Fact sheet: climate change science

The status of climate change science today

Enough is known about the earth's climate system and the greenhouse effect (see annex) to know that urgent action needs to be taken. This year has seen the publication of the first three instalments of the Fourth Assessment Report by the Intergovernmental Panel on Climate Change (IPCC). The IPCC assesses world-wide climate change science in three working groups and in the context of three broad categories: 1) the physical science, 2) climate change impacts, adaptation and vulnerability and 3) mitigation of climate change. It is politically significant that all governments agreed to the conclusions of the scientists, making the assessment a solid foundation for sound decision-making.

Working Group I: The physical science

- Climate change is already happening is unequivocal and this change can now be firmly attributed to human activity.
- Warming during the past 100 years was 0.74C, with most of the warming occurring in the past 50 years. The warming for the next 20 years is projected to be 0.2C per decade.
- The world faces an average temperature rise of around 3°C this century if greenhouse gas emissions continue to rise at their current pace and are allowed to double from their pre-industrial level.
- Continued greenhouse gas emissions at or above current rates would cause further warming and induce many changes in the global climate system during the 21st century that would *very likely* be larger than those observed during the 20th century.

Working Group II: Climate change impacts, adaptation and vulnerability

Observed impacts

- Many natural systems, on all continents and in some oceans, are being affected by regional climate changes, particularly temperature increases:
- enlargement and increased numbers of glacial lakes, with increased risk of outburst floods
- increasing ground instability in mountain and other permafrost regions, and ice and rock avalanches in mountain regions
- changes in some Arctic and Antarctic flora and fauna, including sea-ice biomes and predators high in the food chain
- earlier timing of spring events, such as leaf-unfolding, bird migration and egg-laying
- pole-ward and upward shifts in ranges in plant and animal species

Regions that will be especially affected

- The Arctic, because of high rates of projected warming on natural systems

- Africa:
    - Increased water shortages; (up to 250 million people in Africa at increased risk of water stress in 2020.)
    - Reductions in the area suitable for agriculture
    - Sea-level rise and consequent threat to cities

- Small Island Developing States:
    - Sea-level rise is likely to exacerbate inundation, storm surge, erosion and other coastal hazards, thus threatening vital infrastructure that supports the socio-economic well-being of island communities.
- There is strong evidence that under most climate change scenarios, water resources in small islands are likely to be seriously compromised.
- Asian megadeltas, such as the Ganges-Brahmaputra and the Zhujiang:
    - Large populations and high exposure to sea-level rise, storm surge and river flooding.
    - Himalayan glacier melt leading to flooding, rock avalanches disruption of water sources

Fresh water resources and their management

- Impacts on water resources could be geographically extensive and in some locations dramatic. As the planet warms it is highly likely that, depending on location, there will be an increase in the frequency and severity of floods and droughts.

- By mid-century, annual average river runoff and water availability are projected to increase by 10-40% at high latitudes and in some wet tropical areas, and decrease by 10-30% over some dry regions at mid-latitudes and in the dry tropics, some of which are presently water stressed areas.

Food, fibre and forest products

- Crop yield is projected to increase in temperate regions for a local mean temperature rise of 1-3 °C, and then decrease beyond that in some regions.

- In tropical areas, crop yield is projected to decrease, even with relatively modest rises of 1-2 °C in local temperature, increasing the risk of hunger.

- Increases in the frequency of droughts and floods are projected to affect local crop production negatively, especially in subsistence sectors at low latitudes.

Ecosystems

- Increased risk of extinction, among 20-30% of plant and animal species, is likely if the global temperature increase exceeds 1.5 – 2.5 °C.

- In the second half of this century terrestrial ecosystems will see net carbon uptake weaken or reverse.

Coastal areas and low-lying areas

- Coasts are projected to be exposed to increasing risks, including coastal erosion, due to climate change and sea-level rise. The effect will be exacerbated by increasing human-induced pressures on coastal areas.
- Increases in sea surface temperatures of 1- 3 °C are projected to result in a major decline of most corals.
- Many millions more people are projected to be flooded every year due to sea-level rise by the 2080s. Those densely-populated and low-lying areas where adaptive capacity is relatively low, and which already face other challenges such as tropical storms or local coastal subsidence, are especially at risk. The numbers affected will be largest in the mega-deltas of Asia and Africa while small islands are especially vulnerable.

Health

- Projected changes to the climate will affect the health of millions of people worldwide. The changes will be most felt by those least able to adapt, such as the poor, the very young and the elderly.

Industry, settlement and society

- Areas most likely to be affected are the poorer, often rapidly expanding communities near rivers and coasts, which use climate sensitive resources and are prone to extreme weather.

- Where extreme weather events become more intense and or more frequent, their economic and social costs are predicted to increase.

Responses

- Currently adaptation is occurring very limited
- More extensive adaptation is required
- Future vulnerability depends not only on climate change, but also on the development pathway
- Many impacts can be reduced or delayed by mitigation.

- Impacts of unmitigated climate change will vary regionally but, aggregated and discounted to the present, they are very likely to impose costs, and these costs would increase over time

<u>Working Group III: Mitigation of Climate Change</u>

GHG emission trends

- Between 1970 and 2004, emissions of CO_2, CH_4, N_2O, HFCs, PFCs and SF_6, the greenhouse gases covered by the Kyoto Protocol, have increased by 70% (24% since 1990). CO_2, being by far the largest source, has grown by about 80% (28% since 1990). This has occurred because increases in income per capita and population have outweighed decreases in energy intensity of production and consumption.

- Without additional policies global GHG emissions are projected to increase with 25-90% by 2030 relative to 2000. Fossil fuel dominance is expected to continue to 2030 and beyond, hence CO_2 emissions from energy use are projected to grow with 40-110% over that period. Two thirds to three quarters of this increase is projected to come from developing countries, though their average per capita CO_2 emissions will remain substantially lower than those in developed country regions. Since 2000 carbon intensity of energy has been on the rise due to increased use of coal.

Mitigation in the short and medium term up to 2030

- There is a significant economic potential for the mitigation of greenhouse gas emissions from all sectors over the coming decades, sufficient to offset growth of global emissions or to reduce emissions below current levels.

Mitigation in the long term (after 2030)

- Global emissions must peak and decline thereafter to meet any long-term GHG concentration stabilisation level. The lower the stabilisation level, the more quickly this peak and decline must occur.

- The most stringent scenarios could limit global mean temperature increases to 2 - 2.4C above pre-industrial level .This would require emissions to peak within 15 years and decline to be around 50% of current levels by 2050.

Overview of CO2 concentration level, corresponding temperature increases and year that concentrations would need to peak to maintain specific concentration levels.

CO2 concentration in ppm *(pre-industrial levels at **278 ppm**; current levels at **380 ppm**)*	**Global mean temperature increase in C above pre-industrial levels**	**Peaking year of CO2**
350 - 400	2.0 -2.4	2000 - 2015
400 - 440	2.4 - 2.8	2000 - 2020
440 - 485	2.8 - 3.2	2010 - 2030
485 - 570	3.2 - 40	2020 - 2060
570 - 660	4.0 - 4.9	2050 - 2080

- Mitigation efforts over the next two to three decades will determine to a large extent the long-term global mean temperature increase and the corresponding climate change impacts that can be avoided.

Annex

The greenhouse effect

- The earth's climate is driven by a continuous flow of energy from the sun. This energy arrives mainly in the form of visible light. About 30% is immediately scattered back into space, but most of the remaining 70% that is absorbed passes down through the atmosphere to warm the earth's surface.

- The earth must send this energy back out into space in the form of infrared radiation. Being much cooler than the sun, the earth does not emit energy as visible light. Instead, it emits infrared, or thermal radiation. This is the heat thrown off by an electric fire or grill before the bars begin to glow red.

- Greenhouse gases in the atmosphere block infrared radiation from escaping directly from the surface to space. Infrared radiation cannot pass straight through the air like visible light. Instead, most departing energy is carried away from the surface by air currents and clouds, eventually escaping to space from altitudes above the thickest layers of the greenhouse gas blanket.

- The layer of greenhouse gases is measured in “parts per million” (ppm), which is the ratio of the number of greenhouse gas molecules to the total number of molecules of dry air. For example: 300ppm CO2 means 300 molecules of CO2 per million molecules of dry air.

The climate system is characterised by inertia and does not immediately respond to reductions in greenhouse gas emissions. Some greenhouse gases survive in the atmosphere for years, decades or even centuries. As a result, climate change will continue for hundreds of years after atmospheric concentrations have stabilized.