surroundings, our shrink-wrapped food, our water. We need to rediscover ourselves and our place in nature.'

'We have to move from pockets of innovation in cities to innovative cities.'

Paris is buzzing
Bees have been kept on the roof of the Paris Opera house for 25 years. The colony at this most Parisian institution is thriving and produces almost 500 kg of honey every year.

The city bees are flourishing and there are as many as 400 colonies in the city. New hives are now in place in Versailles Palace and at the Grande Palais. Indeed cities provide an abundance of flowering plants and trees in our gardens and parks. And while there is pollution there are much fewer pesticides in cities. Urban bees appear to be doing better than their country cousins in Europe.

The French National Union of Beekeepers started a campaign — 'Operation Bees' — in 2005 with the goal of integrating bees into the urban landscape. It seems to be working. The beekeepers union estimates that each Parisian beehive produces a minimum of 50–60 kg of honey per harvest and the death rate of the colonies is 3–5 %. That compares to country bees that produce between 10 and 20 kilograms of honey and experience a death rate of 30–40 %.

Bees are also busy in London. According to the London Beekeepers Association, urban bees appreciate the abundance of flowering plants and trees combined with relatively low pesticide use. This, and the slightly milder weather, means that the bee-keeping season is longer and usually more productive than in rural areas. A perfect example of the potential of our urban ecosystem.

Keeping an eye on the earth
At the EEA we believe that if we are to tackle our environmental problems, we must engage with ordinary people and ask how they can 'inform' us. Farmers, gardeners, hunters, sports enthusiasts — all have ready local knowledge.

'Eye on Earth' — a collaboration between EEA and Microsoft — provides fast, interactive, near real-time information on bathing water and air quality across Europe, with more services to come. And it allows users to have their say, supplementing and validating (or perhaps refuting) official information. By engaging citizens as contributors and empowering them with relevant and comparable information, services like Eye on Earth can contribute significantly to better environmental governance: http://eyeonearth.cloudapp.net/.

EYEWITNESS: URBAN

Pioneers of change
Pioneering 'sustainable living' projects exist all over Europe. The following 'eyewitnesses' are taking things in their own hands and leading the way towards sustainable living as they do so.*

Amsterdam, Holland
'The floating city is about dealing with uncertainty. How will we cope with climate change? In the Netherlands, we don't know how high the water will rise. But a floating community is flexible so it's not that important — the homes will simply rise and fall with the water,' Johan van der Pol says.

'The floating city is designed to cope with extreme events associated with climate change but it's also offering an improved quality of living — life beside or on the water is very good. So, we started adapting to the environment and quickly saw quite practical advantages.'

Thisted, Denmark
For the last 30 years, Thisted in Denmark has invested in renewable energies. Thisted's 46 000 inhabitants now produce almost zero carbon emissions in electricity and heat production. 'The customers of this plant receive a heating bill, which is one-third of what it would be if oil were used,' says Lars Toft Hansen, Engineer and Board Director, Thisted Power plant.

'Thisted is harnessing the distributed energy that exists in all our "backyards": sun, wind, waste, agriculture and forestry waste, tides and waves, thermal heat under the ground, hydro power — we've got it all. Why not use what we have? It's called power to the people. We simply have to go from pilot projects to the entire grid.'

* These eyewitness accounts are also taken from the 'Environmental Atlas' project: www.eea.europa.eu/cop15/bend-the-trend/environmental-atlas-of-europe.

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IMAGE REFERENCES

Cover image	'Mother and child', East Greenland, courtesy of John McConnico.
Contents page	Bog cotton, East Greenland, courtesy of John McConnico.
Page 16	Alpine image, courtesy of Sebastian Montaz.
Pages 24, 25	This page is based on the exhibition, Climate Refugees, by photographer Mikkel Stenbark Hansen and journalist Anders Kildergaard Knudsen.
Pages 32, 33	Farmer: from the 'Environmental Atlas' project: www.eea.europa.eu/cop15/bend-the-trend/environmental-atlas-of-europe.
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