

CLIMATE CHANGE

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Climate Change: Impacts

Introduction

The warming effect caused by anthropogenic greenhouse gas emissions (See Climate Change Leaflet 1, Science) has already added the equivalent of around an extra 2.5 Watts per square metre to the planet's energy budget. This is equivalent to around 1% of the current net incoming solar energy that the Earth receives day in, day out, year in, year out, on a continuous basis.

One percent may not sound like much, but added up over the earth's entire surface, it amounts to the energy released by burning 1.8 million tonnes of oil every minute.

This is equivalent to over 100 times the world's current rate of commercial energy consumption.

Since greenhouse gases are only a by-product of energy consumption, it is ironic that the amount of energy humanity actually uses is tiny compared to the impact of greenhouse gases on natural energy flows in the climate system.

Current climate models predict global warming of between 1.4 and 5.8°C by the year 2100, compared to the year 1990 (See Fig.1).

These projections are based on a wide range of assumptions about the main forces driving future emissions- such as population growth and technological change - but do not assume any climate change policies for reducing emissions.

Even a 1.4°C rise would be larger than any century-timescale trend for the past 10,000 years.

Earth's climate is already slowly (and forcibly) adjusting to past greenhouse gas emissions. The climate system must adjust to changing greenhouse gas concentrations in order to keep the global energy budget balanced. This means that the climate is changing and will continue to change as long as greenhouse gas levels keep rising.

Scientists are now convinced that a growing body of evidence gives a collective picture of a warming world and other changes in the climate system (See Table 1).

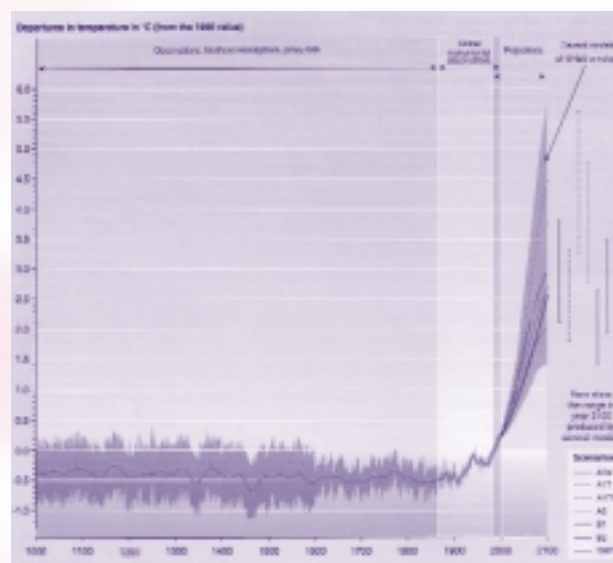
Measurement records infer an increase in global temperature of 0.6°C (±0.2°) since the late 19th century. These observations are in

line with model projections of the size of warming to date, particularly when the cooling effect of aerosols is included. Most of the warming occurred from 1910 to 1940 and from 1976 to the present.

In the Northern Hemisphere, it is likely that the rate and duration of 20th century warming has been greater than any other time during the last 1,000 years. In addition, the 1990s are likely to have been the warmest decade of the millennium, and 1998 the warmest year.

Mean sea level around the world has risen over the last century by between 10 - 20 cm. As the upper layers of the oceans warm, water expands and sea level rises.

Fig. 1 Variations of the Earth's surface temperature: years 1000 to 2100



Source: IPCC/WMO/UNEP

Table 1. Observed Impacts already occurred	
Global mean sea level	Increased at an average annual rate of 1 to 2 mm during the 20th century.
Duration of ice cover of rivers and lakes	Decreased by about 2 weeks over the 20th century in mid- and high latitudes of the Northern Hemisphere.
Arctic sea-ice extent and thickness	Thinned by 40% in recent decades in late summer to early autumn and decreased in extent by 10–15% since the 1950s in spring and summer.
Non-polar glaciers	Widespread retreat during the 20th century.
Snow cover	Decreased in area by 10% since global observations became available from satellites in the 1960s.
Permafrost	Thawed, warmed, and degraded in parts of the polar, sub-polar, and mountainous regions.
El Niño events	More frequent, persistent, and intense during the last 20 to 30 years compared to the previous 100 years.
Growing season	Lengthened by about 1 to 4 days per decade during the last 40 years in the Northern Hemisphere, especially at higher latitudes.
Plant and animal ranges	Shifted polewards (geographically) and shifted upwards (in terms of elevation) for plants, insects, birds, and fish.
Breeding, flowering, and migration	Earlier plant flowering, earlier bird arrival, earlier dates of breeding season, and earlier emergence of insects in the Northern Hemisphere.
Coral reef bleaching	Increased frequency, especially during El Niño events.
Weather-related economic losses	Global inflation-adjusted losses rose an order of magnitude over the last 40 years. Part of the observed upward trend is linked to socio-economic factors and part is linked to climatic factors.

Source: IPCC Synthesis Report 2001

Climate modelling work around the world is re-inforced and supported by the fact that the majority of models do, in fact, suggest and predict that a 0.6°C warming should indeed result in the sea-level rise observed to date.

Snow cover has declined by some 10% since the late 1960s in the mid- and high latitudes of the Northern Hemisphere. It is also very likely that

the annual duration of lake and river ice cover has shortened by about two weeks over the course of the 20th century.

Almost all monitored mountain glaciers in non-polar regions have recorded a retreat over the same period.

In recent decades, the extent of Arctic sea-ice in the spring and

summer has decreased by between 10-15%. Arctic ice during late summer and early autumn has also likely thinned by 40% over the same period. There is more precipitation in many regions of the world. An increase of between 0.5-1% per decade has been measured over most mid- and high latitude areas of the Northern Hemisphere continents, accompanied by a 2% expansion in cloud cover.

Precipitation over the tropical land areas (between 10°N and 10°S) seems to have increased by between 0.2-0.3% per decade.

On the other hand, a decline in precipitation has been observed over Northern Hemisphere sub-tropical land areas (10°N - 30°N) during the 20th century, of about 0.3% per decade. As a result, in large parts of Africa and Asia, both the frequency and intensity of droughts appears to have worsened over the last few decades.

Impacts on Food Security and Health

Global agriculture will face many challenges over the coming decades. Degrading soils and deteriorating water resources will place enormous strains on achieving food security for growing populations. Existing stresses will be exacerbated under climate change. Any warming of more than 2.0°C could seriously threaten the (already fragile) stability of global food security. Existing climate change already has the capacity to affect food prices - even in Ireland bread prices rose by around 15% as a result of the impact of the 2003 European heatwave on the world wheat market. In some agricultural regions of Europe heat stress and drought in 2003 reduced certain crop yields by over 70%..

Food security in temperate latitudes is also likely to be threatened in a changing climate. Pests, parasites and diseases are far more mobile than crops - particularly so in the case of trees. Species preying on crops are able to expand their range and adapt to warming at a far more rapid rate than the rate their victims



can respond to, or agrochemical companies are able to develop treatments for.

The most vulnerable people are the landless, poor, and isolated. Poor terms of trade, weak infrastructure, lack of access to technology and information, and armed conflict will make it more difficult for these people to cope with the agricultural consequences of climate change.

Many of the world's poorest areas, dependent on isolated agricultural systems in semi-arid and arid regions, face the greatest risk. Many of the at-risk populations live in sub-Saharan Africa; South, East and Southeast Asia; tropical areas of Latin America; and some Pacific island nations.

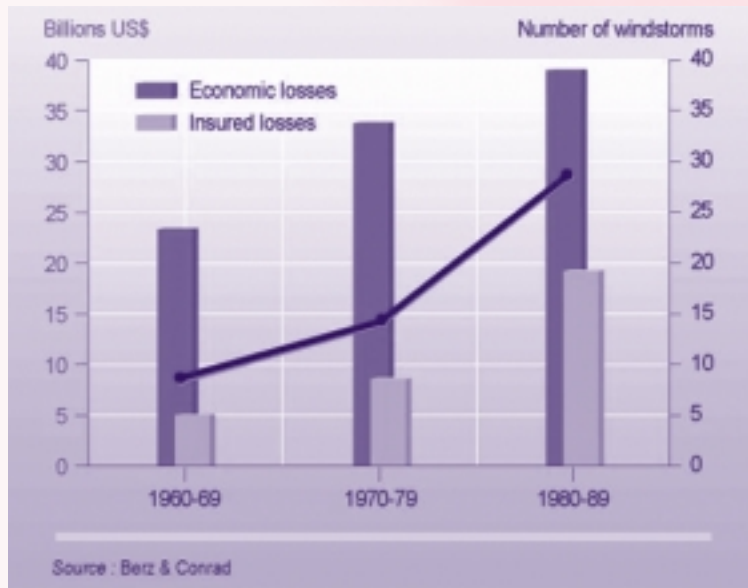
Climate change is expected to have wide-ranging consequences for human health. Public health depends on sufficient food, safe drinking water, secure shelter, good social conditions, and a suitable environmental and social setting for controlling infectious diseases. All of these factors can be affected by climate.

Heat waves are linked to cardiovascular, respiratory, and other diseases. Illness and deaths from these causes could be expected to increase, especially for the elderly and the urban poor. The 2003 heatwave in Europe is estimated to have caused 26,000 premature deaths across the continent, mostly amongst the aged, as a result of heat stress, dehydration and poor nutrition. Economic losses as a whole for this event have been estimated at \$13.5 billion.

Infrastructure will become more vulnerable to flooding and landslides. More intense and frequent precipitation events are expected to intensify urban flooding. The flood risks may also increase for settlements along rivers and within flood plains. The risk of more landslides is greatest for hillside areas.

Tropical cyclones, typhoons, and hurricanes are also expected to become more destructive in areas

Fig. 3 Losses in windstorm catastrophes (billions US\$ 1982 prices)



Source: IPCC/WMO/UNEP

already exposed to such events. There is a strong possibility that with further warming, their range will extend into territories where, currently, such events are extremely rare.

An observable trend in this direction can already be detected through the monitoring of insurance costs and economic losses due to windstorms. Costs have risen steeply over the last 40 years. (See Fig. 3)

Large Scale Discontinuities

Climate change also has the potential to cause large-scale singular events. Unlike most extreme events, singular events would have broad regional or global implications and are essentially irreversible.

One example of such a calamity would be a significant slowing of the ocean's transport of warm water to the North Atlantic, resulting in e.g., the failure of the Gulf Stream which is responsible for Ireland's currently relatively benign climate.

Other possible singularities or discontinuities include:

- **A major shrinking of the Greenland or West Antarctic ice**

sheets, which would raise sea levels by many metres over the next 1,000 years;

- *Accelerated (and possibly very sudden) global warming due to carbon emissions from tropical rainforests suffering dieback from heat and drought stress;*
- *The release of large quantities of methane from melting permafrost, or methane hydrates from long-buried ocean sediments, leading to greatly accelerated warming.*

Such risks have not yet been reliably quantified, and unfortunately most climate models are not currently really robust enough to adequately evaluate the real risk of such non-linear events. Current evaluations for such events tend to assume quite a low risk profile.

Greenhouse gases already in the air and committed warming from emissions already produced, together, mean that most, if not all, of these impacts are likely to occur to various degrees, and over various timescales between a matter of years and the end of this century.

The speed at which they arrive, the geographic areas impacted and the scale of severity are all factors amenable to various degrees of

mitigation, if only local, national and international action were to be initiated and delivered by policymakers as much as by ordinary people (See Climate Change Leaflet 3, Policy).

If action is not taken soon - and global temperature increase not kept below a threshold of around 2°C - climate science and climate impact evaluation tend to show that the challenge is going to be severe.

Table 2: Climate variability, extreme events and climate impacts expected:

Projected Changes	Projected Impacts
Higher maximum temperatures, more hot days and heat waves over nearly all land areas. Prognosis: very likely	Incidence of death and serious illness in older people and urban poor. Heat stress in livestock and wildlife. Risk of damage to a number of crops. Electric cooling demand. Energy supply reliability.
Higher minimum temperatures, and fewer cold days, frost days, and cold waves over nearly all land areas. Prognosis: very likely	Cold-related human morbidity and mortality. Risk of damage to a number of crops. Range and activity of some pests and disease vectors. Heating energy demand.
More intense precipitation events. Prognosis: very likely, over many areas	Flood, landslide and avalanche damage. Soil erosion. Flood run off could increase recharge of some flood plain aquifers. Pressure on government and private flood insurance systems and disaster relief.
Increased summer drying over most mid-latitude continental interiors and associated risk of drought. Prognosis: likely	Crop yields. Damage to building foundations caused by ground shrinkage. Risk of forest fire. Water resource quantity and quality.
Increase in tropical cyclone peak wind intensities, and mean and peak precipitation intensities. Prognosis: likely, over some areas	Risks to human life, risk of infectious disease epidemics. Coastal erosion and damage to coastal buildings and infrastructure. Damage to coastal ecosystems such as coral reefs and mangroves.
Intensified droughts and floods associated with El Niño events in many regions Prognosis: likely	Agricultural and rangeland productivity in regions prone to drought and flood. Hydro-power potential in drought-prone regions.
Increased variability of Asian summer monsoon precipitation. Prognosis: likely	Flood and drought magnitude and damage in temperate and tropical Asia.
Increased intensity of mid-latitude storms. Prognosis: little agreement between current models	Risks to human life and health. Property and infrastructure losses. Damage to coastal ecosystems.

Key to symbols: Increased Extended Decreased

Source: UNFCCC "Caring for Climate"

Sources, citations, further reading and websites:

(1) United Nations Framework Convention on Climate Change, <http://unfccc.int/>

Climate change information kit (UNFCCC/UNEP)

Caring for climate - a guide to the Climate Change Convention and the Kyoto Protocol (UNFCCC)

(2) Intergovernmental Panel on Climate Change: <http://www.ipcc.ch/>

Climate Change 2001: Synthesis Report (IPCC)

(3) United Nations Environment Programme: <http://www.unep.org/>

(4) World Meteorological Organisation: <http://www.wmo.int/index-en.html>

(5) GRIAN (Greenhouse Ireland Action Network): <http://www.grian.ie>

Science; Impacts; Policy.

(6) Department of the Environment, Heritage and Local Government: <http://www.environ.ie>

(7) ENFO-Information on the Environment: <http://www.enfo.ie/>



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