

Climate Change: How serious is it?

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<http://www.sgr.org.uk/>

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Climate change: how serious is it?

- The basics
- How big is the threat?
- Prospects for global action
- Is the UK government doing enough?
- What can I do?

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Climate change: the basics

Main Sources

- Reports by Intergovernmental Panel on Climate Change (IPCC)
 - Especially 'fourth assessment' (2007)
- Other research by climate scientists, policy analysts and campaigners

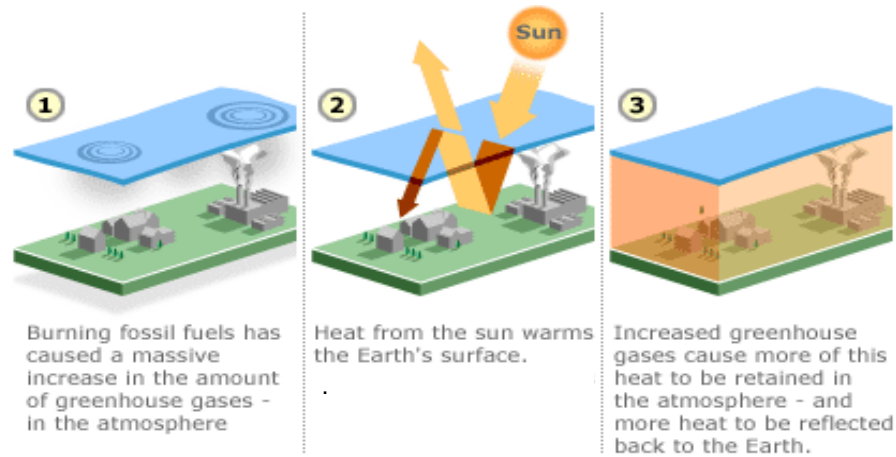
Full list of references is available at the end of this presentation

IPCC

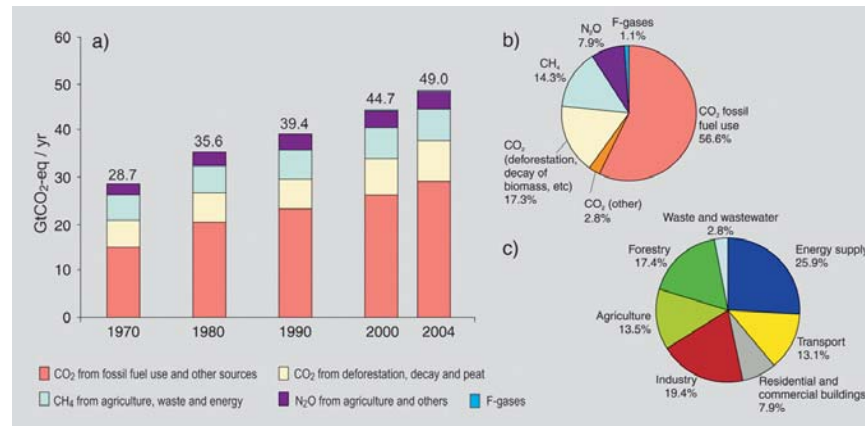
- Intergovernmental Panel on Climate Change
- Set up in 1988
- UN advisory body on climate science
- Over 130 countries are members
- 2007 assessment report involved 3,500+ scientists worldwide
- Summaries of report approved by scientific reps of all member countries
 - including USA, Saudi Arabia

IPCC's remit is 'to assess scientific technical and socio-economic information relevant for the understanding of climate change, its potential impacts and options for adaptation and mitigation'
Source: IPCC (2008)

Greenhouse effect & global warming



Global greenhouse gas (GHG) emissions



CO₂ – carbon dioxide

N₂O – nitrous oxide

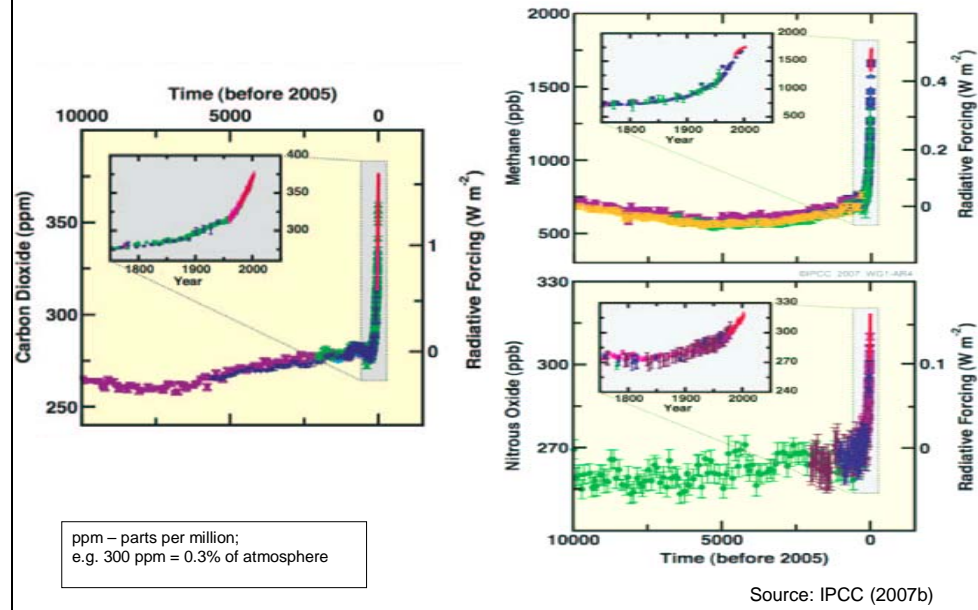
CH₄ – methane

F-gases – gases containing Fluorine
(e.g. HFC, PFC, SF₆)

Source: IPCC (2007a)

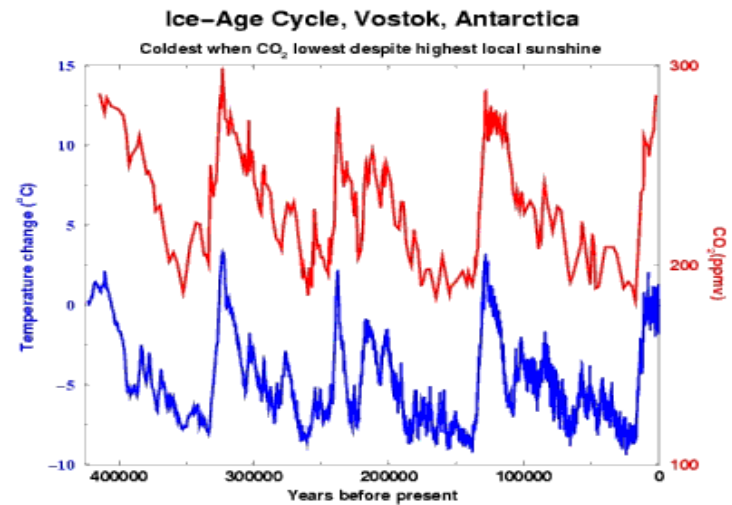
- (a) Global annual emissions of anthropogenic GHGs from 1970 to 2004
- (b) Share of different anthropogenic GHGs in total emissions in 2004 in terms of CO₂-eq.
- (c) Share of different sectors in total anthropogenic GHG emissions in 2004 in terms of CO₂-eq. (Forestry includes deforestation).

Changes in atmospheric levels of GHGs over last 10,000y



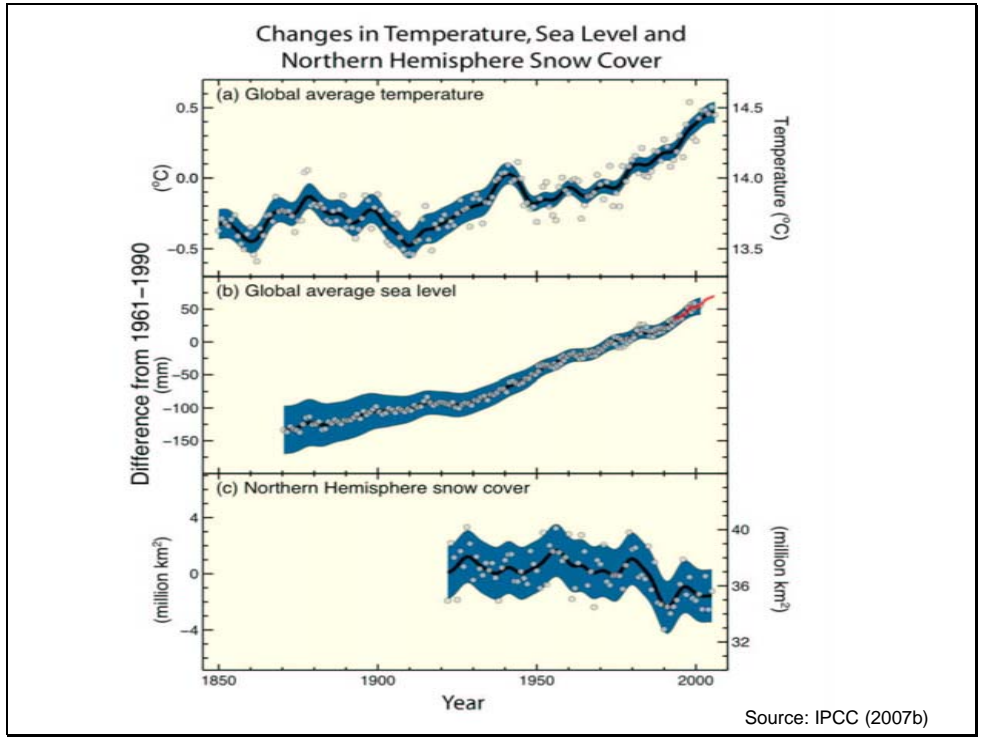
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Atmospheric carbon dioxide and temperature variations over the last 420,000y



ppmv – parts per million by volume;
e.g. 300 ppmv = 0.3% of volume of atmosphere

Data from Petit et al (1999)
Latest data shows that CO₂ levels are now higher than for at least 650,000 years



Current temp is 0.76°C higher than in ~1875 – likely higher than at any time in the last 1300y
 Sea level – ~17cm rise over 20th century (due to water expansion + ice melting)
 From IPCC (2007b)

Examples of impacts so far

- Loss of coastal wetlands & increasing damage from coastal flooding
- Changes in heat-related deaths in Europe
- Reduced growing season in parts of Africa
- Numerous changes in ecosystems
- World Health Organisation estimate:
 - 150,000 deaths due to climate change in year 2000

World Health Organisation (WHO) estimate is based mainly on assessments of changes in death rates due to heat stress and infectious disease

Other examples:

Extreme weather – widespread increases in storm activity (including more intense hurricanes 10in some regions), increases in occurrences of drought

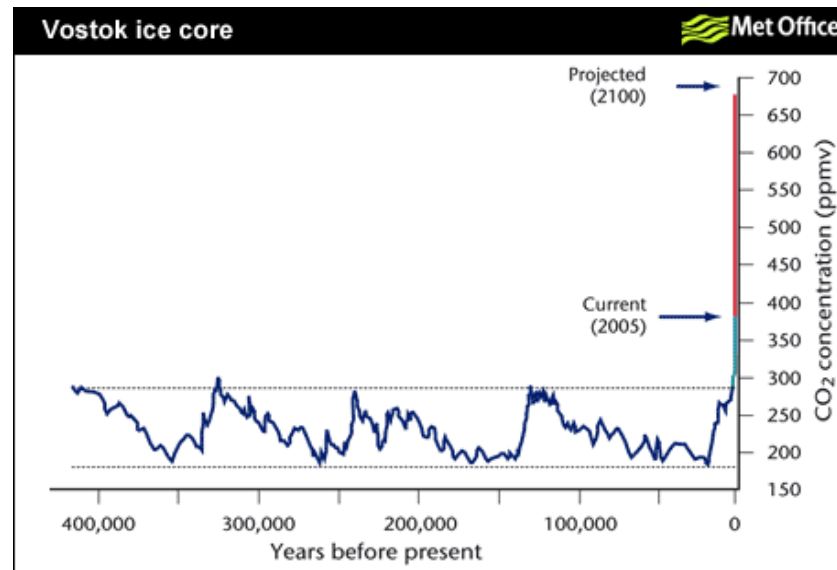
Of 29,000 good quality environmental data sets that are available, 89% show changes consistent with a warming world
All data from IPCC (2007c) except for World Health Organisation study which is from WHO (2003)

Climate change:
how big is the threat?

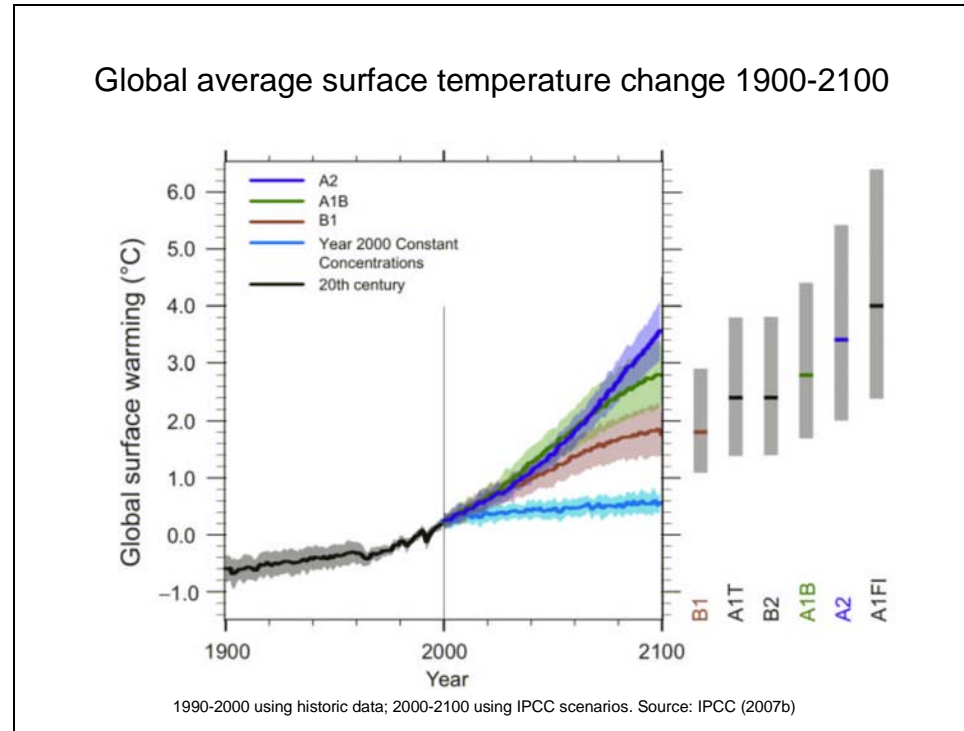
Continued increases in emissions

- Future scenarios project increases of global GHG emissions by 25-90% between 2000 and 2030
- Our current path is taking us towards the upper end of the range

CO₂ levels projected to be much higher in the future



Data from Petit et al (1999)
and IPCC



Predicted temp in 2100 will be between 1.1°C and 6.4°C higher than 1990 (IPCC, 2007b)

For comparison, the temperature difference between the Ice Ages and the warm interglacial periods such as at present has been 4-7°C (IPCC, 2007d)

Available evidence indicates that the upper end of this range would represent a faster change than at any time in the last 50 million years (IPCC, 2007d)

Light blue curve – ‘thought experiment’ based on what would happen if we had stopped emitting GHGs in 2000

Main direct impacts

- Fresh water resources
- Coastal areas
- Food supplies
- Human health
- Ecosystems

Fresh water resources

- Dry areas likely to get drier, wet areas get wetter
- Drought-prone areas likely to expand
 - Africa: 'water stress' likely to affect 75-250 million by 2020
 - Asia: >1 billion may be adversely affected by 2050s
- Increased storminess likely to increase flood risk
- Sea-level rise will increase saltwater contamination of groundwater

Water availability

By 2050s – in high latitudes & some wet tropical areas, average water availability will **increase** by 10-40%; in some dry regions at mid-latitudes and dry tropics, average water availability will **decrease** by 10-30%

Meltwater-fed areas

Water supplies from glaciers & snow cover will decline

Currently 1/6 of world population live in these areas

All data from IPCC (2007c)

Coastal areas

- Sea-level rise will lead to major increase in flooding risk and loss of land
- Huge numbers affected
 - Currently, half world population lives in coastal areas
- Mega-deltas of Asia and Africa, and small island states, will be most affected
 - Eastern China: 30 million currently live in areas under threat
 - Bangladesh: 15 million...
 - Egypt: 7 million...
 - Small island states: ½ million affected

Sea-level rise 18-59cm by 2100 (IPCC, 2007a) – but as these projections do not include all known feedbacks, including ice sheet melting, this rise is likely to be underestimate

China: sea level rise of 0.5m would inundate 40,000km² on eastern coast where 30 million people currently live

Bangladesh: sea level rise of 1m (majority due to land subsidence) would flood area where 15 million people currently live

Egypt: sea level rise of 1m (majority due to land subsidence) would flood area where 7 million people currently live

Small island states: whole land area almost entirely below 3m – but inundation of land, increased flood risk and groundwater salination likely to make them uninhabitable well before reaching that level. Source: Houghton (2004), pp150-155

Food supplies

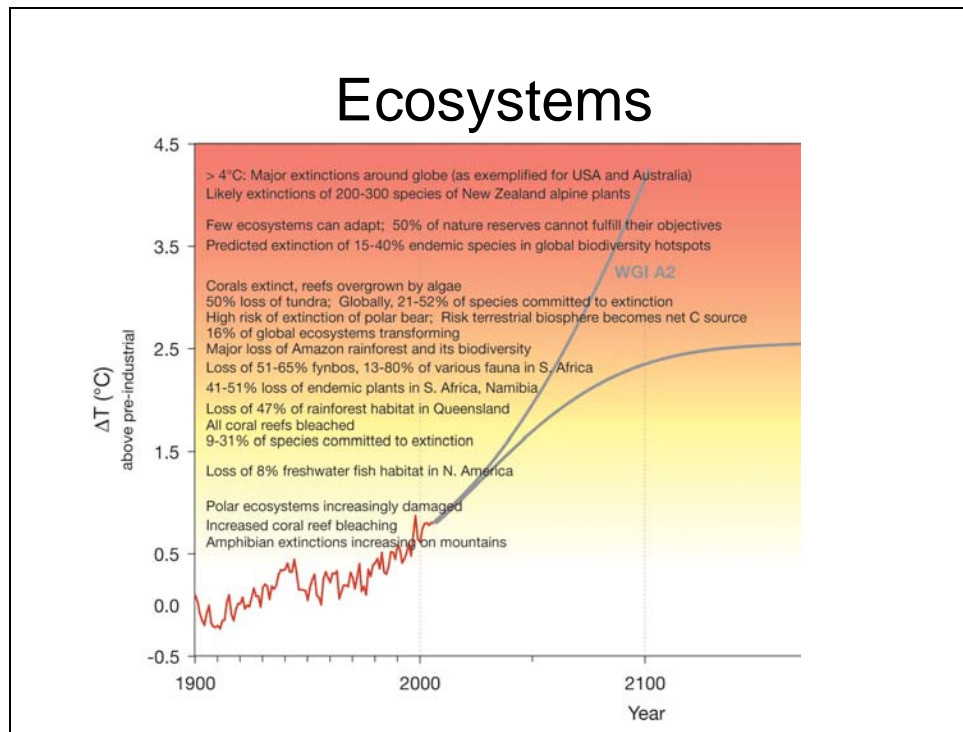
- Potential for major disruption in food supplies
- Crop productivity likely to fall in tropics & subtropics
 - access to food is projected to be “severely compromised” in many African countries
- Crop productivity across the globe will also change
 - *increase* for modest temperature rise
 - *decrease* for large temperature rise
- Adverse effects on fisheries

Impacts will combine with existing problems of soil erosion & water shortages
From IPCC (2007c)

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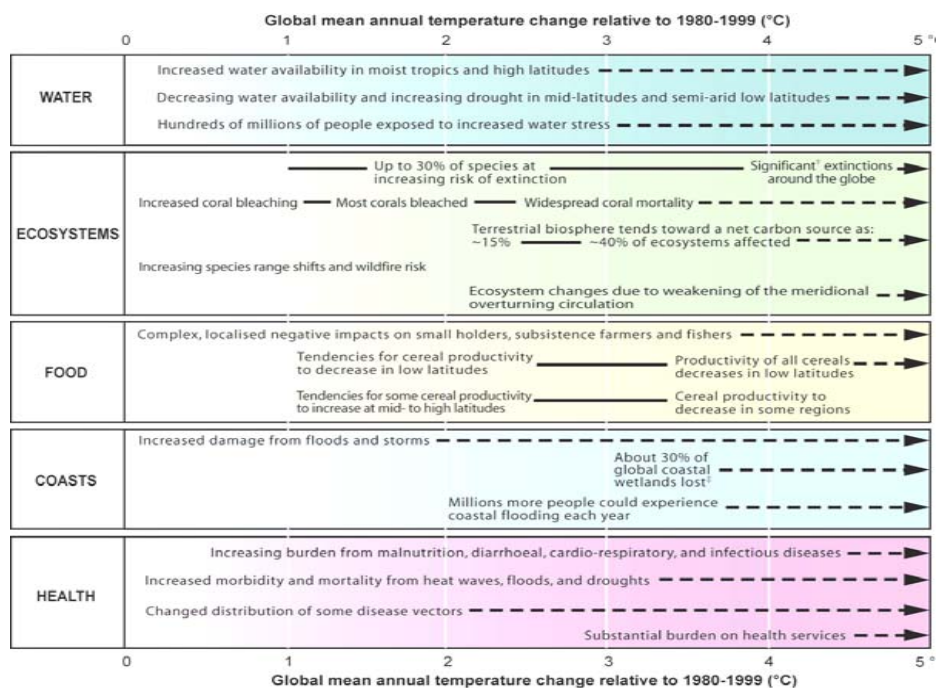


Upper graph – IPCC scenario A2 (high)

Lower graph – IPCC scenario B1 +stabilisation (low)

Source: IPCC (2007c), Figure 4.4

Projected impacts of climate change relative to increase in global temperature



Source: IPCC (2007a)

¹ Significant is defined here as more than 40%.
² Based on average rate of sea level rise of 4.2 mm/year

'Indirect' climate impacts

- Environmental refugees
 - main causes:
 - loss of land (inundation & flooding)
 - disruption of food supplies
 - estimated ~150 million by 2050
- Economic disruption, recessions and (eventually) depression
- Political instability and potential for conflict

Environmental refugees
estimate from Houghton (2004),
p187

Impacts: general point

- Impacts felt most heavily by poor communities who are:
 - already the most vulnerable
 - least responsible for causing the problem

Climate change compounds other problems

- **Poverty**
 - 1 billion currently in extreme poverty
- **Population growth**
 - Global population projected to grow to 9.2 billion by 2050
- **Resource depletion**
 - Groundwater, minerals etc rapidly being depleted
 - 'Peak oil' approaching
- **Biodiversity loss**
 - Forests, fisheries being rapidly depleted
 - On the verge of a 'mass extinction event'
- **Infectious diseases**
 - Currently 40 million people living with AIDS
- **Weapons proliferation and war**
 - 25,000 nuclear weapons, hundreds of millions of 'small arms'

Figures from: UN (2007),
UNFPA (2008),
Federation of American Scientists
(2008)

Major, irreversible climate shifts

- **Examples**
 - Melting of major ice sheets
 - Major weakening of ocean currents
 - e.g. Gulf Stream
 - ‘Die-back’ of Amazon rainforest
 - Release of ‘frozen methane’

Melting of Greenland ice sheet – if global temperature rises to between 1.9°C and 4.6°C above the pre-industrial level, and remains there, then the ice sheet will eventually disappear completely leading to a sea level rise of 7m. This could take centuries to millennia to complete, although some scientists argue it could happen as quickly as a single century. West Antarctic ice sheet is also at risk. Arctic ice sheet is melting rapidly.

Although this will have little direct effect on sea-level rise, this could lead to more rapid warming in the Arctic (IPCC, 2007a; Hansen et al, (2007; Pearce, (2005). Shutdown of Atlantic meridional overturning circulation (MOC) – The Atlantic ocean current that includes the Gulf stream (which keeps the UK warm) is very likely to weaken over the course of the century, due to increased meltwater from Greenland. It could shutdown eventually, but this is thought to be very unlikely this century (IPCC, 2007a; Pearce, 2005). Die-back of Amazon rainforest – Climate models suggest that by mid-century temperature and rainfall changes will cause the shrinking of the Amazon rainforest, with major loss of wildlife. The entire forest could be lost eventually Pearce (2005). Release of frozen methane – 5 trillion tonnes of methane locked away in frozen hydrates in deep oceans. Warming will start to release it accelerating the warming potentially very rapidly (Pearce, 2005).

Prospects for global action

Climate change treaties

- Framework Convention on Climate Change (1992)
 - Aim: “to prevent **dangerous** anthropogenic interference with the climate system”
- Kyoto Protocol (1997)
 - Set legally binding emissions targets for industrialised countries for period 2008-2012
- Copenhagen Protocol (2009)?
 - Aims to set legally binding targets for 2013-2017 (and beyond?)

Framework Convention covers general principles, while *Protocols* deal with specifics
Kyoto Protocol

Set a combined target for industrialised countries of ~5% reduction in GHG emissions from 1990 levels by 2008-2012
US did not ratify

Some of the other countries are having problems meeting their targets, but in combination (including carbon trading) it is likely that we will get close to the target

Copenhagen Protocol

Next round of climate negotiations in Poland in December 2008

Negotiations are proceeding towards the Copenhagen climate conference in December 2009. Source: UN FCCC (2008)

Aims for Copenhagen

- Set GHG emissions **targets** that:
 - prevent 'dangerous' climate change
 - are fair to all
- Support for **adaptation** to climate change that is already happening

'Dangerous' climate change

- Many argue for threshold at 2°C above pre-industrial temperature
- Implication:
 - Global GHG emissions need to start falling in next few years and reduce by at least 50-85% by 2050

2 C threshold

Significant potential for major, irreversible effects

Agreed by European Union

Supported by some scientists

To keep below 2.0-2.4 C above pre-industrial levels,

global emissions need to peak between 2000-2015 and reduce by 50%-85% by 2050

(IPCC, 2007a)

Global emissions comparison

<i>Country</i>	<i>CO2 emissions per head (tonnes)</i>
North America	20.0
Europe	8.3
West Asia	7.6
Asia and Pacific	3.0
Latin America and Caribbean	2.6
Africa	1.3
Global	4.3

Figures for 2004 from UNEP (2006)

Basis for agreement?

- 'Contraction and Convergence'
 - *Contracting* global target to prevent 'dangerous' climate change
 - *Convergence* to equal emissions per head across all countries
- Principle informally accepted by many climate negotiators

Proposed in mid-1990's by
Global Commons Institute
Source: GCI (2008).

Where could the resources to tackle
climate change come from?

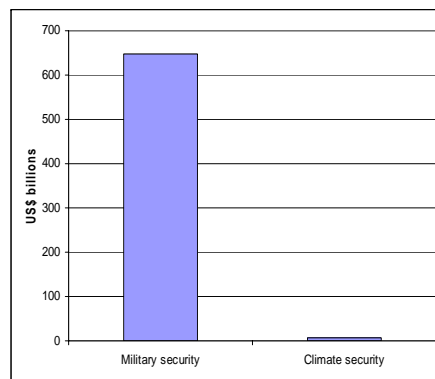
Climate change needs to be tackled...

- *“with a sense of urgency and shared resolve that has previously been seen only when nations have mobilized for war.”*

Al Gore, acceptance speech
2007 Nobel Peace Prize

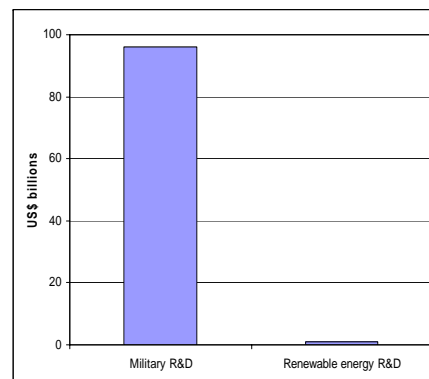
Military spending v climate spending

US Federal spending (FY 2008)



Source: Pemberton (2008)

Government R&D spending in OECD countries (2006)



Source: SGR (2008)

Skilled workers are key; often these are in even shorter supply than money

Is the UK government
doing enough?

UK action so far

- On course to beat Kyoto target
 - official GHG emissions already cut by 21%
- Climate change bill
 - Proposed target of 80% cut by 2050
- Proposals for...
 - Large-scale expansion of renewable energy
 - Nuclear power 'renaissance'
 - Improvements in energy efficiency

Kyoto target

Target for GHG emissions is 12.5% cut from 1990 levels by the period 2008-2012

By 2006, official GHG emissions were 21% below 1990 levels

So UK likely to exceed it by a wide margin

Climate change bill

When it becomes law, it will be the strongest legislation on GHG emissions reduction among the large industrial powers

Source: Parkinson (2008)

How does the UK compare?

<i>Country</i>	<i>CO2 emissions per head (tonnes)</i>
USA	20.2
Germany	10.7
UK	9.4
Europe (average)	8.3
Sweden	6.2
Global (average)	4.3

Figures for 2004 from UNEP
(2006)

Is UK action enough?

- Energy intensive imports not counted in official statistics
- Aviation ignored
- Action on energy efficiency piecemeal
- Action on renewables piecemeal
- Many doubts over nuclear power

Aviation

International aviation not counted in official figures
Emissions have doubled between 1990 and 2006
Plans for massive airport expansion

Source: Parkinson (2008)

UK Research and Development

- Low carbon R&D has been neglected
- But is now expanding through:
 - Research Councils
 - Technology Strategy Board
 - Energy Technologies Institute
 - Environmental Transformation Fund
- Still very small compared with military R&D budget

Low carbon R&D budget is planned to be £2-300 million from 2008 – although exact figures are not available
This is equivalent to about 10% of the annual R&D budget of the Ministry of Defence (~£2.5 billion)
Sources: BERR (2008), p207; DASA (2008), table 1.8

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What can I do?

Living a low carbon life

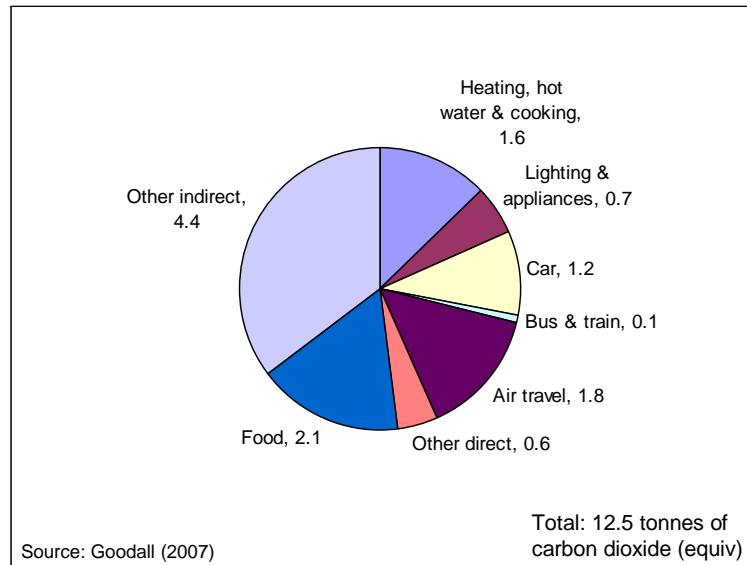
- Key factors
 - Lifestyle choices
 - Technology

Just imagine...

- Living in warm house with virtually no heating bills
- The electricity company *pays you* for generating electricity
- Walking, cycling and buses are preferred for local travel because they are convenient, cheap and safe
- There are very few road accidents and very little local air pollution or congestion due to traffic
- Fresh, locally-produced food is easily available
- There is low unemployment in your town
- There are lots of community events in your town
- There is a strong feeling of community in your town

These are all part of/
compatible with a low carbon
lifestyle

Average GHG emissions per person in UK



The difference between the total figure given in this (12.5 tonnes) and that given in 37 (9.4t) is that this figure includes all the main GHGs (CO₂, CH₄, N₂O, PFCs, HFCs, SF₆) and emissions due to the UK share of international aviation

Source: Goodall (2007), pp73-74

Reducing house emissions

- Good insulation, efficient boiler etc
- Save hot water
- Efficient cooking
- Low energy light bulbs
- Efficient electrical appliances
 - Switch off at wall!

Average
saving:

$\frac{3}{4}$ tonne

Space heating - Better insulation (e.g. loft, cavity wall, double glazing); draft exclusion; more efficient boiler; turn down thermostat

Hot water - Short showers; lower thermostat
Cooking - Use pressure cooker, microwave oven

Lighting - Low energy light bulbs

Electric appliances - Switch off at wall; efficient/ small fridge, TV etc; no tumble drier

Source: Goodall (2007), p75

Reducing other emissions

<i>Carbon saving activity</i>	<i>Average saving (tonnes)</i>
Drive small car fewer miles	0.3
'Eco-diet'	1.3
Green electricity tariff	0.8
Environmental work practices	0.8
Install/ invest in renewable energy	1.0-2.0
Buy less stuff	0.3

NB Actual savings will depend on your current lifestyle!

Car - small car; fewer miles
 Food - less meat & other animal produce; less processed/ chilled food; more local, organic
 Place of work/ education – encourage energy efficient practices & equipment; work from home
 Green electricity tariff – but take care as some are a waste of money (go for Good Energy or Ecotricity)
 Install/ invest in renewable energy – e.g. solar water heating, micro-wind turbine (if in an exposed area), solar electric panels (photovoltaics) or invest in a community renewables project
 Buy less stuff – especially products involving heavy weight of metal, plastics (e.g. cars, electrical goods)
 Source: Goodall (2007), p75 & 78

Avoid flying!

- Average saving from avoiding all air travel
 - 1.8 tonnes
- One return flight to Rome:
 - 1.5 tonnes
- One return flight to New York:
 - 3.6 tonnes

Arguably the most difficult thing to do!

No likely technological solution

Source: Goodall (2007),
p75 & 219

Get personal advice on emissions reduction

- Start at Government's 'Act on CO2' website:
 - <http://campaigns.direct.gov.uk/actonco2/>
- Also ask your energy supplier

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