Met Office

CITYSCAPE
Forecasting the metropolis

BRIGHT LIGHTS
Cleaner energy

FIRM FOUNDATIONS
Safeguarding our heritage

Barometer

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With the changing seasons and climate, the Met Office is helping other government departments recognise the opportunities for growth, explains Rob Varley, Director of Government Services.

Spring fever

Few key influencers in politics and business now doubt that the world is warming, that man-made carbon dioxide emissions are largely responsible, and that there will be significant further warming over the next 30–40 years. Making a difference to the environment takes Government action, which, in turn, relies on solid research. At the Met Office, we specialise in both.

A world-leading authority on the weather and climate, the Met Office Hadley Centre is set to deliver the Integrated Climate Programme (ICP) — a new, five-year plan that brings together, for the first time, the specific needs on climate change of the Department for Environment, Food and Rural Affairs and the Ministry of Defence. *Barometer* introduces Dr. Vicky Pope (pages 7–8) who's responsible for delivering the ICP as Head of Climate Change for Government at the Met Office and describes how its outputs will in turn influence the five-year plans of government departments.

The battle against climate change is set to intensify further this year with the introduction of three, new Government Bills (pages 13–14). The Bills' constitutions were informed by the Government Business Development Team at the Met Office that it is now helping government departments get ready to meet the challenges they contain. The Climate Change Bill, for example — the first of its kind in the world — aims to establish a clear, credible and long-term framework for adapting to the effects of climate change. It commits the UK to a 60% reduction in carbon emissions while consulting on the possibility of raising this to 80%.

Climate change and other environmental concerns will impact right across the energy industry. In particular, the Energy White Paper (forerunner of the Energy Bill) stresses the importance of building a low carbon economy. It aims to have 20% of the UK's energy coming from renewable sources by 2020, and 60% by 2050. Mindful of this priority, *Barometer* describes a landmark alliance that has seen the Met Office's former radar site at Corse Hill transformed into Europe's largest onshore wind farm by ScottishPower Renewables with the support of the Scottish Executive (pages 9–10).

With cities around the world gaining an estimated 60 million people per year (that's over one million every week), *Barometer* explores the less glamorous side of city life. The lack of open spaces, the heat-emitting buildings and the sheer volume of people living in a small geographical area, all influence atmospheric conditions and alter the weather and climate in urban areas. Lingering pollutants and urban heat islands can also affect the quality of city-dwellers' lives (pages 11–12). The Planning Bill proposes new ways of approving building projects like power stations, airports and motorways so that environmental considerations are taken into account.

The growing frequency and intensity of extreme weather is another key area of study at the Met Office that may similarly shape Government policy. *Barometer* looks back at last summer's floods across England (page 5) which reminded us of our vulnerability to extreme weather, even in developed countries. As the rising water threatened lives and caused substantial damage to property, the Met Office was at the hub of the response — providing forecasts and warnings, guiding the Environment Agency and emergency planners, and advising the Cabinet Office Briefing Room so that the UK was as prepared as possible.

As our climate changes and extreme weather, such as heatwaves and intense rainfall, becomes more commonplace in the UK, making the right decisions will safeguard the future in a number of different ways. For the Government, real opportunities for growth lie in the increasing worldwide interest in climate change along with the chance to make a positive difference to the environment. For the Met Office, possibilities lie in its ability to respond quickly to customers' needs with world-class science tailored to their unique requirements. We all need to spring into action; working together to get it right.

In this issue

Barometer is a controlled circulation magazine distributed free of charge to decision-makers in government, science and commerce, for whom weather and climate information has an impact.

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Courtesy of Derek Seaward

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Sea sure

As an island nation our lives are inextricably linked to the sea, which has shaped our culture and our history. In fact, the Met Office was set up in 1854 to provide information on the weather and ocean currents to mariners. Today, it has evolved into one of the world's leading authorities on the weather and climate while still working to protect those for whom the sea is a workplace or source of leisure including the oil, gas and renewable energy industries as well as ports and harbours. Our forecasts enable decision-makers to spot 'weather windows' so that operational work at sea can take place safely and efficiently.

Safesee is a new website from the Met Office for the marine and offshore industries that provides customers with fast and easy access to critical weather information whenever it is needed. Due to be trialled by customers soon, Safesee offers general weather information through to site-specific forecasts and, importantly, hourly weather updates to improve decision-making in weather sensitive situations. It also allows users to set their own weather thresholds with an at-a-glance traffic light code that immediately highlights any weather problems the moment you log on.

Photo: Alamy

Impact of the largest storm surge ever recorded in Britain, 1953 Photo: TopFoto

Stemming the tide

The earliest record of a flood in London is dated 1099 and found in the Anglo-Saxon Chronicle. It took place on the festival of St Martin (a Pagan, mid-winter celebration) when, "the sea flood sprung up to such a height and did so much harm as no man remembered that it ever did before."

Throughout history there have been many failures of coastal defences from the Humber to the Thames. In the North Sea, the largest storm surge ever recorded was on 31 January–1 February 1953 which flooded the east coast and the Thames Estuary, killing 307 people. It was in response to this disaster that the Storm Tide Forecasting Service was set up by the Met Office. Over half a century later, we still provide forecasts and warnings of coastal flooding, storm surge and wave activity to the Environment Agency and Scottish Environment Protection Agency.

Today, London is protected from possible flooding by the Thames Barrier — a series of gates across the Thames at Woolwich Reach. First raised 25 years ago, it defends the capital against storm surges from the North Sea and holds back high tides when the river is swollen by heavy rainfall upstream. The Environment Agency, which maintains and operates the Thames Barrier, is liaising with the Met Office on the possible impact of climate change in the South East as it looks at options for flood risk management in the Thames Estuary up to the year 2100.

Firm foundations

Peter Falloon, Met Office Climate Impacts Scientist addresses the Siemens AGM

Siemens, like the Met Office, is a legacy of Victorian England so has been doing business in the UK for a very long time. Founded in 1843, the company is behind nearly all of the 21st Century technology and services we take for granted in our daily lives including domestic appliances, phones, computers and much more. It has been working with experts from across the Met Office on a problem affecting most, if not all, modern businesses — the impact of climate change.

Specialists from Met Office Consulting and the Met Office Hadley Centre were invited to attend Siemens' 2007 Annual General Meeting to help stimulate debate on the challenges and opportunities posed by a changing climate. Several of Siemens' major markets could be affected including power, water, healthcare, mobility, industry, safety and security.

At the meeting, our experts explained that reducing and preparing for the affects of climate change are equal parts of the solution and should now be central to any related strategy, whether the company is dealing with individual traders or multinational corporations.

Lasting legacy

Historic buildings, archaeological sites and ancient parks and gardens across the UK, some many hundreds of years old, face the same tough choices forced on us all by climate change. Several organisations are now working with the Met Office to protect our national heritage from the impacts.

Heritage managers, like Met Office scientists, see climate change in ten, 50 or 80 years from now as a current problem. They are well aware, too, of the complex interaction between their sites and the local climate and concerned about any forces that may disrupt the finely balanced conditions under which their treasures have been preserved — some for many hundreds of years. That is why the Met Office has been working with the National Soil Resources Institute (NSRI) and Forest Research on behalf of the Department for Environment, Food and Rural Affairs (Defra) to assess the impacts of climate change on different soil functions including at locations of historical importance.

Historic buildings, archeological sites and ancient parks and gardens are exposed to the same risks of climate change as the wider environment — increased year-round temperatures, more extreme high temperatures, more winter storms, more intense downpours, less summer rainfall, sea-level rise and the threat of coastal flooding, erosion and subsidence. But often, because of their location and other complexities such as the delicate materials they contain, these sites are especially imperiled.

Even modern building projects, which are tomorrow's legacy, are not immune to the effects of climate change. Buildings and roads built to specifications based on current conditions may have foundations that become unstable as soils dry out in hotter temperatures. Increased subsidence to buildings in South East England alone, over the period 1987–1997, which was the warmest decade on record, cost the insurance industry around €4,500 billion.

Increased subsidence poses other problems for the building industry too. In addition to concerns over flooding and inadequate drainage, it could affect plans for modern housing as current preferred locations may become unsuitable for development.

But as our climate changes, heritage managers may face the toughest decisions of all regarding what buildings, artefacts and landscapes to save. Adaptation is a major part of the defence against climate change and requires careful planning now based on a meticulous assessment of the risks. The table, below, drawn up by the Met Office with the NSRI and Forest Research as part of a recent scoping study for Defra, describes some of the action that could be taken in the historic environment immediately and in the longer term to preserve our national heritage for the years to come.

Turn to page 18 to read what Tony Robinson, presenter of Channel 4 series Time Team, has to say about archaeology in a changing climate.

Adaptation	Urgent action	Long-term action
Share loss	Identify wetland heritage sites where sustainable management is a possibility. Prioritise others for rescue conservation, where appropriate	Mitigate against the increased erosion of heritage features due to loss of vegetation and increased flood and storm events
Bear loss	Manage vegetation and drainage to reduce water uptake from wetland heritage sites and competition from ancient trees	
Prevent effects [i]: structural and technological	In-depth review and guidance on soil and hydrological management for heritage sites	Application of water and erosion control systems
Prevent effects [ii]: legislative, regulatory, institutional	Develop a multi-agency strategy for managing the historic environment in a changing climate	Protect some sites from adjacent land-use change or development, which could exacerbate impacts
Avoid or exploit changes in risk	Review potential impacts and consider on what types of heritage features they may be limited. Identify sites now which are perceived to be most at risk and develop mitigation strategies.	Increase the value of sustained archaeological wetlands by identifying other site opportunities such as ecological habitats

Photo: Collections

Wetter summer, warmer winter

Weather wise, 2007 was a year to remember and kept people on tenterhooks as to what would happen next. By accurately forecasting the weather's behaviour the Met Office kept all of its customers informed on what they could expect, particularly when conditions turned inclement.

One of the worst floods to hit the Vale of Gloucester leaves thousands without water and electricity after the storms on 24 July 2007
Photo: Getty

The wet start to 2008 was reminiscent of last summer which will be remembered by many in the UK for its extreme rainfall. Torrential downpours in May, June and July 2007 left large swathes of the country under water as the rain was followed by widespread flooding, the consequences of which are still being felt by many today.

Ahead of the heavy rains, the Met Office provided forecasts and warnings, guided the Environment Agency and emergency planners, and advised the Cabinet Office Briefing Room on what was to come, so that the UK could be as prepared as possible.

Late last summer, most areas experienced the chilliest August for over 10 years. With the exception of Scotland and some parts of northern and central England, the above-average rainfall also ceased. But, for us, the work didn't dry up when the rain did — ever since the clean-up began we've been supporting insurers and local councils as they've helped those affected get their lives and belongings back on terra firma.

The Met Office was put to the test again in November 2007 when a large storm surge from the North Sea threatened to flood the east coast of England. As reported on page 3, the largest storm surge ever recorded was on 31 January–1 February 1953 which flooded the east coast and the Thames Estuary, killing 307 people. Over half a century later, the Met Office was at the heart of the 2007 response, advising the Environment Agency and wider government on the areas most at risk. Our accurate and well-timed forecasts allowed local councils to prepare for a possible flood, protecting lives and property along the coast. We also accurately predicted that there would not be a high flood risk on the following spring tide a fortnight later.

Although the wet weather persisted into December, the sun also made its presence felt. Unlike the summer, parts of northern Scotland received over double the average sunshine for the time of year, making it the sunniest December in the region since the areal series began (1929). As we headed into the festive season most areas were in line for a damp and grey Christmas rather than a white one, as bands of yet more rain pushed south-east across the country.

The interest in snowy Christmases has its origins in the colder climate of 1550–1850 when Britain was in the grip of a 'Little Ice Age'. Often, the Thames froze over (it was not uncommon for the freeze to last over three months) and frost fairs were held in London on the ice. 1814 saw the biggest of London's frost fairs but also its last as a new London Bridge, built in 1823, acted as less of a dam than its predecessor. A narrowing of the river through the creation of embankments then altered the river-flow even more. The Thames is now too fast-flowing to freeze even if the temperature were to fall below zero.

Today, for most parts of the UK, Christmas comes at the beginning of the season for snow — wintry weather is more likely in the deepening cold of January. In keeping with its forerunner, however, early 2008 kept our accurate forecasts in very high demand. In the areal series available since 1914 it was the fourth warmest January for England and the wettest January for eastern Scotland and Northern Ireland. Severe gales brought heavy rain and renewed fears of flooding which saw the Met Office working closely with the Environment Agency again to monitor river levels across England and Wales. Arctic air then swept south at the beginning of February and brought with it wintry conditions more in keeping with the time of year. However, with its unsettled start many people were already wondering, weather wise, what 2008 has in store.

Frost fair on the Thames, with Old London Bridge in the distance, painting formerly attributed to Jan Wyck (c.1625)
Image: Yale Center for British Art, USA/Bridgeman Art Library

For more information visit **www.metoffice.gov.uk**

Airquis model of Oslo. Airquis is driven by UM 1km models
Courtesy of the Norwegian Institute of Air Research and the Norwegian Meteorological Institute

World effort

When it comes to the weather, having a global outlook is essential. At the Met Office, accurately predicting what's happening thousands of miles away is a daily challenge that ultimately improves the accuracy of forecasts closer to home.

In spring 2007, the Met Office began licensing its world-renowned Unified Model™ (UM) to weather services in other countries, allowing them to benefit from running the system operationally in their 'public duty' tasks.

Introduced in 1991, the UM is unique — it's the only modelling system capable of producing daily weather forecasts and performing climate predictions. Not only can the UM be used to assimilate observational data in four dimensions (width, height, depth and time), it can be coupled to land surface, sea-ice and ocean models to allow users to model the earth system as a whole. Its continuous enhancement by a Met Office team of 250 research and development scientists has secured its position at the forefront of forecast modelling for the last sixteen years. A number of foreign weather services have shown interest in using the UM in their day-to-day weather forecasting because of its superior capabilities.

"We opened up the UM licence in response to demand," explains George Pankiewicz, manager of UM external collaborations at the Met Office. "But we wanted it to benefit the development of the UM too. By offering global users the option of waiving the annual licence fee in exchange for their commitment to a programme of research, we are able to improve the UM's functions in areas where they have particular interest and expertise."

Working together

With many countries already signed up, or due to soon, these contributions include an improved radiative transfer scheme from Australia; investigations of the impact of different snow models on air temperature by Norway; testing of advanced observation processing techniques by New Zealand; and diagnostic studies of the prediction of the Asian monsoon in India. On top of this combined expertise, South Korea's technological contribution of massive supercomputing power will enable the UM to carry out advanced global ensemble modelling — using multiple versions of the same model with slightly different starting points to forecast risk — and deliver powerful results.

The collaborating countries are also experimenting with the UM in new ways to contribute to the advancement of the system. For example, Norway is running the model at incredibly high resolutions of less than 1 km in the built environment to investigate levels of air pollutants in six of its cities. "Norway's research is an exciting use of the UM which could result in a clearer understanding of how particulates disperse in the atmosphere, improving city living," says George (see pages 11–12 for more on the Met Office's pollutant modelling work).

Simply the best

And global collaborators can contribute much more than expertise and technology. By running the UM in a different part of the world and verifying it against observations, users are able to wheedle out inconsistencies in the model. "It's one of the best modelling systems out there, but it isn't perfect," George continues. "So to have users around the world telling us that the model depicts Africa's land surface as too dry, or convection in Australia as starting too early in the day, is really valuable."

But with increased possibilities comes increased responsibility. India and South Korea are due to become collaborators in March 2008, at which point 20% of the world's population will be relying on the UM for their weather forecasting services. "We have a duty not just to UK citizens but to people worldwide to make sure that the UM continues to deliver the best forecasts possible," concludes George. "And with the help of our global collaborators, we can really make that happen."

Did you know?

> The Met Office started operational numerical weather modelling in the 1960s, with the first version of the UM system brought into operation in 1991 by Mike Cullen and his team. Mike was then Director of Numerical Weather Prediction at the Met Office.

> The UM is a suite of software made up of sub-models and processing systems that can be configured in a number of different ways so that ocean, wave and sea-ice modelling and data assimilation can be switched on or off for a specific modelling application.

> Of the 188 members of the World Meteorological Organization around 40 have the computing capacity and numerical modelling experience to run the UM.

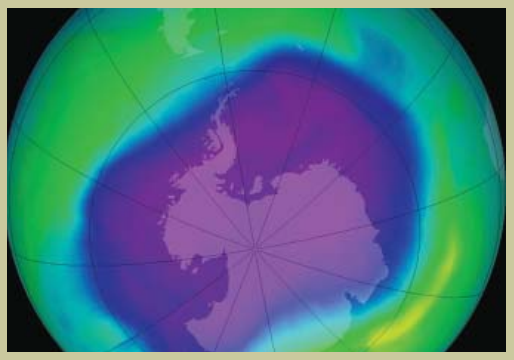
> The UM is upgraded between three and four times a year and a parallel suite is run at the Met Office to test upgrades before they are added to the operational forecasting suite.

Making a difference to the environment takes Government action, which, in turn, relies on solid research. As Head of Climate Change for Government at the Met Office Hadley Centre, no-one understands this better than Dr. Vicky Pope.

Environmental health

From the moment Vicky joined the Met Office in the 1980s her role took on an environmental angle. Building on her maths background, Vicky did a six-month training course that enabled her to apply her knowledge to meteorology. It was during this time that she identified studying the stratosphere, or conditions above the clouds, as an exciting place to work. Vicky's timing was excellent and she joined a team just before the hole in the ozone layer was discovered — a time that marked the point when the world really began to accept the affect it was having on the environment.

"When the ozone hole was discovered, it was strikingly apparent to me that environmental issues would play a much more significant role in our work," Vicky explains. And she was right. The UK was one of the first countries to tackle environmental issues at policy level, which led to the opening of the Met Office Hadley Centre in 1990 to look further into climate change and its effects.



The discovery of the ozone hole, 1985 Image: Corbis

"Up to this point we have been trying to demonstrate that climate change is real but now we have to step up a gear. We need to produce more detailed information so people can make informed decisions."

One purpose

In 1996 Vicky moved from working on the stratosphere to developing climate models. Then from 2002, she took on various Programme Management roles that eventually led to the position she holds today — Head of Climate Change for Government at the Met Office Hadley Centre. In this role, Vicky takes responsibility for the delivery of services to its two main funding departments — the Ministry of Defence and the Department of Environment, Food and Rural Affairs. "My role is to make sure that everything we do answers a policy question," says Vicky, "which is why we developed the new Integrated Climate Programme (ICP)."

Launched in September 2007 as a five-year programme, the ICP will publish cutting-edge climate change science to help guide government departments in their policy development. It not only looks at the evidence for past climate change and predicts future change, but also studies the uncertainty in forecasting it. In addition, Met Office scientists are looking into how we can avoid dangerous climate change and by how much we need to reduce greenhouse gas emissions to make a difference.

Vicky believes that the Met Office is unique thanks to the combination of its world-class science and the emphasis it places on making its work relevant to Government policy. She says "We have always attracted the highest calibre of staff and I think that knowing our work feeds directly into such a globally important issue is an incentive for us all to keep the Met Office Hadley Centre at the top of its field."

Moving forward

The Met Office Hadley Centre takes its responsibilities very seriously. It's the only scientific group to attend every single Conference of the Parties (CoP) — the annual meeting of the nations committed to tackling climate change, the most recent of which was held in Bali, Indonesia, in December 2007. Since the first CoP in Berlin in 1995, the Met Office Hadley Centre has observed, commented and provided information for the delegates in their discussions on climate change.

"It's very valuable for us to be there to see how the process works," Vicky continues. "But we also add value by helping policymakers understand the science behind their arguments."

The meeting in Bali brought together more than 10,000 participants and resulted in the members agreeing the 'Bali roadmap'. This charts the course of a new negotiating process that will ultimately lead to international agreement on climate change and is a further step towards a more secure climate in future. Contributing to that future will be one of the Met Office Hadley Centre's greatest challenges.

"Up to this point we have been trying to demonstrate that climate change is real but now we have to step up a gear," says Vicky. "We need to produce more detailed information so people can make informed decisions. It's my responsibility to ensure that the Met Office can help the UK and foreign governments really make a difference."

To find out more about climate change in the news turn to page 17.

The UN Secretary-General Ban Ki-moon addressing the UN Climate Change Conference in Bali, December 2007
Photo: Reuters

Power sharing

Thanks to a successful partnership between the Met Office and ScottishPower Renewables, Glasgow's future is looking greener.

ScottishPower renewables

A cold winter's day near Glasgow and, as the wind howls across the hillside, workers battle against the elements to lay foundations, unload deliveries and build Europe's largest onshore wind farm, Whitelee. Owned by ScottishPower Renewables, the site will generate enough energy to power almost all the homes in the City of Glasgow. It's a far cry from Whitelee's previous incarnation as the Met Office's Corse Hill radar station. Once part of the UK's radar network, Corse Hill provided continuous real-time information on rainfall across southern Scotland. Now, as a development of 140 wind turbines, it will provide a constant source of renewable energy. So how did such a radical transformation take place?

"ScottishPower Renewables first approached us in November 2001, when it identified Corse Hill as a prime site for its proposed wind farm with its proximity to Glasgow, access to power lines and, of course, its windy aspect," explains Gordon Hutchinson, Team Leader of the Met Office's Remote Sensing Group. Gordon's team contributes to the UK's wind farm approval process by looking at every proposed site in Britain to see whether its wind turbines will interfere with radar signals in that area. At Corse Hill, the wind turbines and radar station could not exist on the same site, but the project was incredibly important because of the huge environmental and economic benefits it would have for Scotland. With this in mind, the Met Office embarked on a first-of-its-kind partnership with ScottishPower Renewables (in consultation with the Scottish Executive) to make Whitelee wind farm a reality.

Finding a site

Before Whitelee, the Corse Hill radar played a vital role in forecasting for Scotland. It was part of the composite observing method, which uses measurements from satellite images, the Global Positioning System, rain gauges and radar to come up with the most accurate forecast possible. "Finding a new site for the radar was essential if the Whitelee wind farm was to go ahead," explains Gordon. "But we had to make sure that no compromises were made in radar imaging, as this could affect the Met Office's ability to forecast for its customers in Scotland."

Photo: Britain on View

Whitelee, Europe's largest onshore wind farm, will generate enough energy to power almost all the homes in the City of Glasgow.

Above and right: The new Met Office radar station at Holehead in Stirlingshire

With the support of ScottishPower Renewables two sites were found that would deliver the coverage needed. Holehead in Stirlingshire and Munduff Hill on the Perth and Kinross/Fife border had both been identified as potential radar sites in the 1970s but, as individual locations, they were rejected. However, Met Office experts recognised that the two sites could work together to replace Corse Hill and even offer better radar coverage for parts of central and southern Scotland.

Did you know?

- On behalf of the MoD, the Met Office has seen almost 6,000 applications for wind farms in the last five years.
- There are currently 160 wind farm sites in the UK, creating enough electricity to power 1.3 million homes.
- 39 wind farm sites are now under construction, including Whitelee, totalling 539 wind turbines which have the combined potential to produce enough electricity to power 763,544 homes.
- The Government's Climate Change Bill, currently awaiting Royal Assent, aims to have 20% of the UK's energy coming from renewable sources by 2020, and 60% by 2050.
- ScottishPower Renewables is the biggest operator and developer of onshore wind energy in the UK with 18 operational wind farms in the UK and Ireland.
- 16% of Scotland's energy already comes from renewable sources compared to 4% for the UK as a whole.

Turbine under construction at Whitelee wind farm Courtesy of ScottishPower Renewables

Keeping it green

Once it was decided the new radars could work practically, the next step was to work out how they could have as little impact on the environment as possible. At Holehead, an innovative grass road was built that provides reliable access without infringing on the area's natural beauty. The designers even incorporated a grass bank that wraps around the station, reducing its visual impact for walkers, climbers and cyclists who regularly enjoy the area.

The Munduff Hill site is partially hidden by forest and strict Forestry Commission guidelines have been followed in its construction, from the quality of the access road to the amount of space cleared for the build. The Met Office has been working to improve the biodiversity of the site, introducing a wider mix of native vegetation to attract a greater variety of animals and birds.

Success story

With Whitelee on schedule to be powering around 180,000 homes by 2010, ScottishPower Renewables is demonstrating how the Government's aims for the Climate Change and Energy Bills can be achieved (see page 13 for more information on the progress of the Bills). And as Munduff Hill and Holehead should be fully operational by spring this year, the relocation project has been successful on many levels.

For Gordon, relationship building has been one of the project's most significant achievements. "Whitelee hinged on the strength of the relationship between the Met Office, ScottishPower Renewables and the Scottish Executive," he concludes. "It stands as a clear demonstration of how the Met Office can work with Government and industry to take action on climate change and support economic growth. It serves as an effective model for similar projects in the future, as the UK continues to build and grow its renewable energy industry."

City limits

Today, more people than ever live in cities around the world — but most are unaware they also live in unique microclimates formed by the city itself.

Predicting the weather in cities presents a real challenge for forecasters. The lack of open spaces, the heat-emitting buildings and the sheer volume of people living in a small geographical area, all influence atmospheric conditions and alter the weather and climate. This can lead to higher temperatures yet reduced sunshine and the potential for more cloud, rain and fog which can seriously affect the quality and safety of city-dwellers' lives.

Increased levels of pollution are a significant by-product of city life. Buildings and other tall structures disturb the mean flow of air, causing pollutants to become trapped between them and stay in the atmosphere for longer, affecting air quality. For authorities, coping with the problems these lingering pollutants can cause is easier if they understand how and where the fumes are going to move, in relation to a city's weather system.

Set up in 1986, partly in response to the Chernobyl disaster, the Met Office's Atmospheric Dispersion team, co-managed by Alistair Manning, does just that. Using the Numerical Atmospheric-dispersion Modelling Environment (NAME), they estimate where and how pollutants released into the atmosphere will disperse and provide this valuable information to affected parties. One day they might be predicting the drift of a toxic smoke plume to help the emergency services understand how best to tackle a fire. The next, they could be monitoring the levels of everyday pollutants and their movement in the atmosphere that are used in air quality forecasts for the public.

However, because every city is unique the pollution in the air disperses differently from location to location, so producing accurate forecasts requires specialist tools. "We are developing a model that calculates movement in localised areas," Alistair explains. "We are also fine-tuning our parametrizations [the process of deciding which variables to include in the urban model and which to omit] both of which will lead to greater forecasting accuracy and ultimately improve the information we give to our customers and the public." (Find out how Norway is using the Met Office's Unified Model™ to investigate levels of air pollutants in six of its cities on page 6.)

Photo: Britain on View

The climate challenge

But pollution isn't the only weather-related danger to public health in today's cities. Concrete buildings and roads retain heat, while city traffic as well as the heating and air-conditioning of buildings generate their own warmth. These and other factors combine to create a dome of heat in the atmosphere above a city referred to as an 'urban heat island'. These heat islands can cause thermal stress, where higher temperatures put a strain on people, materials and buildings.

"Like us, buildings will need to adapt to our changing climate."

Met Office climate impact scientist Mark McCarthy is working to help organisations understand the effects of such temperature increases. For example, he is working with the energy industry to identify the affects climate change and urban heat islands may have on its electricity distribution networks located in the cities.

"We are currently working with building scientists to assess how urban climates might change in the future, to provide a tool that planners and architects can use to assess how this will affect their choice of materials, techniques and even designs," he explains. "Like us, buildings will need to adapt to our changing climate."

Just as with atmospheric dispersion, when it comes to climate change cities are a demanding environment to forecast. But Mark is optimistic the work of his team will have a tangible and positive effect.

"The call for a better understanding of the urban climate is getting louder, as more and more of the UK and world's population lives in cities. So developments are happening fast. In fact, we are continually improving the process to provide the most accurate information possible."

Did you know?

> 80% of the UK's population and 50% of the world's population lives in cities.

> In 2008 the urban population is expected to rise to 3.3 billion people, which is larger than the entire global population in 1967, just 40 years earlier.

> Cities and urban areas are gaining an estimated 60 million people per year — over one million every week. In many developing countries cities are growing two or three times faster than the overall population.

> As a result of the urban landscape, cities' microclimates are generally up to 10% wetter, 2% warmer, 10% more cloudy and 100% more likely to have fog in winter.

> Although strong winds in cities are less likely because tall buildings interrupt normal air flow in the lower atmosphere, the surface roughness that the urban skyline creates actually increases the likelihood of gusts and vortices as winds are often funnelled in between buildings and down streets. This makes the prediction of how pollutants disperse a constant challenge.

To the power of 3

The battle against climate change is set to intensify this year with the introduction of three, new Government Bills. Here, we look at how the Met Office is working with government towards a better environmental future.

Photo: Alamy

The three new Bills each play an important part in delivering the Government's rigorous climate change strategy and could radically change the way public service organisations operate. The Planning Bill increases environmental considerations in construction. The Energy White Paper addresses the changes needed in the generation of energy. And the Climate Change Bill establishes a long-term framework for tackling climate change.

Understanding the weather, climate and environment plays a vital role, not just in the creation of these Bills, but in making them work — and helping government departments deal with this will be a challenge. In response to this need, the Met Office set up the Government Business Development (GBD) team in May 2007, to explore and develop the business relationship it has with other government departments. Broadly, the team acts as a direct link between Met Office services and government needs.

"By offering our customers the right service at the right time, we aim to become their trusted partners and help them use our services to navigate the challenges of climate change," explains Kirstine Dale, Head of GBD.

Planning Bill

The Planning Bill, sponsored by the Department for Communities and Local Government (DCLG), proposes new ways of approving projects like power stations, motorways and airports that includes environmental concerns in the process. Recognising the DCLG's need for accurate weather and climate research to develop the Bill, the GBD team pulled together advice from across the Met Office and provided timely, high-quality information during the Bill's consultation phase.

But it doesn't end there because, as Kirstine explains, the team aims to support other departments and organisations that the Planning Bill will affect.

"The Met Office recently worked with British Energy looking at how future storm surge heights might affect the construction and maintenance of its coastal power stations. This is exactly the sort of service we can provide other organisations involved in the planning and building of the UK's infrastructure."

Aerial view of Stansted Airport Photo: www.baa.com/photolibrary

Energy White Paper

The Energy White Paper, forerunner of the Energy Bill, also provides a range of opportunities for the GBD team. The Paper focuses on the way in which environmental circumstances will change the energy industry. This means it needed in-depth research into the generation, distribution and demand for energy, all of which will be affected by a change in our climate.

Says Kirstine, "In November 2007 we worked with the Department of Business, Enterprise and Regulatory Reform (BERR) on a whole month of events about sustainable development in relation to the energy industry, providing information and speakers on how climate change will affect them. This was designed to better inform BERR staff on likely climate change and how it might be important in their day to day work."

Climate Change Bill

The first of its kind in the world, the Climate Change Bill aims to introduce a clear, credible, long-term framework for adapting to the effects of climate change and reducing carbon dioxide emissions. As world-leader in climate change research and prediction, the Met Office has been involved in the Bill from the outset. But the GBD team wanted to take it a step further.

The Met Office Hadley Centre was the first in the world to develop ten-year climate forecasts which will be used alongside its climate projections for the next 50 or 100 years that are already shared across the globe. These decadal forecasts offer predictions of more direct, practical relevance to organisations where adapting to climate change is a key operational concern, and could prove strategically important to a wide range of users including policymakers, local authorities, emergency services and planners. It is for this reason that the GBD team is working with government customers to ensure that science at the Met Office focuses on addressing the questions most pertinent to them.

Adds Kirstine, "By getting government departments involved at this level we are doing something unique. It's an exciting step forward in what the Met Office can offer the Government."

Through training, consultancy, research and groundbreaking models, the GBD team is eager to promote all the services the Met Office provides. "The Met Office is about so much more than sunshine and showers," concludes Kirstine, "and we are working hard to make every government department aware of that."

To find out more about climate change in the news turn to page 17.

For more than 20 years, OpenRoad from the Met Office has led the market in getting key weather information out to decision-makers in the road transport industry. Here, we look at how our scientists are working alongside these customers to produce new and improved forecasts.

Paving the way

Photo: Alamy

OpenRoad is a weather forecast service that helps local authorities and trunk road operators to manage and minimise the effects of the weather; contributing to the safe and smooth running of public highways. By enhancing its accuracy and value, we aim to instil in our customers even more confidence in their decisions about whether or not to grit roads, especially on marginal nights when temperatures hover close to zero.

We use a number of different numerical models to produce a road weather forecast — from the model used to predict the UK's weather every day to a specialised model for roads. The single most important factor affecting the accuracy of a road forecast is that of the weather forecast that goes into it. For example, the roads on a clear, still and starry night will almost inevitably be much colder than on a cloudy, windy one. The amount of recent rainfall will affect whether the road surface is wet or dry and whether there will be widespread ice if the temperature falls below freezing. Knowing whether precipitation is likely to fall as rain or snow is also crucial to our road customers.

A brand new weather forecasting model is about to be introduced by the Met Office for the UK. This is the highest resolution model available with grid points only 4 kilometres apart (instead of the 12 kilometres used previously) which allows much more detail to be predicted, including the effects of small hills and the movement of showers across the country. It also better represents the effects of urban areas e.g. heat islands. (Turn to pages 11–12 for more on the urban heat island effect).

Cloud forecasts too — one of the most challenging elements for any model — have been improved significantly with the knock-on effect of increasing the accuracy of our near-surface and road temperature forecasts. Looking ahead, the planned move to a 1.5 kilometre resolution model in 2009, thanks to greater supercomputing power at the Met Office, promises to deliver even more forecast accuracy.

Better representation of urban heat islands is to be introduced

Even with accurate weather forecasts, a number of other local effects have to be carefully represented in the road model. These include the effects of small dips and valleys ('frost hollows') and areas of shade (cast by hills, embankments, trees and buildings etc). Both of these processes can lower the temperature of a stretch of road relative to other parts of the same route and have critical safety implications. It may mean that the temperature falls below zero and gritting is required even if the route as a whole is mainly above freezing. Conversely, an obstructed view of the sky (also known as reduced skyview) will diminish the amount of cooling that occurs overnight and make a stretch of road warmer than it would be otherwise. Accurately representing this effect will reduce instances of unnecessary gritting, saving money and benefiting the environment.

To verify the models, Met Office scientists have been carrying out road surveys throughout winter 2007/8 using vehicles equipped to measure air and road temperatures. The routes were chosen in consultation with our customers and provided a wide range of different conditions in which to evaluate and improve the models — inland and coastal, hilly and flat, exposed and enclosed, rural and urban. Data from these surveys is combined with detailed modelling and theoretical work to improve forecasting techniques. And already novel approaches have been included in the road model, which improve the representation of shading, skyview and valley effects.

A prototype service, forecasting along routes rather than for areas, is being trialled with customers this season. While we're working closely with them to roll out a solution that meets their operational needs, the scientific developments are also being fed into our traditional area forecasts so that all of our customers benefit.

For more information on OpenRoad please contact us at **openroad@metoffice.gov.uk**

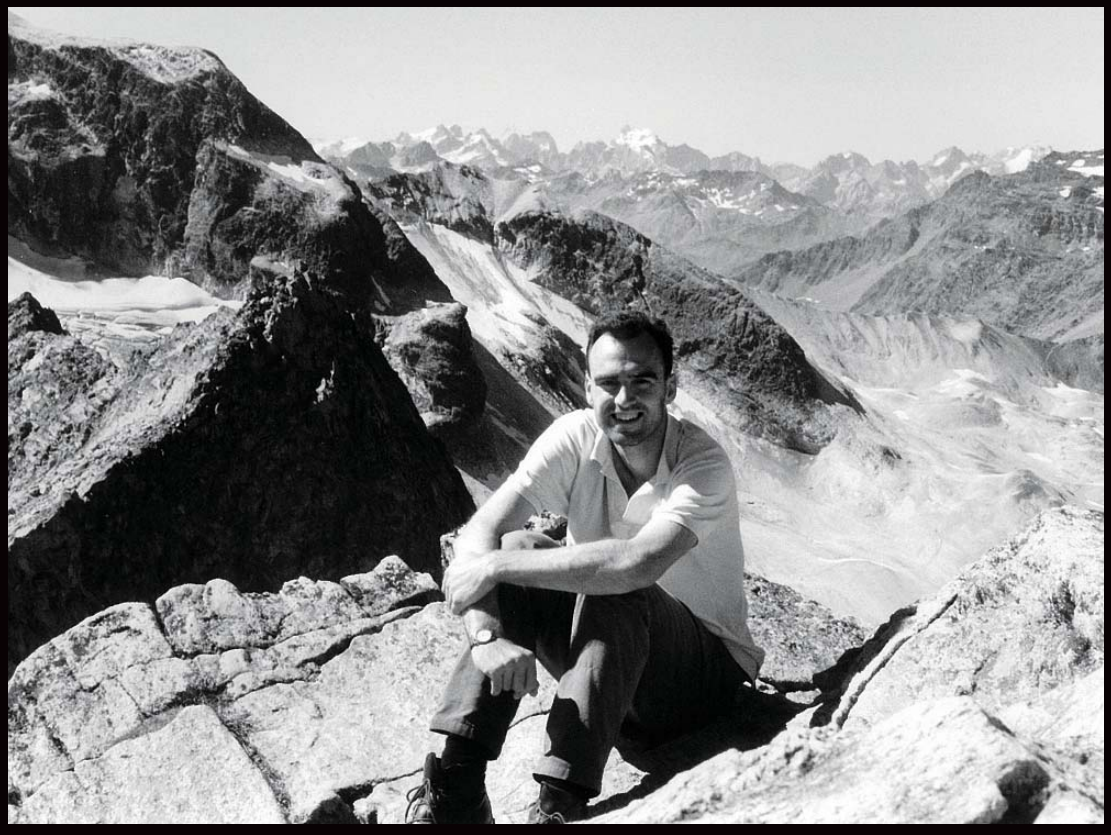
Science profile

Andy Brown, Head of Atmospheric Processes and Parametrizations (APP)

The Met Office employs professionals and experts who are constantly expanding the boundaries of weather and climate prediction.

Scaling some of the world's most famous mountains and working at the Met Office may seem leagues apart but, for Andy Brown, the link couldn't be clearer. "As a climber, the need for accurate weather forecasts is obvious," he explains. "Everywhere I have climbed, from Scotland to Nepal, the Alps to Ecuador, I knew I had to be able to trust and rely on forecasts to succeed, even to survive." From trusting in them, to improving them — today Andy performs a vital role in weather prediction as Head of Atmospheric Processes and Parametrizations (APP).

Made up of 22 highly skilled scientists, the APP team is broken down into four specialist groups. Each group deals with different atmospheric phenomena, from the effects of hills and mountains (orography), to clouds, convection and turbulence in the boundary layer — the layer of air that lies closest to the earth's surface. For the past 18 years, Andy has been working as part of the APP team, refining the Met Office's Unified Model™ (the system forecasters use to predict the weather — see page 6) by calculating the effect these phenomena have on its behaviour.



New challenges

With a Physics degree from Oxford, Andy started out in the Boundary Layer group in 1990 and moved to manage the Orography group in 1999. Following a three-year period as a Research Fellow, he took on the challenge of heading up the APP team late last year. "It's an exciting new area for me," Andy says, "as a scientist you are part of a team completing intense research on a day to day basis. Although I'm still involved in the science in my current role, I'm also responsible for identifying our customers' needs and helping my team cater for them."

Those needs range from helping businesses and organisations understand how the temperature can vary in hills and valleys and predicting local cold spots and frost hollows to prepare for treacherous driving conditions (see article opposite). They even include providing the aviation industry with more accurate information about the way lee waves and rotors could affect their flight paths (covered in Barometer, issue 7). Within APP, the team of scientists that work on individual customer cases also work on the long-term goal of researching and developing the forecast model — something Andy sees as a real strength. "Because everyone works in both areas, the scientific expertise that is applied to specific customer problems is fed into the model and vice versa. This enables them to better deliver on both levels."

Science in action

For Andy it all comes back to helping people get the most out of their weather reports, be it a climber planning an expedition or a government department looking for greater accuracy in long range forecasts to help with strategy. "I originally wanted to work in weather because it is something that every person in the UK relates to," he concludes. "Weather forecasting in all its guises is the most immediate way to see science in action, and I wanted to be involved in making that science work better. Improving the forecast model can improve people's lives — it's that simple."

Warming to the idea

Photo: UPPA/Photoshot

News on climate change continues apace with the UK Government and United Nations calling on world leaders to rise to the challenge of reducing its effects.

"Our mission is, in truth, historic and world changing — to build, over the next 50 years and beyond, a global low carbon economy."

In a recent speech in London, the Prime Minister, Gordon Brown, stressed the importance of building a global low carbon economy and pledged to put the UK at the forefront of the fight against climate change. He said, "Our mission is, in truth, historic and world changing — to build, over the next 50 years and beyond, a global low carbon economy. And it is not overdramatic to say that the character and course of the coming century will be set by how we measure up to this challenge."

He continued by outlining measures from the Climate Change Bill, the Energy White Paper and the Planning Bill, currently journeying through Parliament, which will help the UK to reduce its carbon emissions and move to greener energy sources. (Turn to pages 13–14 to read more on how the Met Office is working across government towards a better environmental future).

On climate change, the Government is committed to a 60% reduction in carbon emissions and is consulting on the possibility of raising this to 80%. The UK will also commit to increasing its use of renewable energy sources to meet its share of a 20% European Union target by 2020. (Turn to pages 9–10 for details on a landmark relationship between the Met Office, Scottish Executive and ScottishPower Renewables).

Pointing to the opportunities afforded by green technology, the Prime Minister added that a low carbon economy could help create hundreds of thousands of jobs in the UK and a "vast new export market."

Planning regulations will also have an impact, with all new homes required to be carbon neutral by 2016. Thanks to government schemes, 2 million homes have been insulated since 2001; a further 5 million homes will benefit from discounted or free loft and cavity wall insulation by 2011; and another 3 million homes will receive discounted or free energy efficient appliances and low energy light bulbs over the same period. Said the Prime Minister, "We have already, as you know, secured agreement that standard high energy light bulbs will start to be phased out from next year, and removed totally by 2011, and we are the first European country to do so."

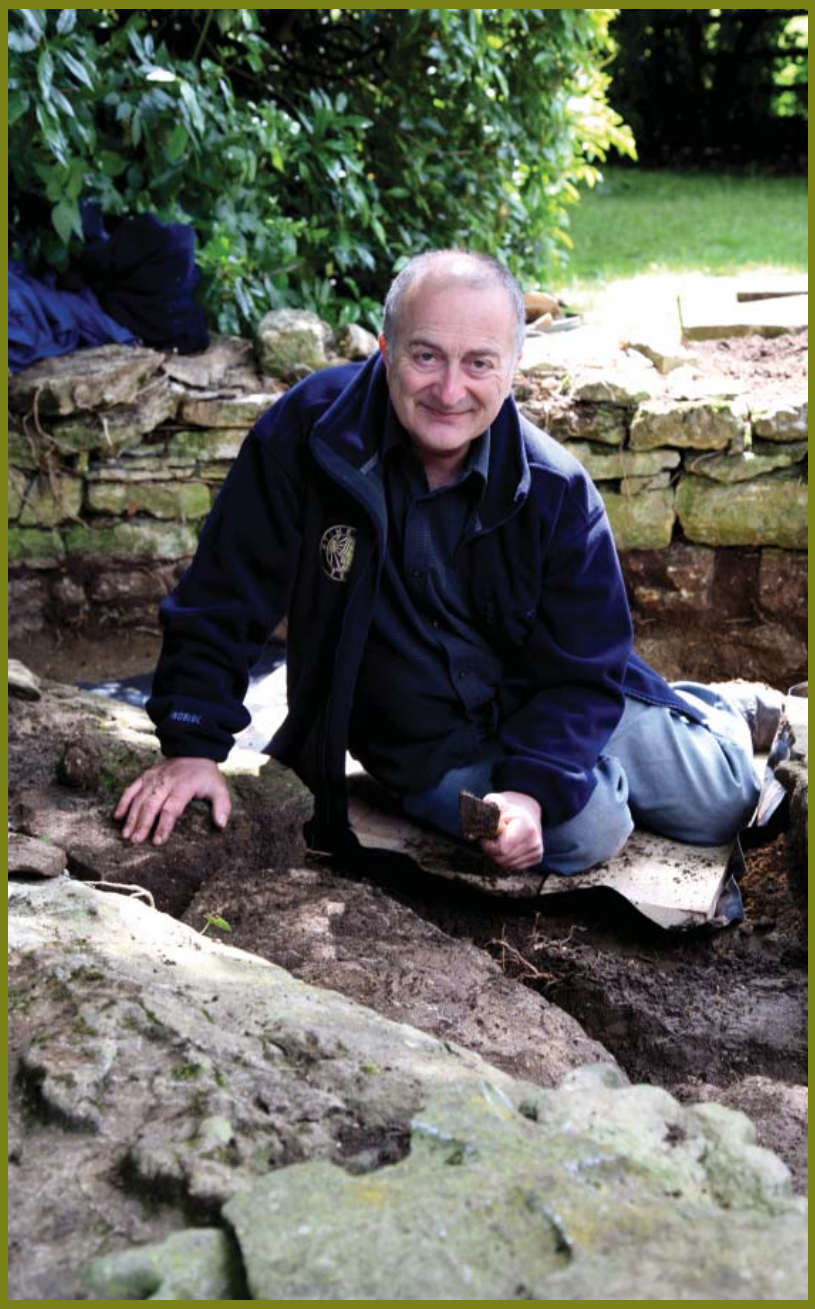
He also highlighted the United Nations (UN) summit on climate change that took place in Bali last December, where world leaders began negotiations on a successor to the 1997 Kyoto Protocol. As reported on pages 7–8, the Met Office attended this thirteenth Conference of the Parties, played an active part in the discussions and launched its Integrated Climate Programme that will deliver and stream of cutting-edge climate change information to the UK Government over the next five years. The summit resulted in members agreeing the 'Bali roadmap' — a new negotiating process that will ultimately lead to international agreement on climate change.

The UN Intergovernmental Panel on Climate Change (IPCC) also published the final part of its Fourth Assessment Report late last year. The 'Synthesis Report' outlined observed changes in the climate, rehearsed the causes and impacts of climate change and anticipated what the future climate might be like. A summary is available for policymakers. Commenting on this integrated view of climate change, the Prime Minister felt it clearly showed that "pervasive and prolonged consequences" would result from inaction.

He concluded, "All of us — Government, business, civil society and individuals — have a part to play. Working apart we will surely fail. But working together I have no doubt that this is a challenge to which the human spirit, and our powers of ingenuity and enterprise, will rise."

Meeting the challenge will also be one of the Met Office's greatest accomplishments.

A life less ordinary Tony Robinson



Courtesy of Channel 4

By Tony's own admission, he is a bit of a 'restless soul' when it comes to his career. In fact, it's the variety of his work that keeps him inspired. "I love the fun of doing comedy, for example, when I know the next project will be a novel."

Tony was hugely popular as the hapless Baldrick in the BBC's Blackadder series in which he played alongside Rowan Atkinson. But even before Blackadder, Tony had already held the post of Theatre Director and worked with the Royal Shakespeare Company and National Theatre. And while Tony is, perhaps, best known for his acting and presenting, he has also written 18 children's stories and a range of books for adults including 'Archaeology is Rubbish — A Beginner's Guide.' He has also penned and starred in children's TV shows, for which he drew on many of the skills he learnt in Blackadder. In fact, Tony has won two Royal Television Society awards, a BAFTA and the Prix Jeunesse International.

Today, he has found some very different challenges and is now perhaps best known for Time Team — the show that brings archaeology into peoples' living rooms and puts Tony into the elements as he digs for artefacts.

The runaway success of the programme came as a complete surprise to Tony. "Originally I just did [Time Team] for the crack and thought it would be interesting to experiment with a documentary."

But while he believes it's very difficult to predict which TV shows will succeed, he puts Time Team's popularity down to the fact that it's a journey of discovery which viewers can really get involved with. Although he does concede that "a five year-old might like it simply because it's got diggers and men with big beards."

It's evident Tony feels very passionate about archaeology and has a fascination with history in general. He believes archaeology has a very important place in today's world as a tangible link between past and present. But he also believes it's a link that faces a growing threat...

> "The affects of climate change on archaeology could be huge."

"The affects of climate change on archaeology could be huge," says Tony "especially around coastal areas. In the short-term, more archaeology could be revealed as wave patterns change. But in the long-term, it could be a completely different story."

Tony suspects global warming could have a catastrophic affect on archaeology as temperatures and sea levels rise. And the threat is not constricted simply to coastal regions but inland areas too. Due to their chemical makeup, boggy areas, for example, preserve a wealth of archaeological treasures, dating back centuries, which could be lost forever if they dry out.

In fact, Tony even suggests archaeology acts as "a metaphor for the problems we will all face in the next 50 years or so with climate change." He adds, "We may all need to decide what we can save."

Time Team is now in its fifteenth series, but typically for Tony he has many other projects on the go, including a four-part series on the history of British Law and another on the supernatural. With so much going on, does he have any time left for other creative pursuits?

"I do have a novel in the pipeline but writing a book can take a long time — especially when I have so much else to fit in."

Northern lights

Snapped by a passing satellite, this striking image of the northern hemisphere shows major cities and roads as clusters of bright lights.

Light pollution is a side effect of urbanisation and its sources include commercial offices, factories, streetlights and advertising billboards. It's most visible in highly industrialised, densely populated areas such as Europe, Japan and North America.

Life exists with natural patterns of light and dark, so any disruption of these patterns can influence behaviour — including our own. Once inside our modern, well-lit buildings, for instance, it's all too easy to lose track of time. Worryingly, medical research suggests that over-illumination can have a detrimental effect on human health.

But around the world, cities and urban areas are gaining over one million new inhabitants every week. This means that in 2008 the urban population is expected to rise to 3.3 billion people, which is larger than the entire global population in 1967 — just 40 years earlier. Light pollution, along with the pollution of air and water, are significant by-products of city life that can also damage the environment. Lighting alone is responsible for a quarter of all energy consumed worldwide.