平成22年度（第19回）ブループラネット賞
受賞者記念講演会

2010 Blue Planet Prize
Commemorative Lectures

ジェームス・ハンセン博士　講演スライド集
「人起源の気候変動：道徳的、政治的、法的課題」

ロバート・ワトソン博士　講演スライド集
「オゾン層破壊、気候変動及び生物多様性の損失：
　　食糧、水、人間の安全保障に関する意味合い」

Dr. James Hansen
Slides for the Lecture
“Human – Made Climate Change: A Moral, Political and Legal Issue”

Dr. Robert Watson
Slides for the Lecture
“Ozone Depletion, Climate Change and Loss of Biodiversity:
Implications for Food, Water and Human Security”

af 公益財団法人 旭硝子財団
THE ASAHI GLASS FOUNDATION

ロバート・ワトソン博士

講演スライド集

「オゾン層破壊、気候変動及び生物多様性の損失：
食糧、水、人間の安全保障に関する意味合い」

Dr.Robert Watson

Slides for the Lecture

"Ozone Depletion,Climate Change and Loss of Biodiversity:
Implication for Food,Water and Human Security"

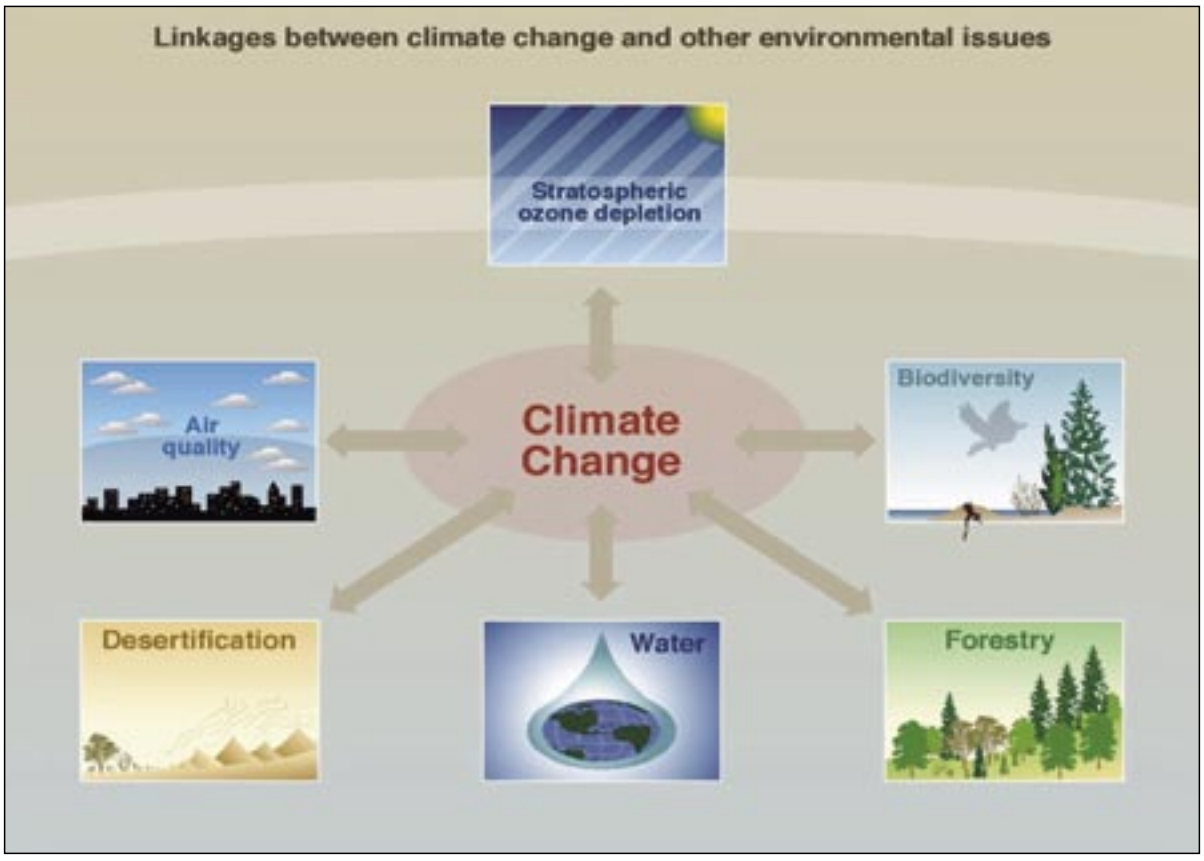
Climate change, biodiversity loss and ecosystem degradation: implications for food, water and human security

Robert T. Watson
Chief Scientific Advisor at Defra
Strategic Director of the Tyndall Centre, UEA

Blue Planet Prize

Tokyo, Japan
October, 2010

slide 1



slide 2

Climate change, loss of biodiversity and ecosystem degradation

- Climate change, loss of biodiversity and ecosystem degradation are environment, development and security issues, i.e., they undermine:
  - food, water and human security
  - the economy (loss of natural capital)
  - poverty alleviation and the livelihoods of the poor
  - human health
  - personal, national and regional security

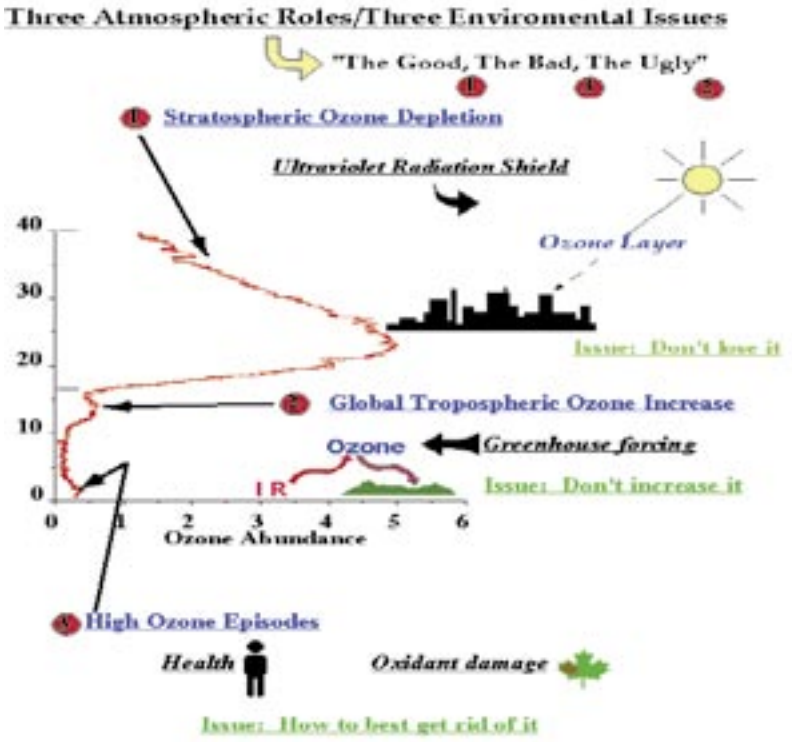
- Climate change and ecosystem degradation are inter- and intra-generational equity issues:
  - developing countries and poor people in developing countries are the most vulnerable
  - the actions of today will affect future generations

slide 3

Ozone Depletion

slide 4

Atmospheric Ozone



slide 5

Catalytic Cycles- The Anthropogenic Impacts

HOx catalysis

$OH + O_3 \rightarrow HO_2 + O_2$

$HO_2 + O_3 \rightarrow OH + O_2 + O_2$

net: $2\,O_3 \rightarrow 3\,O_2$

Hampson

A major breakthrough

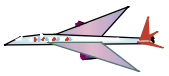
A very important reaction to catalyze
Equivalent of one of Chapman's reaction

NOx catalysis

$NO + O_3 \rightarrow NO_2 + O_2$

$O + NO_2 \rightarrow NO + O_2$

net: $O + O_3 \rightarrow 2\,O_2$



Crutzen
Johnston

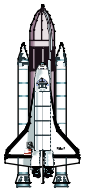
Chapman's other reaction

ClOx catalysis

$Cl + O_3 \rightarrow ClO + O_2$

$O + ClO \rightarrow Cl + O_2$

net: $O + O_3 \rightarrow 2\,O_2$



Stolarski and Cicerone

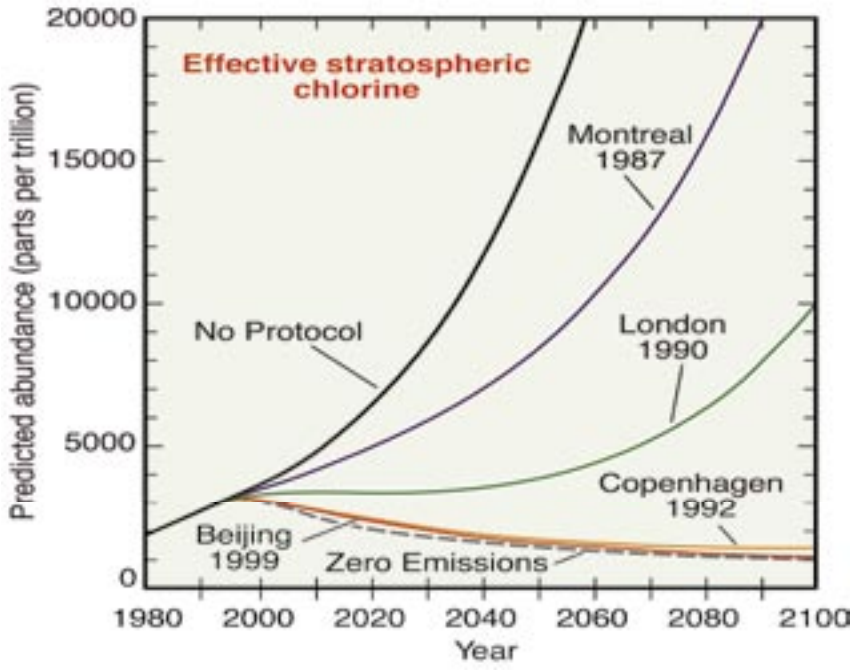
BrOx, SOx, ...?

CFCs as providers
of stratospheric chlorine

Rowland and Molina

slide 6

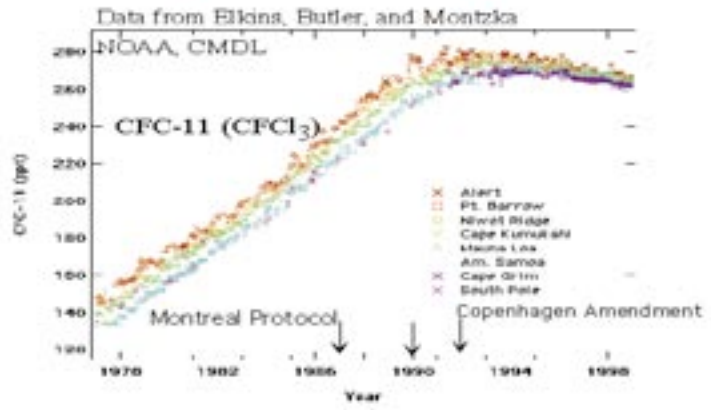
Evolution of Effective Chlorine under the Montreal Protocol



- UNEP/WMO, 2002.

slide 7

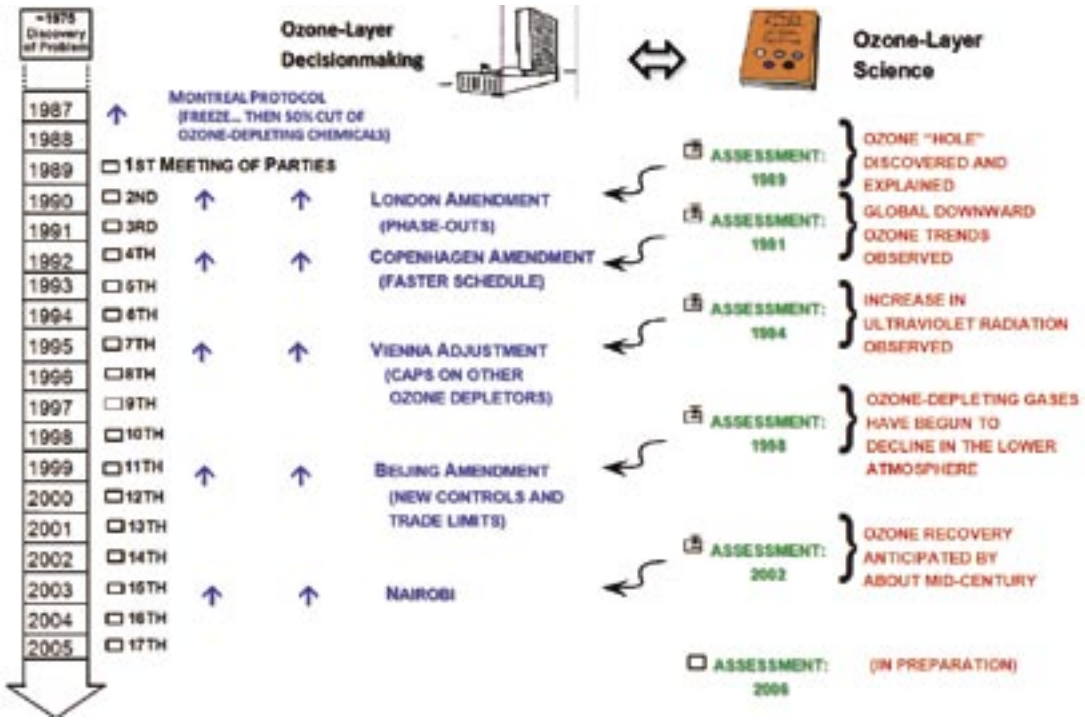
Current state of CFCs



- CFC concentrations have turned around since protocol
- Tropospheric concentrations of CFCs are consistent with our expectations/knowledge

Montreal Protocol is Working

slide 8



slide 9

Climate Change

slide 10

Climate Change

- The composition of the atmosphere, and the Earth's climate has changed, mostly due to human activities (highly certain), and is projected to continue to change, globally and regionally:
  - Increased greenhouse gases and aerosols
  - Warmer temperatures
  - Changing precipitation patterns – spatially and temporally
  - Higher sea levels – higher storm surges
  - Retreating mountain glaciers
  - Melting of the Greenland ice cap
  - Reduced arctic sea ice
  - More frequent extreme weather events
    - heat waves, floods and droughts
  - More intense cyclonic events, e,g., hurricanes in the Atlantic

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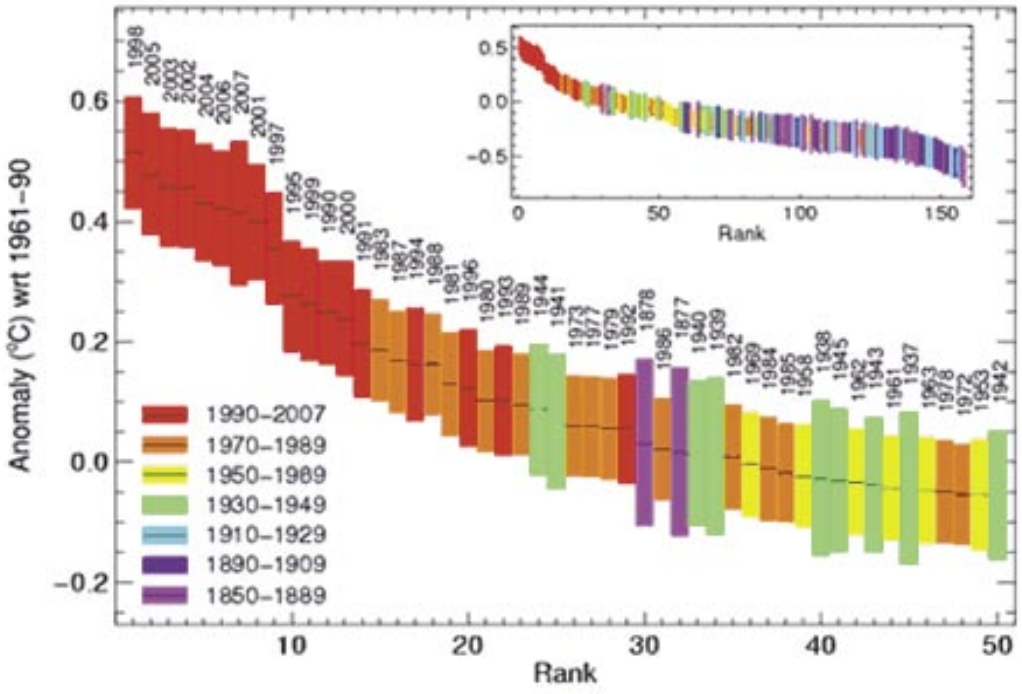
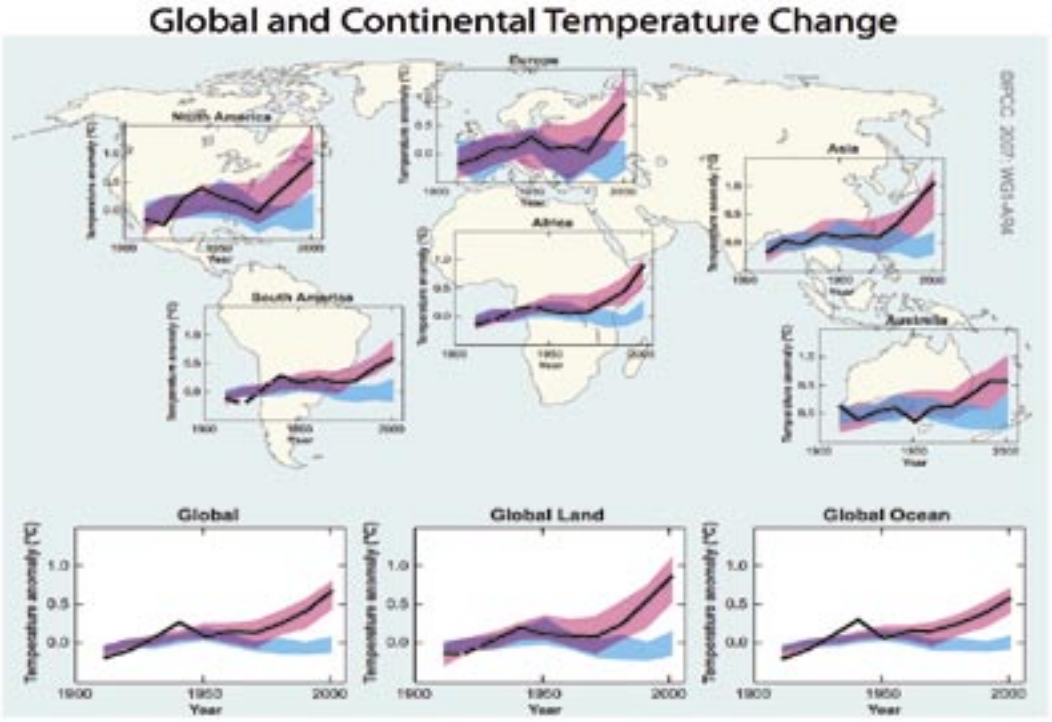
Climate is Warming



slide 12

Understanding and Attributing Climate Change



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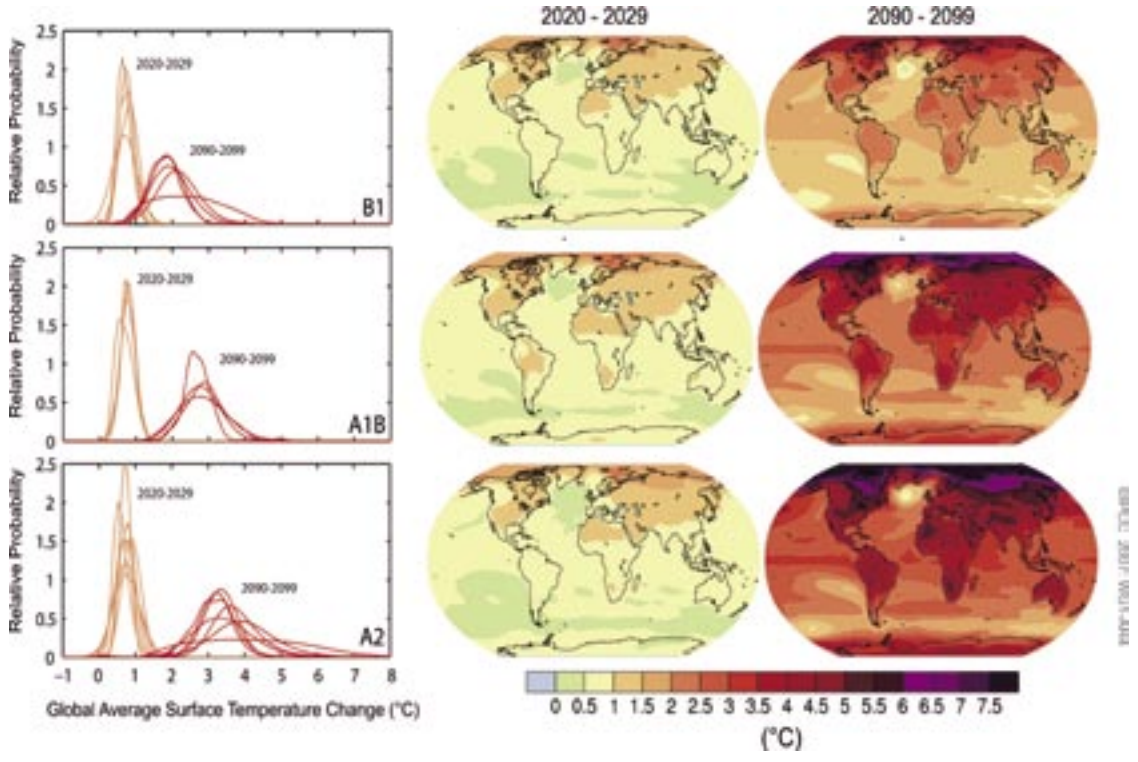
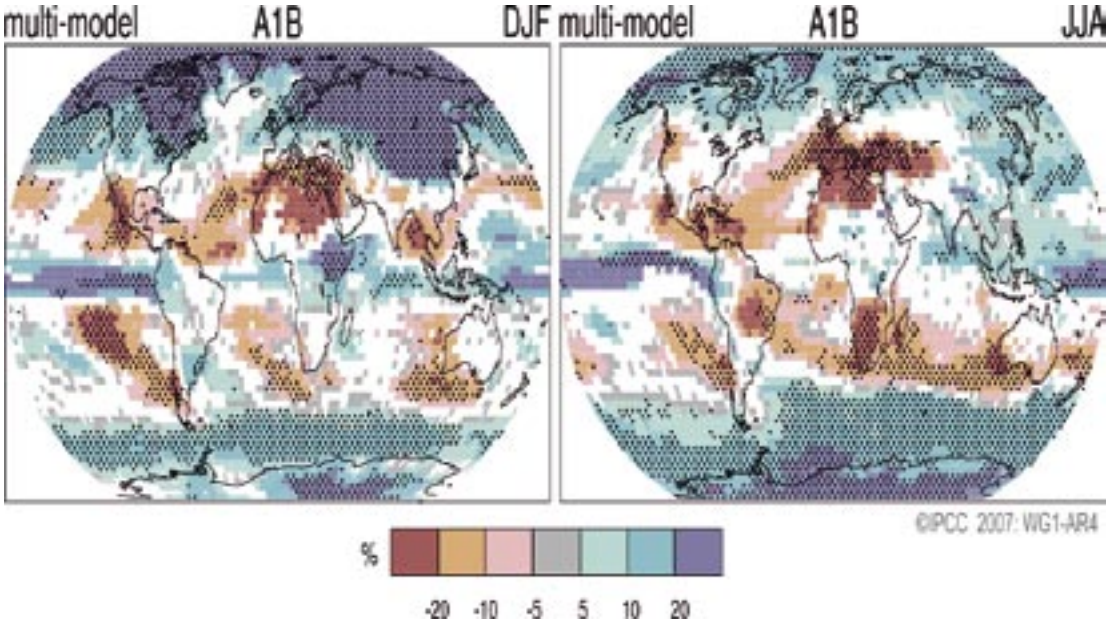
Surface Temperature



slide 14

Precipitation



slide 15

Projected Impacts of Human-induced Climate Change

•Adversely effect ecological systems, especially coral reefs, and exacerbate the loss of biodiversity

•Decrease agricultural productivity for almost any warming in the tropics and sub-tropics and adverse impacts on fisheries – food security

•Decrease water availability and water quality in many arid- and semi-arid regions – increased risk of floods and droughts in many regions – water security

•Increase the incidence of vector- (e.g., malaria and dengue) and water-borne (e.g., cholera) diseases, heat stress mortality, threats nutrition in developing countries, increase in extreme weather event deaths

•Adverse effects on human settlements due to flooding, coastal erosion and sea level rise

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Biodiversity and ecosystem services

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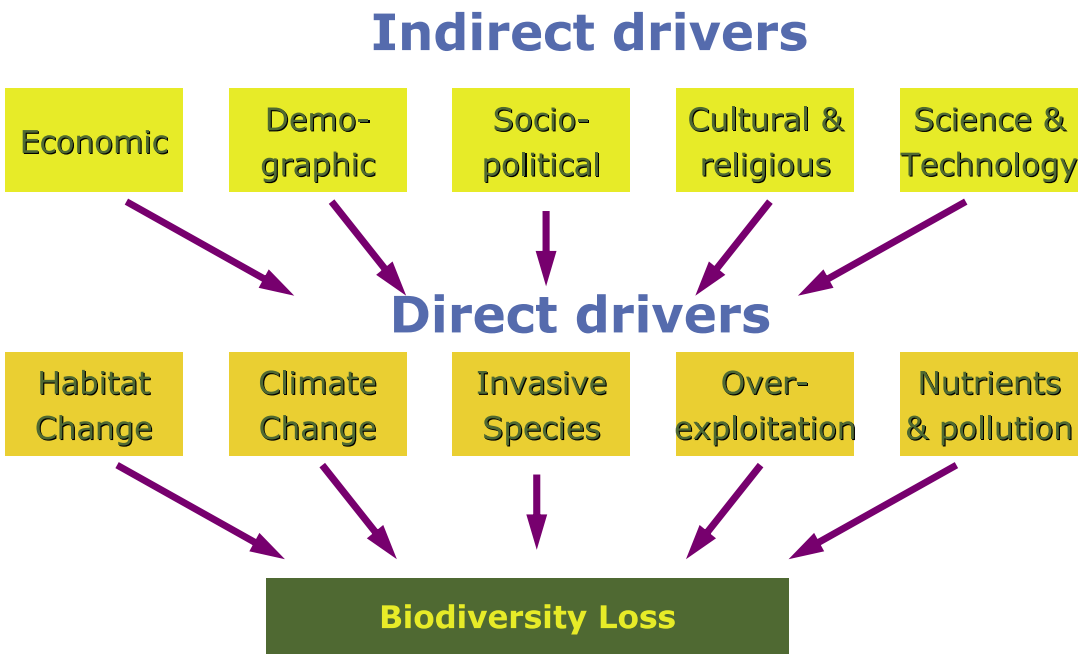
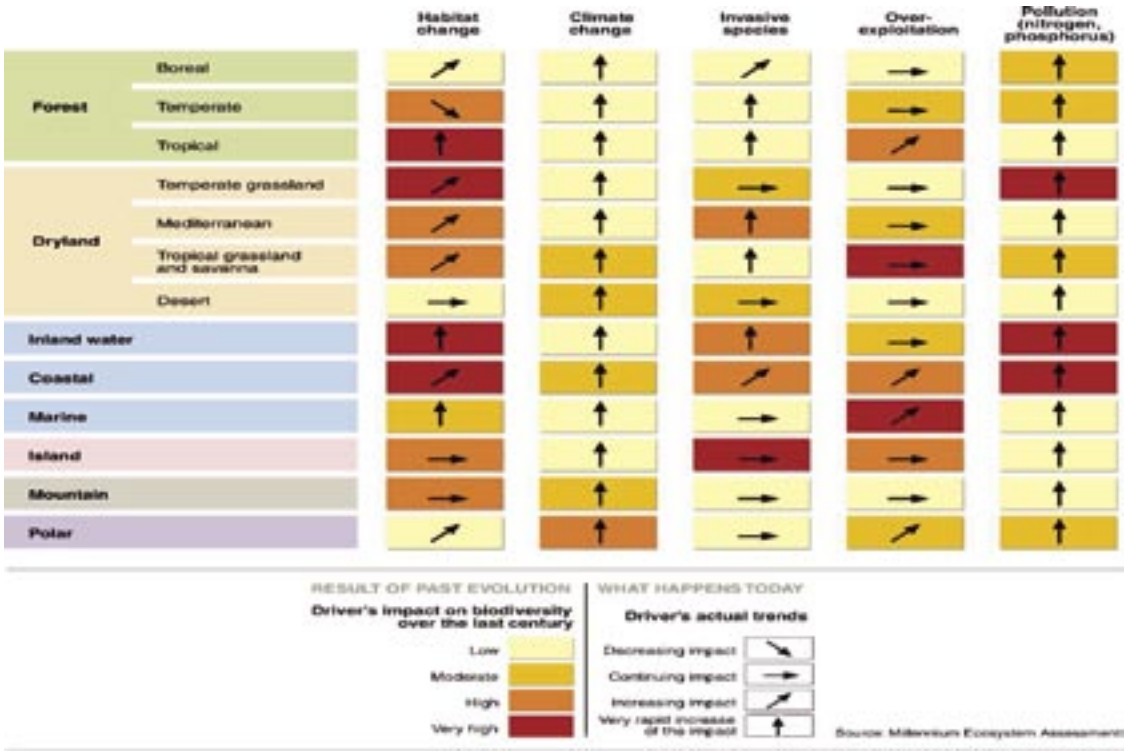
Drivers of Biodiversity Loss



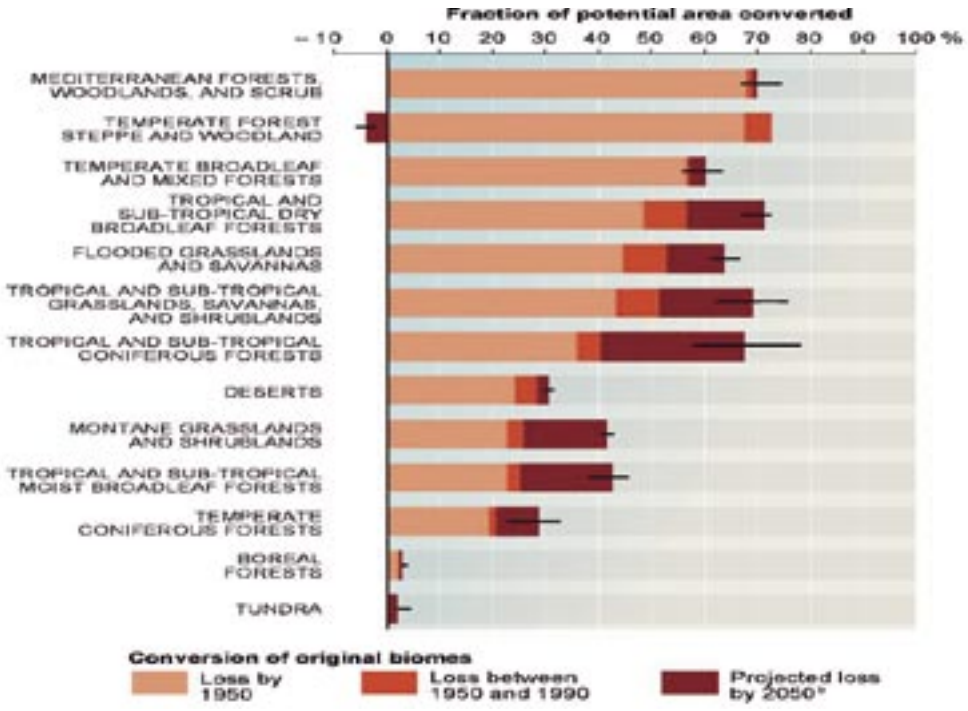
slide 18

Drivers of biodiversity loss growing



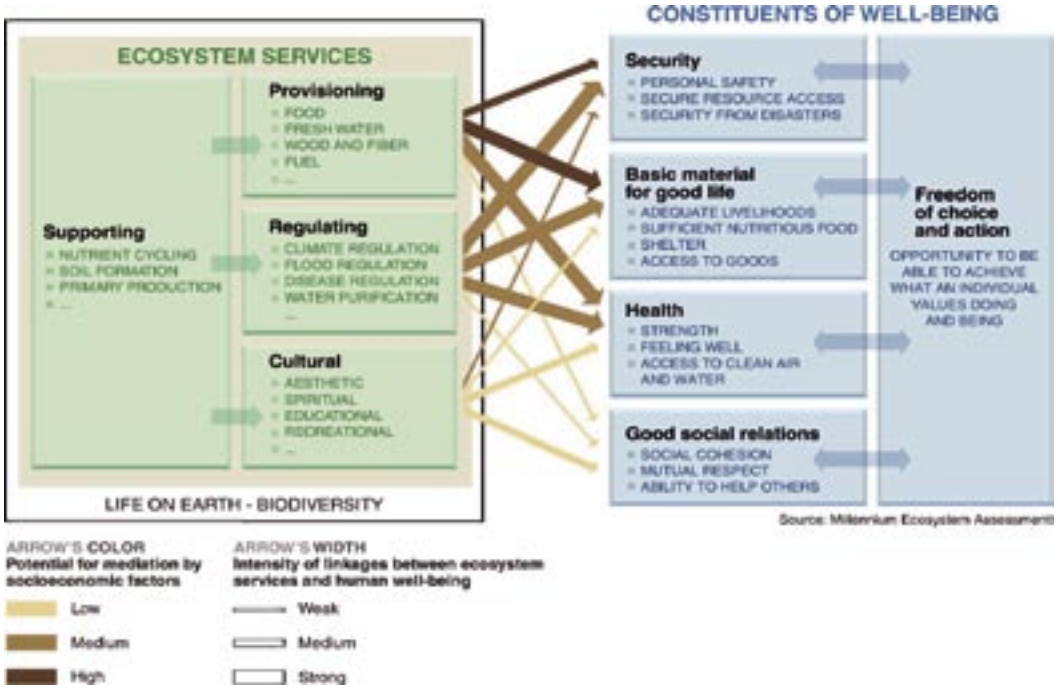
slide 19

Unprecedented change: Ecosystems



slide 20

Consequences of Ecosystem Change for Human Well-being



slide 21

Changes in climate exert an additional pressure and have already affected biodiversity

- the timing of reproduction or migration events
- the length of the growing season
- species distributions and population sizes
- the frequency of pest and disease outbreaks
- increased incidence of coral bleaching and mortality - increases in temperature, sea level and acidification

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Climate change is projected to affect all aspects of biodiversity, i.e., individuals, populations, species distributions and ecosystem composition and function

- *directly, for example through increases in temperature, changes in precipitation (and in the case of marine systems changes in sea level etc)*
- *indirectly, for example through climate changing the intensity and frequency of disturbances such as wildfires)*

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The risk of extinction will increase for many species, especially those that are already at risk due to factors such as low population numbers, restricted or patchy habitats, and limited climatic ranges.

Ecosystems that may be most threatened by climate change include coral reefs, mangroves and other coastal wetlands, remnant ecosystems, some ecosystems with restricted distribution and high latitude/high altitude ecosystems

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Climate change impacts on biodiversity and ecosystems are unavoidable

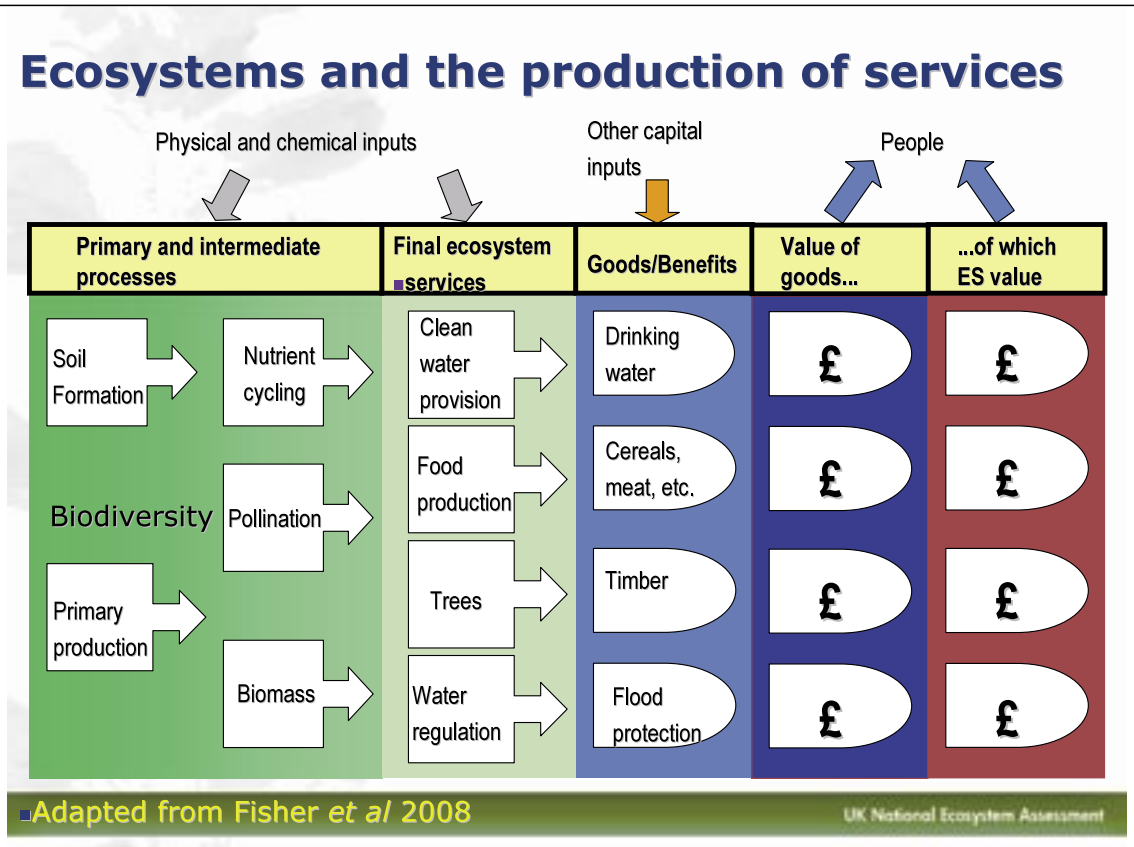
- an increasing number of ecosystems, including areas of high biodiversity, are likely to be further disrupted by a temperature rise of 2° C or more above pre-industrial levels.

- 10 per cent of species will face an increasingly high risk of extinction for every 1° C rise in global mean surface temperature (up to an increase of about 5° C).

- Wetlands, mangroves, coral reefs, Arctic ecosystems and cloud forests are particularly vulnerable to climate change.

- Without strong mitigation action, some cloud forests and coral reefs would may cease to function within a few decades.

slide 25



slide 26

Change the economic background to decision-making to implement ecosystem-based activities

- Make sure the value of all ecosystem services, not just those bought and sold in the market, are taken into account when making decisions
- Remove subsidies to agriculture, fisheries, and energy
- Payments to landowners in return for managing their lands in ways that protect and enhance ecosystem services
- Appropriate pricing policies for natural resources, e.g., water
- Apply fees, taxes, levees and tariffs to discourage activities that degrade biodiversity and ecosystem services
- Establish market mechanisms to reduce nutrient releases and carbon emissions in the most cost-effective way

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Non-financial incentives to implement ecosystem-based activities

- Laws and regulations
- Promote individual and community property or land rights
- Improve access rights and restrictions
- New governance structures to improve policy, planning, and management
  - Integrate decision-making between different departments and sectors, as well as international institutions
  - Include sound management of ecosystem services in all planning decisions
- Develop and use environment-friendly technologies
- Influence individual behavior

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Food Security

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Food Production

- Uneven benefits:
  - One billion people still hungry
  - Hunger has increased in several parts of the world – SSA
  - Institutional and policy environments
- Significant environmental degradation
  - GHG emissions
  - loss of biodiversity
  - land and water degradation

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Food Security

Drivers of the recent increase in food prices

- Poor harvests due to variable weather - possibly related to human-induced climate change
- Increased use of biofuels
- Increased demand , especially for meat
- High energy prices, hence higher fertilizer prices
- Speculation on the commodity markets
- Export bans from some large exporting countries

The future Challenge

- The demand for food will double within the next 25-50 years, primarily in developing countries, **and** the type and nutritional quality of food demanded will change
- We need sustained growth in the agricultural sector to feed the world, enhance rural livelihoods and stimulate economic growth, while meeting food safety standards

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Global Context for Food Security

- **Less labor – disease, rural to urban migration**
- **Less water – competition from other sectors**
- **Less arable land – competition from energy crops**
- **High energy prices**
- **Distorted trade policies – OECD subsidies**
- **Land policy conflicts**
- **Loss of biodiversity: genetic, species and ecosystem**
- **Increasing levels of air and water pollution**
- **A changing climate**

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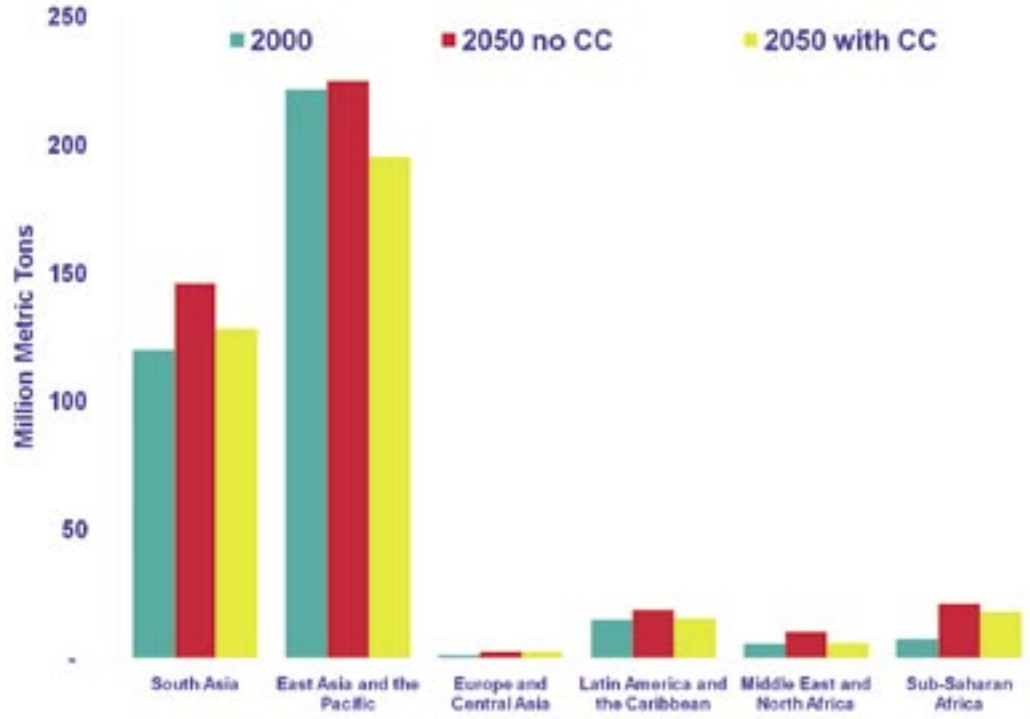
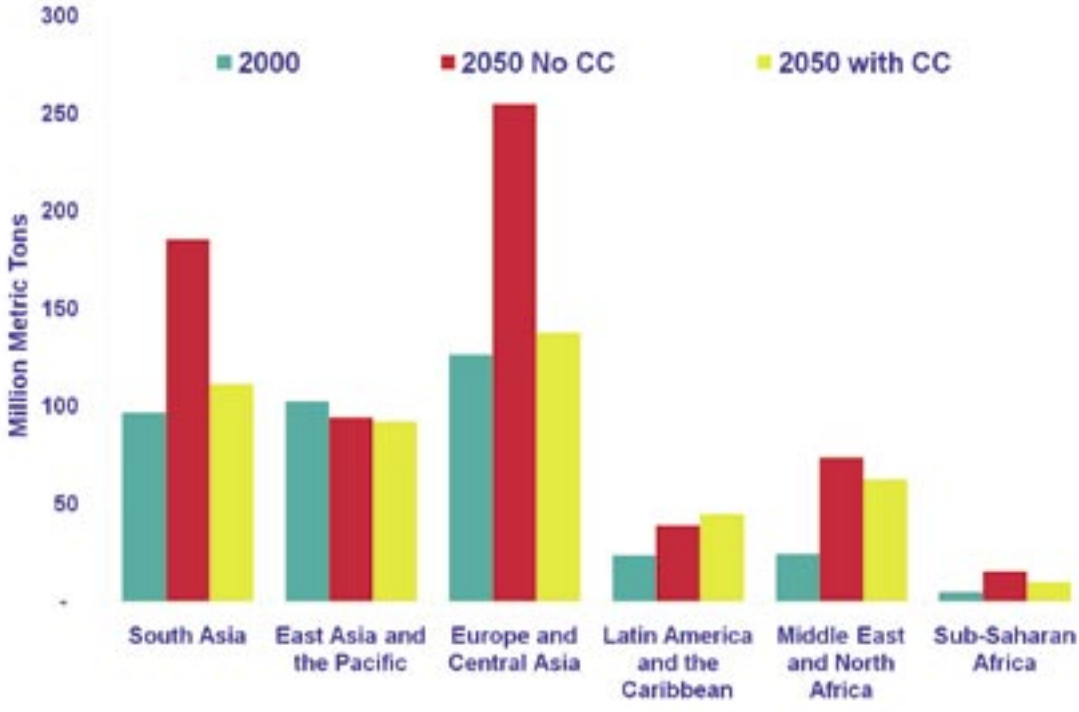
Impact on Rice Production



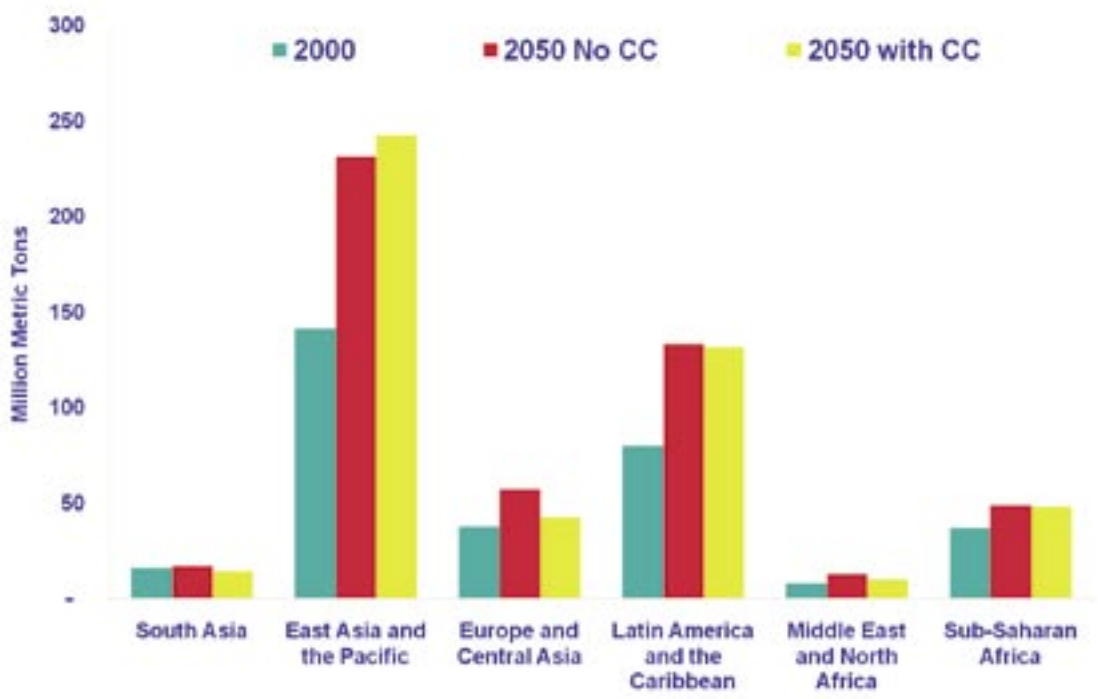
slide 33

Impact on Wheat Production



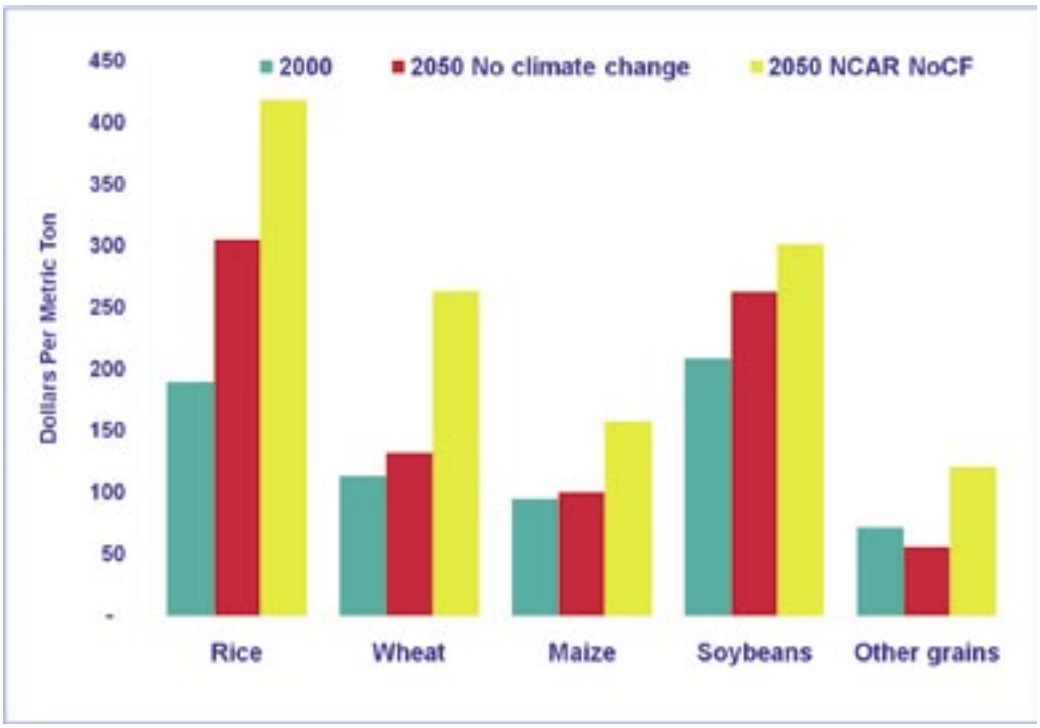
slide 34

Impact on Maize Production



slide 35

Impact on International Food Prices



slide 36

Agricultural S&T Challenges

- to produce, by region, the diversified array of crops, livestock, fish, forests, biomass (for energy) and commodities needed over the next 50 years in an environmentally and socially sustainable manner:
  - address water deficit problems, e.g., through improved drought tolerant crops, irrigation technologies, etc
  - improve the temperature tolerance of crops
  - combat new or emerging agricultural pests or diseases
  - address soil fertility, salinzation of soils and improve nutrient cycling
  - reduce external and energy-intensive inputs
  - reduce GHG emissions while maintaining productivity
  - improve the nutritional quality of food
  - reduce post harvest losses
  - improve food safety

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Food Security: Options for Action

- **Most of today's hunger problems can be addressed with appropriate use of current technologies, emphasizing agro-ecological practices (e.g., no/low till, IPM and INRM), coupled with decreased post-harvest losses**

- **Advanced biotechnologies may be needed to address future demands for increased productivity and emerging issues such as climate change and new plant and animal pests – but the risks and benefits must be fully understood**

- **Place the farmer in the middle – understand their needs and integrate as appropriate their local and traditional knowledge with formal AKSTD – innovation involving all relevant stakeholders along the complete food chain**

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Food Security: Options for Action

- **Recognize the critical role of women and empower them (e.g., education, property rights, access to financing)**
- **Reform international trade, e.g., eliminate OECD production subsidies, eliminate tariff escalation on processed products, recognize the special needs of the least developed countries through non-reciprocal market access**
- **Provide payments to the farmer for maintaining and enhancing ecosystem services**
- **Increase public and private sector investment in research and development, extension services, and weather and market information**

We can feed the world with affordable food, while providing a viable income for the farmer, but business-as-usual will not work

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Water Security

slide 40

The Global Water Crisis

- Water scarcity is growing - by 2025 more than half of the world's population is projected to live under conditions of severe water stress
- Water quality is declining in many parts of the world
- 70% of all freshwater is used for irrigation - 15 - 35% of irrigation withdrawals exceed supply rates and are therefore unsustainable
- 50-60% of wetlands have been lost
- Water has the lowest rate of cost recovery among all infrastructure sectors (about 20%)
- Human-induced climate change is projected to decrease water quality and availability in many arid- and semi-arid regions, and increase the threats posed by floods and droughts in most parts of the world

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Options for Action

- **Implementation of the Dublin Principles**
  - **Ecological Principle: River basin management (often transnational); multi-sectoral management, (agriculture, industry, households); land and water must be managed together**
  - **Institutional Principle: All stakeholders, state, private sector and civil society, especially women, must be involved in the management – principle of subsidiarity – action at the lowest level**
  - **Instrument Principle: Incentives and economic principles to improve allocation and enhance quality - pricing policies**

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Human security

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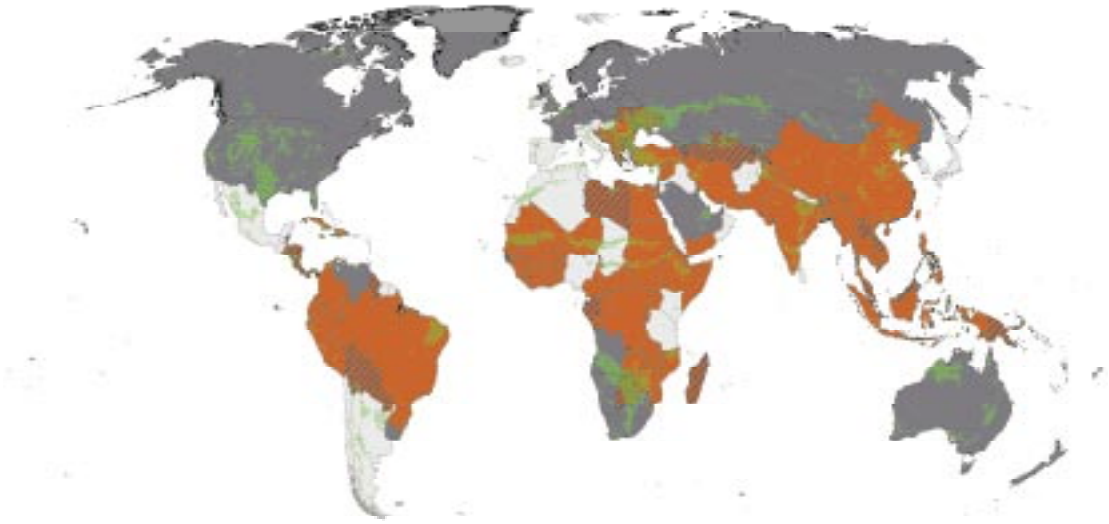
Emissions and Vulnerability to Climate Change



Highest vulnerability towards climate change vs. largest CO_2 emissions (from fossil fuel combustion and cement production, and including land use change, kg C per person and year from 1950 - 2003)

- Largest per capita CO_2 emitters
- Highest social and / or agro-economic vulnerability
- Largest per capita CO_2 emitters, and highest social and / or agro-economic vulnerability
- Areas with highest ecological vulnerability

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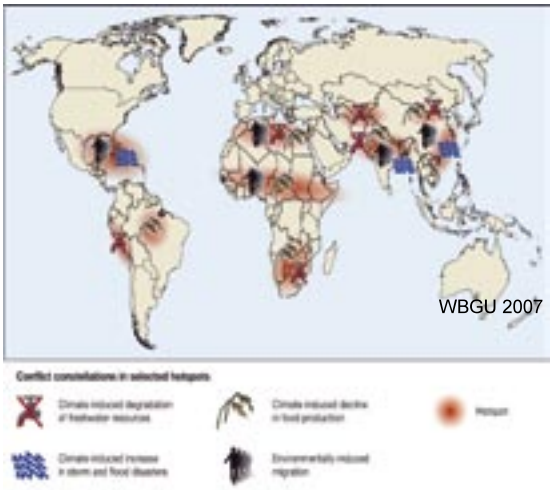
Climate Change and Conflict



- Tens of millions of people displaced
  - Low lying deltaic areas
  - Small Island States
- Food shortages where with hunger and famine today
- Water shortages in areas already with water shortages
- Natural resources depleted with loss of ecological goods and services
- Increased incidence of disease
- Increased incidence of severe weather events

Climate Change, coupled with other stresses can lead to local and regional conflict and migration depending on the social, economic and political circumstances

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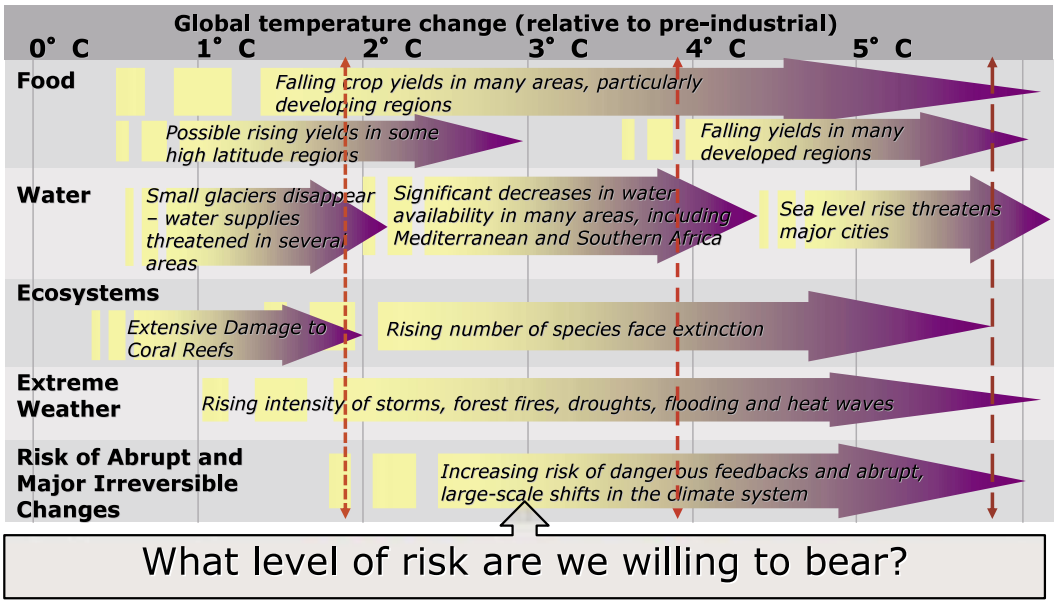
Mitigation of, and adaptation to, climate change

slide 46

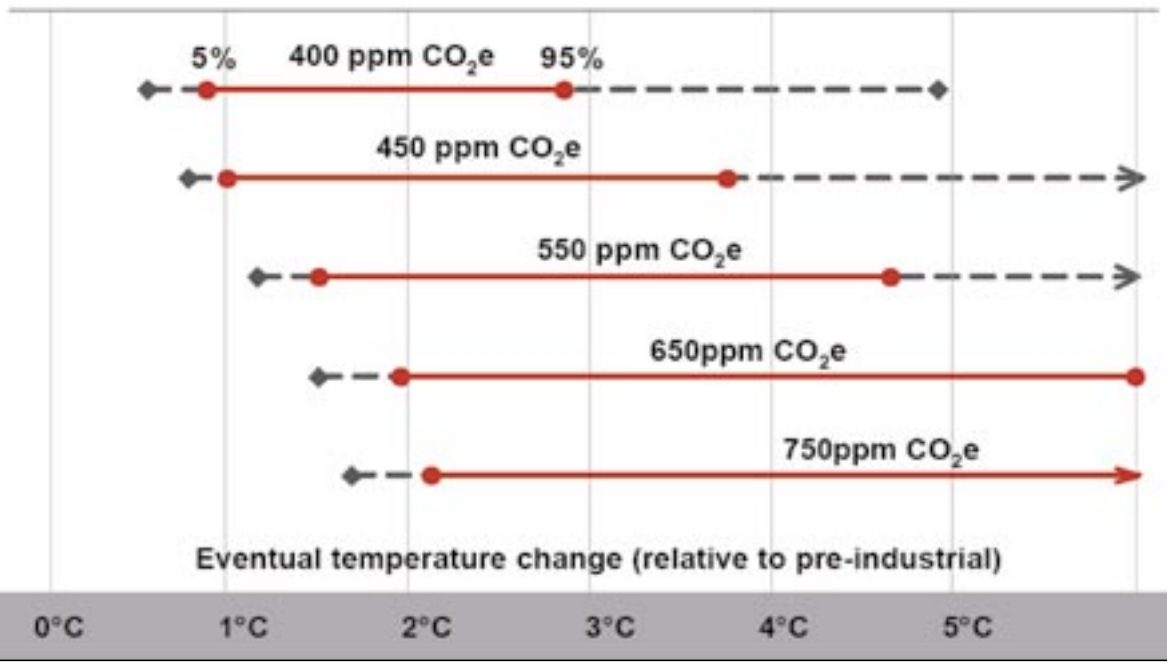
Dealing with impacts is about managing risk - economic, environmental and social economy



- **Stern Review (2006)**

slide 47

Emissions Paths to Stabilization



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Mitigation Strategy

- Putting a price on carbon through
  - emissions trading
  - taxation
  - regulation - national, regional and global
- Technology transformation
  - Carbon capture and storage
  - Future generation biofuels
- Mobilising behaviour change
  - Citizens
  - Business
  - Public sector

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Potential technological options

- **Efficient production and use of energy:** coal plants (e.g., re-powering old inefficient plants and developing IGCC); vehicles (e.g., fuel cell cars) and reduced use of vehicles (e.g., mass transit and urban planning), buildings, and industries
- **Fuel shift:** coal to gas
- **Renewable Energy and Fuels:** Wind power; solar PV and solar thermal; small and large-scale hydropower; bio-energy
- **CO_2 Capture and Storage:** Capture CO_2 in the production of electricity followed by geological storage (e.g., IGCC – CCS)
- **Nuclear fission:** Nuclear power
- **Forests and Agricultural Soils:** Reduced deforestation; reforestation; afforestation; and conservation tillage

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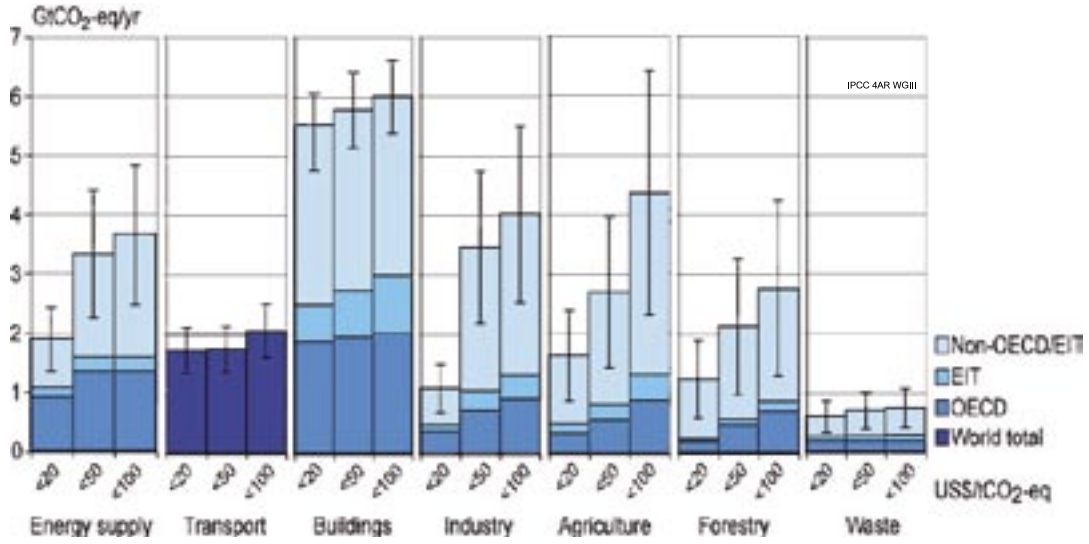
Mitigation Potential Exists For All Sectors & Regions

At least a 50% reduction global greenhouse gas emissions by 2050 is needed for a chance of meeting the EU 2°C target



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Policy Instruments

- Policies, which may need regional or international agreement, include:
  - Energy pricing strategies and taxes
  - Removing subsidies that increase GHG emissions
  - Internalizing the social costs of environmental degradation
  - Tradable emissions permits--domestic and global
  - Voluntary programs
  - Regulatory programs including energy-efficiency standards
  - Incentives for use of new technologies during market build-up
  - Education and training such as product advisories and labels
- Accelerated development of technologies requires intensified R&D by governments and the private sector

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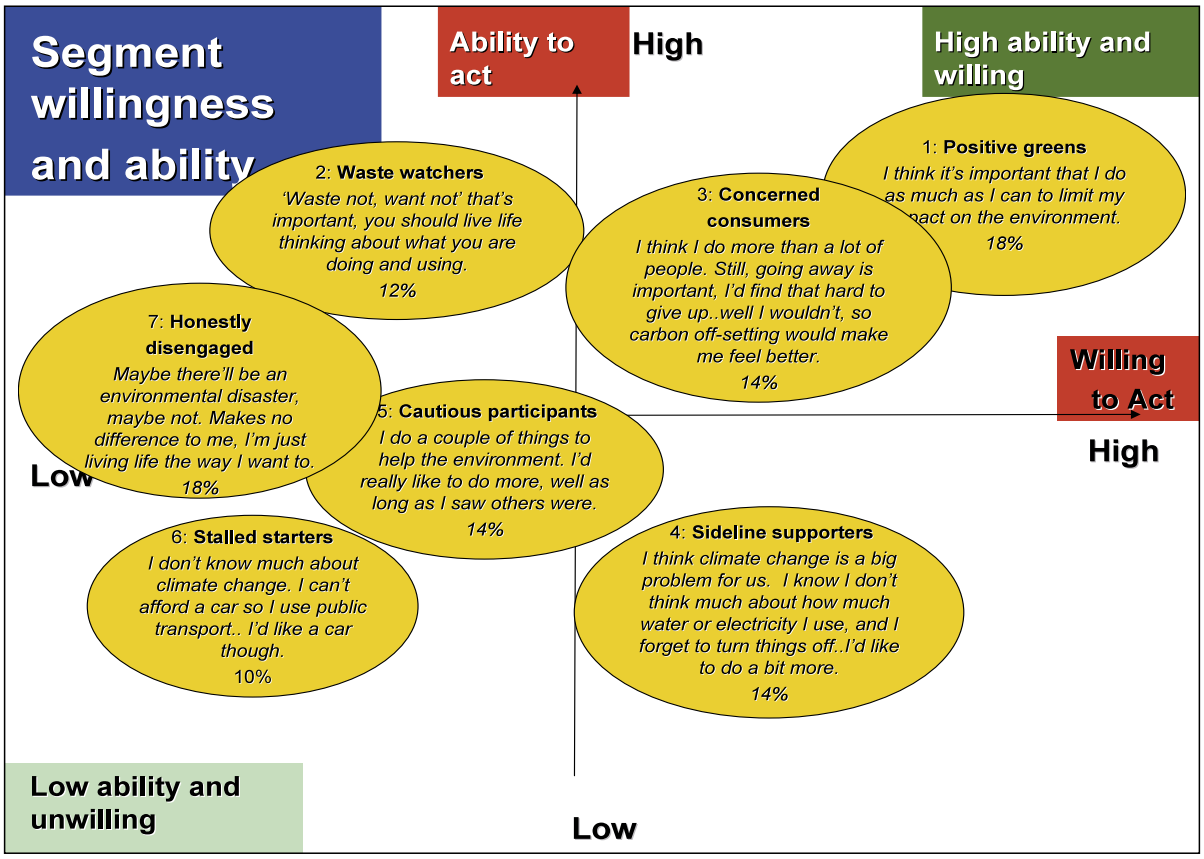

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Summary of the Major Mitigation Challenges

- International policy
  - A long-term (2030 – 2050) global regulatory framework, involving all major emitters, with an equitable allocation of responsibilities – with intermediate targets
  - Kyoto plus 5 years will not provide the right signals to the private sector or national governments
  - Expand range of eligible CDM activities, including avoided deforestation, green investment schemes, energy efficiency standards, and exploring sectoral and programmatic approach
  - Key challenges include engaging USA, China and India

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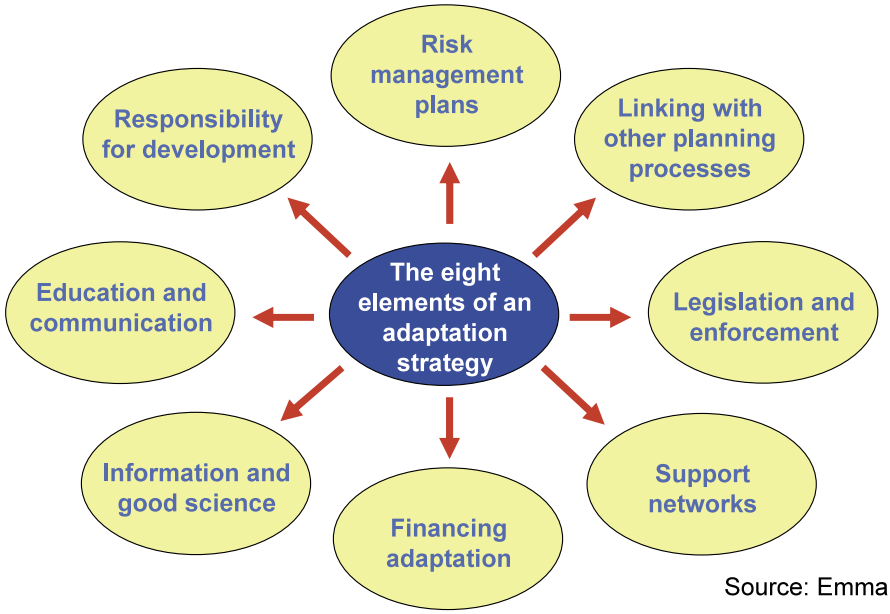
Elements of an adaptation strategy



Source: Emma Tompkins

- Delivery of adaptive responses depends on **governance** mechanisms
- Adaptive capacity and society's self-organisation is determined by **governance**
- Distribution of costs and benefits in society is determined by **governance**

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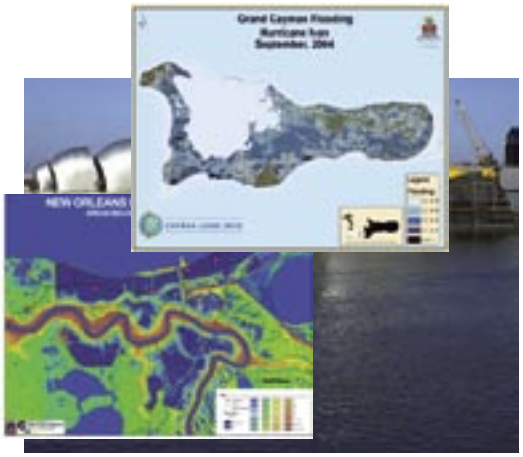
Are there limits to how much we can adapt? ...physical, behavioural and technological limits



- **Physical limits: there are physical limits to potential adaptation on small low lying islands e.g. Cayman Islands**

- **Behavioural limits: there are behavioural constraints that influence where we live and why, e.g. New Orleans**

- **Technological limits: there are technological limits to the flood defences that can be constructed, e.g. Thames Barrier, London**

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Elements of a Post-2012 framework

1. Long-term goal	(2C) 50% cut by 2050 on 1990 level
2. Developed country targets	30% cut by 2020 and 60-80 by 2050 for developed countries
3. Developing countries	Graduated approach to commitments
4. Carbon market	Broader, deeper, longer carbon market
5. Technology	Technology Protocols, IFI financing, R&D, energy fficiency
6. Adaptation	Adaptation integrated into development and finance strategies
7. LULUCF inc Deforestation	LULUCF integrated in post-2012 framework. Incentives to tackle deforestation
8. Aviation & maritime	Global sectoral approach

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In Conclusion

- There is no dichotomy between environmental protection and economic growth
- Get the economics right – eliminate perverse subsidies – value ecosystem services – internalize externalities – recognize the wealth of a nation is dependent on built, human, natural and social capital
- There are cost-effective and equitable solutions to address issues such as climate change and biodiversity loss, but political will and moral leadership is needed, and the changes in policies, practices and technologies required are substantial and not currently underway
- Public and private sector decision-makers need to take a longer-term perspective
- Advances in science and technology are required – investments are needed now to address these issues cost-effectively

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