

Global Climate Change

Why Does it Matter for the CGIAR?

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Global Climate Change

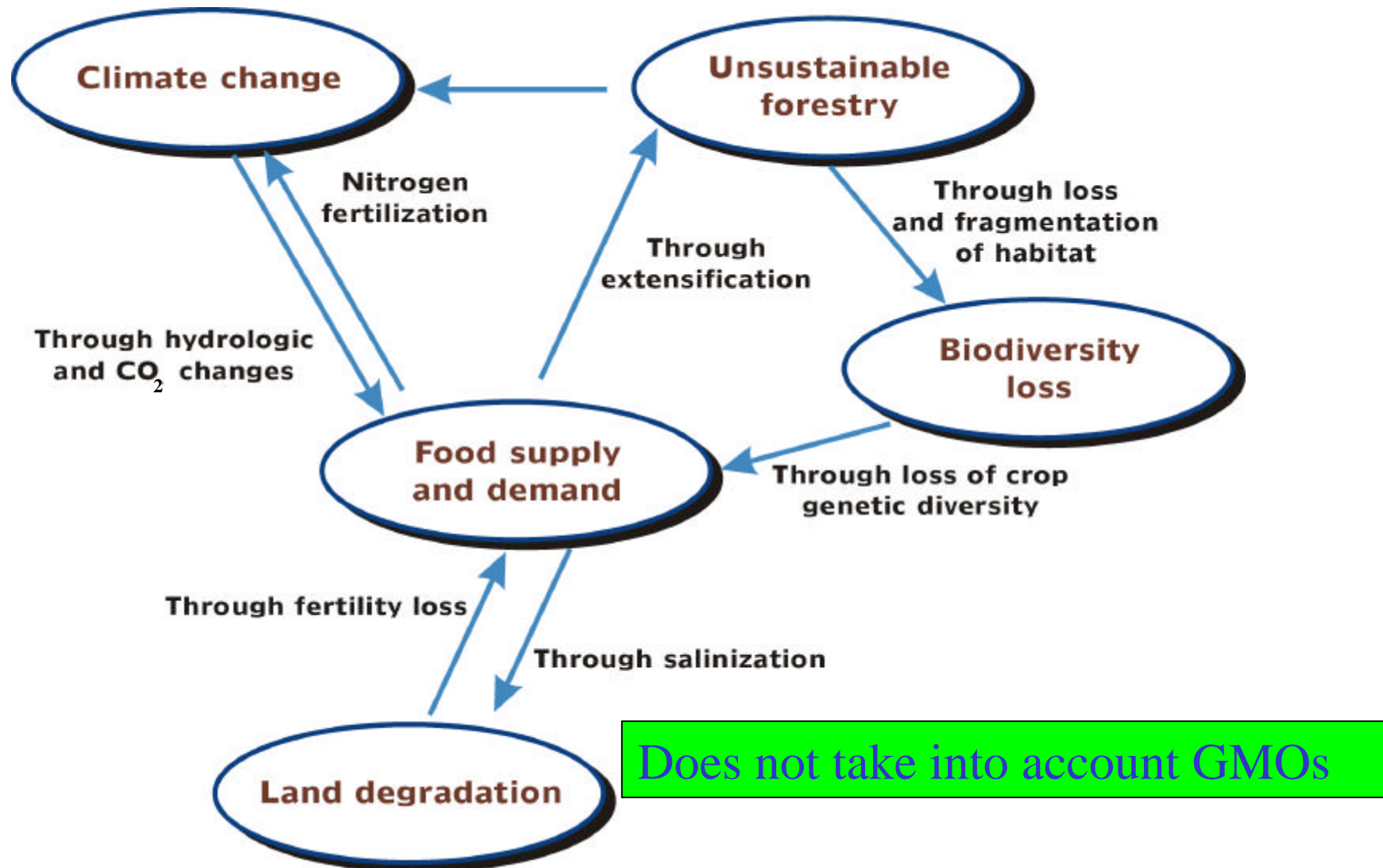
A Threat to Sustainable Development, especially in Developing Countries

The sustainable development challenge is to:

- **alleviate poverty** for the 1.3 billion people who live on less than \$1 per day and the 3 billion people who live on less than \$2 per day
- **provide adequate food, especially for the 800 million people who are malnourished today—this will require food production to double in the next 35 years without further environmental degradation, e.g., deforestation**
- provide **clean water** for the 1.3 billion people who live without clean water and provide sanitation for the 2 billion people who live without sanitation
- provide **energy** for the 2 billion people who live without electricity
- provide a **healthy environment** for the 1.4 billion people who are exposed to dangerous levels of *outdoor pollution* and the even larger number exposed to dangerous levels of *indoor air pollution and vector-borne diseases*
- provide **safe shelter** for those that live in areas susceptible to civil strife due to environmental degradation and those vulnerable to natural disasters

Food Production and Global Environmental Issues

How to double food production without environmental degradation?



Poverty is Multi-Dimensional

Dimensions of Poverty

Opportunity

Capability

Security

Empowerment

Examples of Determinants

Income and Consumption

Health

Education

Vulnerability

Participation in Decision-making

Environmental Links

Natural Resources, e.g., agriculture, forests

Access to markets

Water quantity, quality and sanitation

Air quality, Vector-borne and water-borne diseases

Environmental awareness

Ecological fragility

Natural shocks, e.g., severe weather

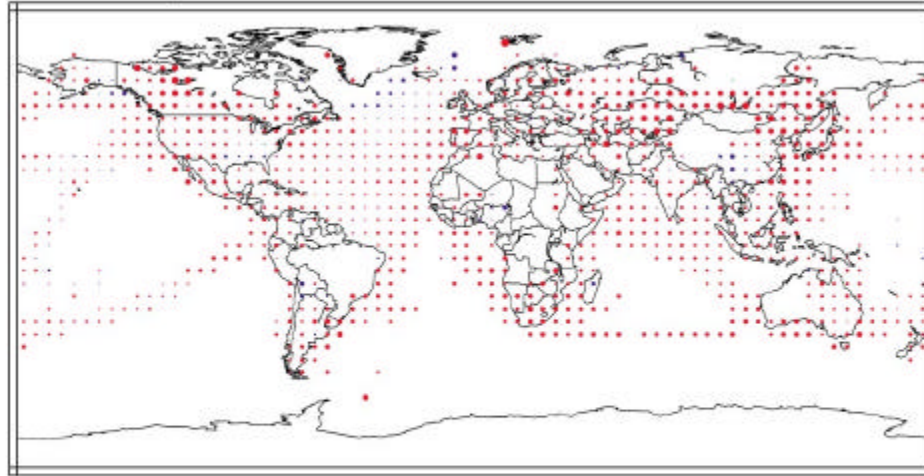
Environmental governance

Climate Change affects these environmental links

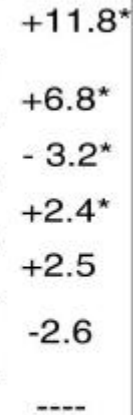
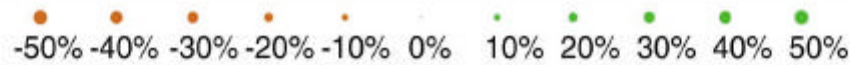
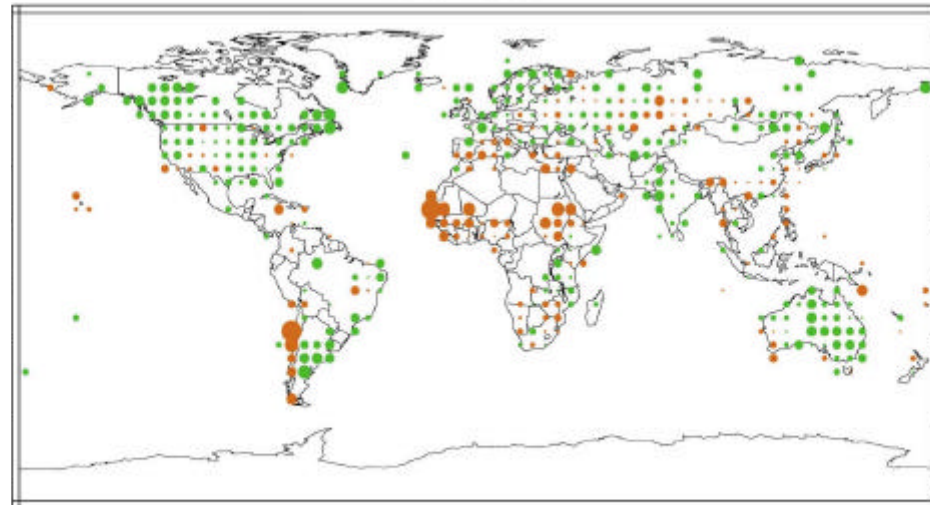
Key Conclusions from WG I

- The Earth's climate is changing
 - global mean surface temperature increased 0.6°C between 1861 and 2000
 - rainfall patterns have changed with more heavy precipitation events
 - the El-Nino phenomena has become more frequent, persistent and intense
 - sea level increased 10-20 cm between 1900 and 2000
- Human activities are changing the atmospheric concentrations of greenhouse gases
 - combustion of fossil fuels
 - deforestation
- There is new and stronger evidence that most of the observed warming of the past 50 years is attributable to human activities

Annual temperature trends, 1901 to 2000

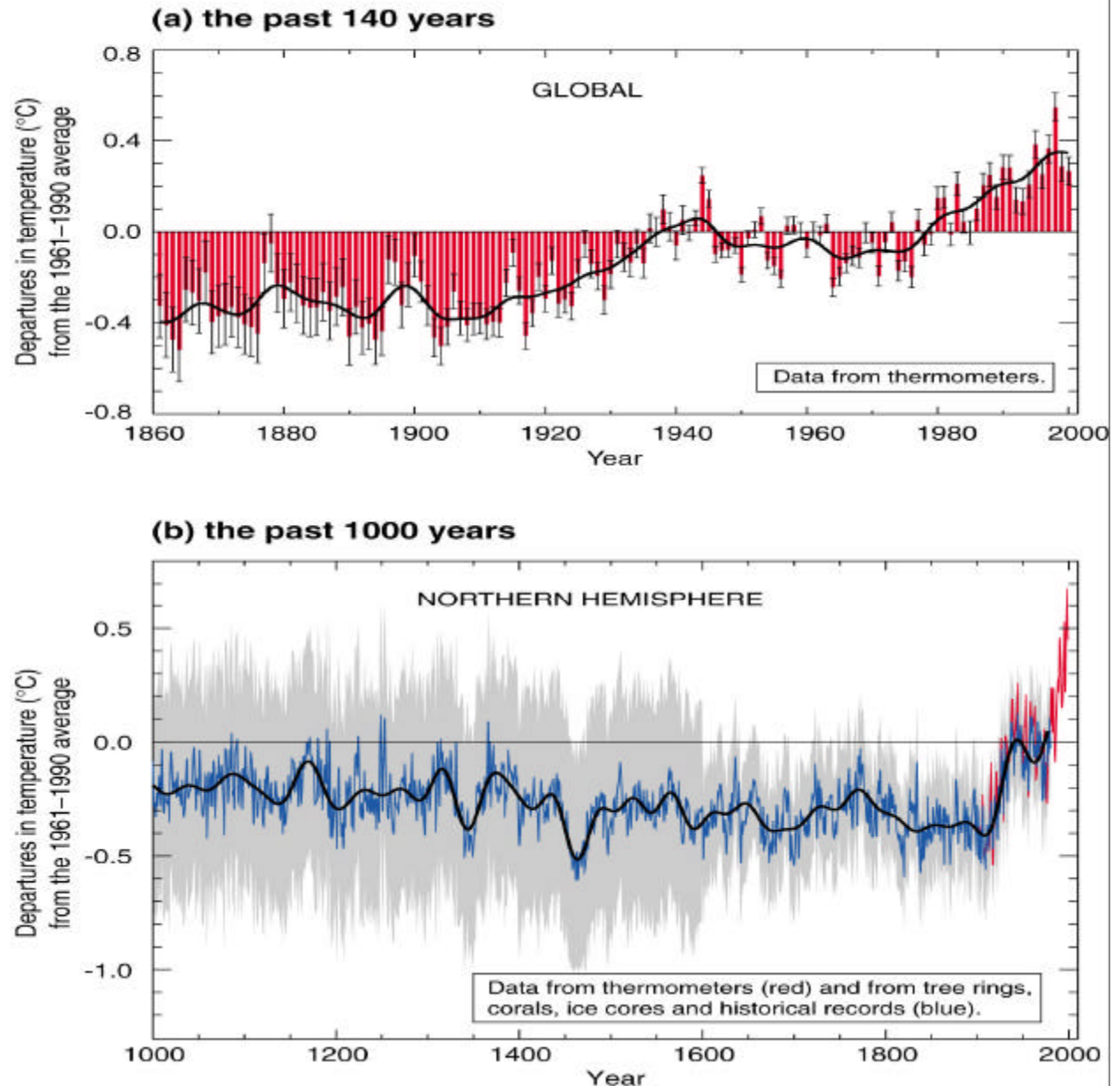


Trend (%/century) in Annual Precipitation
1900 - 1999

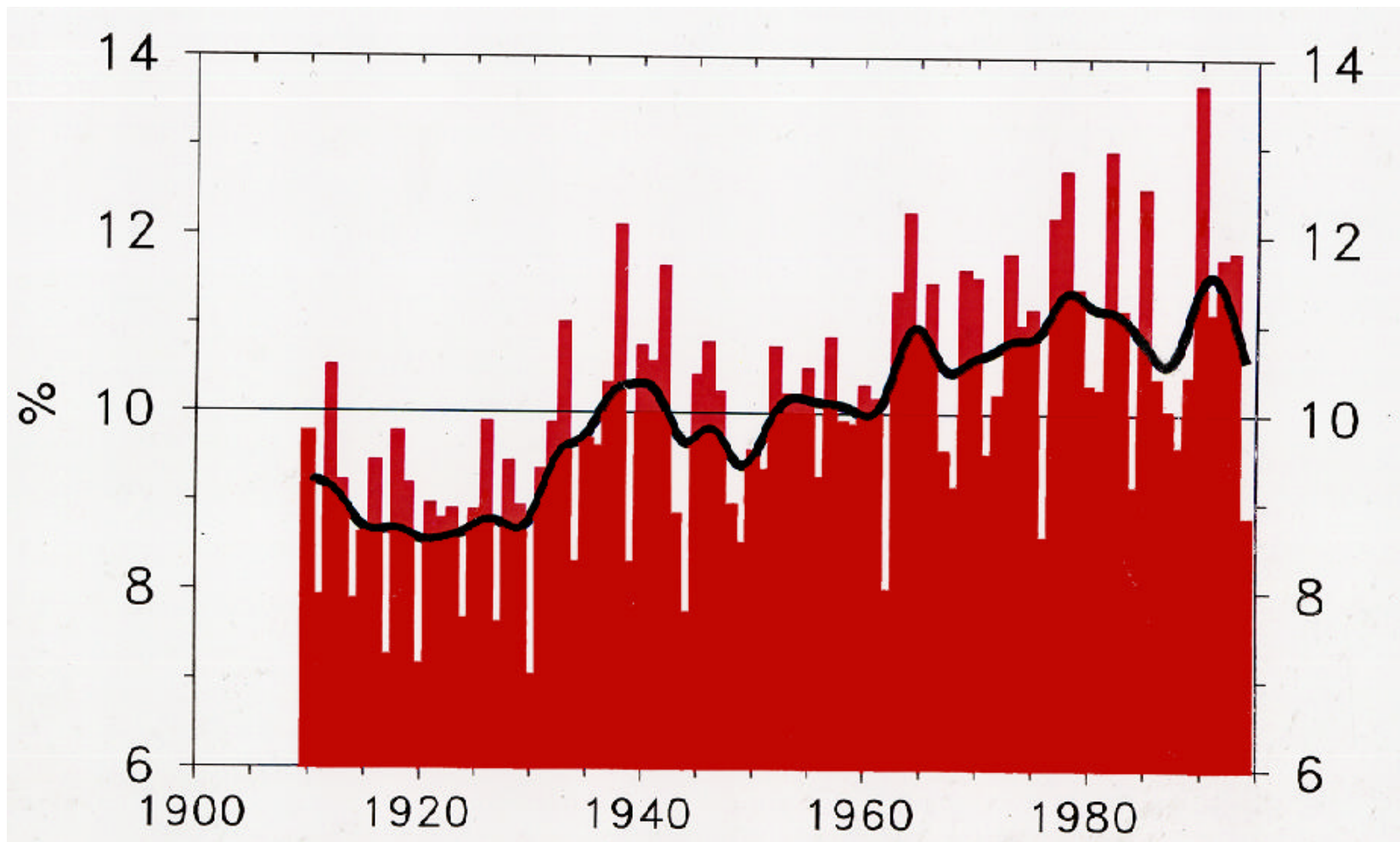


Variations of the Earth's Surface Temperature

Climate models cannot simulate the observed changes in temperature by natural phenomena alone, but can if human activities are taken into account, i.e., the emissions of greenhouse gases and sulfate aerosols

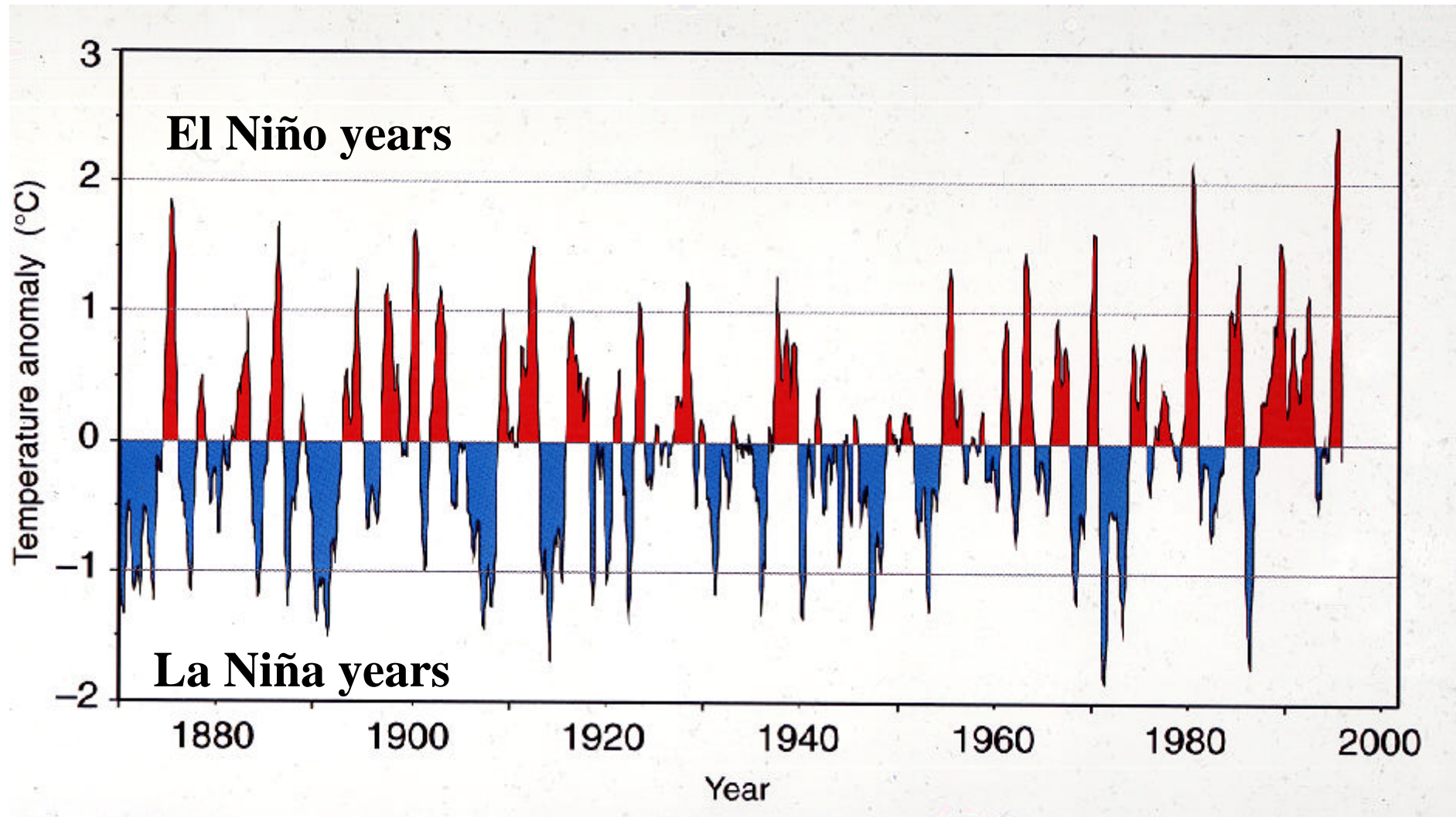


Percent of the Continental U.S. with A Much Above Normal Proportion of Total Annual Precipitation From 1-day Extreme Events (more than 2 inches or 50.8mm)



Source: Karl, et.al. 1996.

Frequency, Persistence and Magnitude of the El-Niño Phenomena



*As shown by changes in sea-surface temperature (relative to the 1961-1990 average) for the eastern tropical Pacific off Peru.

Key Conclusions from WG I and II

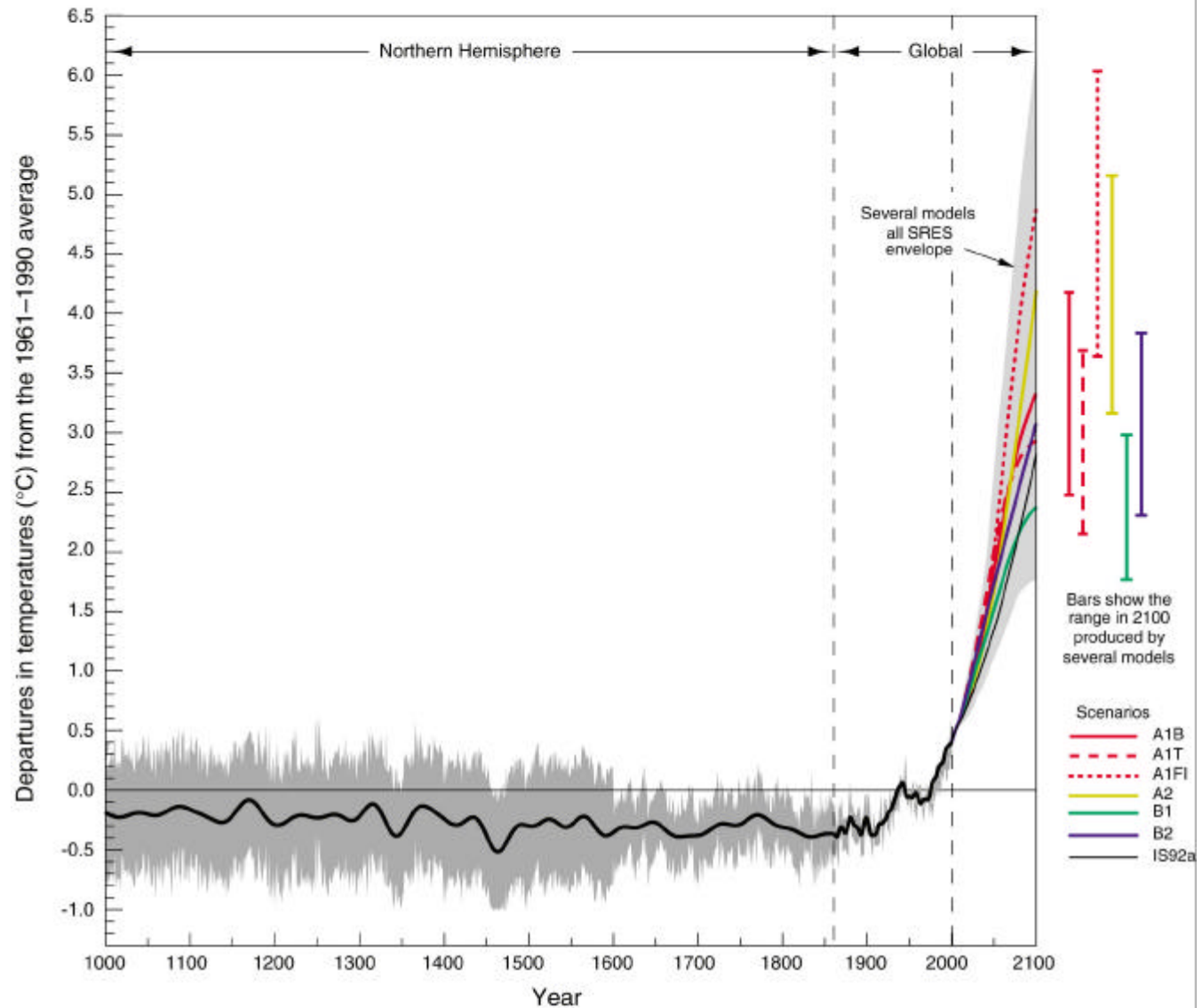
- Observed regional changes in temperature have been associated with observed changes in physical, ecological and socio-economic systems world-wide, examples include:
 - non-polar glacier retreat
 - reduction in Arctic sea ice extent and thickness in summer
 - earlier plant flowering and longer growing season in Europe
 - poleward and upward (elevation) migration of plants, insects and animals
 - earlier bird arrival and egg laying
 - increased incidence of coral bleaching
 - increased economic losses due to extreme weather events

Key Conclusions from SRES and WG I

- Future emissions of greenhouse gases and sulfate aerosol precursors depend on population growth, economic growth, technological changes and governance structures
- All SRES scenarios project an increase in the atmospheric concentrations of greenhouse over the next 100 years, but decreases in sulfate aerosols by 2100
- Climate models project that:
 - the Earth's mean annual surface **temperature** will increase by about 1.4 to 5.8°C between 1990 and 2100 with land areas warming more than oceans
 - **precipitation** will increase globally, with both increases and decreases locally, and with more heavy precipitation events
 - incidence of **extreme weather** events will increase
 - **sea level** will rise between 9-88 cm between 1990 and 2100

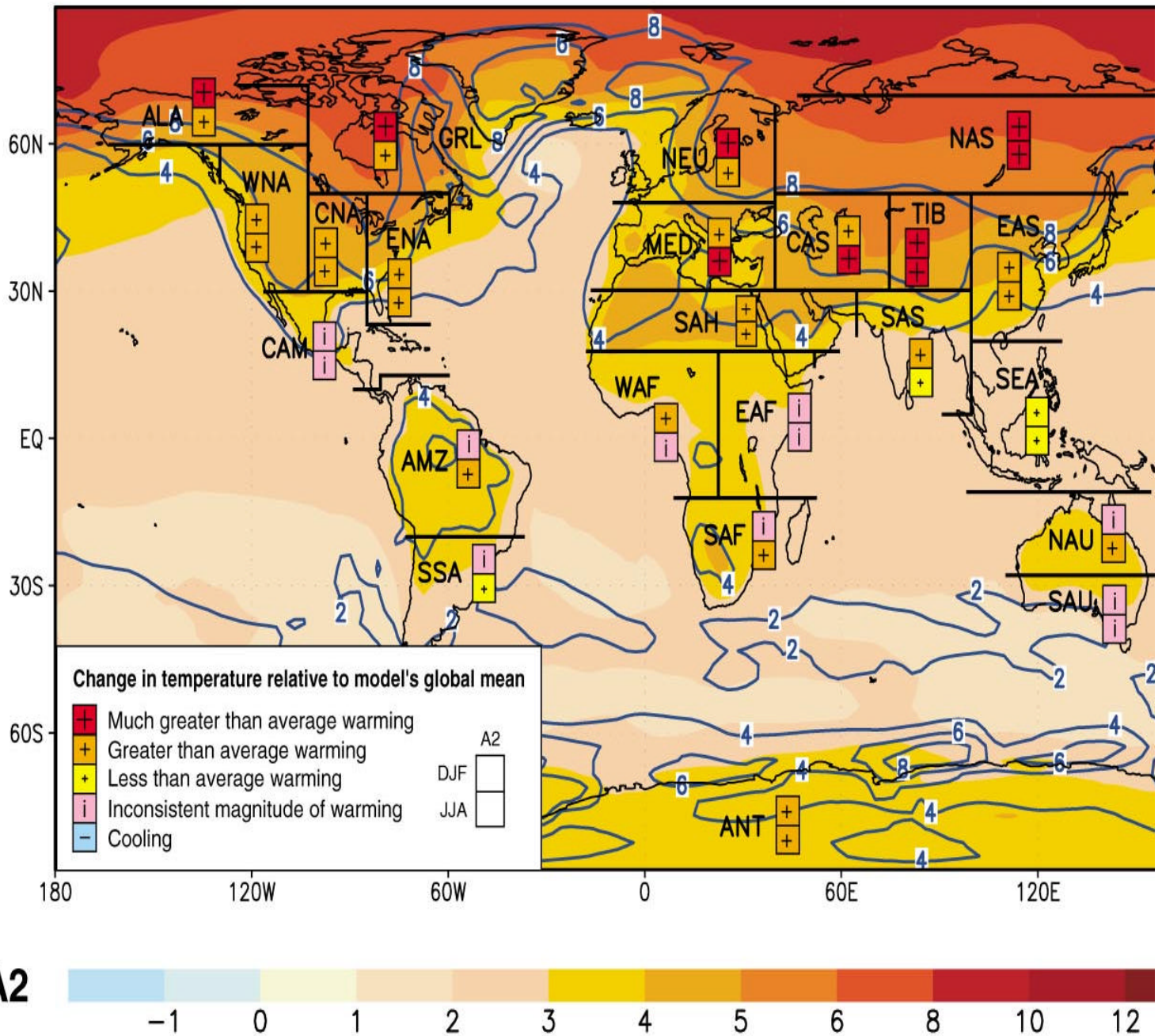
Variations of the Earth's Surface Temperature: 1000 to 2100

- 1000 to 1861, N. Hemisphere, proxy data;
- 1861 to 2000 Global, Instrumental;
- 2000 to 2100, SRES projections

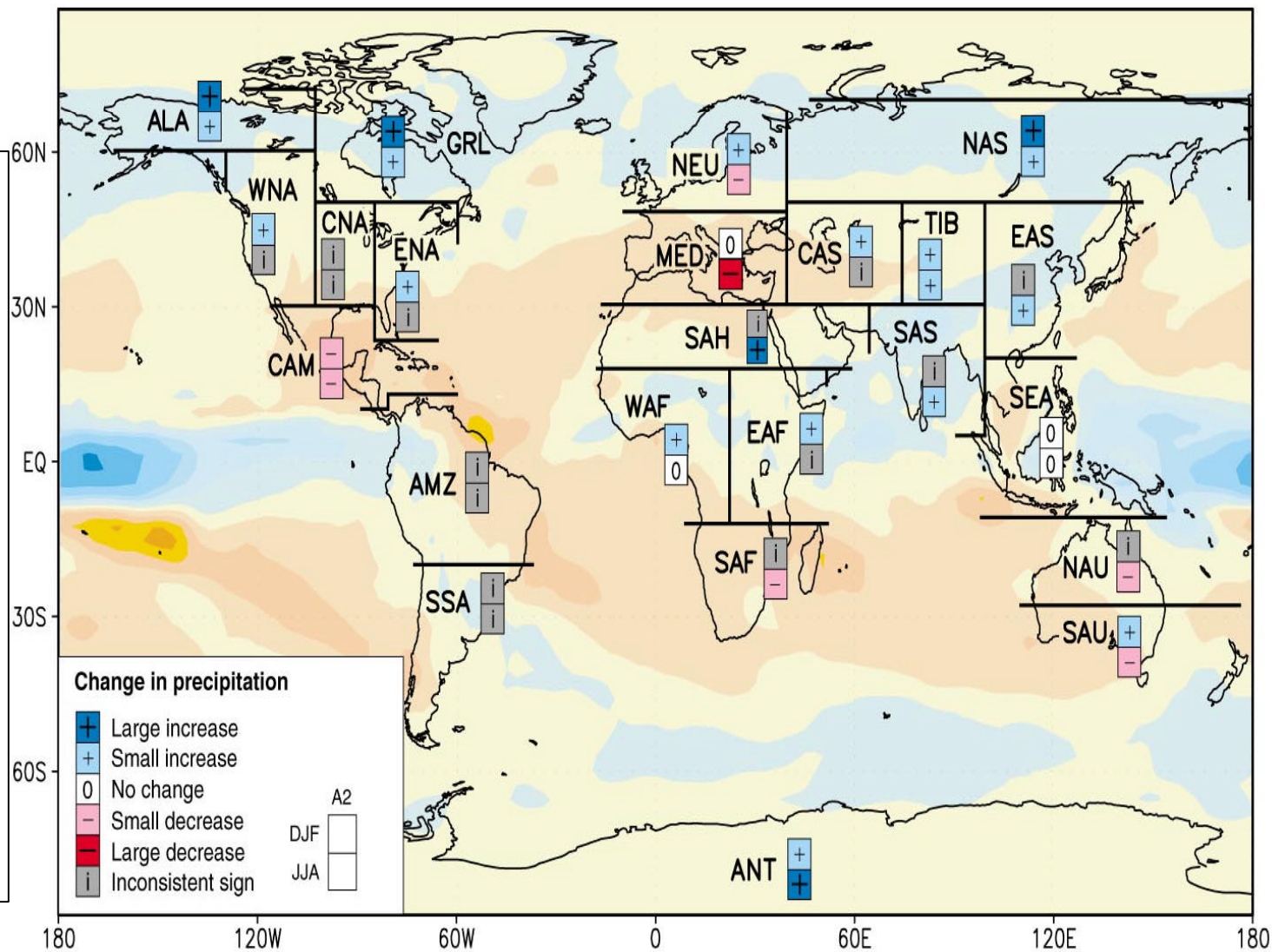


**Annual Mean
Temperature
Change,
2071-2100**

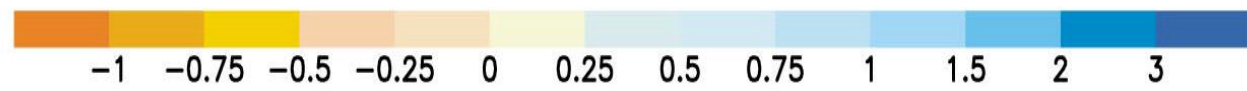
**Global
Average in
2085
A2=3.1°C**



Annual Mean Precipitation Changes



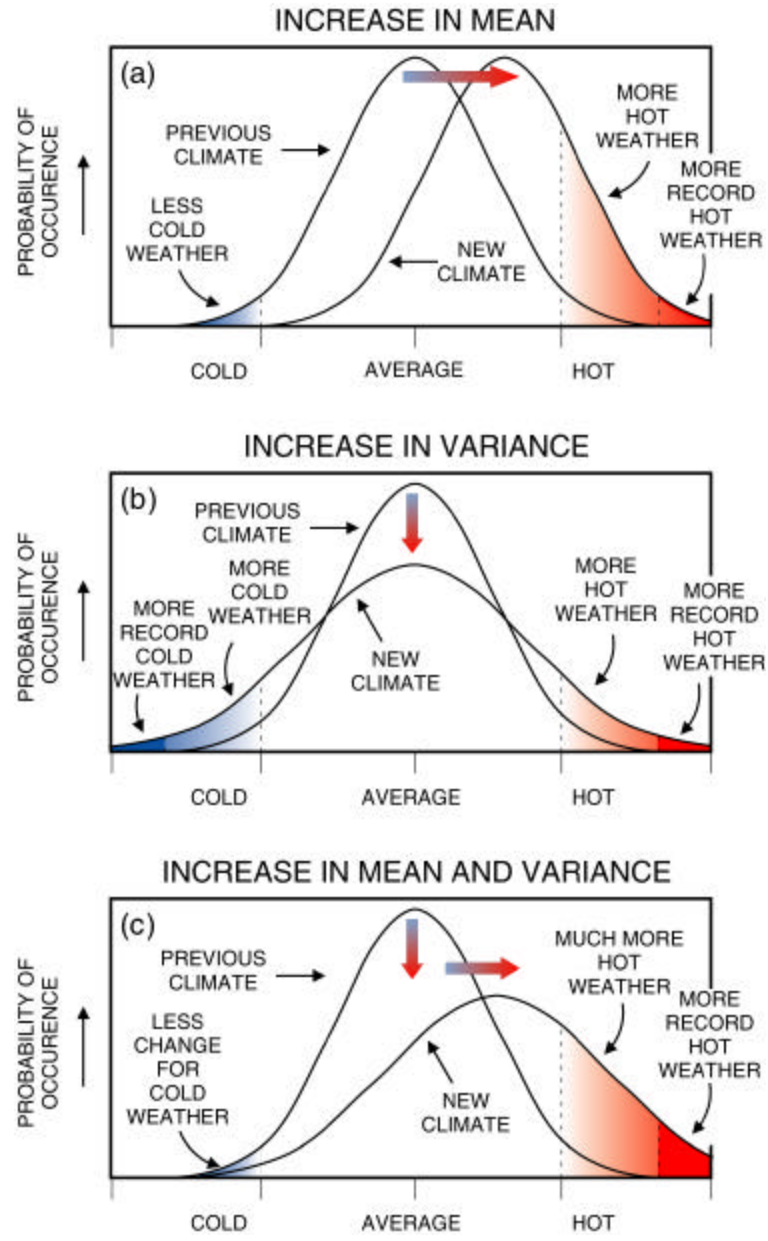
A2



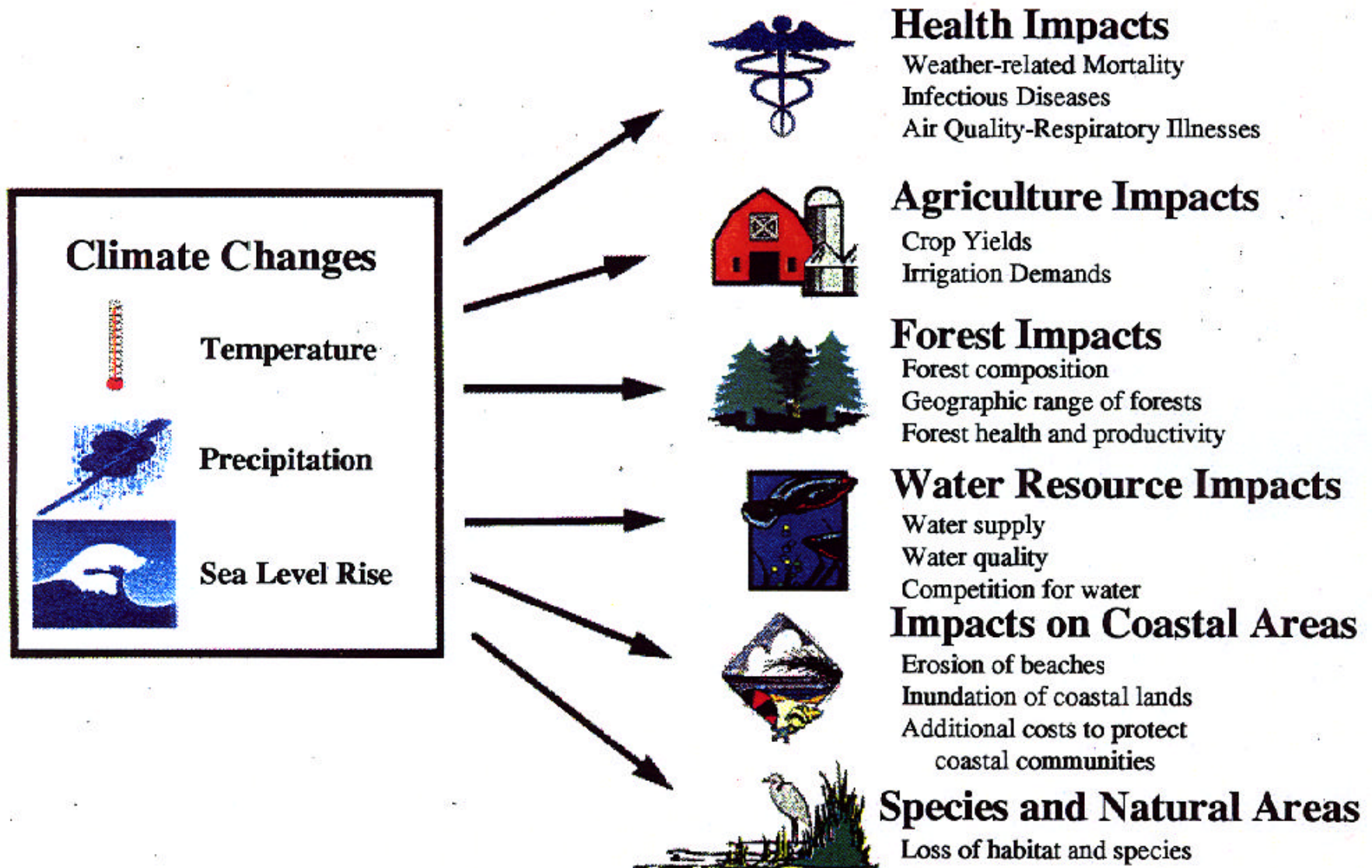
Key Conclusions from WG I

- An increase in extreme weather events
 - higher maximum temperatures, hot days and heat waves over nearly all land areas (*very likely*)
 - higher minimum temperatures, fewer cold days, frost days and cold spells over nearly all land areas (*very likely*)
 - more intense precipitation events over many areas (*very likely*)
 - increased summer drying over most mid-latitude continental interiors and associated risk of drought (*likely*)
 - increase in tropical cyclone peak wind intensity, mean and peak precipitation intensities (*likely*)
 - intensified floods and droughts associated with El-Nino events in many regions (*likely*)
 - increased Asian summer monsoon precipitation variability (*likely*)

Climate Extremes



Potential Climate Change Impacts



Vulnerability to Climate Change

- Vulnerability is a function of three factors
 - degree of climate change
 - sensitivity of a sector to a change in climate
 - adaptive capacity

Key Conclusions of WG II

- Projected **adverse** consequences of climate change
 - ↗ **decreased water availability** in many water scarce regions, especially in **arid and semi-arid lands in the sub-tropics**
 - ↗ **reduction in agricultural productivity**: (a) in the **tropics and sub-tropics** for almost any warming, and (b) in mid-latitudes for warming more than a few degrees
 - ↗ changes in the productivity and composition of **ecological systems**, with **coral reefs and forests** being most vulnerable
 - ↗ increased risk of **floods**, potentially displacing millions of people, due to sea level rise and heavy rainfall events, especially in **small island states and low-lying deltaic areas**
 - ↗ increased incidence of **heat stress** mortality, and the number of people exposed to **vector-borne diseases**, such as malaria and dengue and **water-borne diseases** such as cholera, especially in the **tropics and sub-tropics**

Key Conclusions of WG II Continued

- Projected **beneficial** consequences of climate change
 - ↑ increased **agricultural productivity** in some **mid-latitude regions** for increases in warming of up to a few degrees
 - ↑ increased **water availability** in some water-scarce regions, e.g., in **some parts of S. East Asia**
 - ↑ reduced **winter mortality** in **mid- and high-latitudes**
 - ↑ a potential increase in **global timber supply** from appropriately managed forests

Developing Countries are the Most Vulnerable to Climate Change

- Climate change is likely to impact disproportionately upon the poorest countries and the poorest persons within countries, and thereby exacerbate inequities in health status and access to adequate food, clean water and other resources.
- Net market sector effects are expected to be negative in most developing countries, **dominated by agricultural losses**, but mixed for developed countries for a warming of up to a few degrees Centigrade.
 - A warming of greater than a few degrees Centigrade is likely to result in net market sector effects becoming negative for most countries

Why Developing Countries Are More Vulnerable:

a) Impacts are worse



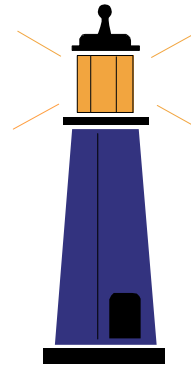
Closer to margin of tolerance

for temperature and precipitation changes (more drought- and flood-prone areas)



Economic structure

Larger share of the economy in climate sensitive sectors, such as agriculture



Coastal vulnerability

49 out of 50 countries with shore protection costs due to climate change above 0.5% of GDP are less developed countries



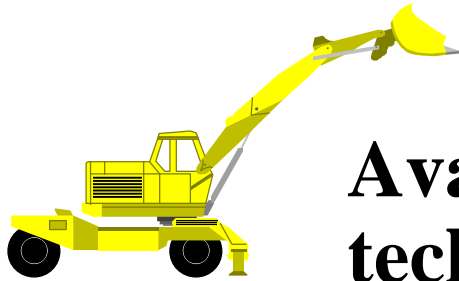
Poorer nutrition and health infrastructure

and therefore higher losses of human life



Why Developing Countries Are More Vulnerable:

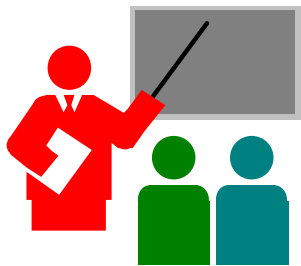
b) Lower capacity to adapt



**Availability of
technology**



**Institutional
capacity**

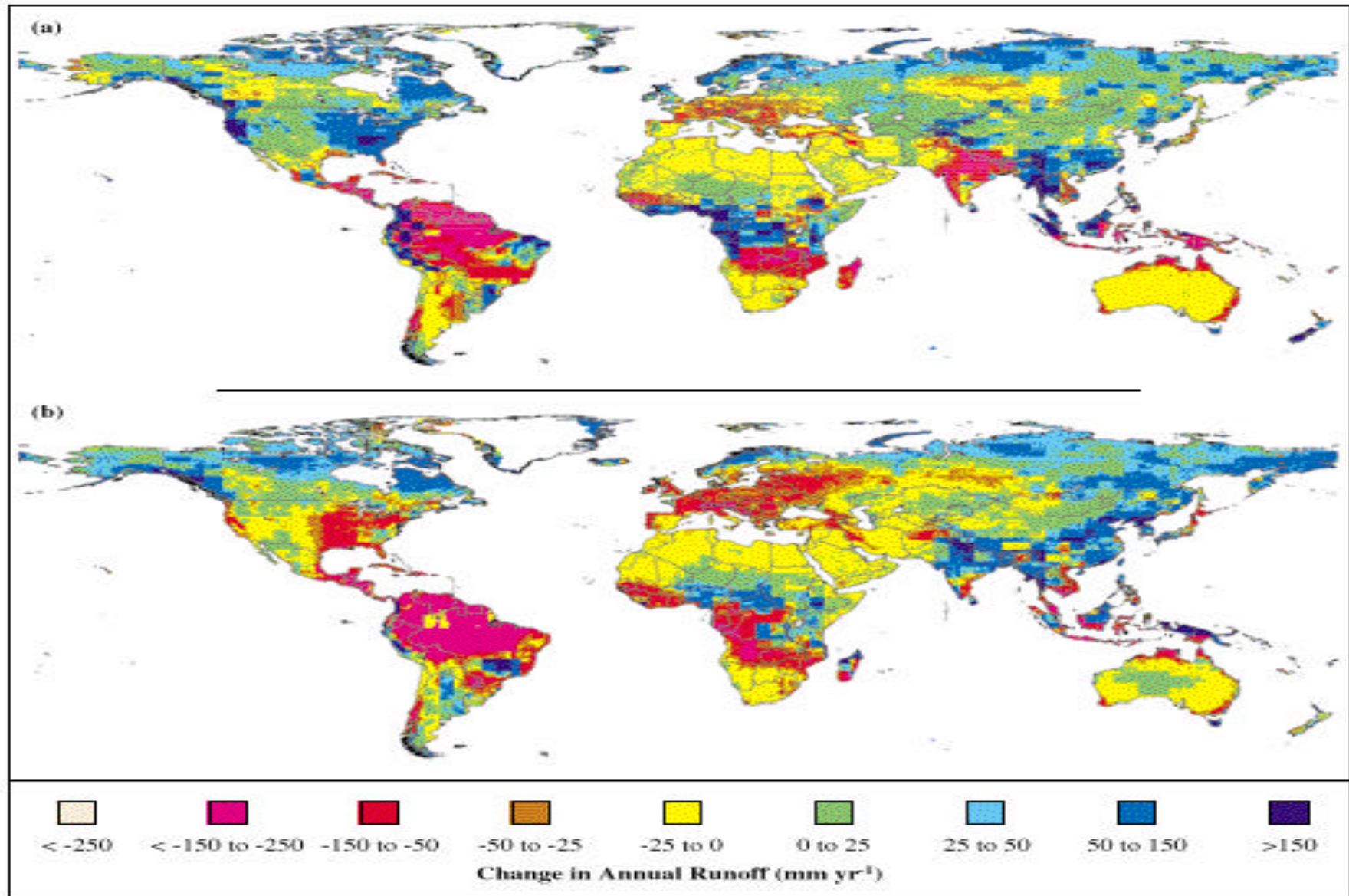


**Know-how
and education**

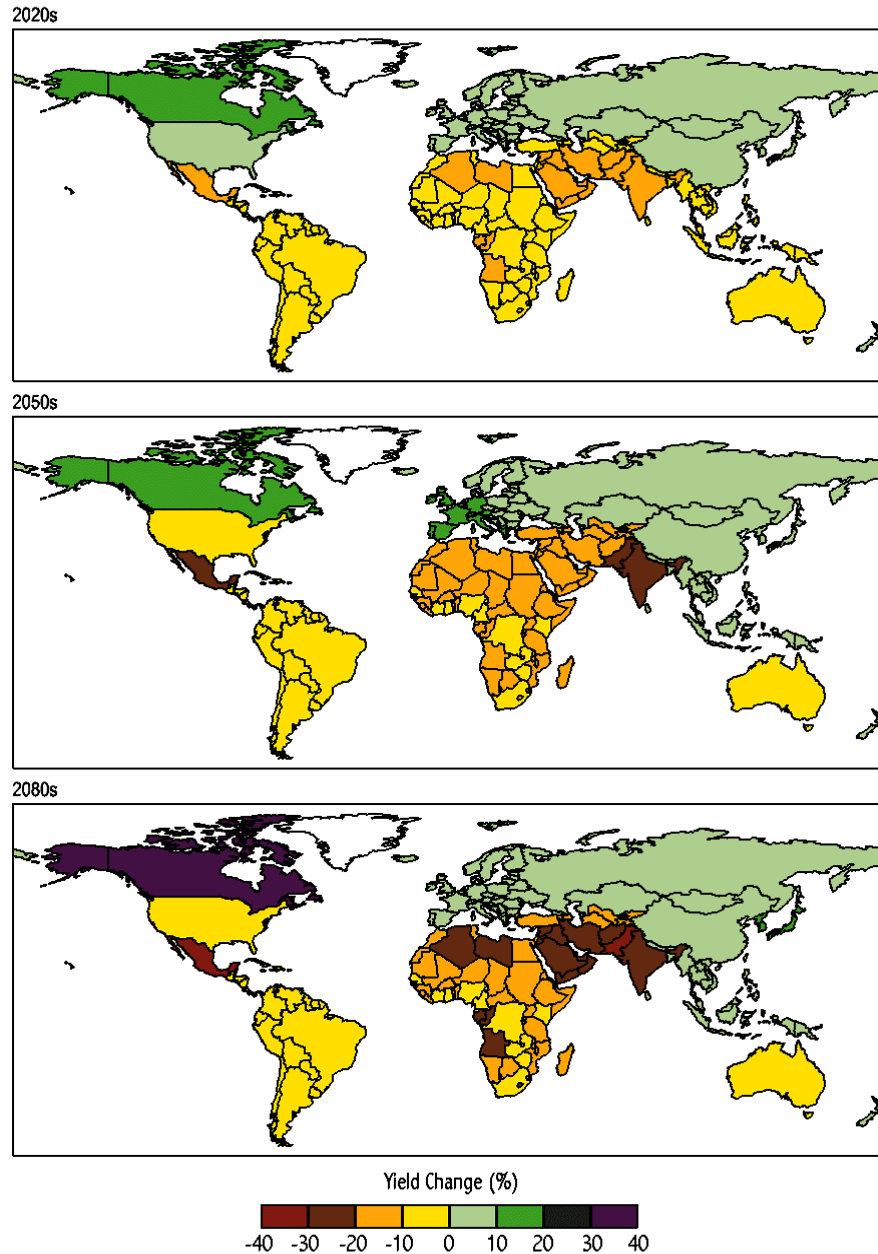


**Financial
capacity**

Projected Change in Run-Off by 2050 relative to 1961-1990



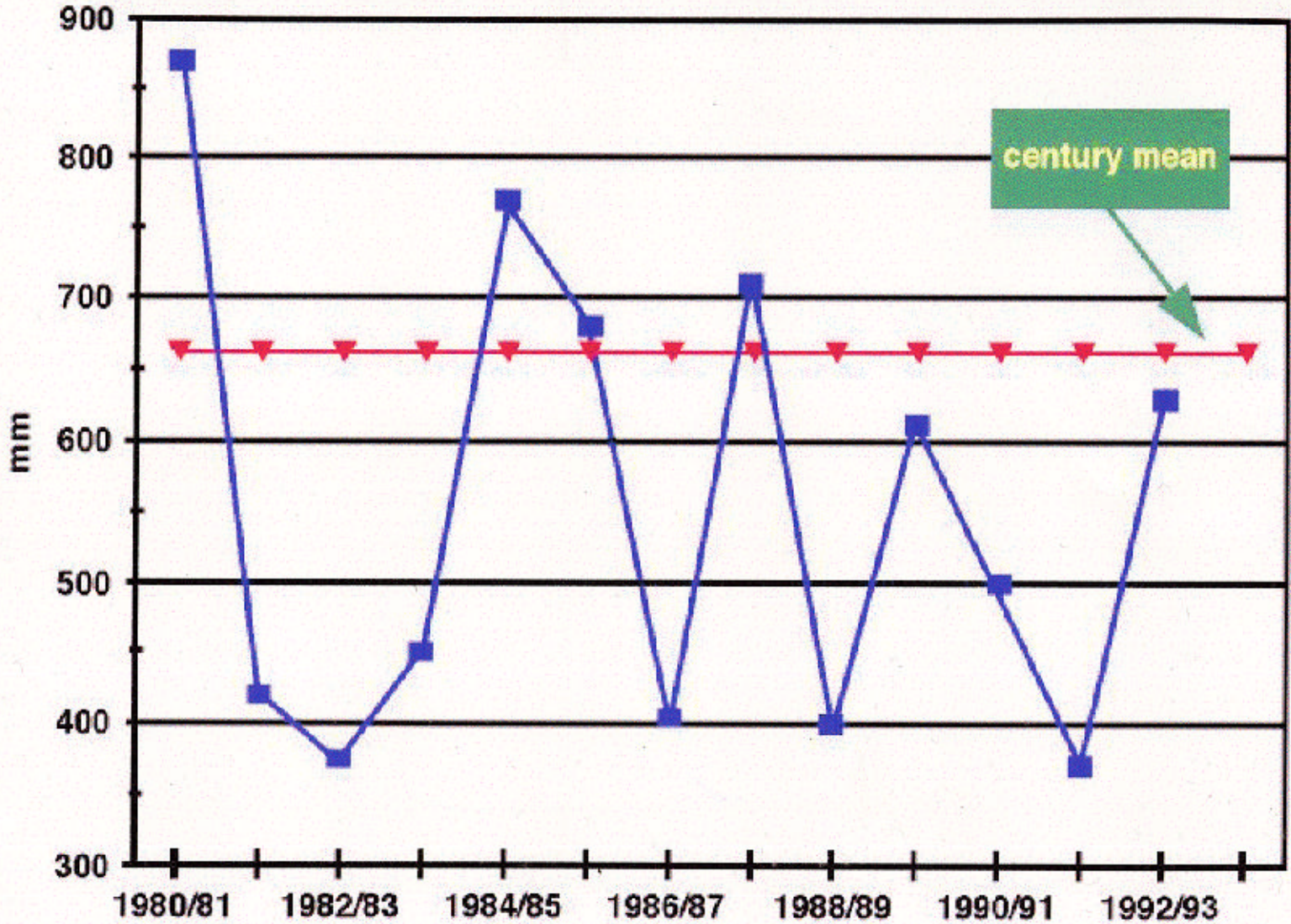
Crop Yield Change



Percentage change in average crop yields for the climate change scenario. Effects of CO₂ are taken into account. Crops modeled are: wheat, maize and rice.

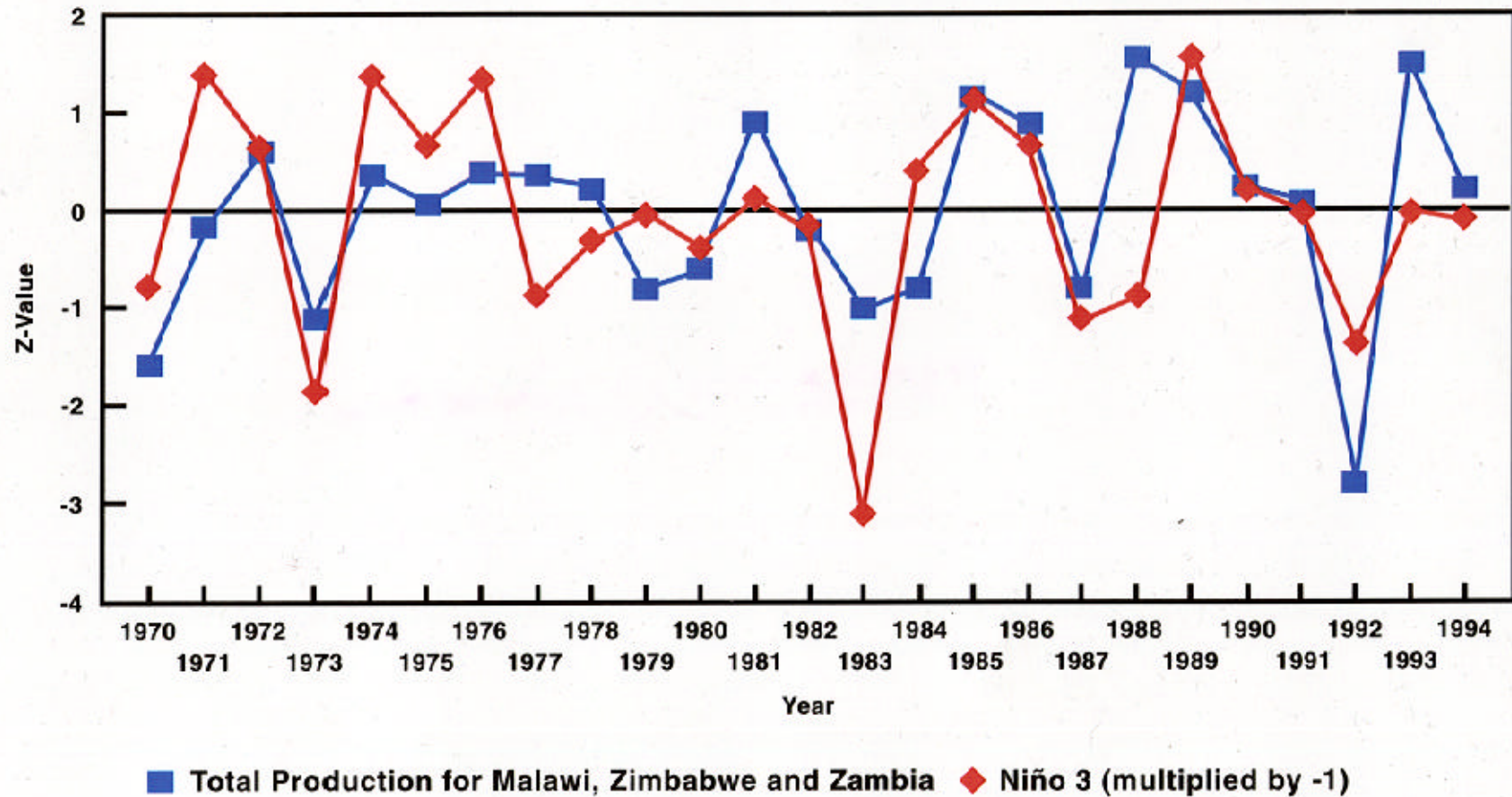
Jackson Institute, University College London / Goddard Institute for Space Studies / International Institute for Applied Systems Analysis

Zimbabwe's Rainfall Record 1980-1993



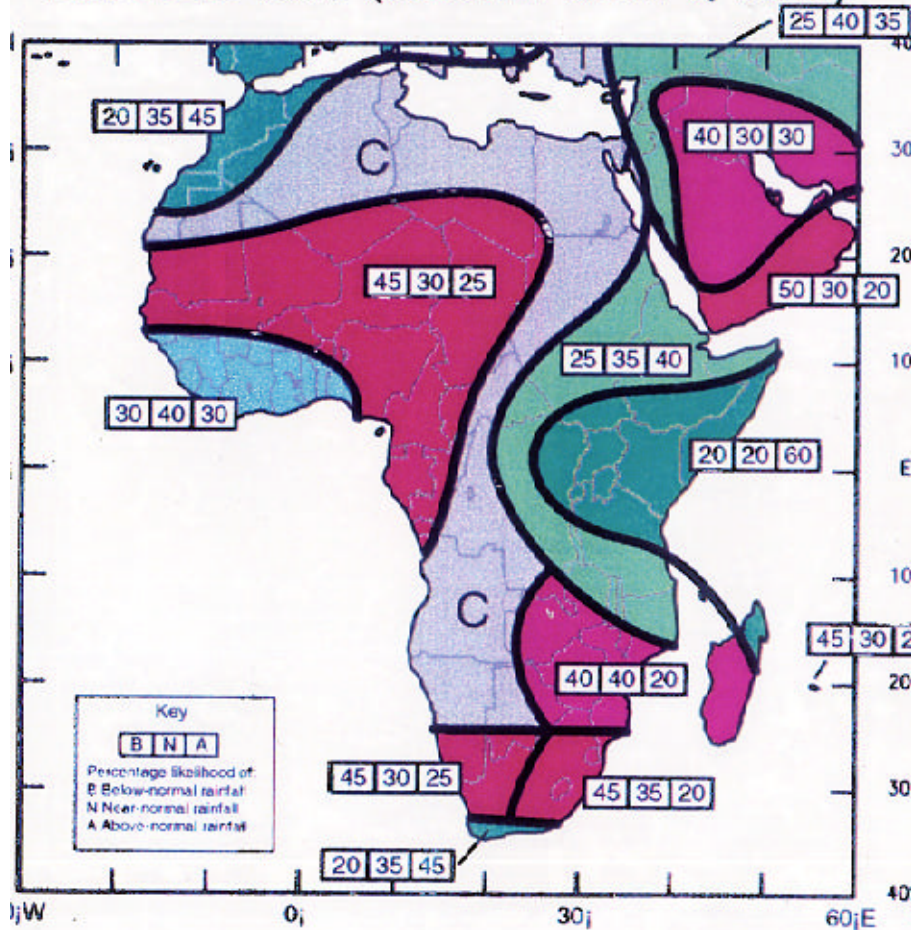
Source: US Mission

Maize Production in Selected Southern African Countries* versus Niño 3 Data Malawi, Zimbabwe, Zambia 1970-1994

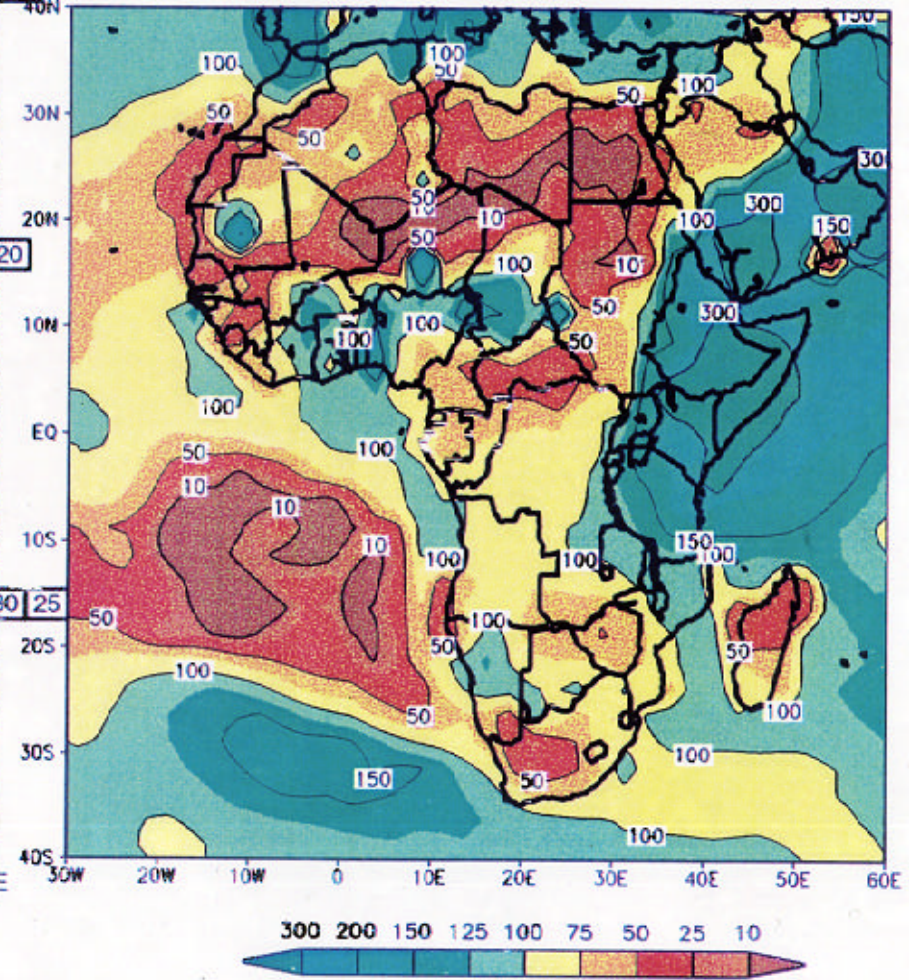


* The selected countries are agriculturally based economies.

IRI RAINFALL FORECAST FOR OCT-DEC 1997 (ISSUED OCT. 1, 1997)



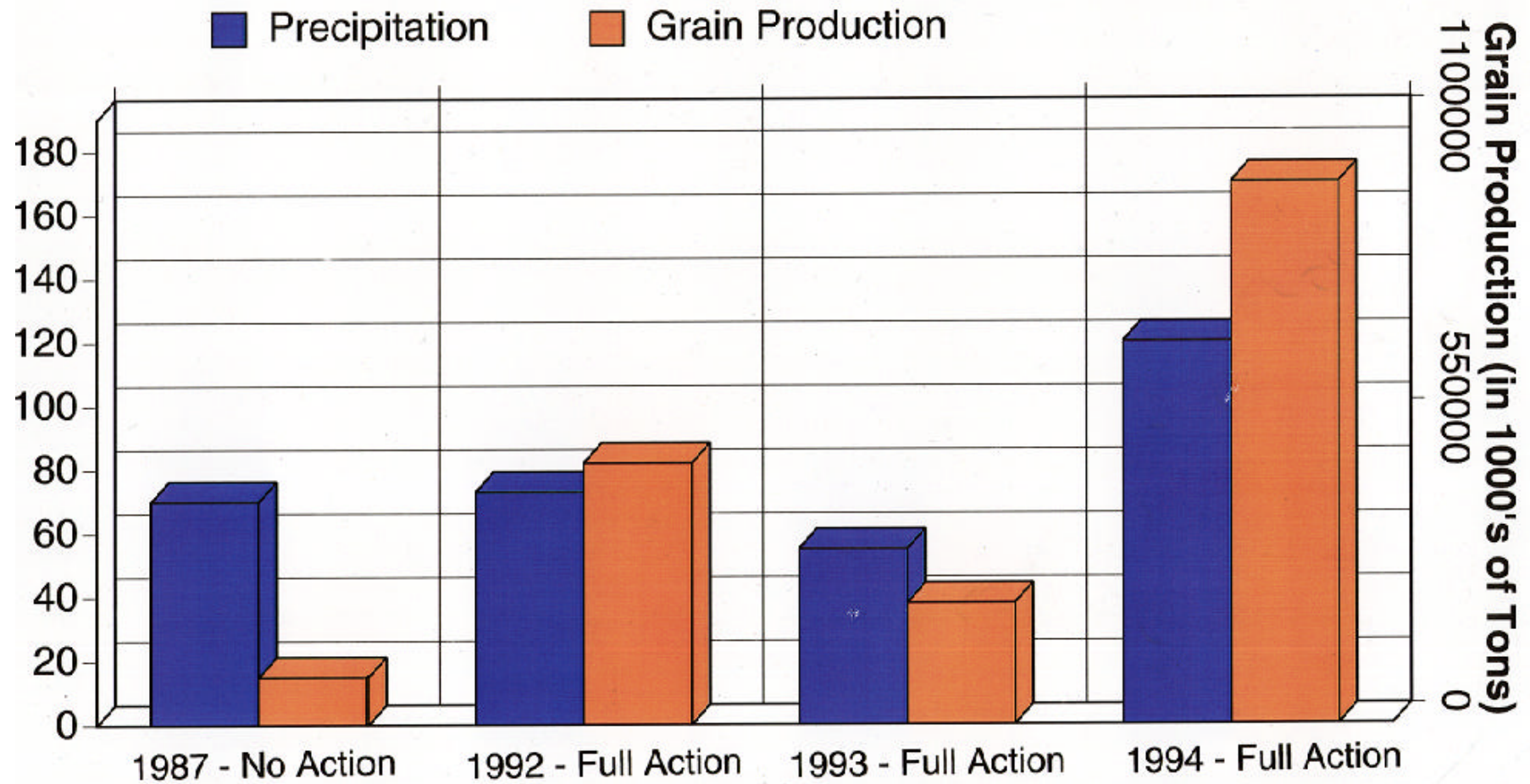
OBSERVED RAINFALL FOR OCT-DEC 1997 (NCEP/CPC)



http://iri.ucsd.edu/forecast/net_asmt

Source: IRI (International Research Institute for Climate Prediction
 Experimental Climate Forecast Division)

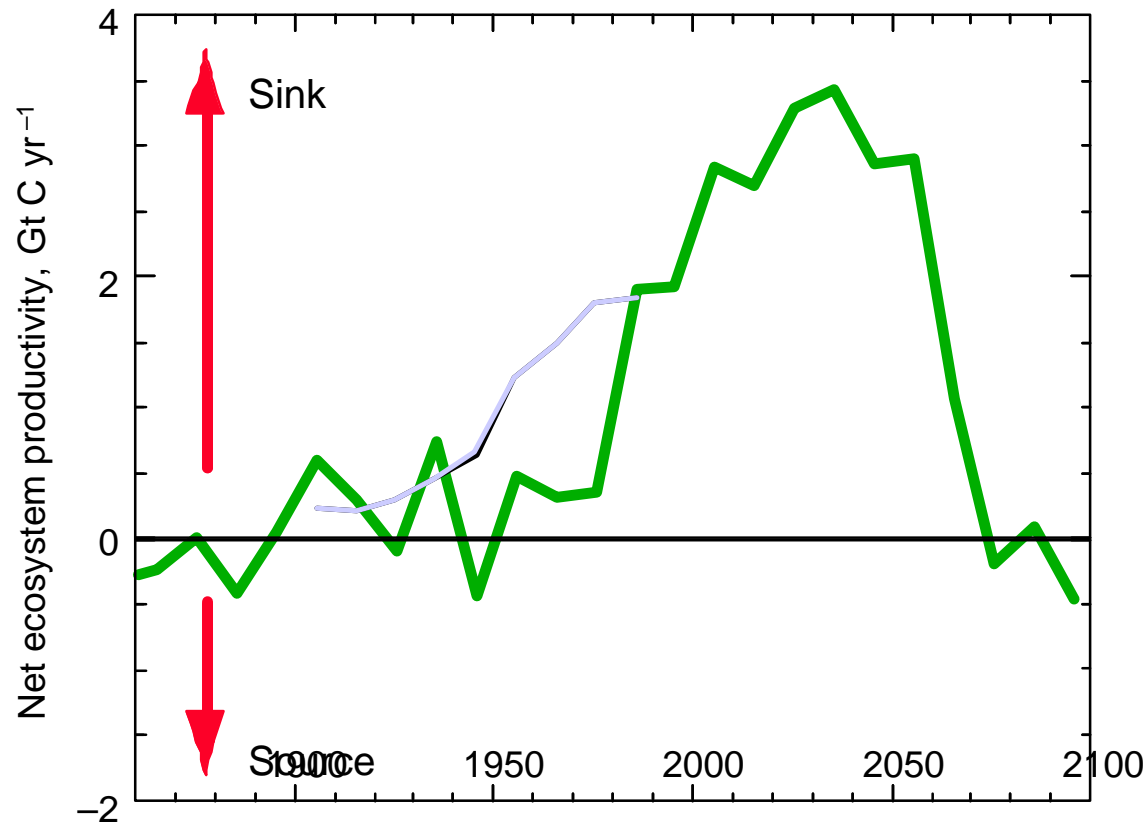
Applications of Experimental Climate Forecasts in NE Brazil



Climate Change and Ecological Systems

- Biological systems have already been affected by changes in climate at the regional scale
- The structure and functioning of ecological systems will be altered and the biological diversity will decrease, especially in niche systems, e.g., alpine and arctic
 - ↑ forests, especially tropical and boreal forests are vulnerable due to changes in disturbance regimes (pests and fires), very likely to change species composition
 - ↑ coral reefs are threatened by increases in temperature, more than increases in sea level - increased mortality
 - ↑ the current terrestrial uptake of carbon will likely diminish over time and forest systems may even become a source of carbon

Global Net Ecosystem Productivity



Predicted effects of changes in climate and atmospheric CO₂ on global net ecosystem productivity (i.e. the rate of increase in the terrestrial carbon store) showing when the land surface is a sink or source of carbon. Also shown is the estimated carbon sink (orange) required to balance the global carbon budget in atmosphere–ocean models, 1900–1990.

Co-Benefits - Adaptation

- Many sectors (e.g., water resources and agriculture) are vulnerable to natural climate variability, e.g., floods and droughts associated with ENSO events
- Identify technologies, practices and policies that can reduce the vulnerability of sectors to natural climate variability and can increase resilience to long-term climate change
 - ↑ incorporate modern scientific forecasts of ENSO events into sector management decisions
 - ↑ integrated multi-sector watershed management and appropriate water pricing policies
 - ↑ elimination of inappropriate agricultural subsidies

Key Uncertainties --- Impacts and Adaptation

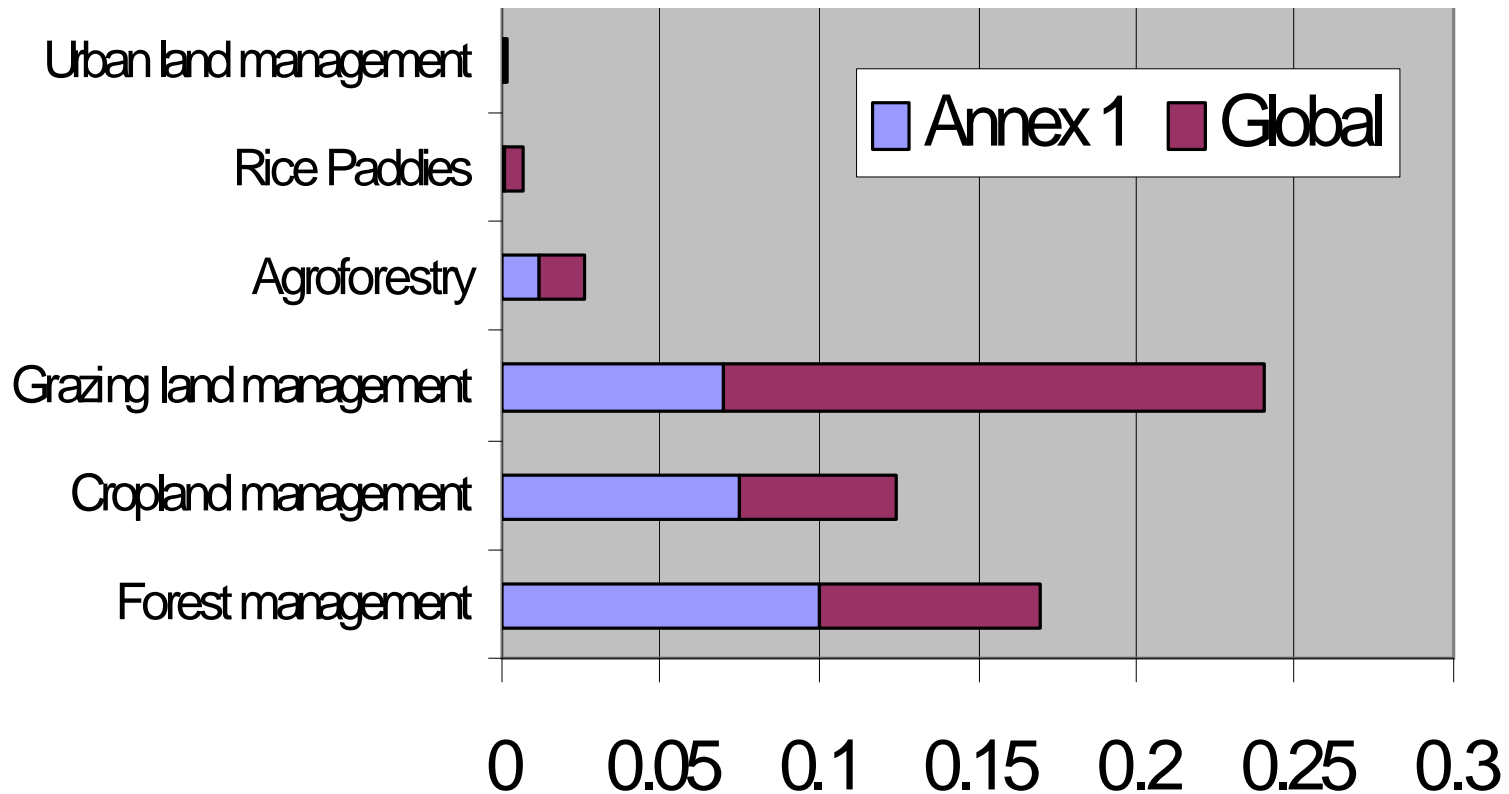
- The response of agricultural, pastoral and forest systems to **simultaneous** changes in atmospheric and climatic parameters:
 - carbon dioxide -- **are there saturation effects, if so at what concentration level**
 - mean temperature and its variability (day-night and summer-winter ratios)
 - mean precipitation and its variability
 - other factors, including tropospheric ozone, UV-B and acid deposition
- The impact of changes in climate and atmospheric composition on:
 - disturbance regimes, including fires and **pest outbreaks**
- Adaptation options
 - planting times
 - crop selection
 - irrigation
 - fertilization
 - new cultivars -- **the role of biotechnology, including transgenic crops**

Mitigation Options

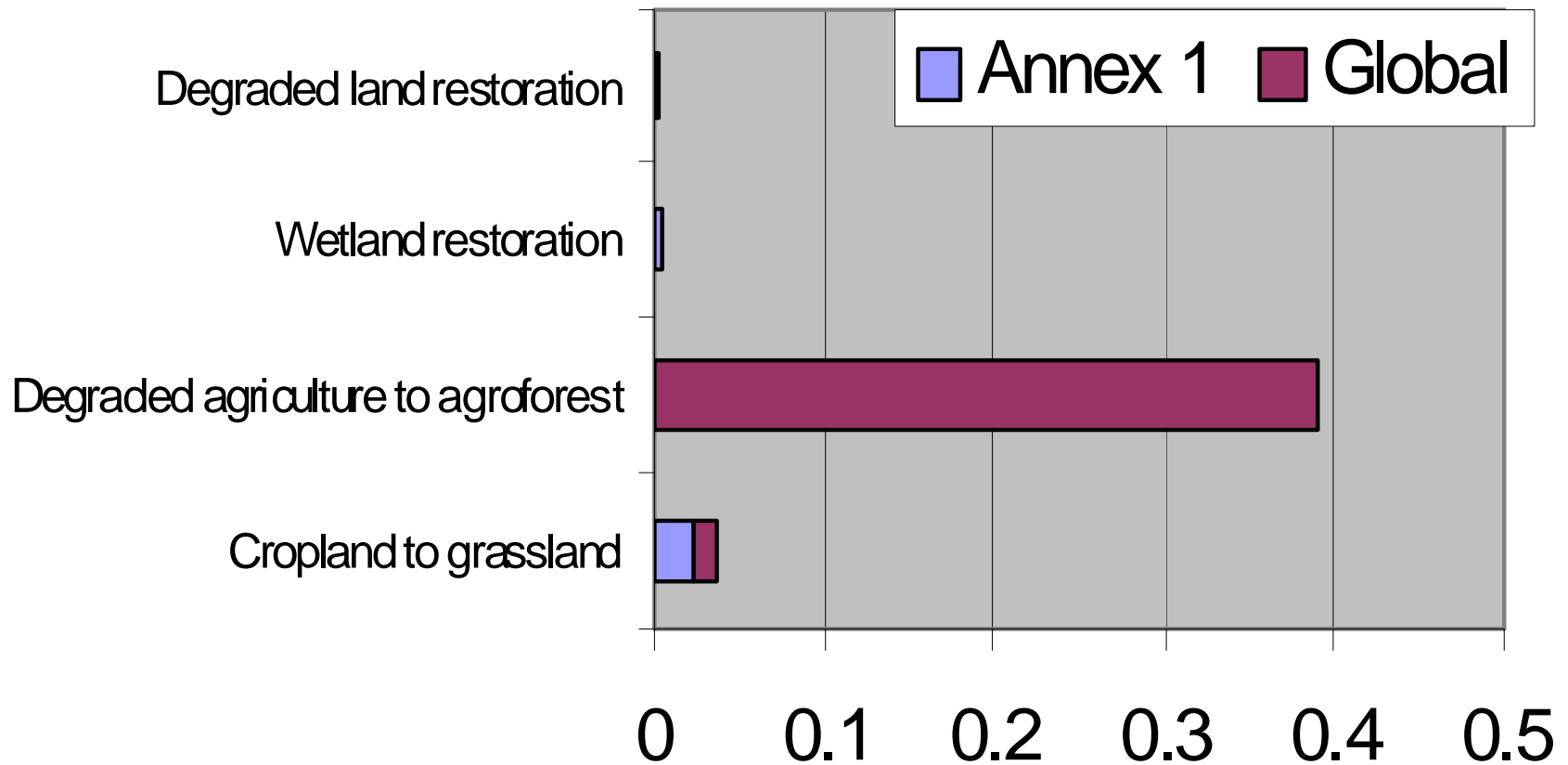
- **Energy - both supply and demand-side**
- **Waste Management and Reduced Halocarbon Emissions**
- **Land-Use, Land-Use Change and Forestry**
 - ↳ **Afforestation, Reforestation and slowing Deforestation**
 - ↳ **Improved Forest, Cropland and Rangeland Management**
 - ↳ **Agroforestry**
- **LULUCF activities have significant potential in both developed and developing countries, therefore part of the solution, especially in the near term**

Annual C Sequestration Potential (GtC/y)

Improvement of Management within Cover Type



Annual C Sequestration Potential (GtC/y) Transformation Between Cover Types



Key Uncertainties --- Mitigation

- The potential for agricultural systems, rangelands and forests to sequester carbon
 - response functions for different ecosystems for different management practices
 - amount of land available for each type of management activity
 - barriers and opportunities that control the rate of adoption of changed management practices by farmers and foresters
 - institutional barriers
 - financial barriers
 - knowledge barriers
 - how to address issues of permanence, leakage, baselines, and sustainability criteria
 - whether and to what extent these activities will be eligible activities under the CDM

LULUCF Mitigation Options

LULUCF activities and projects can have a broad range of environmental, social and economic impacts, e.g.,

↑ Biodiversity

↑ Forests, soils and water resources

↑ Food, fiber and fuel

↑ Employment, health, poverty and equity

Criteria and Indicators for LULUCF Activities

- **A system of criteria and indicators could be valuable to compare sustainable development impacts across LULUCF alternatives**
- **Criteria and indicators developed for other purposes might be adapted for this purpose**
 - **U.N. Commission on Sustainable Development**
 - **Indicators of sustainable forest management, sustainable agriculture**
 - **Environmental and social safeguard policies, e.g., those developed at the World Bank - natural habitats, etc.**
- **If sustainable development criteria vary significantly across countries or regions, there may be incentives to locate activities and projects in countries or regions with less stringent criteria**

Key Issues for the CGIAR

- A Global Challenge program on climate would build upon the underlying core competencies of the CGIAR system
- The program should be a partnership program, fully competitive within the CGIAR system using an independent transparent peer-review process, and include an external grants component
- Needs to be an integrated program with well defined priorities
 - **impact** of climate change on agriculture, forests, livestock, fisheries
 - **adaptation** strategies
 - **mitigation** strategies

Key Issues for COP-6bis

- **Flexibility mechanisms**
- **LULUCF**
- **Technology transfer**
- **Capacity-building**
- **Financing**
- **Adaptation**

Key Flexibility Mechanism Issues at COP-6

which affect the size of a potential CDM LULUCF market

- **capped or uncapped markets**
- **secondary markets**
- **liability** if a seller fails to deliver, i.e., seller vs buyer beware
- **open market or regional allocations** (ability of Africa and small countries to access the market)
- **eligibility of LULUCF activities in CDM** (next slide)

Key LULUCF Issues at COP-6

these issues will affect size of the CDM market for LULUCF

- Which, if any, LULUCF activities are eligible in the CDM
 - afforestation, reforestation, **slowing deforestation**, forest/rangeland/cropland management, agroforestry
- Whether to limit credits under Articles 3.3, 3.4 and CDM
- Whether Business-as-usual uptake can be credited under Article 3.4

Climate Change and Biodiversity

Assessment of Knowledge

- The **IPCC** has been requested to prepare a technical paper for the CBD on:
 - the impact of climate change on biodiversity
 - the impact of changes in biodiversity on climate
 - the impact of climate change mitigation activities (LULUCF) on biodiversity
 - the impact of climate change adaptation measures on biodiversity
- The **Millennium Ecosystem Assessment** will address the past, present and future condition of ecological systems, their goods and services, and will address the multiple stresses on these systems, including climate change.