Appendix F

Thematic Paper 1

Dr. Pak Sum Low
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Bangkok, Thailand

Dr. Pak Sum Low is a Consultant to the Energy and Resources Section of the Environment and Sustainable Development Division at the United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP) based in Bangkok, Thailand.

He was Regional Adviser on Environment and Sustainable Development of UNESCAP and has previously worked in the United Nations Environment Programme (UNEP) on issues related to ozone layer depletion, climate change and the Global Environment Facility (GEF). He was also a Consultant for the Secretariats of the UN Convention on Climate Change and the UN Convention to Combat Desertification.

First trained as a chemical engineer at the University of Canterbury in New Zealand, Dr. Low later specialized in environmental studies, focusing on atmospheric research, and completed a Masters at the University of Adelaide and a PhD at the University of Tasmania, both in Australia.

He has given extensive presentations on issues relating to environment and sustainable development, including climate change, environmental sustainability, eco-efficiency, eco-effectiveness, MDGs, and Agenda 21, among others. In 2007, Dr. Low has provided training on climate change negotiations for the Governments of Kiribati, Indonesia, and Lao PDR.

Dr. Low has edited a book titled "Climate Change and Africa," published by the Cambridge University Press in UK. He is currently editing a book titled "Global Change and Sustainable Development: Asia-Pacific Perspectives," which has been accepted by the Cambridge University Press for publication.

Biodiversity: Impacts, Vulnerability, and Adaptation to Climate Change

Pak Sum LOW

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Environment and Sustainable Development Division

UNESCAP

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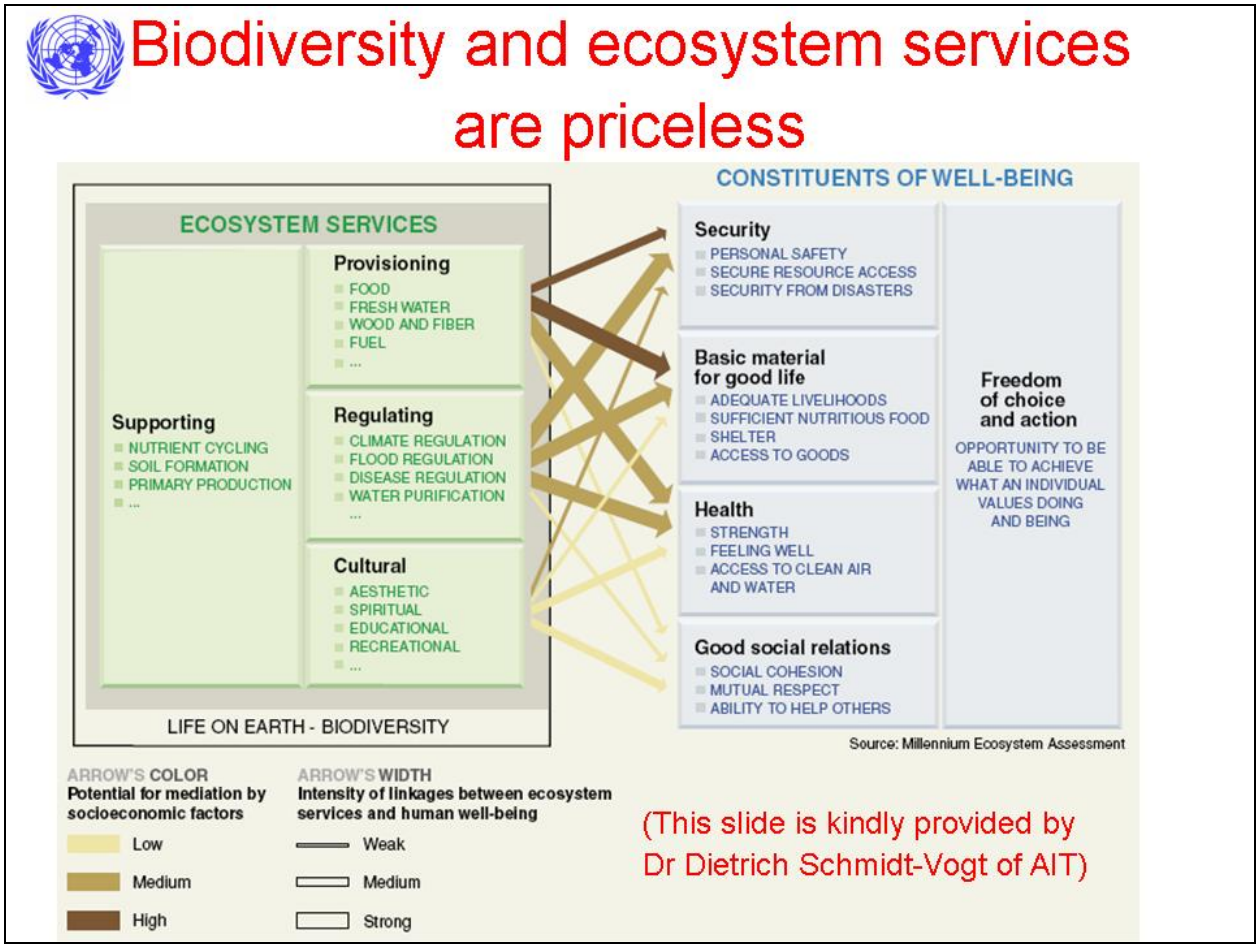
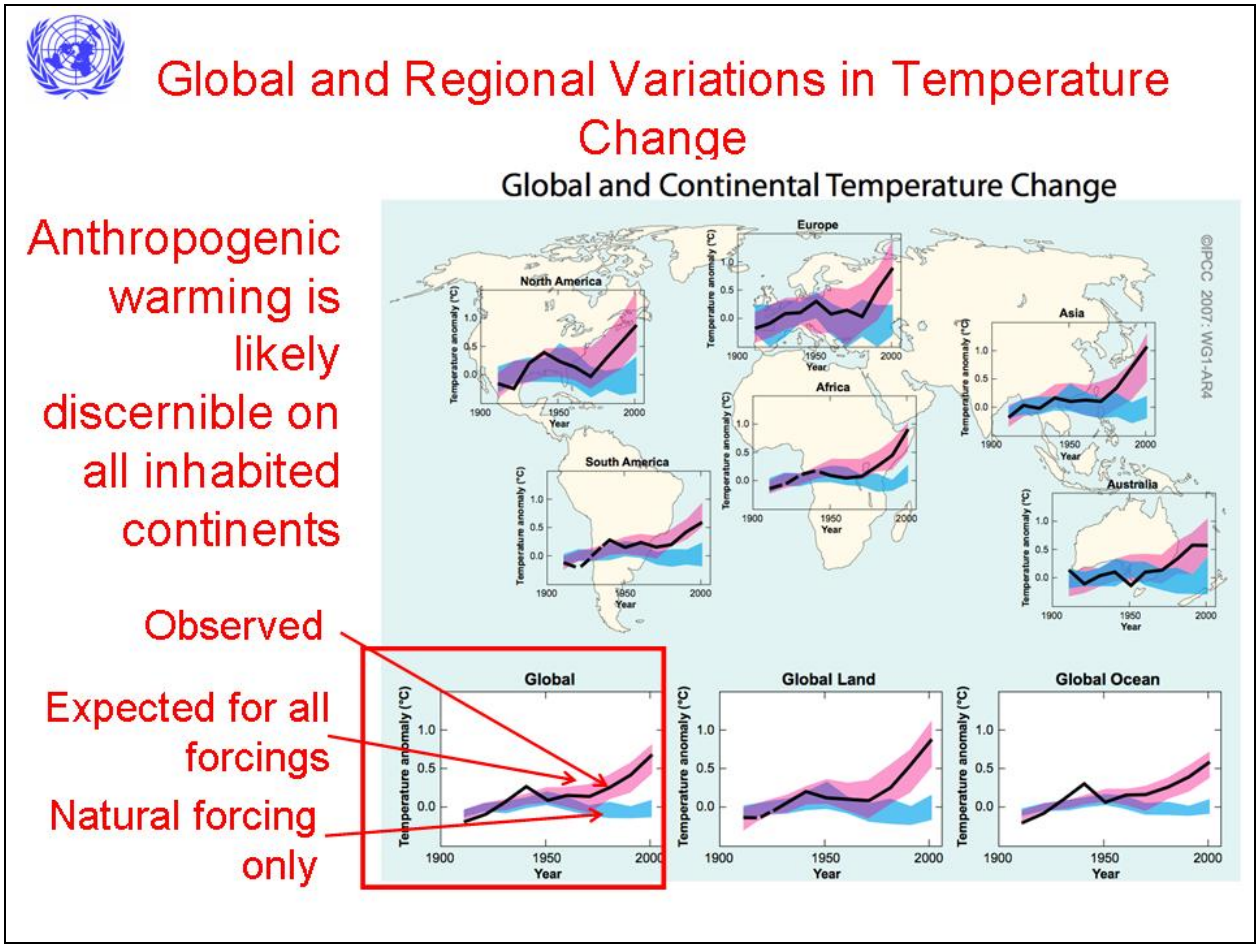
A Presentation at the

International Conference on Biodiversity and Climate Change in Southeast Asia: Adaptation and Mitigation

19 – 20 February 2008

Manila, The Philippines


Biodiversity and ecosystem services are priceless
ECOSYSTEM SERVICES
Provisioning
FOOD
FRESH WATER
WOOD AND FIBER
FUEL
...
Regulating
CLIMATE REGULATION
FLOOD REGULATION
DISEASE REGULATION
WATER PURIFICATION
...
Cultural
AESTHETIC
SPIRITUAL
EDUCATIONAL
RECREATIONAL
...
Supporting
NUTRIENT CYCLING
SOIL FORMATION
PRIMARY PRODUCTION
...
LIFE ON EARTH - BIODIVERSITY
CONSTITUENTS OF WELL-BEING
Security
PERSONAL SAFETY
SECURE RESOURCE ACCESS
SECURITY FROM DISASTERS
Basic material for good life
ADEQUATE LIVELIHOODS
SUFFICIENT NUTRITIOUS FOOD
SHELTER
ACCESS TO GOODS
Health
STRENGTH
FEELING WELL
ACCESS TO CLEAN AIR AND WATER
Good social relations
SOCIAL COHESION
MUTUAL RESPECT
ABILITY TO HELP OTHERS
Freedom of choice and action
OPPORTUNITY TO BE ABLE TO ACHIEVE WHAT AN INDIVIDUAL VALUES DOING AND BEING
Source: Millennium Ecosystem Assessment
ARROW'S COLOR
Potential for mediation by socioeconomic factors
Low
Medium
High
ARROW'S WIDTH
Intensity of linkages between ecosystem services and human well-being
Weak
Medium
Strong
(This slide is kindly provided by Dr Dietrich Schmidt-Vogt of AIT)

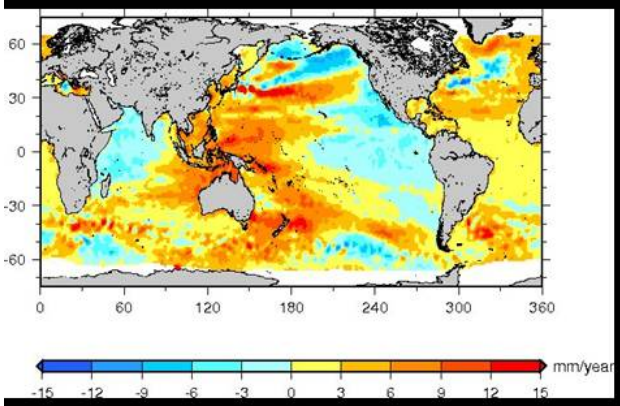

Global and Regional Variations in Temperature Change
Global and Continental Temperature Change
Anthropogenic warming is likely discernible on all inhabited continents
Observed
Expected for all forcings
Natural forcing only
North America
Europe
Asia
Africa
South America
Australia
Global
Global Land
Global Ocean
Temperature anomaly (°C)
Year
©IPCC 2007: WG1-AR4

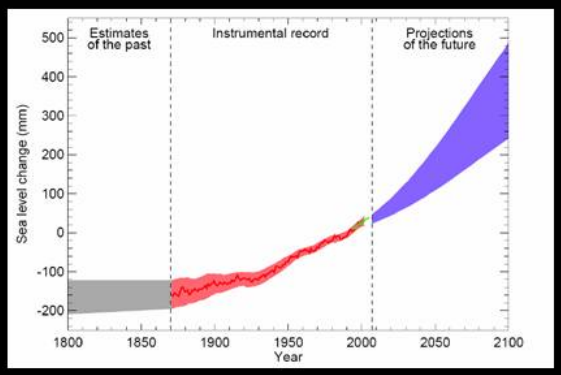
Melting of Glaciers has profound implications for water resources

Freshwater availability in Central, South, East and South-East Asia, particularly in large river basins such as Changjiang, is likely to decrease due to climate change (IPCC, 2007)

- Picture: View of Manshuk Mametova glacier melting down to a lake in northern Tien Shan mountains in Kazakhstan, 24 August 2003. (Alexei Kalmykov/Reuters)

Sea-Level Rise





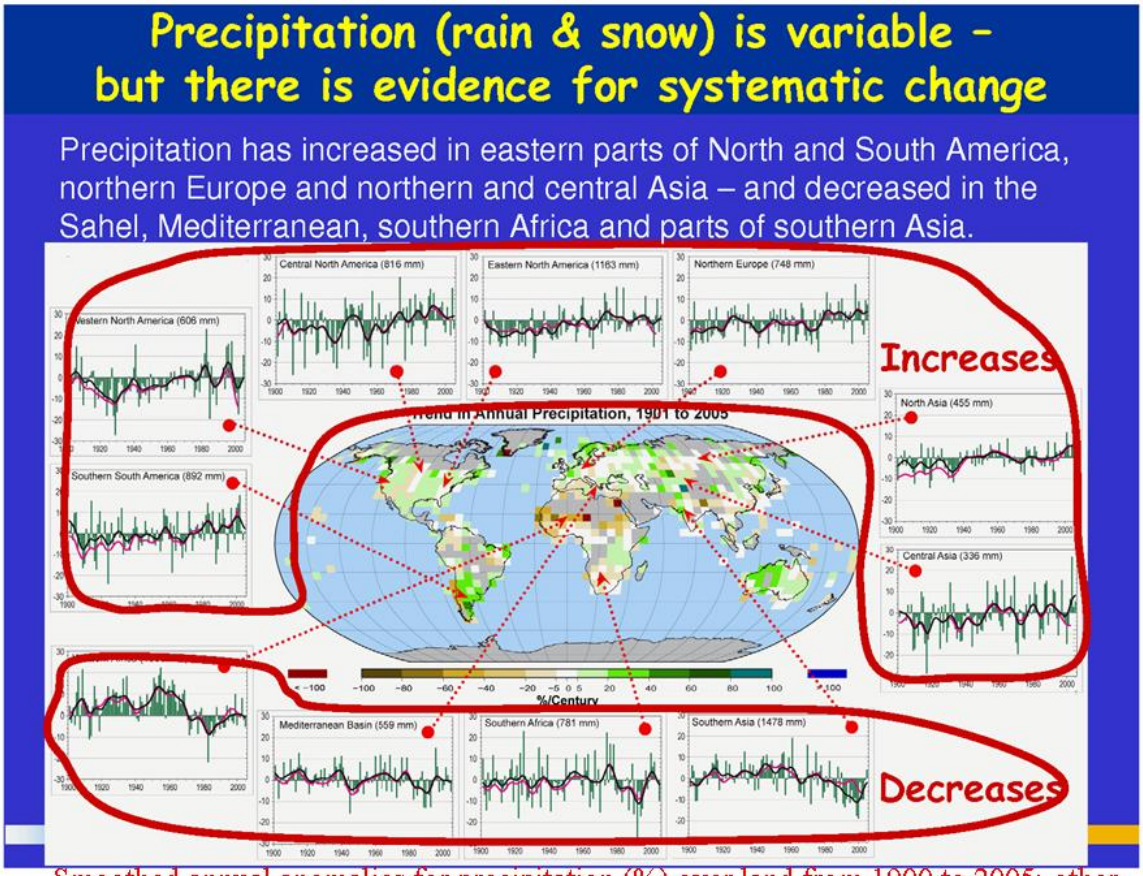
Observations of sea level rise from satellites, 1993-2003.

The global average SLR for the 20th century was about 0.17 m (6 inches), mostly from expansion of the warmer ocean, and with contributions from glacier melt (Alaska, Patagonia, Europe….).

Future changes just from these processes could be up to 0.5 m (1.5 feet) by 2100, and up to 1 m (3 feet) within about 2-3 centuries, depending on how much GHGs are emitted.

But what about other processes? Rapid ice flow?

Nam Dinh, Viet Nam,
14 August 2003



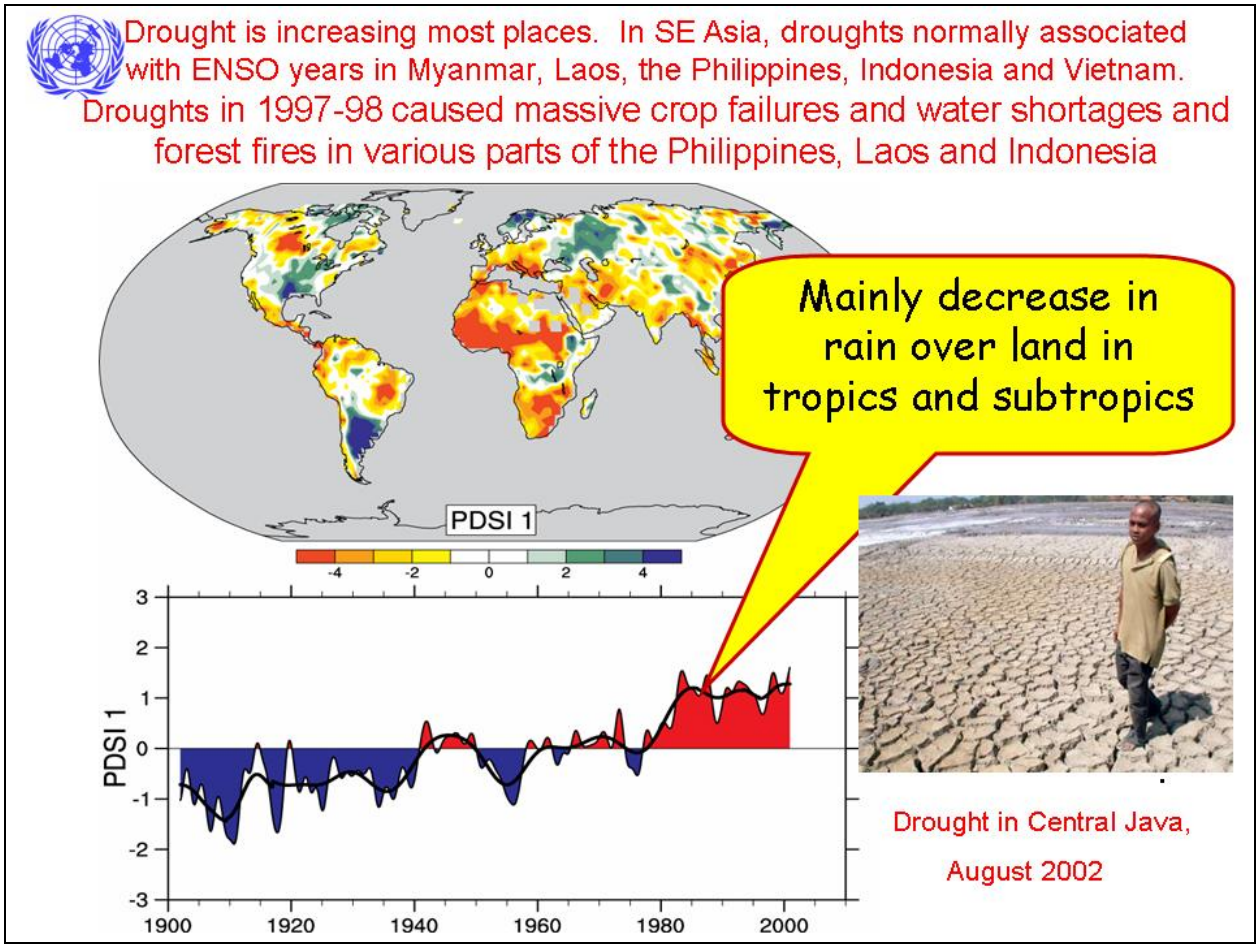
Smoothed annual anomalies for precipitation (%) over land from 1900 to 2005; other regions are dominated by variability.

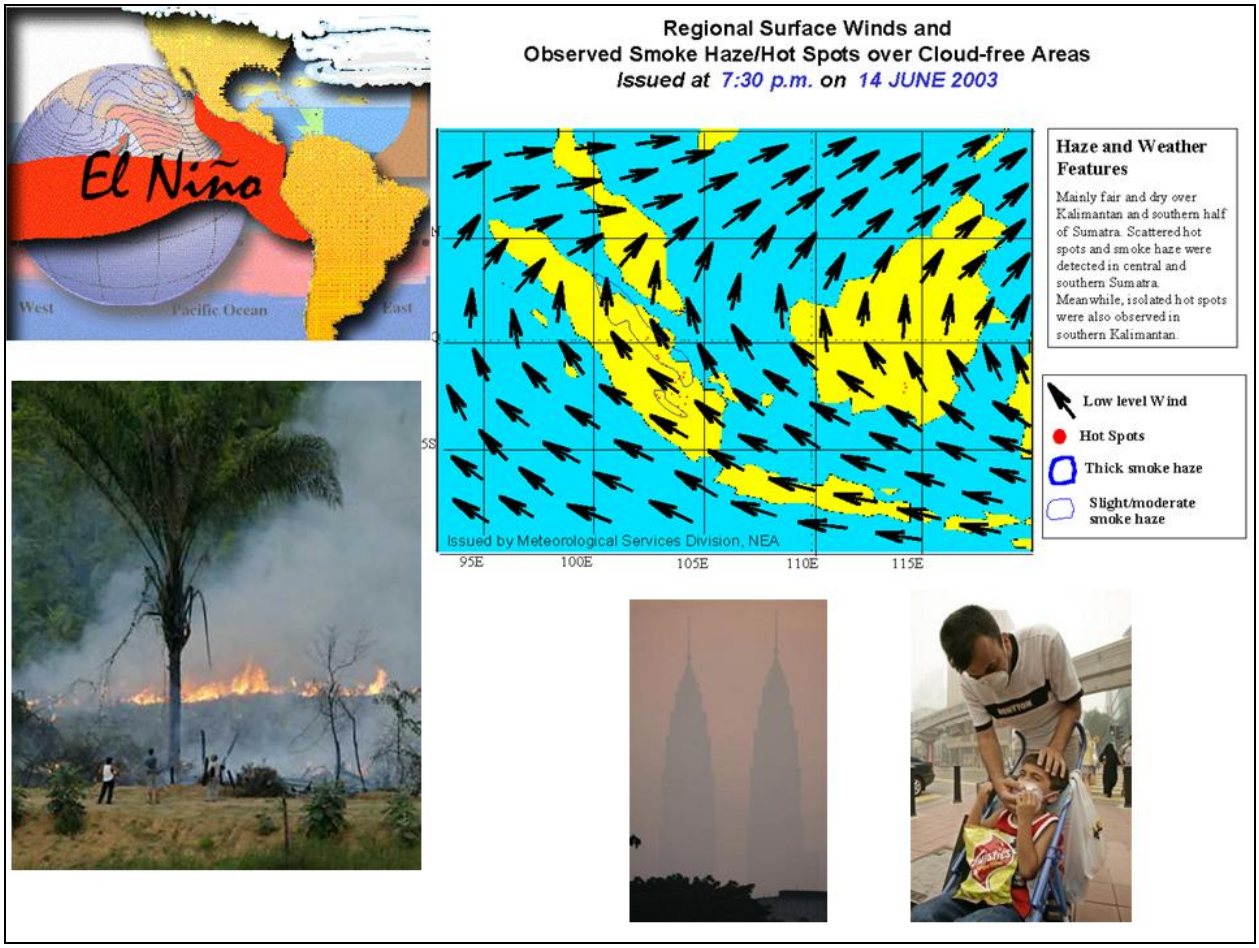
More floods in some places at certain time

Pangasinan province, north of Manila May 29, 2003.

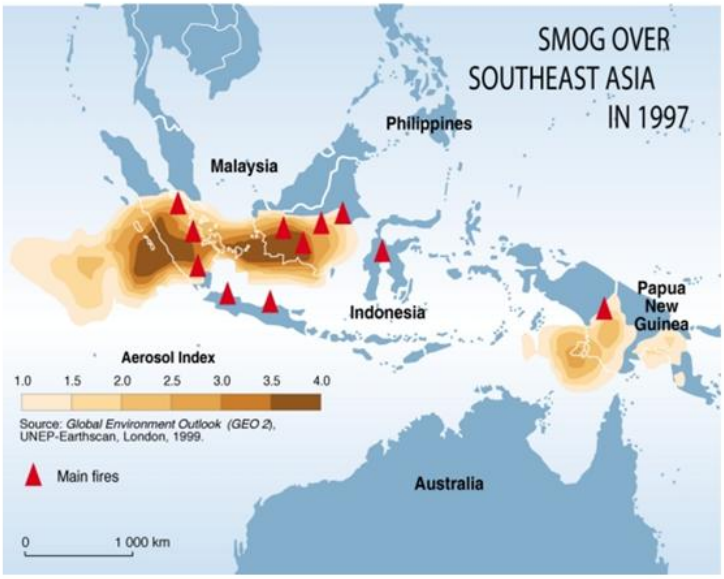
Hanoi June 5, 2003.


Jakarta, Indonesia Flood, 1 Feb. 2008


Drought is increasing most places. In SE Asia, droughts normally associated with ENSO years in Myanmar, Laos, the Philippines, Indonesia and Vietnam. Droughts in 1997-98 caused massive crop failures and water shortages and forest fires in various parts of the Philippines, Laos and Indonesia
Mainly decrease in rain over land in tropics and subtropics
PDSI 1
-4
-2
0
2
4
PDSI 1
3
2
1
0
-1
-2
-3
1900
1920
1940
1960
1980
2000
Drought in Central Java, August 2002


El Niño
West
Pacific Ocean
East
Regional Surface Winds and
Observed Smoke Haze/Hot Spots over Cloud-free Areas
Issued at 7:30 p.m. on 14 JUNE 2003
Haze and Weather Features
Mainly fair and dry over Kalimantan and southern half of Sumatra. Scattered hot spots and smoke haze were detected in central and southern Sumatra. Meanwhile, isolated hot spots were also observed in southern Kalimantan.
Low level Wind
Hot Spots
Thick smoke haze
Slight/moderate smoke haze
Issued by Meteorological Services Division, NEA
95E
100E
105E
110E
115E

Haze caused by the 1997 Indonesian forest fires during drought induced by El Niño

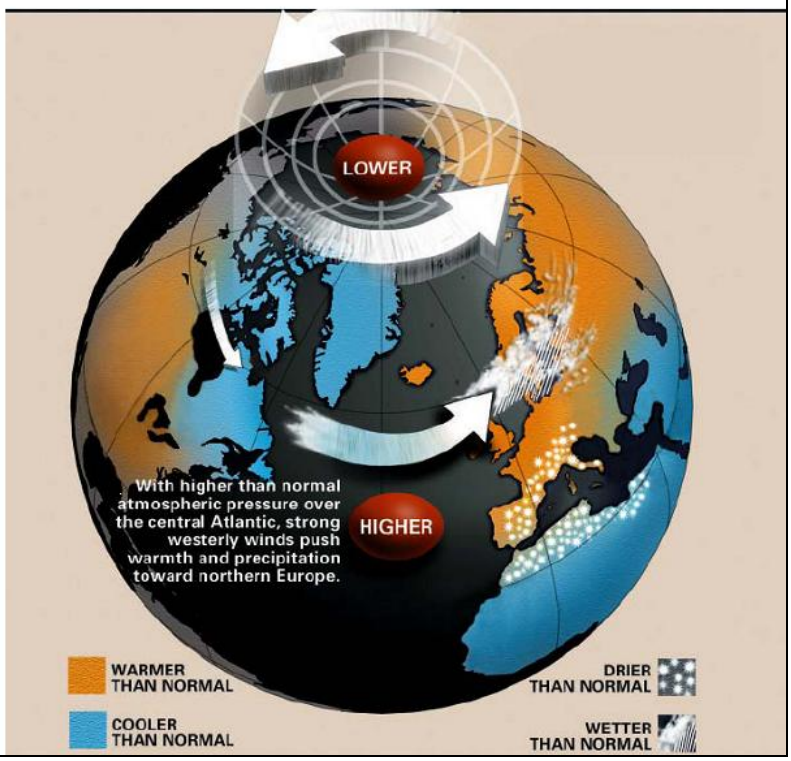


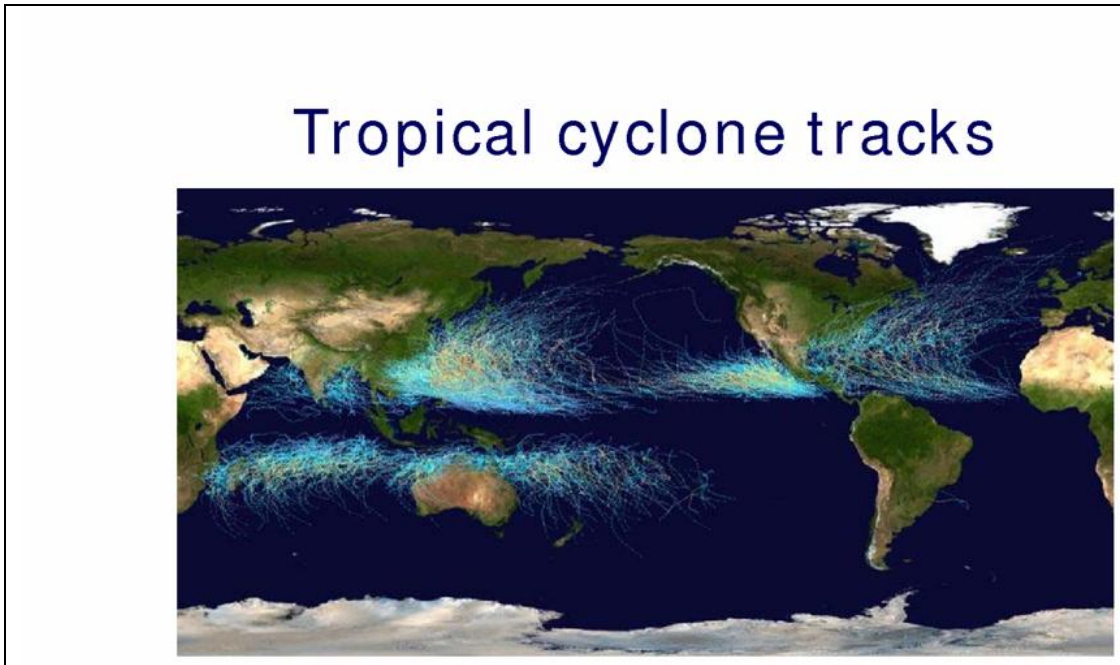
- 10 million ha were destroyed, with economic losses estimated at around US$9.3 billion
- Prolonged haze covered 3,200 km^2 affecting six neighbouring countries and some 70 million people (impact on biodiversity?)
- At least 19 protected areas, many of which are rich in biodiversity, were threatened

•Many avian frugivores, such as the helmeted hornbill *Buceros vigil*, experienced population declines of up to 50%.

Climate change has caused circulation change and increase in extreme events

- Climate change is affecting storm tracks, winds and temperature patterns
- Anthropogenic forcing has likely contributed



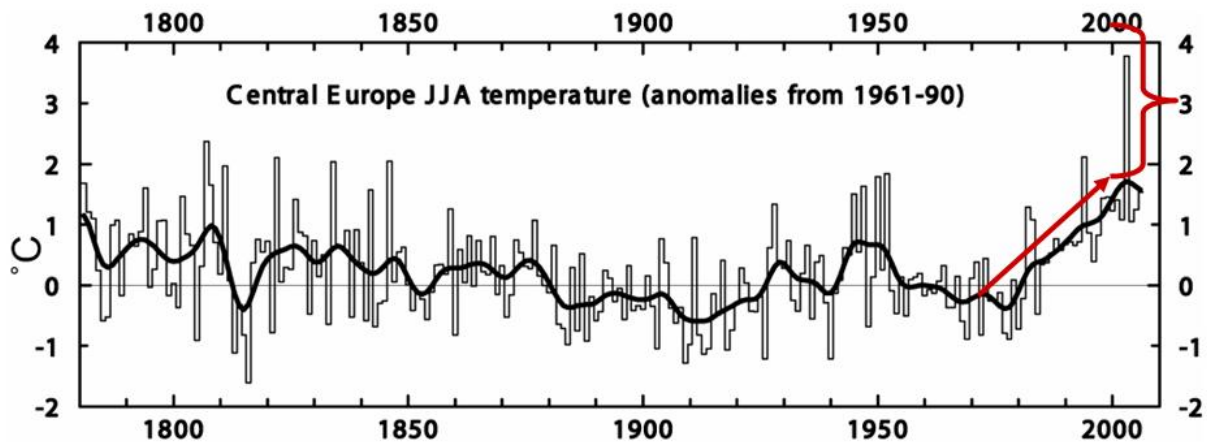

Tropical cyclone tracks
Map of the cumulative tracks of all tropical cyclones during the 1985–2005 time period. The Pacific Ocean west of the International Date Line sees more tropical cyclones than any other basin, while there is almost no activity in the Atlantic Ocean south of the Equator.
WMO
UNEP

Cyclones/typhoons are frequent in SE Asia

- Recent studies indicate that the frequency and intensity of tropical cyclones originating in the Pacific have increased over the last few decades (Fan and Li, 2005).
- On an average, 20 cyclones cross the Philippines Area of Responsibility with about 8 to 9 landfall each year; with an increase of 4.2 in the frequency of cyclones entering PAR during the period 1990 to 2003 (IPCC, 2007)
- Vietnam should be more or less the same as cyclones/typhoons would normally hit the Philippines first before hitting Vietnam – a very good "early warning" system!

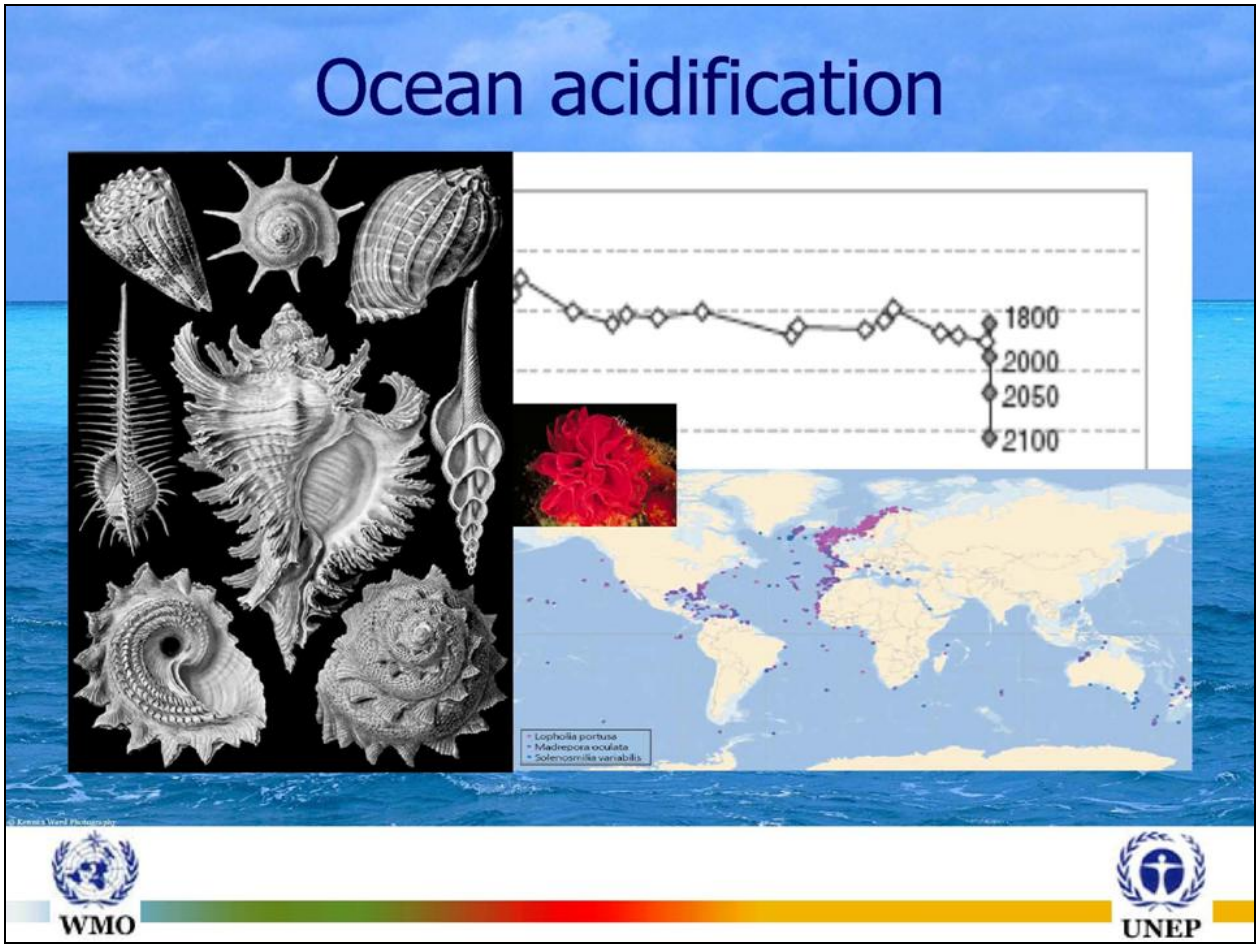

Typhoons frequently hit Vietnam
VIETNAM
Danang
Manila
PHILIPPINES
27 September 2005
2 October 2006
3 November 2005
AFP
AP

Heat waves are increasing: an example



Extreme Heat Wave
Summer 2003
Europe

- Heat waves in SE Asia: Increase in hot days and warm nights and decrease in cold days and nights between 1961 and 1998 (IPCC, 2007);


Ocean acidification
1800
2000
2050
2100
Lophelia pertusa
Madrepora oculata
Solenosmilia variabilis
WMO
UNEP

Biodiversity is more vulnerable than humans

- All the above climate-induced changes and events have caused profound impacts not only on the humankind, but also on the ecosystem services and biodiversity, which could be even more vulnerable because of other human activities (e.g., deforestation)
- Many of the people most vulnerable to climate change and its impacts are also those that are most dependent on biodiversity

Vulnerable ecosystems

- Coral reefs, sea-ice biomes
- Tundra, boreal forests, mountain and Mediterranean regions
- mangroves, salt marshes

WMO UNEP

Table 10.11. *Vulnerability of key sectors to the impacts of climate change by sub-regions in Asia.*

Sub-regions	Food and fibre	Biodiversity	Water resource	Coastal ecosystem	Human health	Settlements	Land degradation
North Asia	+1 / H	-2 / M	+1 / M	-1 / M	-1 / M	-1 / M	-1 / M
Central Asia and West Asia	-2 / H	-1 / M	-2 / VH	-1 / L	-2 / M	-1 / M	-2 / H
Tibetan Plateau	+1 / L	-2 / M	-1 / M	Not applicable	No information	No information	-1 / L
East Asia	-2 / VH	-2 / H	-2 / H	-2 / H	-1 / H	-1 / H	-2 / H
South Asia	-2 / H	-2 / H	-2 / H	-2 / H	-2 / M	-1 / M	-2 / H
South-East Asia	-2 / H	-2 / H	-1 / H	-2 / H	-2 / H	-1 / M	-2 / H

Vulnerability:
-2 – Highly vulnerable
-1 – Moderately vulnerable
0 – Slightly or not vulnerable
+1 – Moderately resilient
+2 – Most resilient

Level of confidence:
VH- Very high
H - High
M - Medium
L - Low
VL - Very low

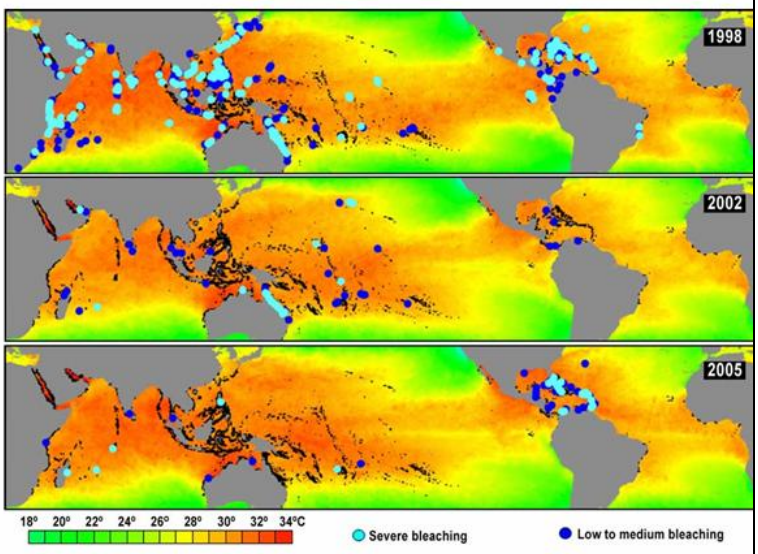
- Up to 50% of the Asia's total biodiversity is at risk due to climate change (IPCC, 2007).
- South-East Asia is *highly vulnerable* to the impacts of climate change

- What are the observed impacts of climate change on biodiversity?

Coral reefs, often called “rainforests of the sea”, are at risk due to warmer ocean temperature (coral bleaching).

About 4,000 species of fish and 800 species of reef-building coral have been identified.

Recent coral bleaching events



Coral reefs are highly sensitive to changes in water temperature - an increase of one to two degrees in the El Nino event of 1998 destroyed 90% of coral in the central Indian Ocean.

WMO

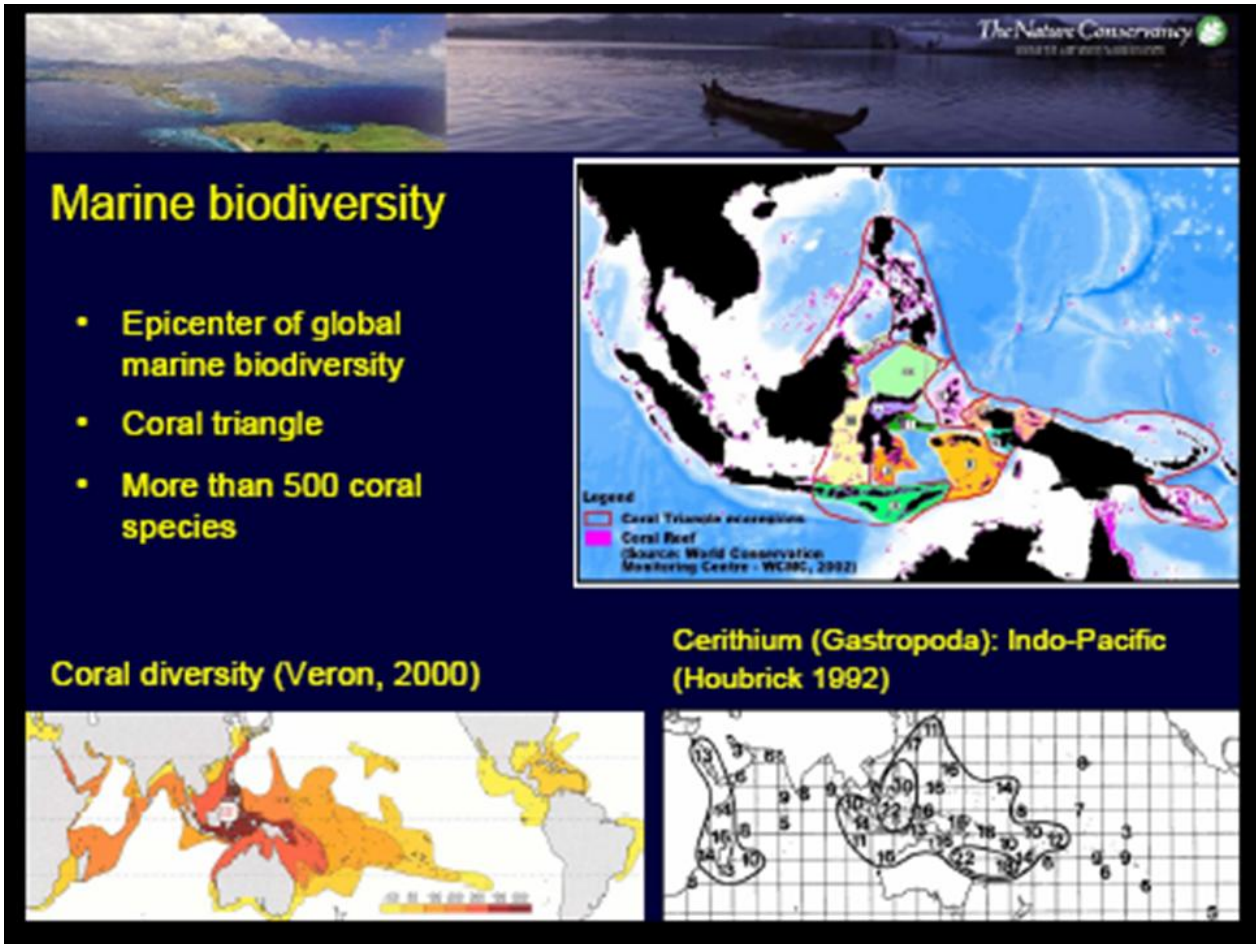
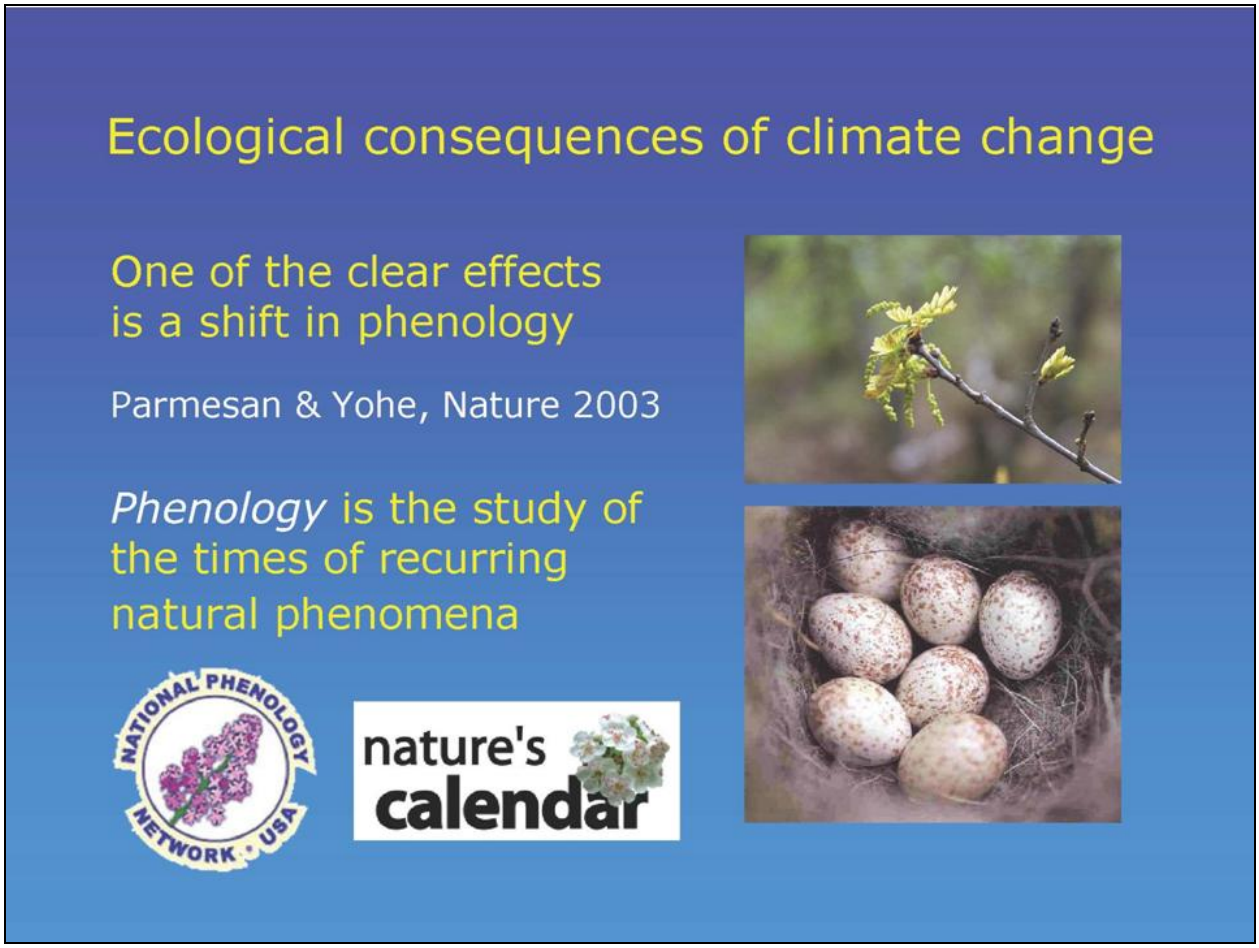

The Nature Conservancy
Marine biodiversity
• Epicenter of global marine biodiversity
• Coral triangle
• More than 500 coral species
Legend
Coral Reef
Coral diversity (Veron, 2000)
Cerithium (Gastropoda): Indo-Pacific
(Houbrick 1992)

Table 10.6. *The 2004 status of coral reefs in selected regions of Asia (Wilkinson, 2004).*

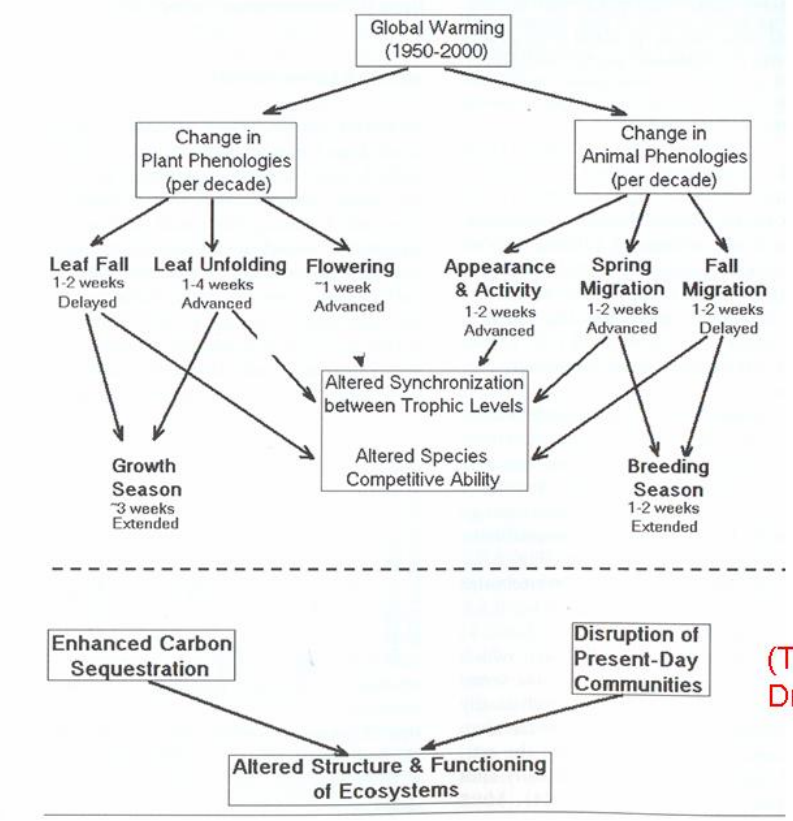
Region	Coral reef area (km²)	Destroyed reefs (%)	Reefs recovered since 1998 (%)	Reefs at critical stage (%)	Reefs at threatened stage (%)	Reefs at low or no threat level (%)
Red Sea	17,640	4	2	2	10	84
The Gulfs	3,800	65	2	15	15	5
South Asia	19,210	45	13	10	25	20
S-E Asia	91,700	38	8	28	29	5
E & N Asia	5,400	14	3	23	12	51
Total Asia	137,750 (48.4%)	34.4	7.6	21.6	25.0	19.0

Note: Destroyed reefs: 90% of the corals lost and unlikely to recover soon; Reefs at a critical stage: 50% to 90% of corals lost or likely to be destroyed in 10 to 20 years; Reefs at threatened stage: 20 to 50% of corals lost or likely to be destroyed in 20 to 40 years.

S-E Asia has 91,700 km^2 of coral reef area, of which only 5% is considered as "*low or no threat level*", the lowest compared to other parts of Asia.


Ecological consequences of climate change
One of the clear effects is a shift in phenology
Parmesan & Yohe, Nature 2003
Phenology is the study of the times of recurring natural phenomena
NATIONAL PHENOLOGY NETWORK • USA
nature's calendar

Phenological changes in plants and animals

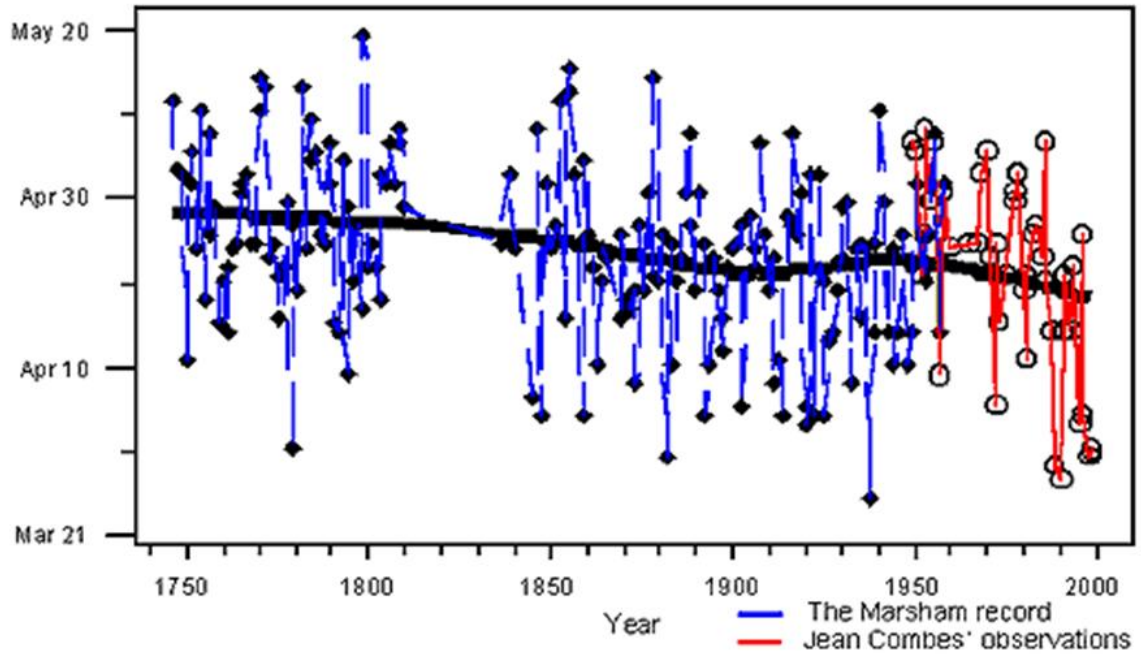


The anomalous warming of the last few decades has already had significant effects on the life cycles of many species
(Penuelas & Filella, *Science*, 2001)

(This slide is kindly provided by Dr Dietrich Schmidt-Vogt of AIT)

Leafing Dates of Oak (1746–present)

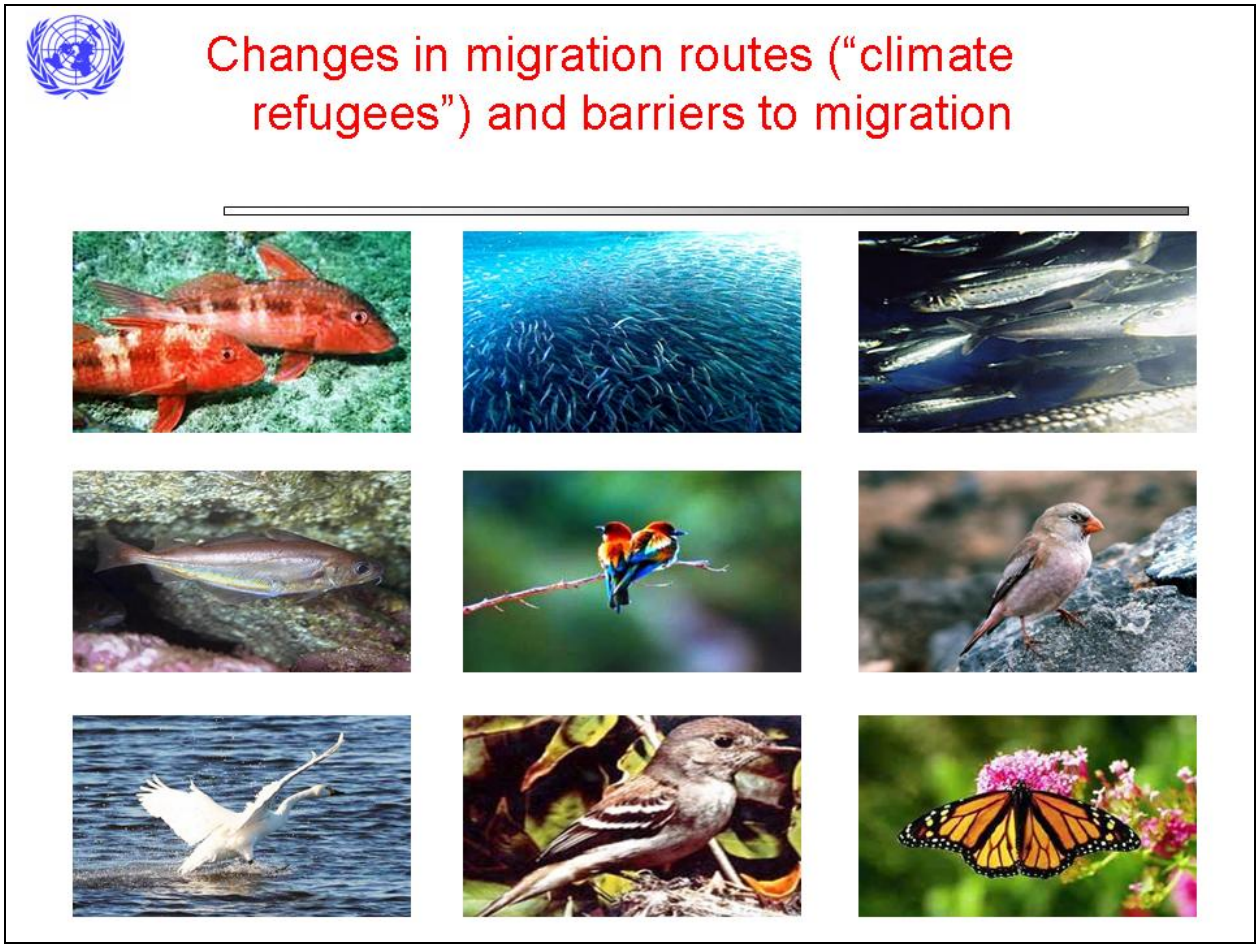
- For oaks in England, it is generally true that the warmer the temperature is, the earlier the trees leaf. On this graph, the overall trend shows average leafing dates —one measure of the start of spring (represented by the smooth line) advancing by several days over the period shown (*Source:* Woodland Trust)





- Climate change is **changing species** through:
  - shifting habitat
  - changing life cycles
  - the development of new physical traits




Changes in migration routes ("climate refugees") and barriers to migration


Changes in feeding

Changes in breeding, nesting and reproduction success

Resting, incidence of diseases and 'feminization'

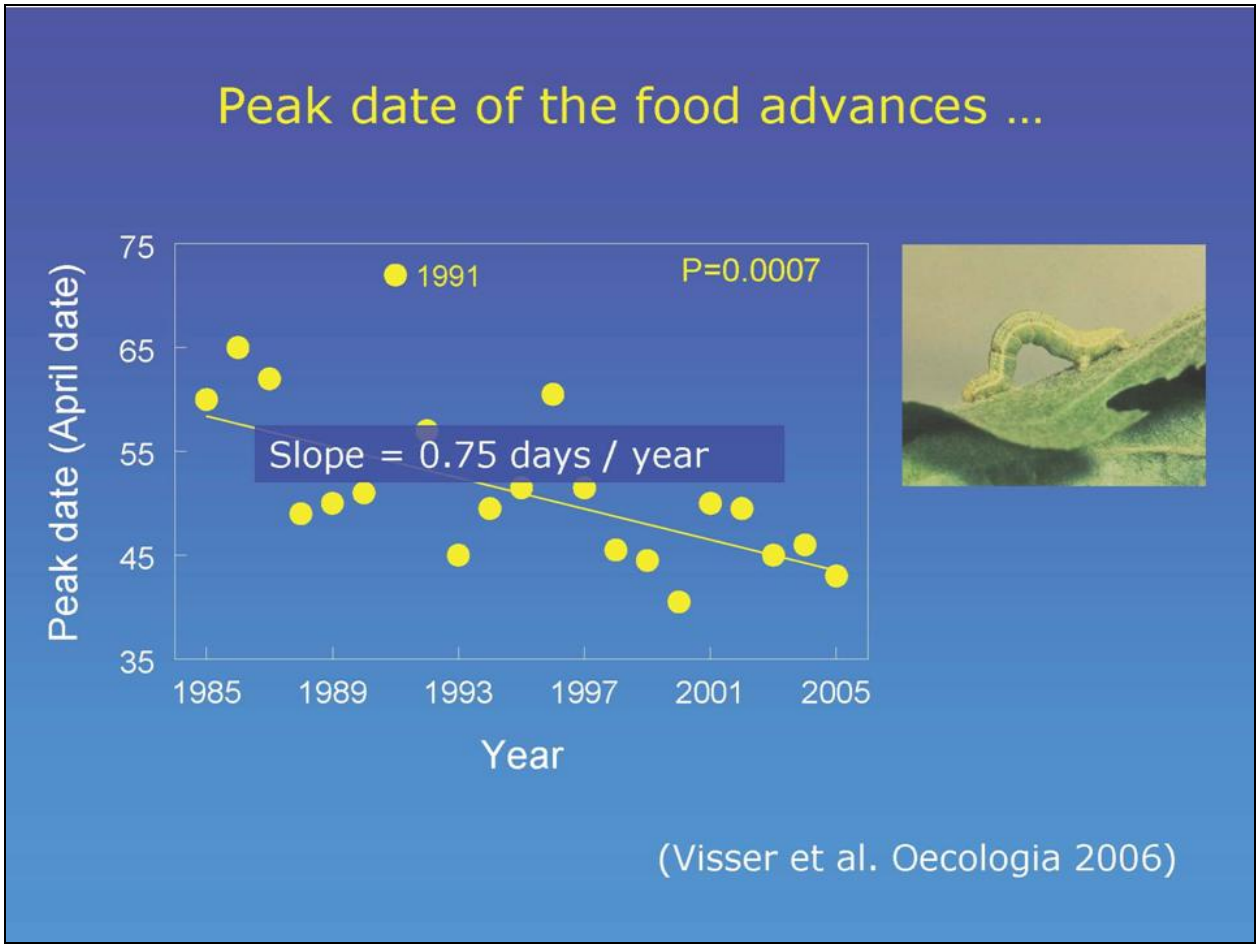


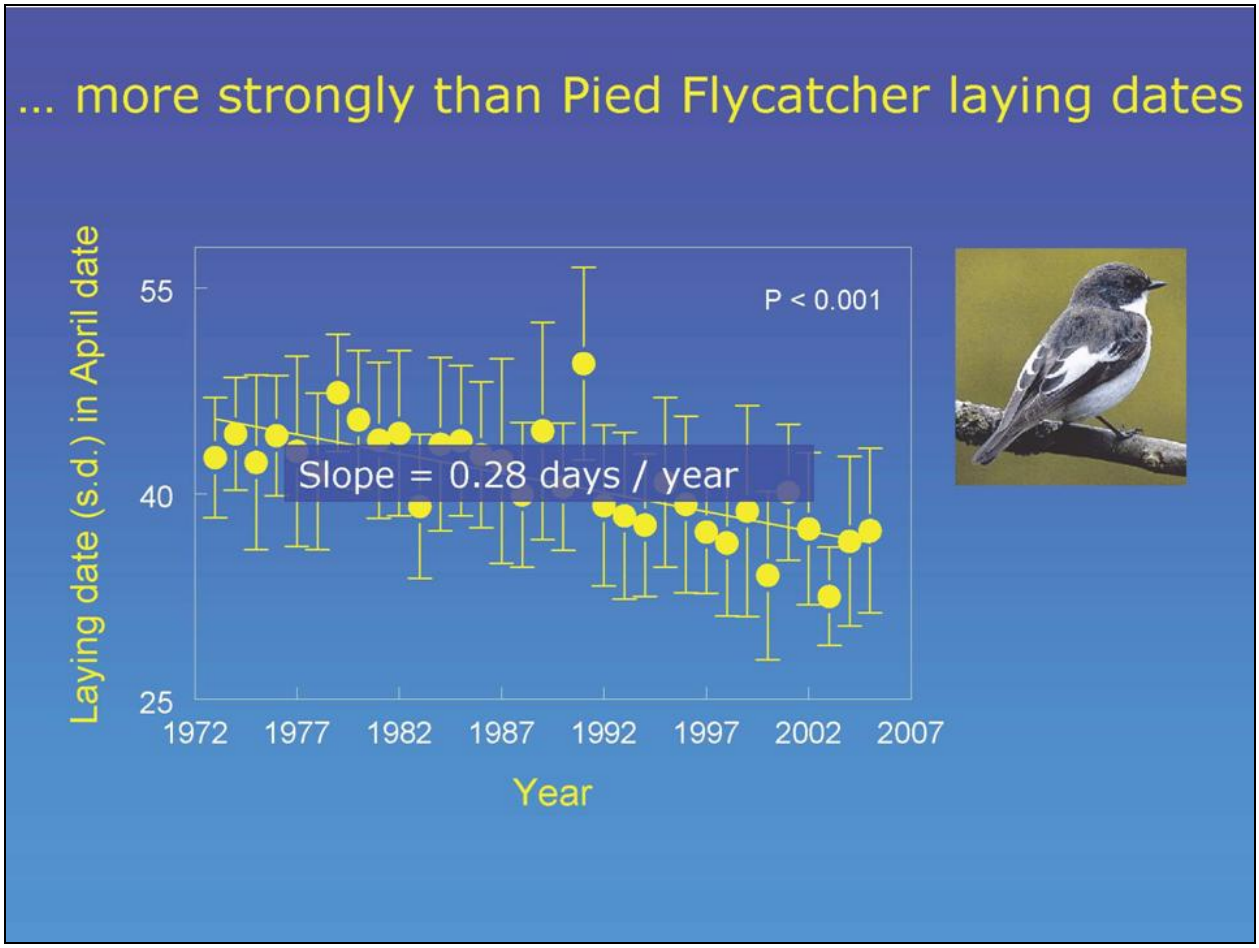




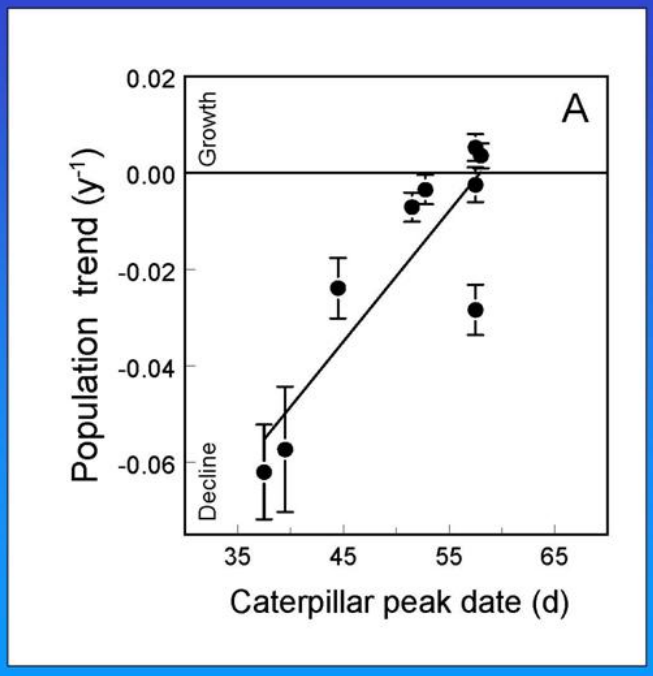
Climate change leads to selection on temperature sensitivity of avian timing of reproduction
Marcel E. Visser
NIOO
DEPARTMENT OF ANIMAL POPULATION BIOLOGY
NETHERLANDS INSTITUTE OF ECOLOGY


Pied Flycatcher system
Winter Moth
Pied Flycatcher
(Both & Visser, Nature 2001; Both et al. Nature 2006)


Peak date of the food advances …
Peak date (April date)
75
65
55
45
35
1991
P=0.0007
Slope = 0.75 days / year
1985
1989
1993
1997
2001
2005
Year
(Visser et al. Oecologia 2006)


... more strongly than Pied Flycatcher laying dates
Laying date (s.d.) in April date
55
40
25
P < 0.001
Slope = 0.28 days / year
1972
1977
1982
1987
1992
1997
2002
2007
Year

Population consequences of mistiming



Populations in areas where food is early, i.e. where the birds are most mistimed, their numbers decline.

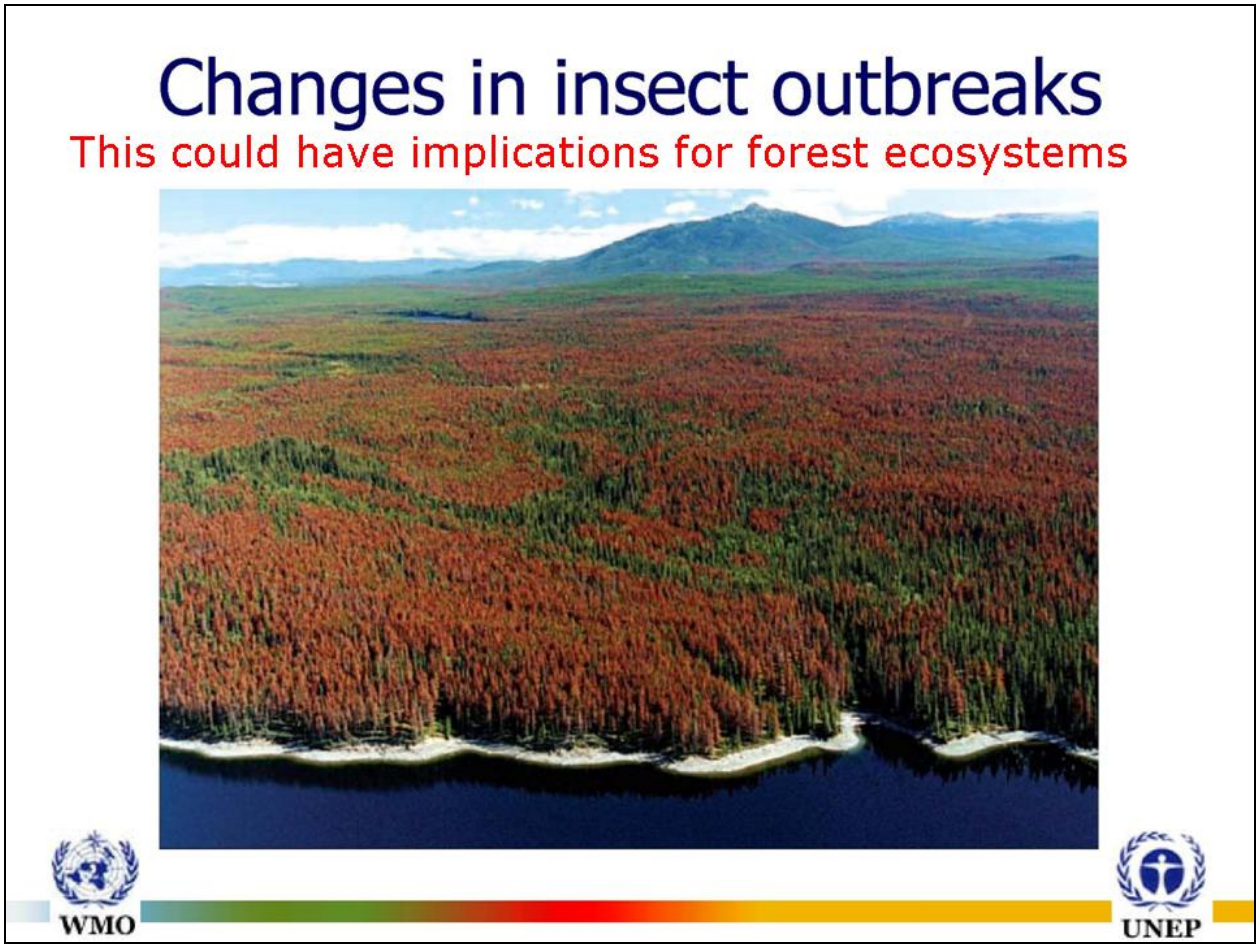
Both et al., Nature 2006

Conclusions

Climate change leads to disrupted phenology in food chains

Natural selection will lead to adaptation, but likely at a rate too slow to match the ecological changes

Mistiming is likely to have population consequences


Changes in insect outbreaks
This could have implications for forest ecosystems
WMO
UNEP

Other reported biological responses to climate change

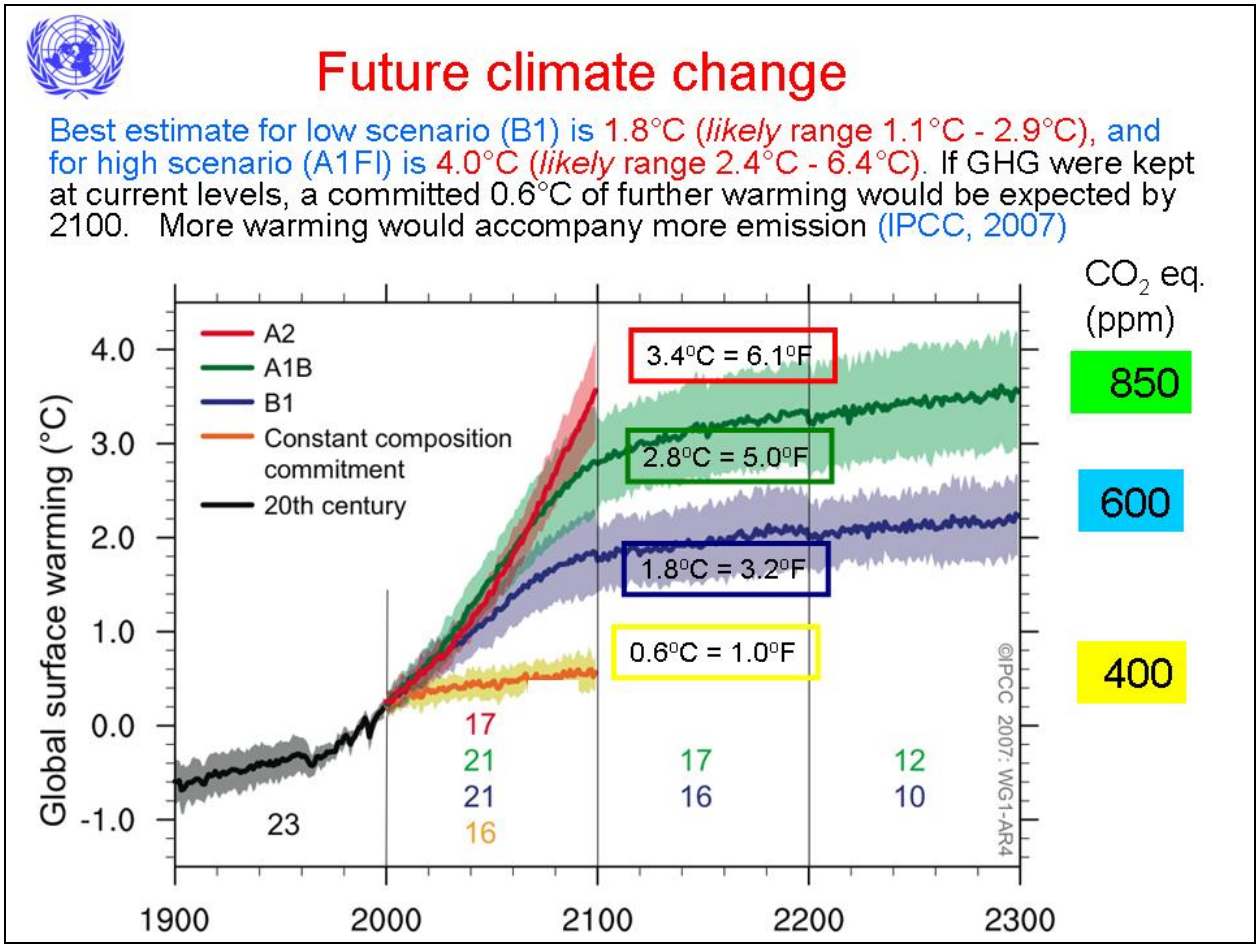
- The growing season in the Northern Hemisphere has lengthened by about 1-4 days per decade during the last 40 years;
- There has been a pole-ward and upward migration of plants, insects and animals;
- Two-thirds of the 35 species of European butterflies had shifted northward by 22 to 150 miles (e.g., the gatekeeper butterfly shown at the bottom right is moving north into Scotland;
- A decline in body weight of polar bears, resulting from early melting of sea ice;
- Reduction of phytoplankton growth in the Ross Sea, a change that could disrupt the Antarctic food chain
- Changes in the abundance of winter songbirds in four Great Plains states;
- Shifts in the species that inhabit California's tidepools;

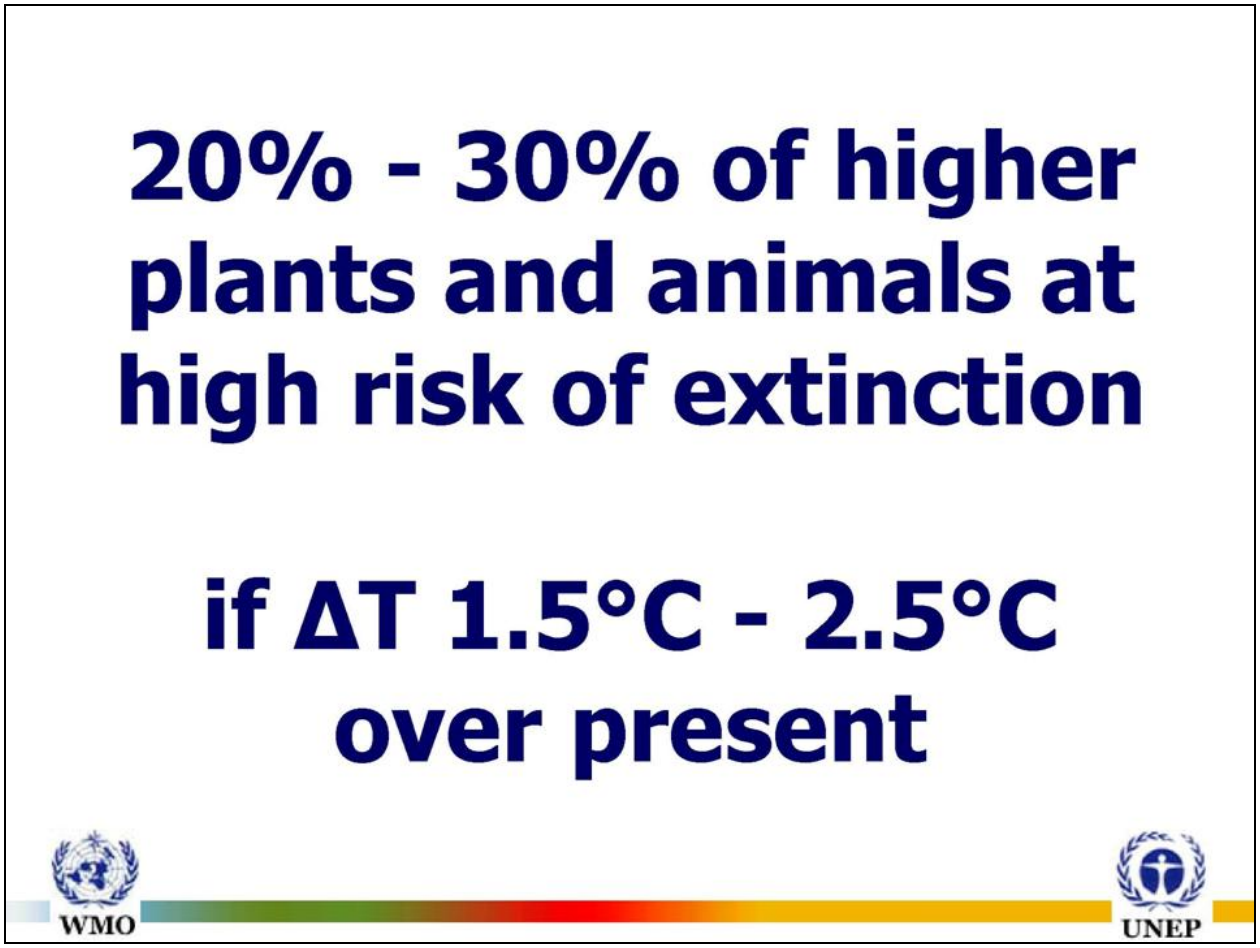
Insect enjoys warmer UK climate

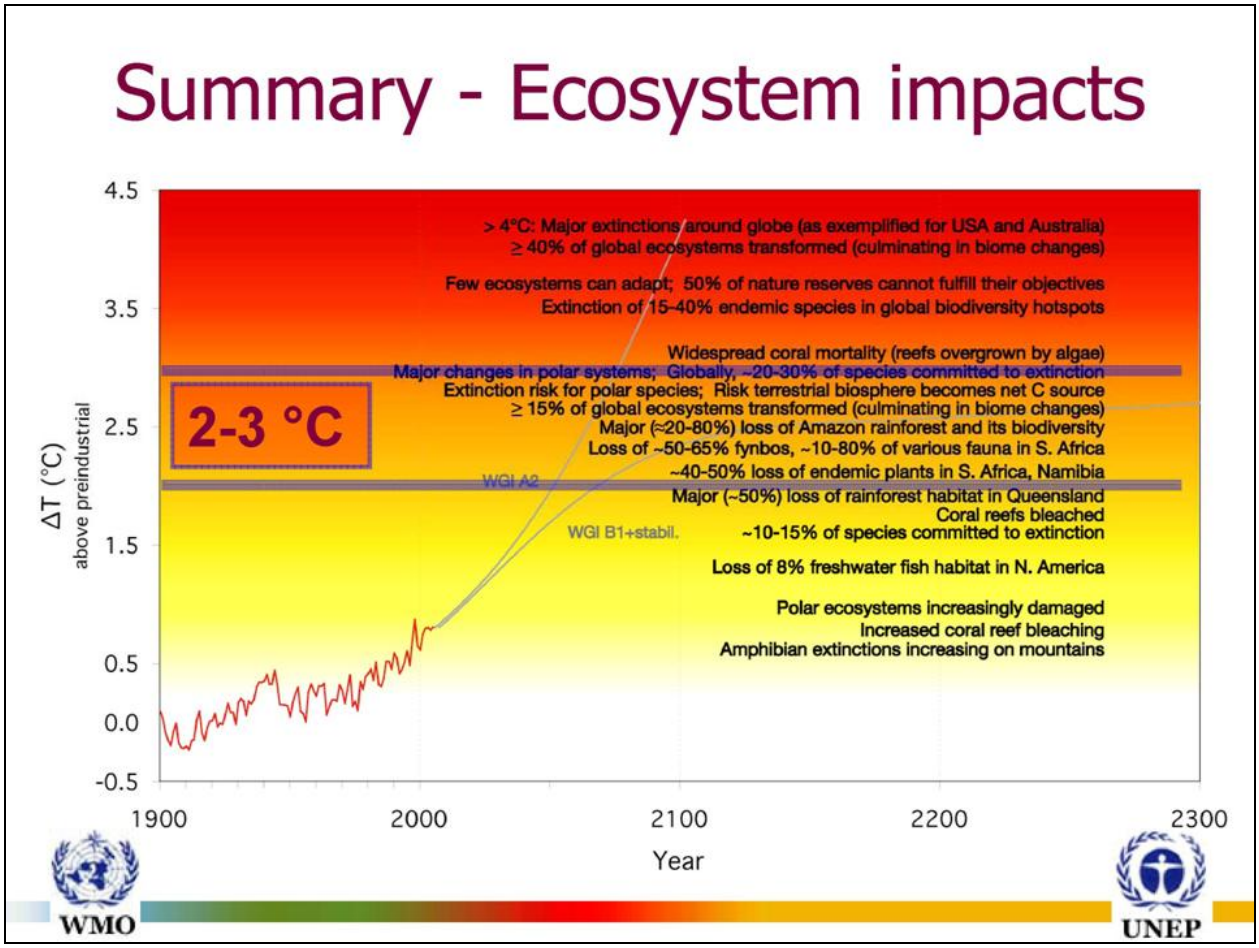
The green "shield" bug, an insect that attacks a broad range of crops and normally inhabits warm countries in the Mediterranean, Middle East, Australia, North America and Africa, has been found living and breeding in the UK. Its arrival in Britain is a clear sign of climate change, claim experts from the Natural History Museum, London.



Climate change is threatening to redraw the world's wine-producing map, and the effects are already being seen in earlier harvests and coarser wines. While global warming is threatening the viability of the drought-stricken wine industry in Australia, it is expected to make cold areas of New Zealand more temperate and better suited to grape cultivation.


Future climate change
Best estimate for low scenario (B1) is 1.8°C (likely range 1.1°C - 2.9°C), and for high scenario (A1FI) is 4.0°C (likely range 2.4°C - 6.4°C). If GHG were kept at current levels, a committed 0.6°C of further warming would be expected by 2100. More warming would accompany more emission (IPCC, 2007)
CO2 eq. (ppm)
850
600
400
A2
A1B
B1
Constant composition commitment
20th century
3.4°C = 6.1°F
2.8°C = 5.0°F
1.8°C = 3.2°F
0.6°C = 1.0°F
Global surface warming (°C)
4.0
3.0
2.0
1.0
0.0
-1.0
1900
2000
2100
2200
2300
23
17
21
21
16
17
16
12
10
©IPCC 2007: WG1-AR4


20% - 30% of higher plants and animals at high risk of extinction
if ΔT 1.5°C - 2.5°C over present
WMO
UNEP


Summary - Ecosystem impacts
4.5
3.5
2.5
1.5
0.5
0.0
-0.5
ΔT (°C)
above preindustrial
1900
2000
2100
2200
2300
Year
2-3 °C
WGI A2
WGI B1+stabil.
> 4°C: Major extinctions around globe (as exemplified for USA and Australia)
≥ 40% of global ecosystems transformed (culminating in biome changes)
Few ecosystems can adapt; 50% of nature reserves cannot fulfill their objectives
Extinction of 15-40% endemic species in global biodiversity hotspots
Widespread coral mortality (reefs overgrown by algae)
Major changes in polar systems; Globally, ~20-30% of species committed to extinction
Extinction risk for polar species; Risk terrestrial biosphere becomes net C source
≥ 15% of global ecosystems transformed (culminating in biome changes)
Major (≈20-80%) loss of Amazon rainforest and its biodiversity
Loss of ~50-65% fynbos, ~10-80% of various fauna in S. Africa
~40-50% loss of endemic plants in S. Africa, Namibia
Major (~50%) loss of rainforest habitat in Queensland
Coral reefs bleached
~10-15% of species committed to extinction
Loss of 8% freshwater fish habitat in N. America
Polar ecosystems increasingly damaged
Increased coral reef bleaching
Amphibian extinctions increasing on mountains
WMO
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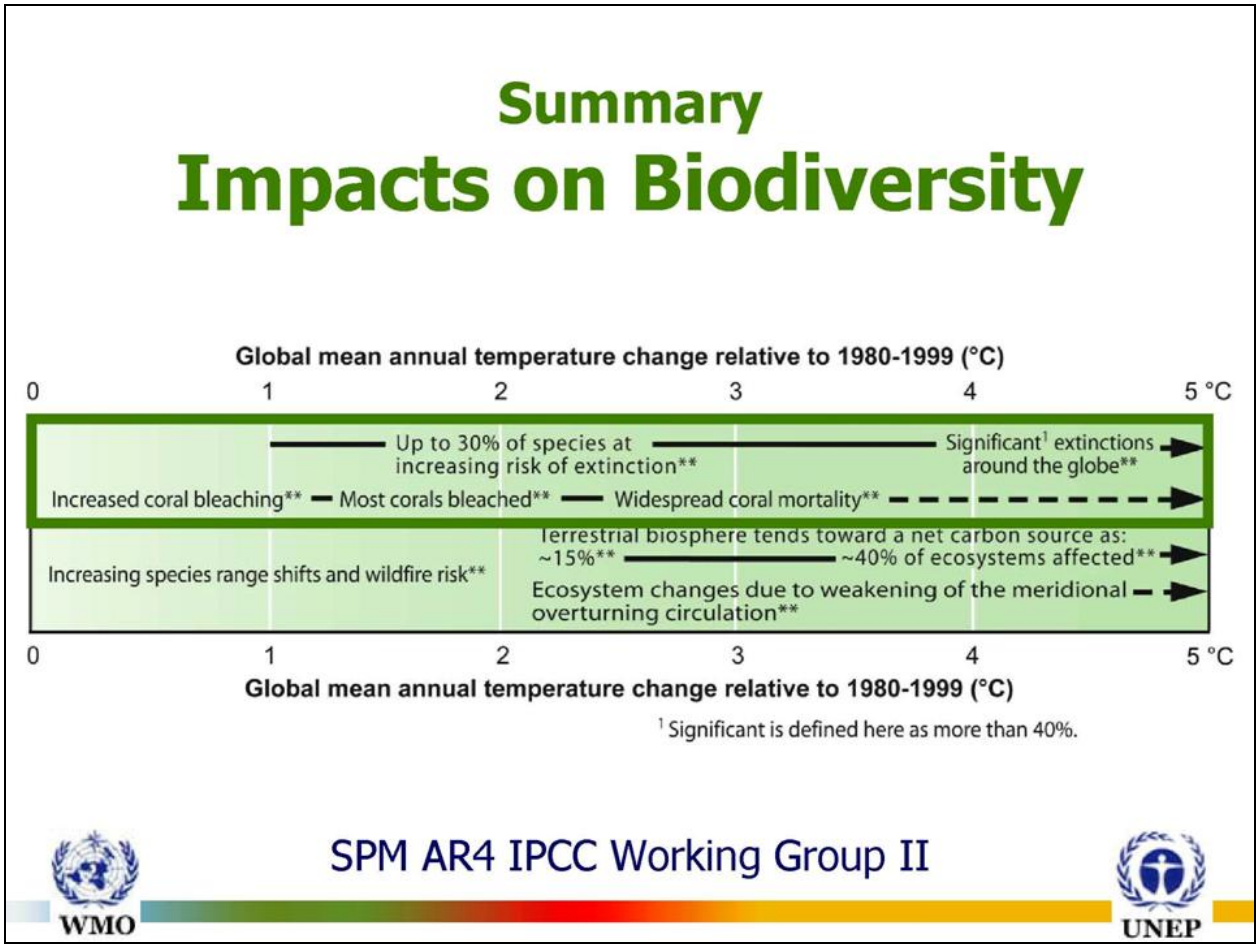
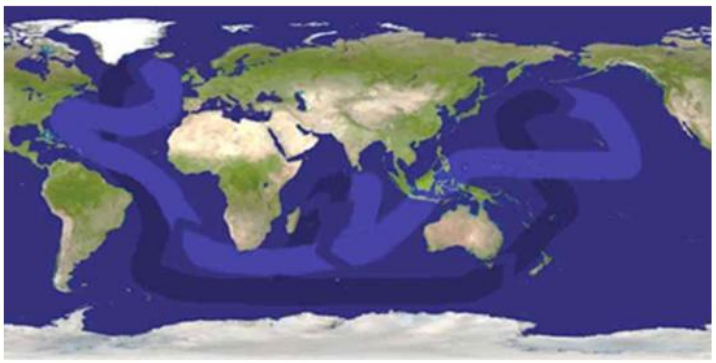

Summary
Impacts on Biodiversity
Global mean annual temperature change relative to 1980-1999 (°C)
0
1
2
3
4
5 °C
Up to 30% of species at increasing risk of extinction**
Significant[1] extinctions around the globe**
Increased coral bleaching**
Most corals bleached**
Widespread coral mortality**
Increasing species range shifts and wildfire risk**
Terrestrial biosphere tends toward a net carbon source as:
~15%**
~40% of ecosystems affected**
Ecosystem changes due to weakening of the meridional overturning circulation**
Global mean annual temperature change relative to 1980-1999 (°C)
[1] Significant is defined here as more than 40%.
SPM AR4 IPCC Working Group II
WMO
UNEP

Projections of Future Changes in Ocean Circulation

- Based on current model simulations, it is *very likely* that the meridional overturning circulation (MOC) of the Atlantic Ocean will slow down during the 21st century.
  - longer term changes not assessed with confidence



MOC or Thermohaline Circulation.
Darker arrows:deep-water currents;
Lighter arrows:surface currents

- Temperatures in the Atlantic region are projected to increase despite such changes due to the much larger warming associated with projected increases of greenhouse gases.

Future indirect impacts?

•What about the future indirect impacts associated with other climatic parameters (e.g., rainfalls, increase in frequency and intensity of cyclones/typhoons?)

- For example, an increase of 10 to 20% in tropical cyclone intensities for a rise in sea-surface temperature of 2 to 4°C relative to the current threshold temperature is projected in East Asia, South-East Asia and South Asia (Knutson and Tuleya, 2004).
- The impacts of an increase in cyclone intensities in any location will be determined by any shift in the cyclone tracks (Kelly and Adger, 2000).

- Projected sea-level rise is very likely to result in significant losses of coastal ecosystems and a million or so people along

  the coasts of South and South-East Asia will likely be at risk from flooding (high confidence)

Projected Sea-Level Rise and Red River Delta

- Projected sea-level rise is very likely to result in significant losses of coastal ecosystems and a million or so people along the coasts of South and South-East Asia will likely be at risk from flooding (high confidence) (IPCC, 2007)
- For a 1 m rise in sea level, half a million square hectares of Red River delta and from 15,000 to 20,000 km^2 of Mekong River delta is projected to be flooded; 2,500 km^2 of mangrove will be completely lost, while approximately 1,000 km^2 of cultivated farm land and sea product culturing area will become salt marshes (Tran *et al.*, 2005).

What is "dangerous" climate change?

- EU has proposed to set the target of global actions to limit the rise in near-surface air temperature to a maximum of 2°C relative to the pre-industrial value in order to avoid the so-called "*dangerous*" climate change.
- "Dangerous" to human being? Biodiversity? Or both?
- It is clear that different biodiversity species may have different level of tolerance, and so a single temperature parameter threshold may be inappropriate

Multi-dimensional threshold

- Apart from temperature threshold, other factors (such as *changes in precipitation and in large scale atmospheric circulation patterns, socio-economic change, population, settlement patterns, water demands, human choices and behaviour, etc.)* all play roles of equal or greater importance than temperature in determining the final magnitude and timing of adverse impacts in certain areas. In other words, the risk can be very low or high depending on how the other factors develop as a consequence of both climate change and socio-economic choices.
- Thus, other than a certain temperature threshold, it is more important to consider, assess and capture the "**multi-dimensional threshold**" for both climatic and non-climatic factors that will cause the impacts.

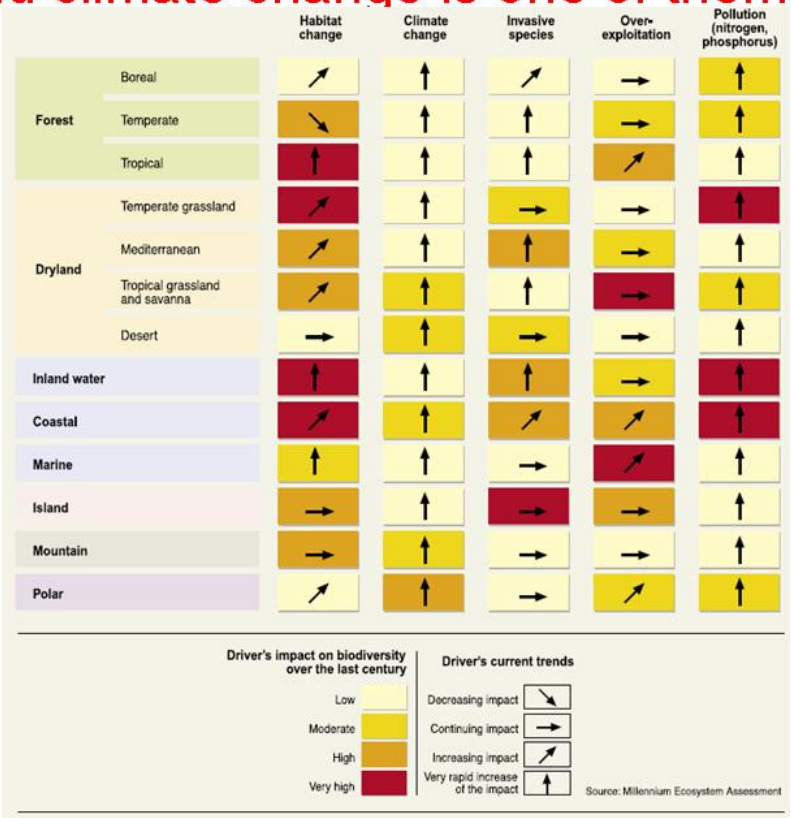
Pathways towards stabilization

Characteristics of stabilization scenarios

Stabilization level (ppm CO_2-eq)	Global mean temp. increase at equilibrium (°C)	Year CO_2 needs to peak	Year CO_2 emissions back at 2000 level	Reduction in 2050 CO_2 emissions compared to 2000
445 – 490	2.0 – 2.4	2000 - 2015	2000- 2030	-85 to -50
490 – 535	2.4 – 2.8	2000 - 2020	2000- 2040	-60 to -30
535 – 590	2.8 – 3.2	2010 - 2030	2020- 2060	-30 to +5
590 – 710	3.2 – 4.0	2020 - 2060	2050- 2100	+10 to +60
710 – 855	4.0 – 4.9	2050 - 2080		+25 to +85
855 – 1130	4.9 – 6.1	2060 - 2090		+90 to +140

- Mitigation efforts over the next two to three decades will have a large impact on opportunities to achieve lower stabilization levels

Impacts of various drivers on biodiversity, and climate change is one of them



2010 Biodiversity Target

- In April 2002, the Parties to the CBD committed themselves to achieve by 2010 *a significant reduction of the current rate of biodiversity loss at the global, regional and national level* as a contribution to poverty alleviation and to the benefit of all life on Earth.
- This target was subsequently endorsed by the World Summit on Sustainable Development and the United Nations General Assembly and was incorporated as a new target under the Millennium Development Goals (MDG 7).
- At the **Gothenburg Summit in June 2001**, leaders of the European Union launched the **first EU Sustainable Development Strategy**, which addresses as a headline objective for a more responsible natural resources management "…*to protect and restore habitats and natural systems and halt the loss of biodiversity by 2010*…".

Is the 2010 Biodiversity Target Realistic?

- This target is, of course, most admirable. But is it realistic, especially the EU objective?
- For example, has the target taken climate change into consideration when it is formulated?
- If not, then just like the targets of all the MDGs, it would not be achievable, at least in those countries that are most vulnerable to climate change!

How vulnerable is your country to climate change? What are the risks?

Hazard x Vulnerability = Risk

(natural or human-induced)

Climatology, Probabilities, Forecasts

(social, economic, environmental & even political factors)

Population growth and shifts
Urbanization
Technology (EWS; Water conservation technologies)
Land use practices
Env. degradation
Water use trends
Govt policies
Env. Awareness
Capacity (technical & institutional)

To apply this for biodiversity

Hazard x Vulnerability = Risk

Climate change

Depends on both biodiversity and human factors

- biological adaptation and natural selection capacity
- human land use practices (deforestation)
- pollution

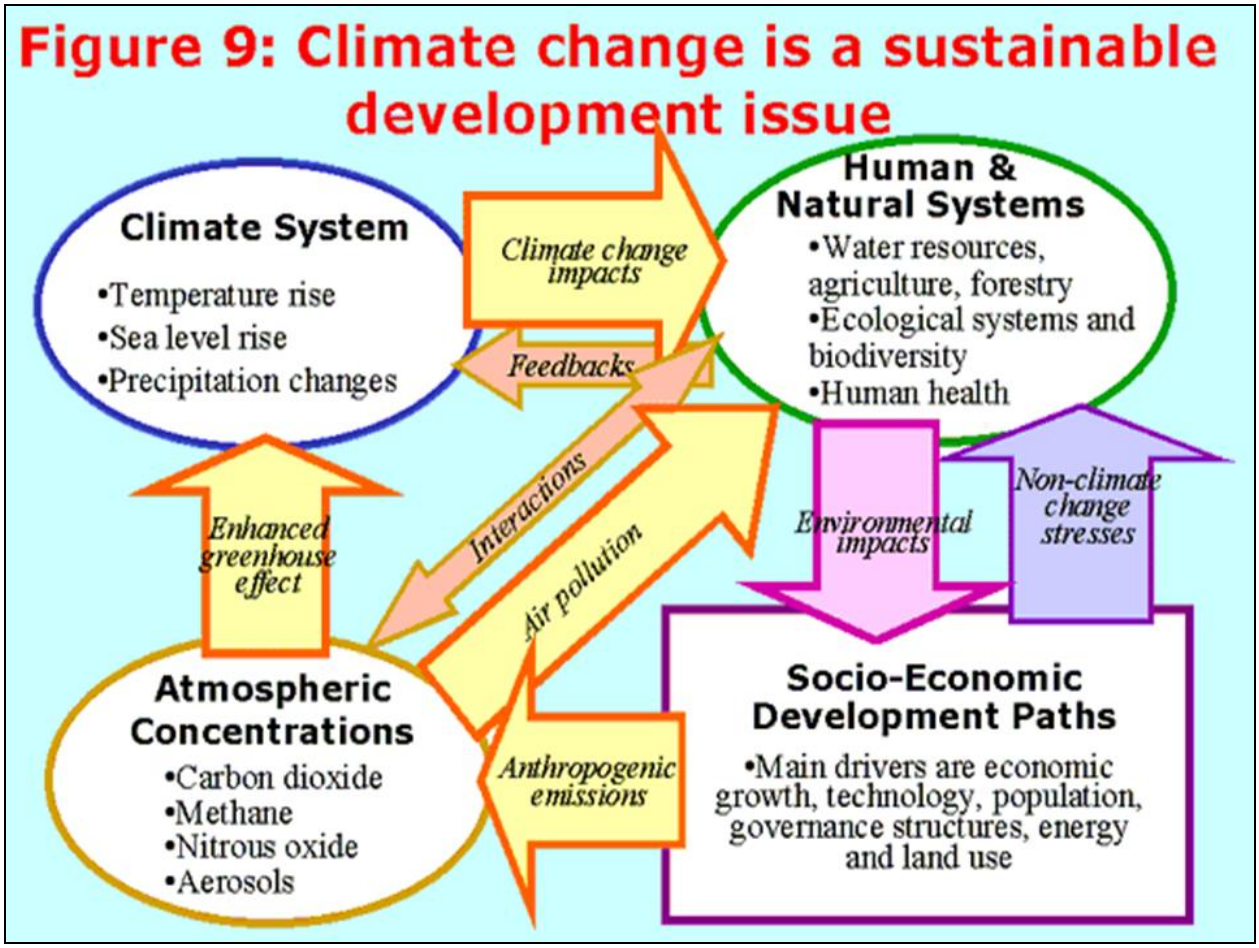


Figure 9: Climate change is a sustainable development issue
Climate System
•Temperature rise
•Sea level rise
•Precipitation changes
Climate change impacts
Human & Natural Systems
•Water resources, agriculture, forestry
•Ecological systems and biodiversity
•Human health
Feedbacks
Interactions
Air pollution
Enhanced greenhouse effect
Environmental impacts
Non-climate change stresses
Atmospheric Concentrations
•Carbon dioxide
•Methane
•Nitrous oxide
•Aerosols
Anthropogenic emissions
Socio-Economic Development Paths
•Main drivers are economic growth, technology, population, governance structures, energy and land use

Acknowledgements

- The information given here is collected from various sources, including the IPCC Fourth Assessment WG II Report and presentations (*http://www.ipcc.ch)* and other published literature.


Thanks for your attention!
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