Moray Tourism Audit **Topic Paper**

Summary of Climate Change: Impacts and Implications

Compiled by the Stevens View Partnership – 17 September 2007

BACKGROUND

As part of informing the debate about the future of tourism in Moray, the Stevens View Partnership has prepared this Topic Paper on Climate Change and its potential implications for tourism in Moray.

This is one of a series of Topic Papers that synthesize existing knowledge and trends about various factors affecting the tourism industry or of fundamental importance to the future of tourism in the area. The other papers will be on:

(i) Well-Being as a Driver of Market Demand;

(ii) The Whisky Industry;

(iii) Corporate Social Responsibility and Tourism.

INTRODUCTION TO CLIMATE CHANGE

Day to day weather patterns are continually changing on Earth. This is as it has been for millions of years. These daily weather patterns are the building blocks for wider and longer term climate patterns.

The problem is that, as Earth has become more industrialised over the last two centuries, and the population has grown from 1 billion to 6 billion (US Census Bureau 2002), so the pressures on the Earth are beginning to show. Although population has grown fastest in developing countries, energy demands have also risen in developed countries, and will continue to do so globally. Energy use has rocketed in the past 150 years, primarily through the burning of fossil fuels. For example, petroleum, gas and coal together make up around 90% of the fuel mix for energy in the United Kingdom.

This, together with certain farming practices, increased felling of tropical forests, and certain industrial practices has led to increases in levels of so called 'greenhouse gases' in the atmosphere, which evidence suggests are causing changes in the climate. In some parts of the world measures to reduce greenhouse gas emissions are beginning to take hold (European Environment Agency 2004b), but it remains the largest global environmental threat. It is no longer just environmental organisations who recognise that there is a problem.

On 11 June 2001, US President George W Bush stated (White House 2001):

> The issue of climate change respects no border. Its effects cannot be reined in by an army nor advanced by any ideology. Climate change, with its potential to impact every corner of the world, is an issue that must be addressed by the world.

In January 2004, the Chief Scientific Adviser to the UK Government, Sir David King said (Science Magazine 2004):

> In my view, climate change is the most severe problem that we are facing today – more serious even than the threat of terrorism.

On 14 September 2004 Prime Minister Tony Blair said (Prime Minister's Office 2004a):

> What is now plain is that the emission of greenhouse gases, associated with industrialisation and strong economic growth from a world population that has increased sixfold in 200 years, is causing global warming at a rate that began as significant, has become alarming and is simply unsustainable in the long-term. And by long-term I do not mean centuries ahead. I mean within the lifetime of my children certainly; and possibly within my own.

The new European Environment Commissioner Stavros Dimas has stated (European Parliament 2004):

> The main priorities for environmental policy over the next five years are to find ways of addressing the major long-term challenges facing the EU and the world. These are combating climate change, protecting biodiversity, dealing with the environmental factors which are harming human health, especially in the urban environment where the problems are more acute, and finding more sustainable patterns of production and consumption.

Whilst these quotes indicate the global nature of the problem, there has also been recognition that more local action must play a part. In February 2002, First Minister Jack McConnell said (Scottish Executive 2002):

> The world's climate is changing, and is changing too fast for comfort. We are living lifestyles and building economies which waste the world's limited resources. The more we use, the less we replace.
>
> We must take responsibility for the world that we live in. If previous generations had known what we know now, then perhaps the decisions taken by them would have been different.

THE SCIENTIFIC CONSENSUS

Global evidence

As indicated above, change is normal in the climate. What is not normal is the rate of change in recent times. According to the UNFCCC the main evidence is:

- Extra strength weather – flooding and droughts more frequent and intense. More powerful cyclones and hurricanes happening more often. Increase in variation of 'normal' weather, with hotter, longer dry periods. Greater evaporation due to increased temperatures means more precipitation;
- Decline of winter – the air temperature in the Arctic has increased by 5°C during the 20th century. Decline in snow cover by 10% in mid and high latitudes of Northern Hemisphere since late 1960s. Most mountain glaciers in non-polar regions have retreated during 20th Century. Glacier volume in Switzerland has decreased by two-thirds. In a report, the Scottish Executive Central Research Unit (2001b) concluded that changes to snow cover in Scotland as a result of climate change will be sufficient as to require adaptation strategies;
- Shifts in the natural world - at least 420 physical processes and biological species or communities have been affected by climate related changes.

The scientific consensus is that the global average temperature is getting warmer, and the frequency of incidence of devastating weather events is increasing. The global average temperature in 2003 was the third warmest since records began in the late 19th Century, with 1998 and 2002 the first and second warmest. The 1990s was the warmest decade in the northern hemisphere for 1000 years (according to the Worldwatch Institute). Records for the first eleven months of 2004 indicate that it will be the fourth highest on record, with

record temperatures in March and April (Earth Policy Institute 2004a and The Met Office 2004).

According to the UK Climate Impacts Programme (2005d):

> The Earth's climate has been relatively stable since the end of the last ice age, about 10,000 years ago, but it is now changing. The average global temperature is rising. The 20th century was probably the warmest century in the last 1,000 years: there was about 0.6°C of warming, with land warming more than the sea. The 1990s were the warmest decade in the last 100 years. There is also evidence that rainfall patterns are changing, sea levels are rising, glaciers are retreating, arctic sea-ice is thinning and the incidence of extreme weather is increasing in some parts of the world.

Recent temperature figures (ICES 2004) for the North Atlantic showed some higher than average temperatures with some records set during 2003.

Climate change science is complicated, and this means that it is important to understand how long a time series is being used in evidence. Ice core records give figures for the last 400,000 years. An example where it is important to have the full story is: NASA's Goddard Institute for Space Studies (2004) indicates that Antarctica has broadly cooled over the last 30 years, but this is likely to reverse sharply over the next 50 years.

The Earth has had large natural fluctuations in temperature in the past. Over the last 2.4 million years, there have been up to 50 warm and cold oscillations in the climate in Scotland (Joint Nature Conservation Committee (JNCC 2005). As the climate swung between these extremes, records show that the country came under great stress. The rate of warming now is regarded as faster. The JNCC say:

> Repeated climate change also subjected the flora and fauna of Britain to stress: fundamental changes in the distribution of plants and animals took place. Beyond the margins of the ice sheets and during the cold climatic phases of the Quaternary Period, periglacial conditions prevailed. Such environments were characterised by frost-assisted processes and by a range of frost- and ground ice-generated landforms and deposits.… Increased wind action was prevalent, also producing a range of characteristic features…the flora and fauna of these cold periods is, not surprisingly, restricted in diversity and dominated by cold-tolerant species; large areas were dominated by tundra vegetation.
>
> Conversely, the warmer or interglacial periods…are characterised by the absence of glacial, periglacial and glaciofluvial features, and there were times when chemical weathering, soil formation and the accumulation of organic sediments took place. Variations in the quantity and type of pollen grains preserved in organic deposits, such as peats and lake muds, have been used to define systems of pollen zones or pollen biozones. These zones are characterised by particular vegetational assemblages which can be used to chart sequences of vegetational, climatic and environmental change.

The recent temperature rises are linked by scientists to the increasing levels of greenhouse gases in the atmosphere. The Earth Policy Institute (2004b) states:

> In 2003, carbon emissions from the burning of fossil fuels climbed to a record high of 6.8 billion tons, up nearly 4 percent from the previous year. Global emissions of carbon have been rising steadily since the late eighteenth century—and rapidly since the 1950s. In fact, annual emissions have quadrupled since 1950

According to the European Environment Agency (2004a) the early 1990s saw a decrease of greenhouse gas emissions followed by a stabilisation in the mid 1990s and an increase in 1999 and 2000. The cuts in the 1990s were largely due to increased efficiency in German power stations, and a change in fuel for electricity generation in the UK from oil

and coal to the less emitting natural gas. The EEA further points out that current measures alone would not allow the EU to met its obligations under the Kyoto Protocol. Additional planned measures would see the target reached but will rely on a disproportionate effort from some Member States.

It seems that every day there is a new story or report published adding to the weight of evidence. A selection of recent stories includes:

- Scotland braced for more storms (BBC 18 January 2005) Himalaya glaciers melt unnoticed (BBC 10 November 2004) and Climate change ruining Everest (BBC 17 November 2004)
- New Report Shows Disturbing Ecological Changes in the U.S. (Pew Center on Global Climate Change 2004)
- Spectacular leaf colours may be due to global warming (Guardian 16 November 2004)
- Barrage of Hurricanes May Just Be Florida Normality (Planetark 13 September 2004)

SCOTTISH EVIDENCE

WWF Scotland has published some recent analysis (WWF Scotland 2005) which shows that 2004 was the second warmest and third wettest on record. WWF also provided some extreme weather examples including:

- The average temperature for Scotland in 2004 was 8.17°C, just behind 2003 with 8.24;
- 2004 was the third wettest year with a total annual rainfall of 1673mm, behind 1990 and 1998;
- Eight months in 2004 were more than 1°C above average, classed as 'well above average';
- It was the wettest June at Kinloss, since records began in 1951;
- Leuchars had its wettest October since records began in 1921.

The Scottish Executive, in its review of the Scottish Climate Change Programme, gives little Scottish evidence aside from the fact that spring plants are now blooming earlier.

However, Indicators of Climate Change in the UK (Defra 2004f) outlines that it is expected that winter weather in Scotland will become wetter, while summer weather in eastern Scotland and southern England will become drier. This is in line with evidence they have provided that the ratio of difference between these has increased over the last few decades.

IMPACTS – WHAT IS LIKELY TO HAPPEN?

The size and nature of atmospheric processes mean that there is a time lag between increasing greenhouse gases and their having an impact on the global climate. By the same token, reductions in greenhouse gases will take time to have an effect – at least 40 years (UKCIP 2005a). This time lag means that the impacts of climate change are inevitable, and indeed many current weather patterns are as predicted by climate change models.

Climate change impacts are likely to be global and will vary enormously depending on prevailing conditions. In general terms, any change in climate involves a change in the close and relatively stable relationship between temperature, level of precipitation, wind and pressure systems.

Impacts in Europe include (European Environment Agency 2004a):

- Atmosphere and climate – central and northern Europe receive more rain; southern Europe has become drier. Extreme weather events (droughts, heatwaves, floods) have increased, while cold extremes have decreased
- Glaciers, snow and ice – 8 out of 9 glacial regions are showing significant retreat; extent and duration of snow cover has decreased since 1960
- Marine – increasing sea surface temperature especially in isolated basins like the North Sea, with resultant increased phytoplankton biomass; increasing presence of warmer water species; sea level rise of 0.8-3.0 mm/year will continue and increase rate
- Terrestrial ecosystems and biodiversity – increased growing season and northward movement of plant species; Northwest Europe biodiversity increased offset by reduction elsewhere; Increased carbon uptake of CO2 though this likely to be reduced in future
- Water – water availability beginning to change – will increase in northern Europe and decrease in southern Europe
- Agriculture – increasing CO2 and rising temperatures may allow earlier sowing dates, and increased yield, though increased temperatures increase water demand. Agriculture likely to prosper only where sufficient water resource
- Economy – increased frequency of extreme events, leading to economic losses
- Human health – increases in heatwave related health problems, tick-borne diseases and flooding.

IMPACTS IN SCOTLAND

The UK Climate Impacts Programme indicates that, in general terms, the climate will change in the following ways:

- Temperature – UK climate will become warmer. Warming over coastal waters will increase, but not as rapidly as over land. High summer temperatures will happen more often, very cold winters will reduce in frequency
- Rain and snow – winters will become wetter, with summers perhaps becoming drier. Snowfall will decrease though heavy winter rainfall will increase
- Sea level – sea level will continue to rise around most of the UK. Extreme sea levels (storm surges) will occur more frequently. According to SNH (2004):

  > The sea level at Aberdeen, with one of the longest tide gauge records, has risen by 0.6 mm per year since 1862. Intensified storminess in the north-east Atlantic over the last 30 years is evident from an increase in wave height of between two and seven mm per year. Scottish coastal waters warmed by about 1^{o}C between 1980 and 1998. However, the long term trend remains unclear. Recent models suggest that heating of the ocean surface will be transferred to cooler deep waters whereby the resultant volume expansion is predicted to initiate an average global sea level rise of around six or seven centimetres by 2020.

UKCIP (2005d) further outlines some likely impacts on broad areas of activity:

- Agriculture - new pests and diseases may affect crops and livestock. Changing public taste may see shifting demands for new types of farm produce based on warmer temperatures

- Biodiversity – species distribution will change, as will the composition of habitats – in general the habitats where species currently live will move northward and upward. It is unclear whether associated species will be able to move as quickly
- Built Environment – increased requirement for long term thinking when designing infrastructure e.g. roads, railways, bridges which have a design life of 50-60 years. Also ensuring they are built in a way which works with natural processes, for example using surfaces that reduce run-off rates
- Business – new opportunities but also threats to existing industries and services. Again, need for long term thinking and 'climate-proofing' businesses
- Gardens – change in the type of species that can survive in a different climate
- Health – decrease in cold related illness and death, but increase in heat related. Higher incidence of extreme weather heightens risk to human health
- Local Authority – as deliverers of key services, have key role to play as demands change regarding waste processing, emergency planning, public transport etc
- Water and Coasts – increased risks of flooding, both at coasts and inland. Increased pressures on water supply, demand and quality. More pressure on infrastructure e.g. storm drains.

There is an argument that increased temperatures in Scotland could lead to a Mediterranean lifestyle here. Whilst the temperature may indeed rise here, that does not mean that the climate will be stable. Increased temperatures will be accompanied by increased evaporation which leads to higher precipitation, and increased frequency of storm events during warmer, wetter winters. In general, there is likely to be a change in precipitation patterns towards increasingly severe bouts of rain separated by dry periods. Of course increased temperatures may be good for some businesses, but Scotland has a winter tourist industry which relies on snow, and already has a long, relatively stable, growing season. Reports already suggest that climate change is having a negative effect on winter sports resorts.

There have been some analyses carried out of the impacts of climate change on Scotland, and possible adaptation measures. Some of these are summarised below:

Studies of climate change in Scotland

Document	Published	Key findings
Climate change: Scottish Implications Scoping Study	Scottish Executive (1999)	By the end of next century average temperatures are likely to rise by between 1.2 to 2.6°C with relatively more warming in winter than summer. Annual precipitation is likely to increase by between 5 and 20 per cent with autumn and winter seeing biggest increases. Spring amounts will be lower and there will be little change in summer. Rainfall intensity will increase, leading to increased risk of flooding. Possible increase in frequency of very severe gales but decrease in number of gales overall. Water balance is likely to remain favourable. Direct short-wave solar radiation likely to reduce over the next century as a result of increased cloud cover
Climate change and changing snowfall patterns in Scotland	Scottish Executive (2001b)	Reduced snow cover exposing more land to other pressures e.g. trampling; reduces snow recreation resource. Direct flooding consequence as more precipitation falls as rain; less transport disruption (from snow at least); longer forestry planting season; forestry developing uphill
Climate Change North Atlantic Comparisons	Scottish Executive (2001c)	Nordic countries should provide benchmark for Scotland; Opportunities exist for co-operation with Nordic countries and Iceland at local authority level
Climate change – review of levels of protection offered by flood prevention schemes	Scottish Executive (2003)	Further research required
Requirements for flood mapping	Scottish Executive (2004a)	Can be backward or forward looking. Must be publicly accessible, nationally consistent and should not change very often
Scenarios of climate change for islands within the BIC region and Scottish Executive press release	British-Irish Council (2003)	North Atlantic ocean circulation, which includes the Gulf Stream, is predicted to decrease in strength by about 20% over the next 100 years, but not to switch off
Preliminary Analyses of Changes in the First Flowering Dates of a Range of Plants Between 1978 and 2001	SNH (2004)	Spring now arrives earlier in Scotland

KEY POINTS BASED ON CURRENT KNOWLEDGE

- The overwhelming scientific consensus is that climate change resulting from the use of fossil fuels is real and is happening, with average global temperatures on the rise, a fact confirmed at the meeting in London of the UN's International Panel on Climate Change (IPCC) on 18 September 2007;
- We are already beginning to see the impacts of changing climate patterns, especially in the increased occurrence and intensity of extreme weather events e.g. storms and droughts;
- There is likely to be an increase in rainfall throughout the winter with drier summers;
- There is likely to be an increase in both the winter and summer mean temperatures.

The following table sets out the **predicted climate changes for Scotland** (taken from UKCIP 2002). This is the most up to date climate change scenarios for the UK. The UKCIP model suggests significant variations in likely climate change between different areas of Scotland with the south and east of the country likely to see the most significant increases in temperatures and greatest decline in summer precipitation.

Table 1: Summary of Predicted Climate Changes for Scotland (drawn from UKCIP, 2002) Figures are for variation from the 1961-1990 average

Climate Variable	2020s	2080s
Annual Mean Temperature	Up to 1.0C warmer	Between 1.0C and 3.5C warmer
Winter Mean Temperature	Up to 1.0C warmer	Between 1.0C and 2.5C warmer
Summer Mean Temperature	Up to 1.0C warmer	Between 1.0C and 4.5C warmer
Annual Precipitation	No significant change	Up to 20% drier in some areas
Winter Precipitation	Up to 15% wetter	Up to 30% wetter
Summer Precipitation	Up to 20% drier	Up to 50% drier
Annual Soil Moisture	N/A	Decline of up to 20%
Summer Soil Moisture	N/A	Decline of up to 40%
Mean Annual Snowfall	N/A	Decline of between 50% & 90%+
Sea Level Change	N/A	Sea level rise of up to 61cm
Change in length of Thermal Growing Season	N/A	Growing season extended by up to 90 days
Number of 'Extremely Warm Days'	N/A	Increase of up to 60 per annum

CLIMATE CHANGE AND MORAY – CURRENT SITUATION

The impacts and implications of climate change on the quality of life and economy of Moray has and is being discussed by various organisations and fora. For example:

(a) **The Moray Flood Alleviation Group** published '*The Climate Change Review Report*' in October 2001. This followed the devastating floods that hit the area in 1997 at a cost of £157 million. The review focused on predictions for North East

Scotland and drew heavily upon the findings of the following national and internationally funded research programmes:

- The Scotland and Northern Ireland Forum for Environmental Research (SNIFFER);
- The Scottish Executive's Environment Research Programme;
- The UN Intergovernmental Panel on Climate Change (IPCC);
- The UK Climate Change Impacts Programme (UKCIP).

The **two key findings** of this review are:

1. The annual rainfall is predicted to increase by 20% by the year 2080 resulting in changes to the area catchment wetness index;
2. Little data exist to confirm if storm intensity will increase.

(b) **The Moray Firth Partnership** has prepared '*Management Guidelines and Action Programme*' specifically related to climate change.

(c) **Moray's** '*Local Economic Development Strategy*' (Sept 2006) identifies climate change as a significant threat to the economy of the area and in particular the ski areas of the Cairngorms and the Lecht. Flooding is also noted as a major problem. This is highlighted as an issued in the *Moray Structure Plan*.

(d) **Aberdeen University** and the **Whale and Dolphin Conservation Society** have published research that highlights the impacts of climate change increasing the number of adult salmon in the Moray Firth could be leading to an increase in the whale and dolphin populations. There are also implications for the timing of the breeding of birds.

(e) **Moray Council's** '*Local Agenda 21*' highlights the importance of sustainable forestry to the economy and the role that forestry performs as a carbon sink. Moray Council is also a signatory to the '*Delivery of Scotland's Climate Change Declaration*' of 21 March 2007.

In addition, the area has a number of specialist centres with expertise in issues associated with climate change. The **CIFAL Centre at Findhorn** hosts a range of seminars and conferences on this topic (including a major conference 18-20 September 2007). In addition, **John Coll** at the **Environmental Research Institute of UHI** and **Dr Gary Campbell** of **Moray College** are recognised specialists in this field. Finally, the **Environmental Education for Communities Organisation** (EECO) is based in Aberlour. This expertise should be harnessed to explore the impact of climate change in Moray in more detail and on a regular basis.

The whisky industry is a major feature of the Moray economy and is vital to the area's tourism industry. Climate change has potentially significant implications for the whisky industry in Speyside. The industry's trade body, the **Scottish Whisky Association**, is a signatory to the Climate Change Levy and most local whisky companies are also within the *Spirits Energy Efficiency* initiative both as part of Schedule 6 of the Finance Act 2000 (ref. Climate Change Levy).

Consultations confirm two primary local concerns within the whisky industry of the impacts of climate change:

(i) The consistency of quality in barley crops within the UK and especially from Moray whilst noting the potential for better harvests;

(ii) The potential decline in the quality of water as a result of (a) increased rainfall of greater intensity and (b) changing vegetation cover and the potential of uncertainty in the volume of water at certain times of the year.

In its evidence to the Stern '*Review of the Economics of Climate Change*' (published October 2006) the Scotch Whisky Association made the following comments which are generic and non-specific to the particular issues associated with whisky production in Moray:

> "*The Scotch Whisky Association represents the interests of 98% of the Scotch Whisky Industry …*
>
> *The Industry takes the issue of climate change and environmental protection very seriously. We rely on high quality environmental conditions for our raw water supplies and have a need for sustainable and competitively priced energy for production purposes. Our members contribute towards the UK's programme of mitigation measures through the Climate Change Levy (CCL), under which they have met and exceeded their milestone targets to date, and participate in emissions trading. On the adaptation side, the Association is a member of the Scottish Climate Change Impacts Partnership …*
>
> - *Scotch Whisky, by legal definition, has to be produced and matured in Scotland for a minimum of three years (though in reality, often a considerably longer period). If the economic climate becomes too harsh, the Industry does not have the option of moving its production out of Scotland in search of most cost-effective inputs. Energy is an important input cost for an Industry which has to remain competitive on an international basis – 90% of Scotch Whisky is exported worldwide. Competitive energy markets and process are critical to the continued sustainability of the Scotch Whisky Industry.*
> - *Some aspects of Scotch Whisky production such as bottling and labeling are mobile and may be undertaken in any location and producers have flexibility to locate such activities in more cost-effective non-UK locations. The Industry is a major contributor to the UK economy, particularly in rural and deprived areas of Scotland, and any reduction / loss of whisky-making would have a heavy, adverse effect on local economies.*"

But things are changing and there is a local impact:

From: Roskrow, D (2007) '*Where it all Started – Glenlivet, Speyside*'. Whisky Magazine No 64

> "*It's in places like this, on days like this, that you can fear most for our planet. We're standing in the heart of historic Speyside, high about the River Spey, and the sun is warm on our faces. The rich green grass and clear blue skies make us screw up our eyes from the glare. The view is magnificent.*
>
> *And then a chill breeze cuts through us and we are reminded in the starkest terms that this is not high summer or even late spring. This is early April and this is not how it should be. For if there are few outward signs that anything is wrong, then that's the whole point; there should be signs. The glitter of ground frost in the glen below perhaps, or the icing cake beauty of snow on the hills and bens.*

Instead there is nothing. There has been no snow this winter of any note at all. And without snow to melt in spring and run into the Spey, the Livet and its tributaries, there is a problem.

People round here have known of this problem for a long time. Years before the scientists elsewhere started speaking of it. Tell them that their memories are playing tricks and it was never that bad in these parts, surely, and they'll snort with derision and regale you with tales of digging tunnels out of their driveway and living with banks of snow and drifts for weeks, sometimes months. Then they'll compare that with today's smatterings, the couple of centimeters that are here today, gone tomorrow.

Nor is rain a solution because it sinks into the dry earth and is lost."

ISSUES AND CONSIDERATIONS FOR TOURISM IN MORAY

The interpretation of evidence available and summarised in this topic paper suggests the following primary issues are likely to affect the future of tourism in Moray as a result of known changes in three key aspects of weather patterns:

(1) Increasing Temperatures Year Round

Positives

- Year-round opportunities for many outdoor activities;
- Increased levels of salmon in rivers prompting growth in angling;
- Increased levels of dolphins and whales in Moray Firth;
- Increased and extended crop growing season;
- Increased appeal of area in spring and summer.

Negatives

- Less snow and further decline of winter sports;
- Potential over supply reducing value and appeal of area;
- Commonplace sightings reduce the 'appeal' and uniqueness of area;
- Changes of breeding patterns of birds having impact on game shooting and wildlife appeal of area;
- Reduced 'seasonality' with less obvious difference in four seasons.

(2) Increased Winter Precipitation

Positives

Negatives

- Reinforces perception of 'always raining';
- Decline of snow fall as precipitation falls as rain and further loss of 'winter' sports;
- Potential for flooding;
- Increase flow of rivers, higher incidence of rivers in spate and therefore less attractive to fish;
- Uncertainty over impact on water quality for us in whisky production;
- Potential impact on preparing ground for crops;
- Greater likelihood of more storms and extreme weather conditions;
- Increased sea level with loss of key habitats and tourism assets.

(3) Decrease in Summer Precipitation

Positives

- Enhanced appeal of area for short break and long stay visits;
- Greater predictability of dry weather for organisers of outdoor events;
- Increased appeal of camping.

Negatives

- Lower levels of water in lochs and rivers reducing opportunities for water sports;
- Potential water shortages and use regulations;
- Increased need for air conditioning in tourist accommodation.

SIMPLIFYING THE JARGON

Climate change sometimes seems to have a language of its own, understood by scientists but not many others. This section of the briefing aims to simplify some of this language (IPPC 2001a & from Tyndall Centre).

Adaptation – the effects of climate change develop over decades. Because of the complex ways that the atmosphere and oceans behave there is a time lag of some 40 years between changes in the level of greenhouse gases in the atmosphere and changes in global climate (UK Climate Impacts Programme 2005a). It is important that we adapt to cope with our changing climate e.g. to deal with increased flooding and higher incidences of extreme weather, including a tendency for summer drought on the east coast of Scotland.

Carbon sequestration – carbon sequestration is the capture of carbon from the atmosphere to soils, biomass, geological formations and the oceans. Gases can be captured at the point of emission e.g. at a power station, and stored in underground reservoirs (geological sequestration), injected in deep oceans (ocean sequestration), or converted to rock-like solid materials (Carbon Sequestration Leadership Forum 2005). Carbon is removed from the atmosphere in huge amounts, and constantly, by natural

processes such as growing plants, (though there is argument over whether this is just a short term solution as plants emit carbon dioxide when they are burned or allowed to biodegrade). It has been suggested these natural processes can be added to sequestration by humans, although it is recognised that there is not enough space on the planet to grow the volume of vegetation required (Royal Society 2001).

Climate – this is the 'average weather' over, normally, a period of some 30 years. This time period flattens out yearly anomalies. 'Climate' can refer to the weather type in a geographical area e.g. Mediterranean, tropical, sub-Saharan.

Climate change levy – a tax on energy use in private and public sector, with associated cuts in employers' National Insurance Contributions depending on commitments to use less energy, or energy from renewable sources.

'Contraction & convergence' – this relates to a 'fair share' of carbon dioxide emissions for each person on Earth. The theory is that there is a requirement for 'contraction' of carbon dioxide output, and a need for a focused date for 'convergence', for example 2045, the centenary of the United Nations (more information on website of Global Commons Institute).

Emissions trading – one of the tools used to reduce greenhouse gas emissions, emissions trading is essentially the right to emit a certain level of gases. The theory is that creating a market in 'emissions permits' allows reductions to take place in the sectors where it is cheapest to do so, by creating an incentive to reduce emissions and make money from selling surplus emissions permits. Emissions trading was pioneered in the UK and rolled out across Europe from 1 January 2005. The European Emissions Trading Scheme allocates each Member State government with a budget of greenhouse gases which they can emit. The Member State breaks this down further and allocates it to different types of applicable industries. An **Emissions permit** is a permit granting the right to emit a specified amount of gas or gases – these can be sold on the open market. The measures can reflect either total emissions, or emissions per tonne of product produced. Over time the budgets/quota can be reduced so that the permits become scarcer (and more expensive), creating a market incentive to reduce emissions. A **carbon tax** is a similar policy instrument. The Royal Society (2002) has argued this should be extended to individuals.

Global dimming – this is a recently recognised concept whereby visible pollution (known as particulate matter) produced primarily through combustion of fossil fuels, acts to reflect sunlight from the Earth. Action to reduce levels of particulate matter, which is harmful to health, could lead to increased temperature at the surface of the Earth, exacerbating the temperature increases of the enhanced greenhouse effect. Particulate matter and greenhouse gases arise from similar activities, so the key remains to reduce those (BBC 13 January 2005).

Global warming – this is the term used to describe the recent warming in the Earth's temperature. It can, on occasion, be misleading because, whilst it describes the overall global effect, climate change may lead to a cooling in some parts of the planet. Broadly, 'climate change' is a better term.

Greenhouse effect – in the same way that a greenhouse traps heat from the sun and does not readily let it leave, so 'greenhouse gases' trap energy from the sun after it has reached the earth surface and been directed back towards space. Greenhouse gases are essential for life on Earth – atmospheric temperatures are about 30°C higher than they would be without them. Too many greenhouse gases as a result of 150 years of fossil fuel burning has led to an average warming of global temperatures, and increased water vapour in the atmosphere. Increased energy in the atmosphere has led to a more unstable climate.

Greenhouse gases – water vapour is the principal greenhouse gas. The 6 main greenhouse gases legislated for under international agreements are carbon dioxide (CO2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF6). The different gases have different chemical properties and so have varying abilities to absorb energy from the sun once it has been re-emitted from Earth. This is known as '**greenhouse warming potential**'. For instance, sulphur hexafluoride is 24,000 times more potent than carbon dioxide while methane is 21 times more potent ((National Atmospheric Emissions Inventory 2004). This means that the most plentiful gases may not cause the biggest problems. Carbon dioxide amounts for about 85% of the greenhouse warming potential of greenhouse gas emissions in the UK. Ozone is not a greenhouse gas but is implicated because of the way it reacts with other gases.

Kyoto Protocol - adopted in 1997 in Kyoto, Japan, the 'Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCCC)' contains legally binding commitments, which add to those included in the UNFCCC (which is explained below). Over 80 countries signed the Protocol indicating that they intended to ratify it, but in reality not all have done so, despite further talks designed to flesh out the detail of the Protocol, most notably at COP 7 in Marrakesh.

The Protocol could only come into force when at least 55 Parties to the UNFCCC, accounting for over 55% of emissions from all the Parties, had formally agreed to it. This process was held up as neither Russia nor the USA had done this, and so the 55% target could not be reached. However with Russia ratifying on 18 November 2004, the Protocol will enter into force on 16 February 2005. The list of countries yet to ratify the protocol includes the USA and Australia. For those that have formally signed up, they will now have to act to meet legally binding commitments to reduce the main greenhouse gases. Despite the political posturing around the Protocol, the measures contained therein are only really a starting point.

Intergovernmental Panel on Climate Change – established in 1988 by the World Meteorological Organization and the United Nations Environment Programme, the IPCC has since reviewed scientific research and provided governments with advice.

Mitigation – whilst there is a time lag of some 40 years between changing greenhouse gas levels, and these influencing climate, measures must be taken now to reduce the release of greenhouse gases in order to reduce future climate change. These are mitigating measures.

UNFCCC (The United Nations Framework Convention on Climate Change) - an international treaty, was very important in pulling together international action. It recognised that the climate is a shared resource, and put in place a framework whereby governments must gather and share information, launch national strategies, and co-operate with each other in preparing for adaptation to climate change. UNFCCC entered into force in March 1994 and to date, 189 countries are signatories. These countries are known as 'Parties' to the Convention, thus conferences of the signatories are known as Conferences of the Parties (COP). The most recent of these, in December 2004, was **COP 10**.

Weather - shorter term and more localised conditions than climate, primarily precipitation, temperature and wind.

REFERENCES AND MAIN SOURCES

Appenzeller, T and Dimick, K (2004) The Heat is On *National Geographic* September

British-Irish Council (2003) *Scenarios for climate change for islands within the BIC Region* Met Office

Brown, Dr K *Responding to climate change: Inclusive and integrated coastal analysis* Tyndall Centre, Technical Report 24

Cook, G (2005) *Climate Change* SPICe Briefing Scottish Parliament

Engineering and Physical Sciences Research Council (ESPRC) (2001) *Building knowledge for a changing climate* ESPRC/UKCIP

Eden, P (2007) *A Change in the Weather* Continuum Press, London

Intergovernmental Panel on Climate Change (IPCC) (2001) *Third Assessment Report* IPCC

Kerr, A and McLoed, A (2001) *Potential Adaptation Strategies for Climate Change in Scotland* Scottish Executive/HMSO

Scottish Executive (2003) *Scottish Climate Change Programme* Scottish Executive/HMSO

SNIFFER (2005) *A Survey of Scottish Local Authority Activities on Climate Change* CC05 Scottish and Northern Ireland Forum for Environmental Research

UK Climate Impacts Programme (2001) *Climate Change and Nature Conservation in Britain and Ireland* UKCIP

UK Climate Impacts Programme (2002) *Climate Change Scenarios for the United Kingdom: The UKCIP-2 Scientific Report* Tyndall Centre

Werrity, Prof A *et al* (2001) *Environment Group Research programme Research Findings No 19 – Climate Change: Flood Occurrences Review* Scottish Executive/HMSO