



Climate Change – implication for water resources

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What is climate change?

Greenhouse effect

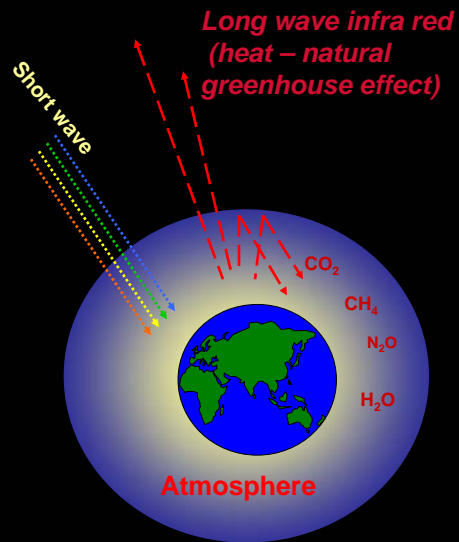
What are observed changes related to climate change

Greenhouse gases, temperature, precipitation, sea level etc

What are the projected changes?

What does this mean for water resource management?

Climate change



Land use and land cover change, energy production and use



Increasing greenhouse gases (GHG)



Enhanced Greenhouse Effect

Contributions from different sectors to greenhouse gases

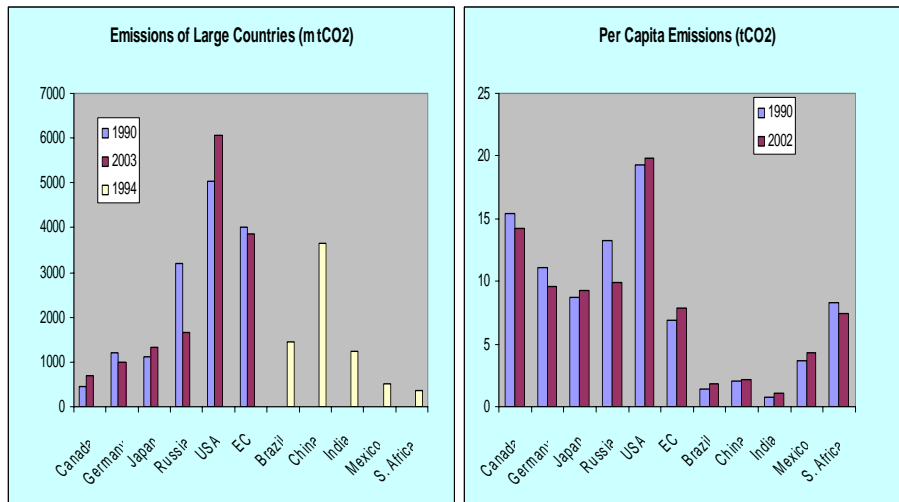


Land use and land cover change: about 17%

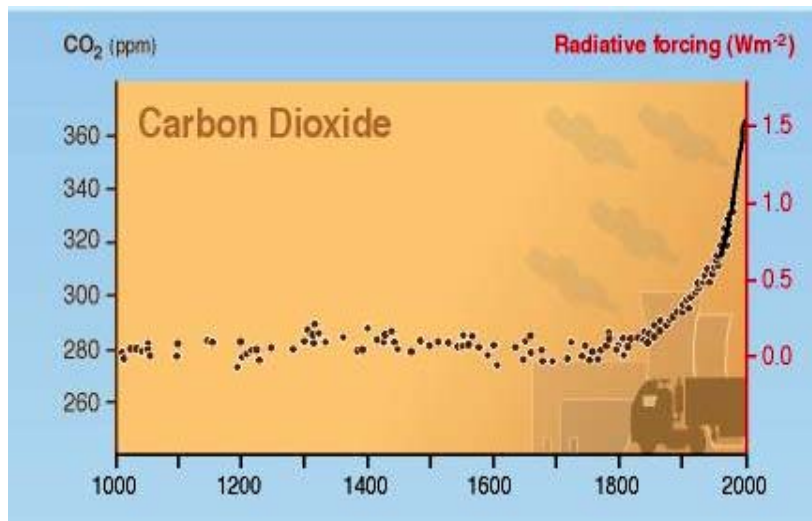


Energy production and use : 80-83%

GHG Emissions

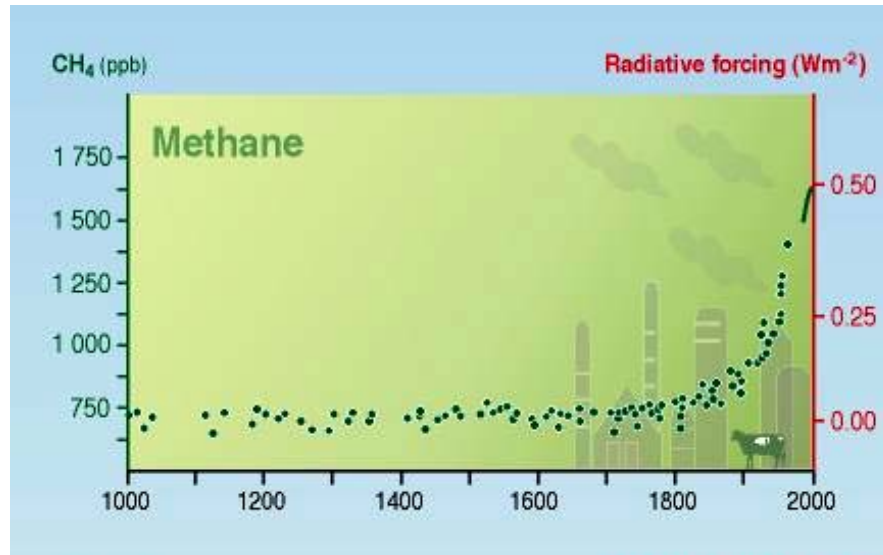


Human activities have changed composition of the atmosphere since the pre- industrial era



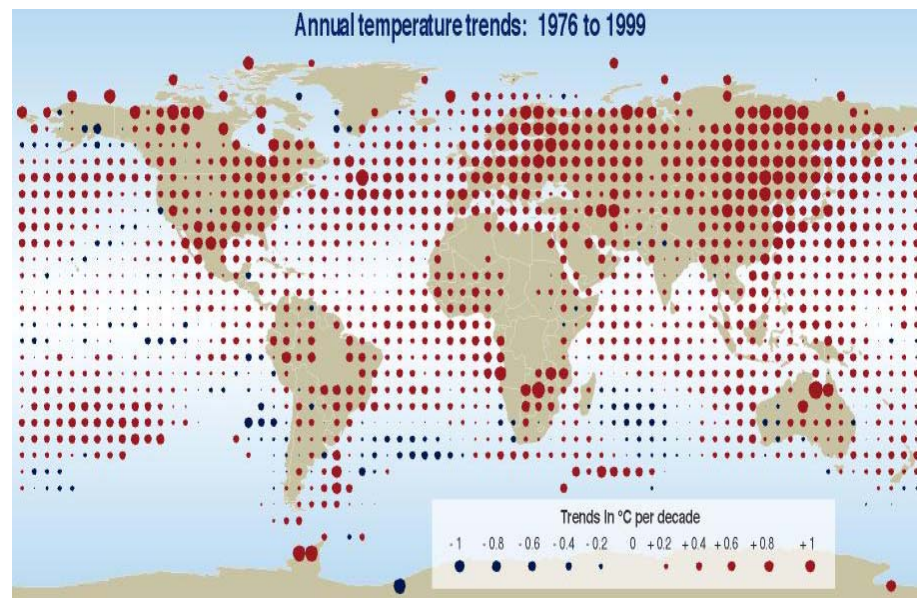
Carbon dioxide has increased by about a third

Human activities have changed the composition of the atmosphere since the pre-industrial era



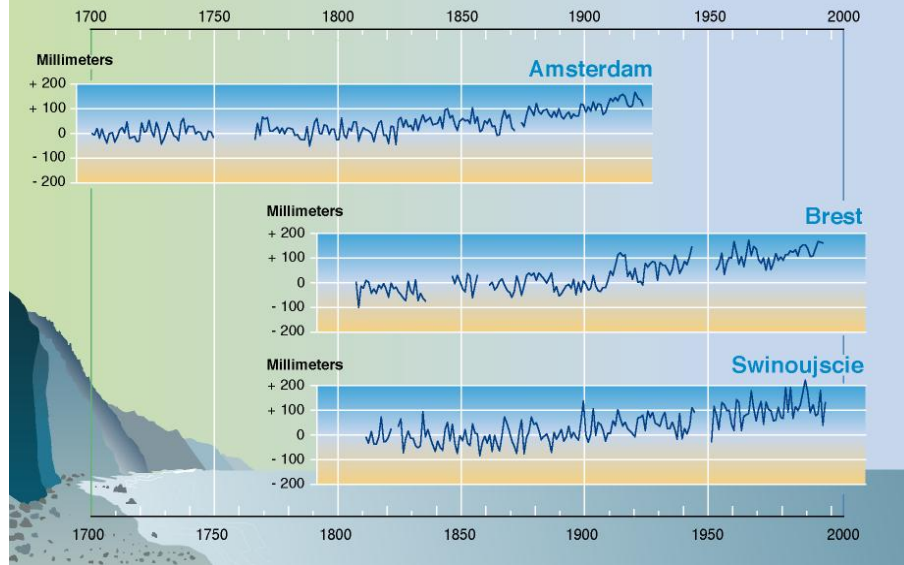
Methane has doubled

**The land and oceans have warmed
0.4 to 0.8 °C**



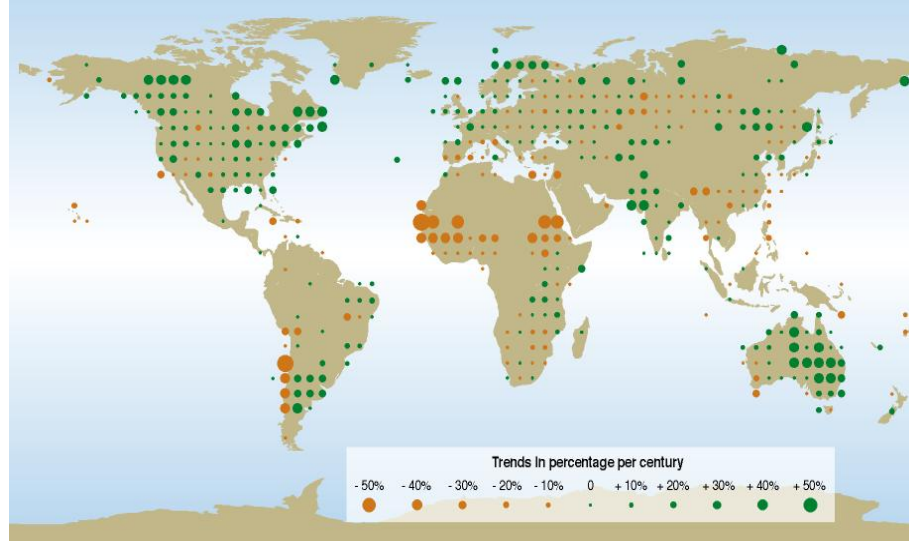
Sea Levels have risen

Relative sea level over the last 300 years



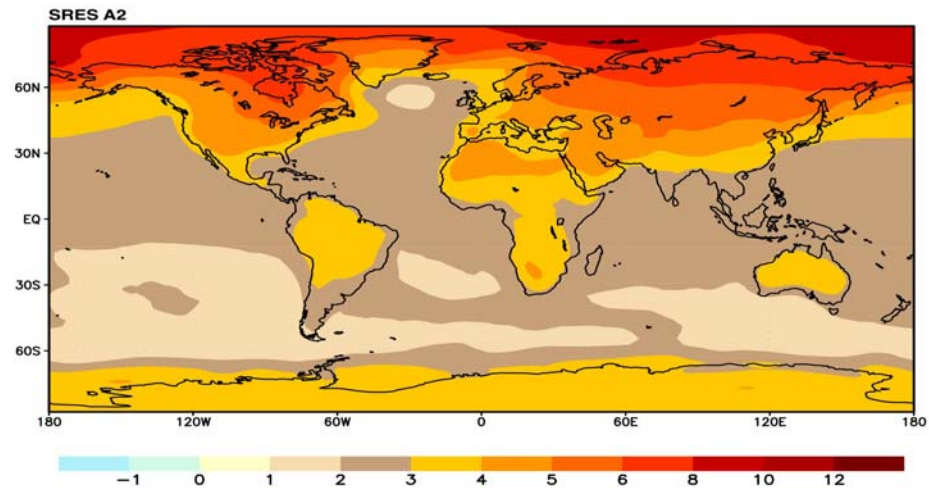
Precipitation patterns have changed

Annual precipitation trends: 1900 to 2000



More droughts and heavy rain events

Projected temperature changes to 2100

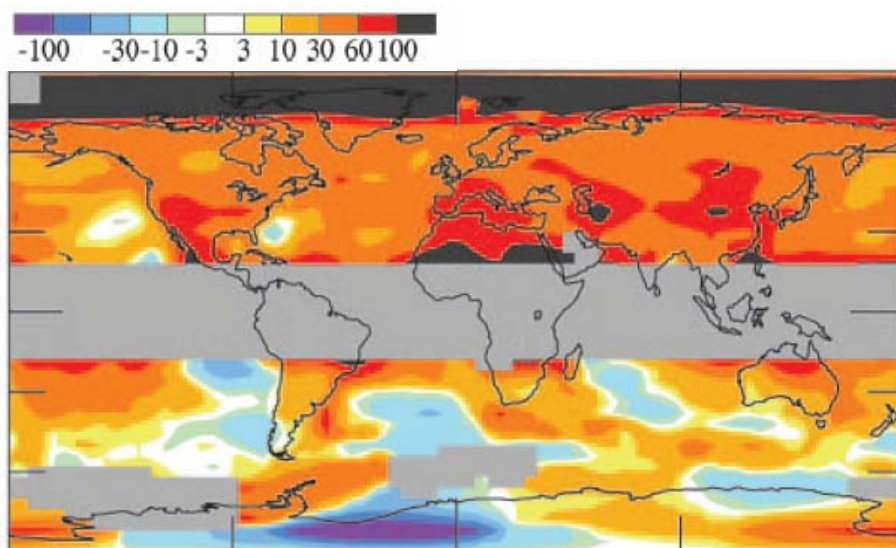


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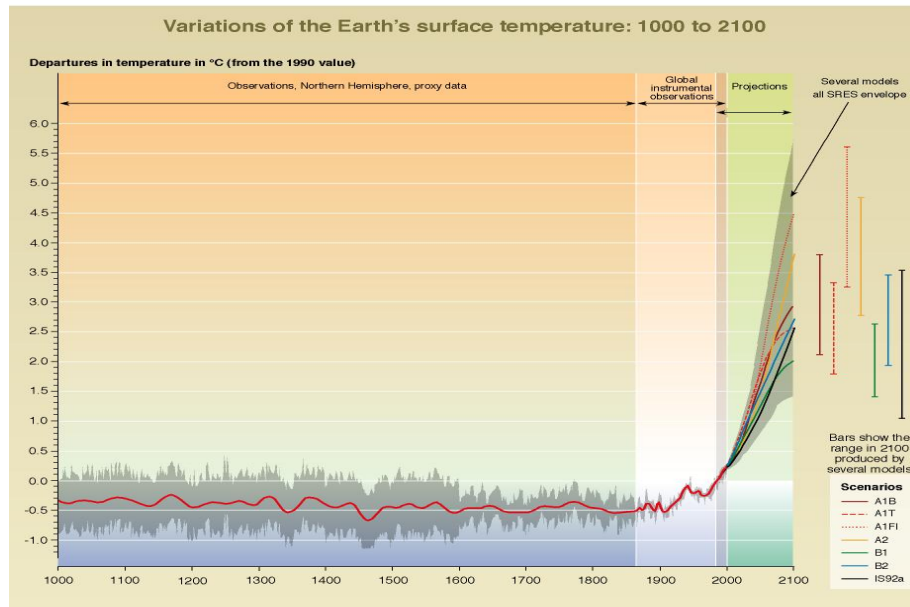
A mid-range scenario - projection of change from 1990 to 2100 – a global average of 3.1°C with a range from 1.4°C to 5.8°C

Pole ward migration of isotherms (km/decade) – Observed

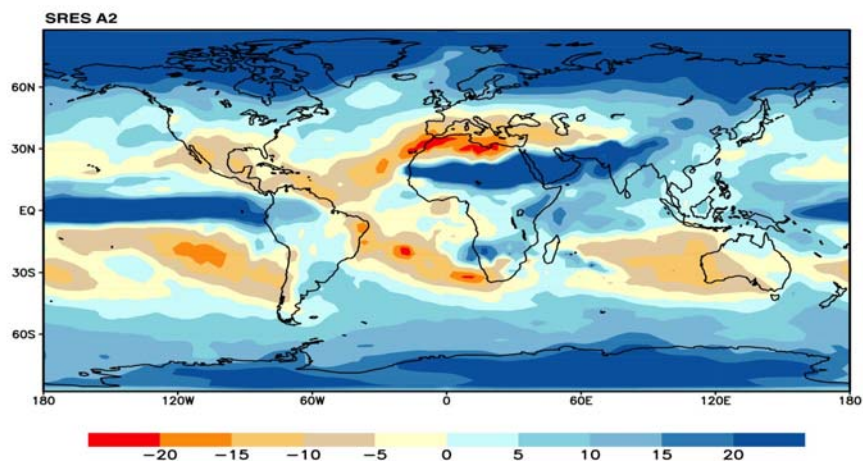
1975-2005 (Hansen et al 2006 PNAS)



Projected Temperatures During the 21st Century Are Significantly Higher Than at Any Time During the Last 1000 Years

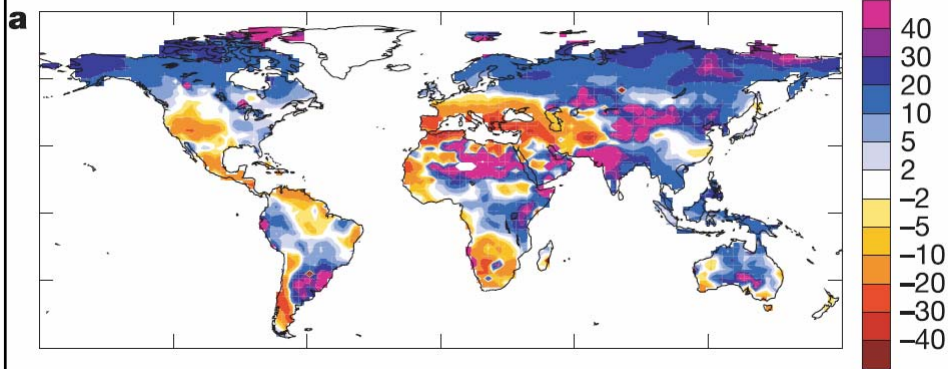


Some areas are projected to become wetter, others drier with an overall increase projected

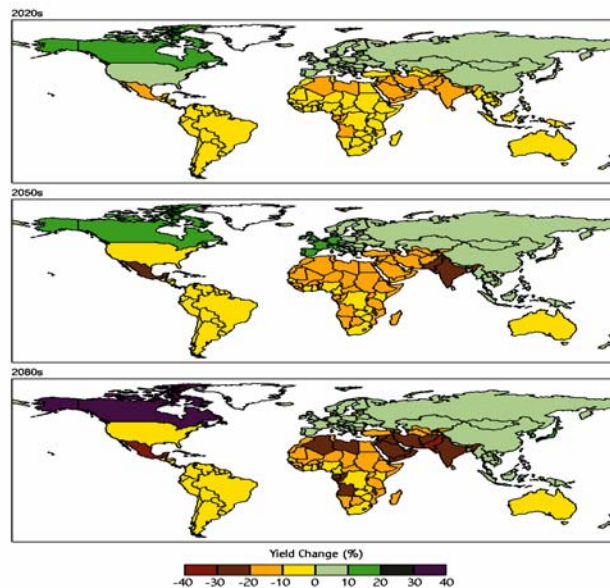


Annual mean precipitation change: 2071 to 2100 Relative to 1990

Precipitation projections Wetter, but more variable in time and space



Crop yields projected to decrease in the tropics and sub-tropics, but increase at high latitudes



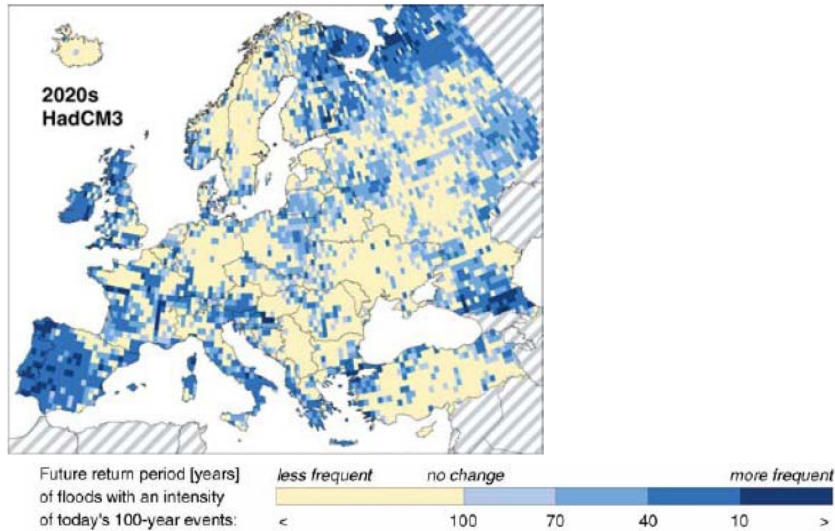
Percentage change in average crop yields for the IS 92a climate change scenario.

Effects of CO₂ fertilization are taken into account and some adaptation, but not increased incidence of pests. Crops modeled are: wheat, maize and rice -- 2020s, 2050s and 2080s

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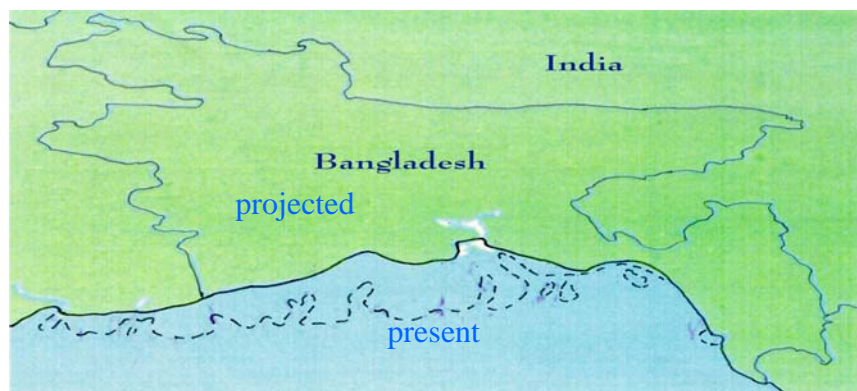
100-year flood frequency 2020

Lenher et al 2006 Climatic Change

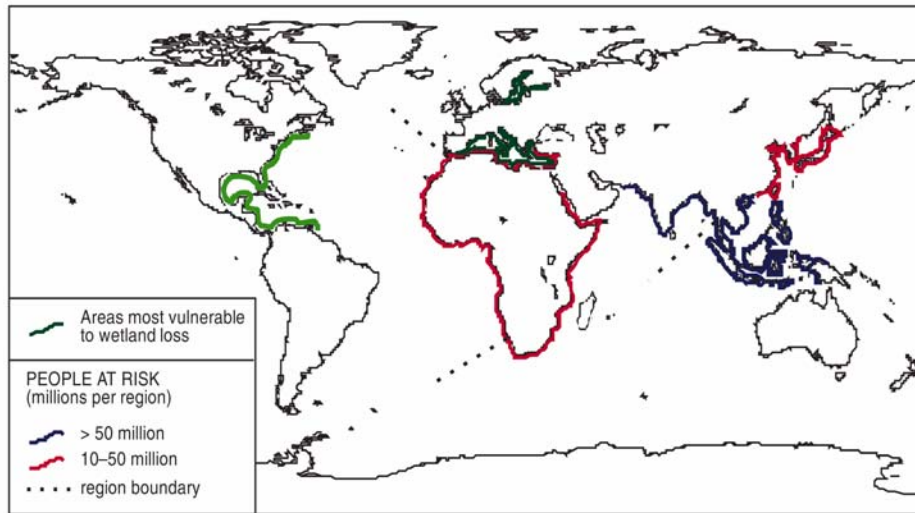


Increased risk of floods, potentially displacing tens of millions of people

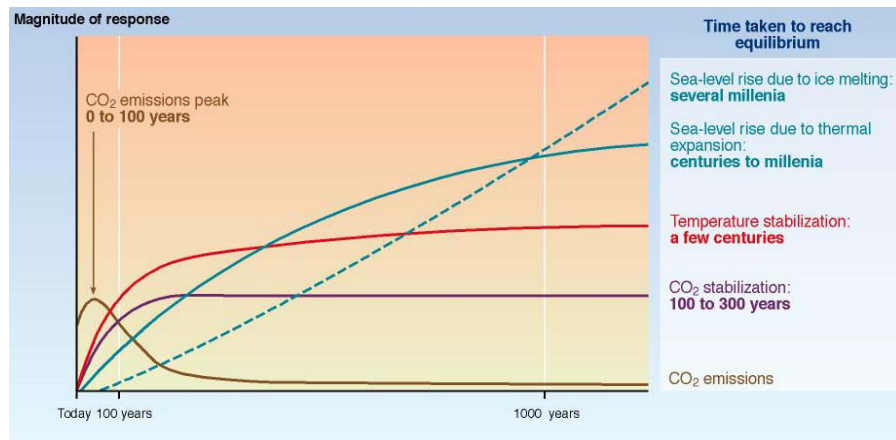
Bangladesh is projected to lose about 17% of its land area with a sea level rise of one meter



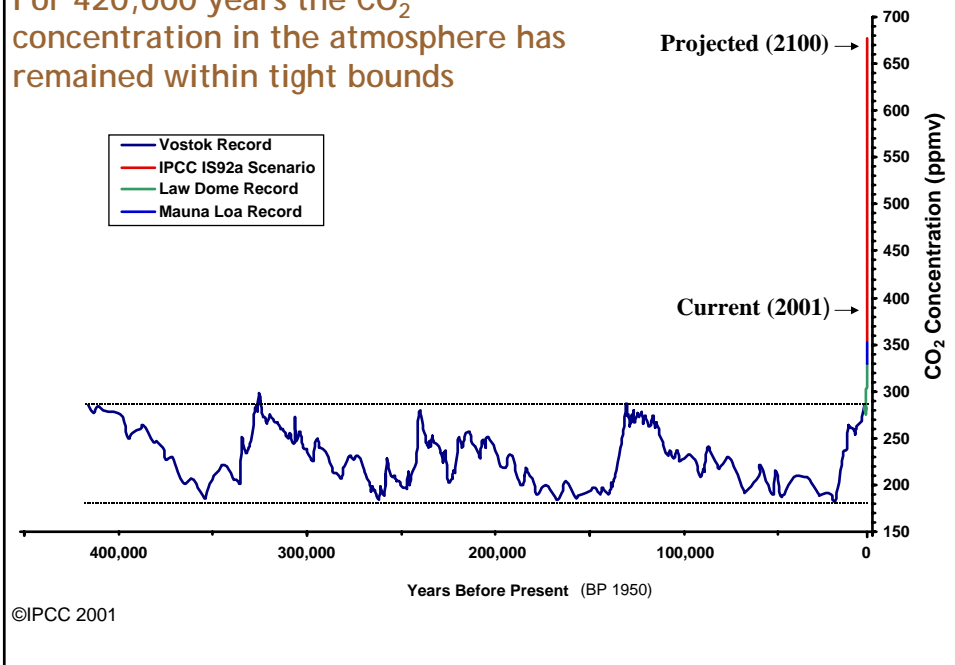
Many coastal wetlands would become vulnerable due to sea level rise - fisheries will be adversely affected



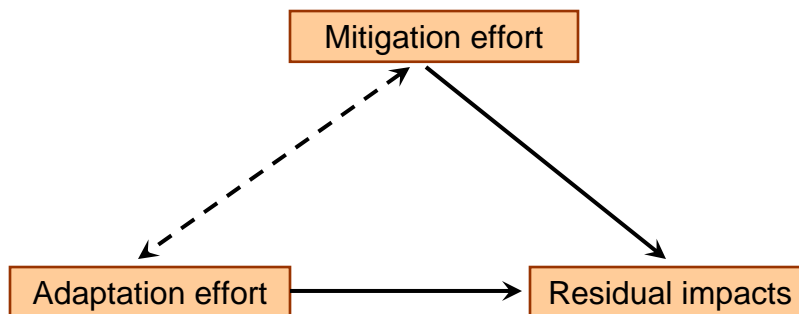
CO₂ concentrations, temperature and sea level continue to rise long after emissions are reduced

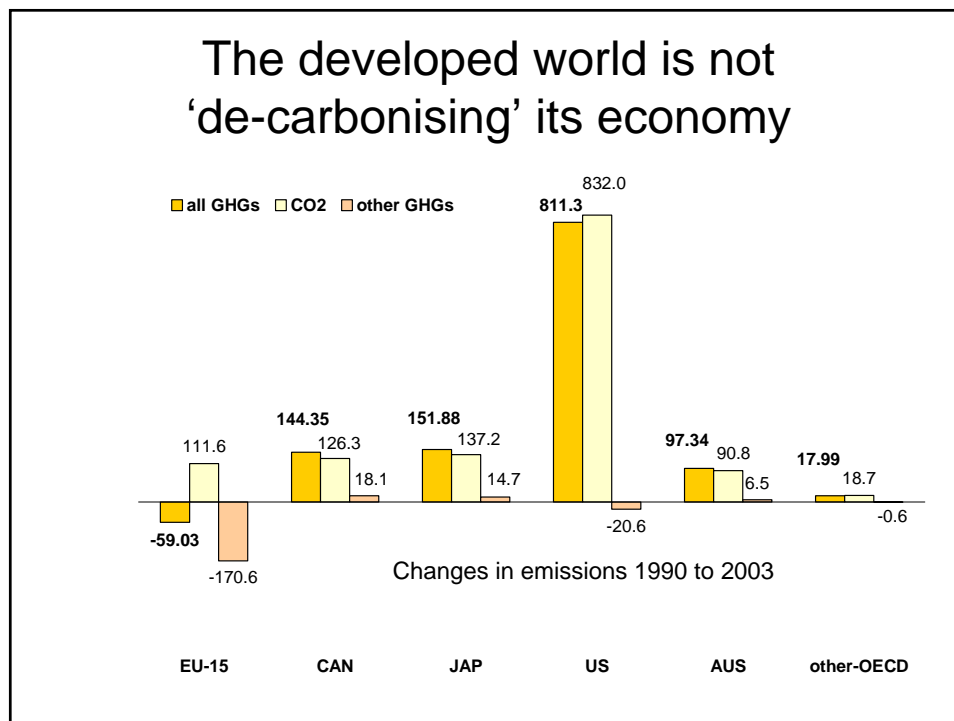
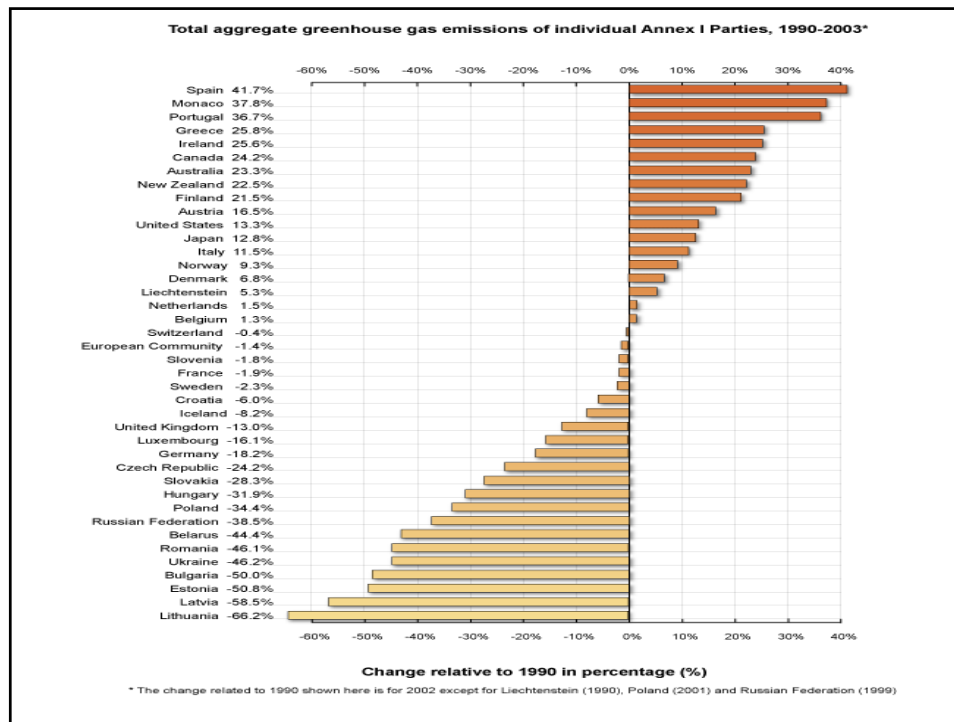


For 420,000 years the CO₂ concentration in the atmosphere has remained within tight bounds

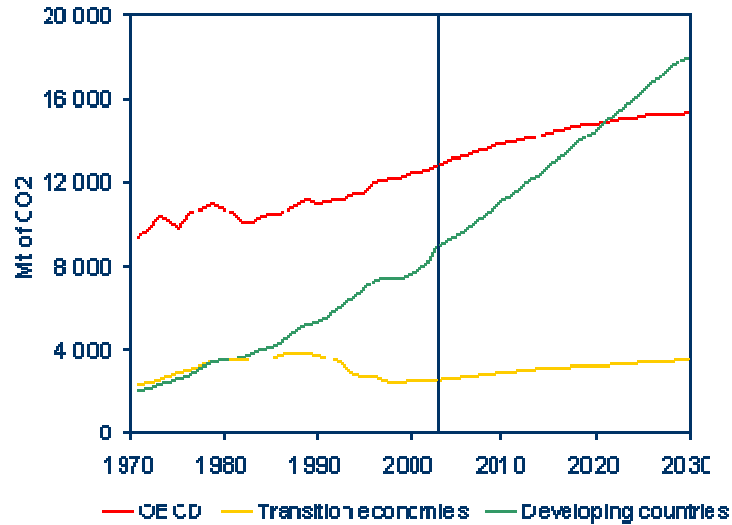


The triangle of tradeoffs





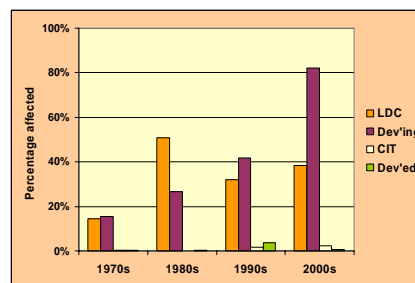
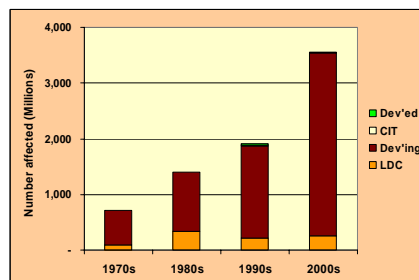
Barely started to deal with the growth in energy demand in developing countries



People affected by climate related disasters have increased

2 Billion people in developing countries affected by climate related disaster in the 1990s.

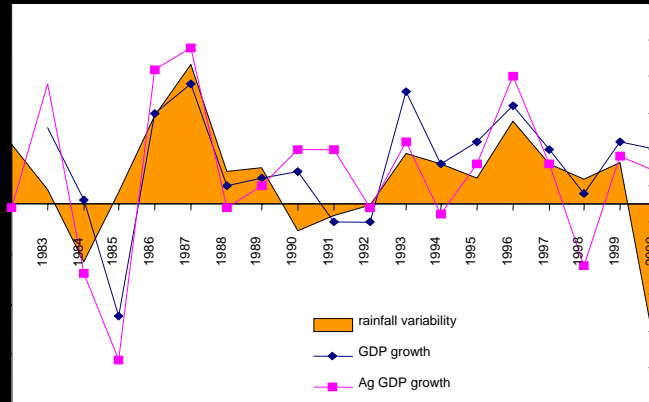
Double in the 2000s?



40 to 80% of the population in developing countries versus a few % in more developed countries

Climate variability is already a major impediment to development.

Ethiopia - A relatively water rich developing country, but with GDP still tied to yearly rainfall variations



Preliminary results from : A Country Water Resources Assistance Strategy for Ethiopia
From Claudia Sadoff

Impacts and ability to cope with them worst in developing countries

will be further affected
(direct and indirect)

lack of knowledge,
technology, institutions for
adapting to change

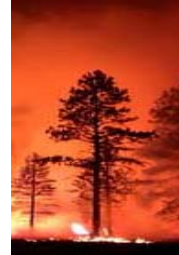


Climate change is but one of the pressures...

Pressures interact with each other and climate change

Examples:

- Land use and land cover change: habitat loss and fragmentation*
- Land and water degradation*
- introduction of exotic/invasive species*



Approach to Adaptation

- **Climate risk approach** – in all development planning take into account issues arising from current climate variability while ensuring actions are consistent with future climate projections
- *Tackling the here-and-now is the best step to addressing future changes*