Climate Change and Food Security

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Madrid

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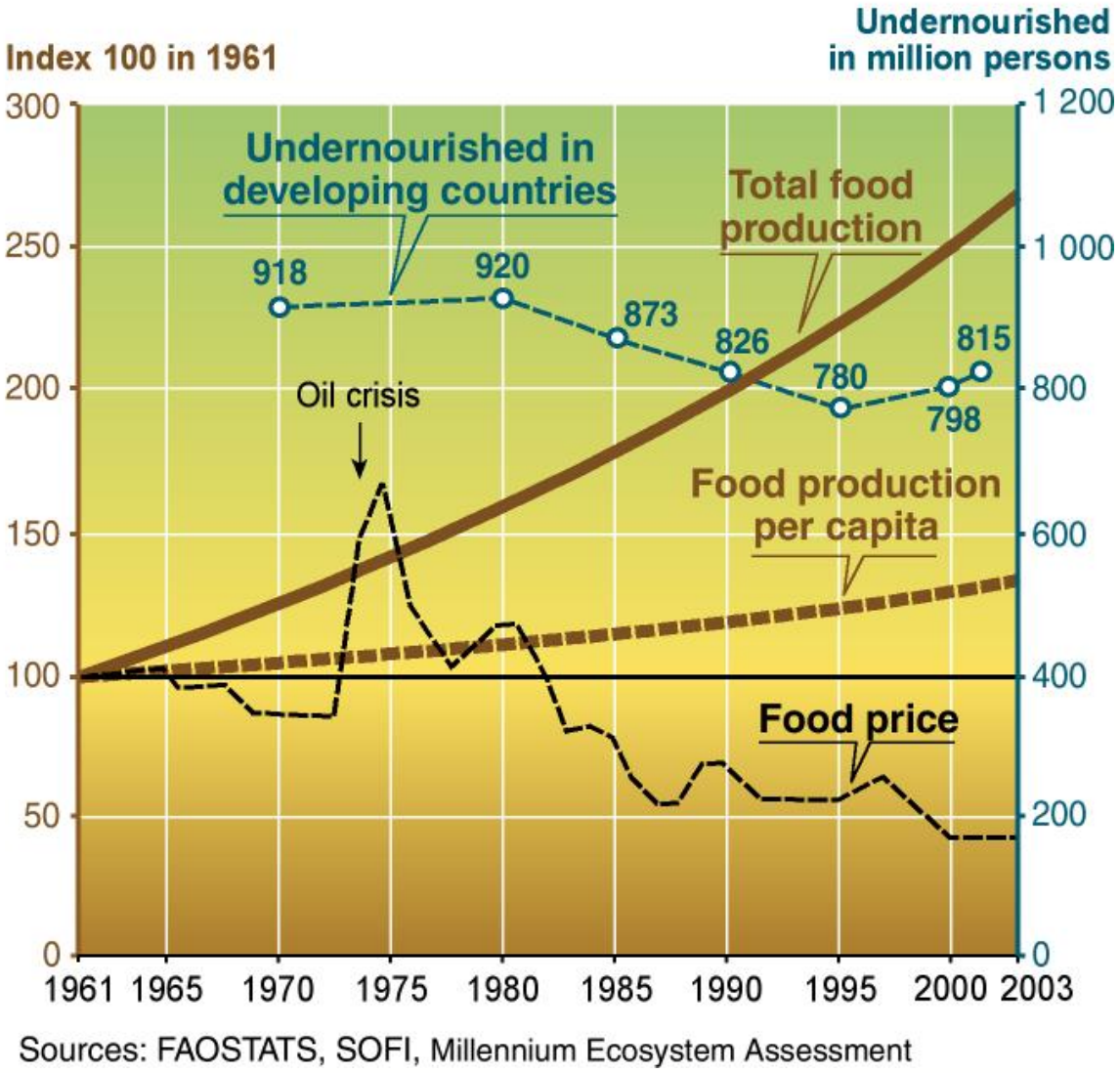
Current situation

FAO recently announced that the number of undernourished people in mid-2009 exceeded 1billion due to the global economic recession and the cereal price rise in 2008/2009



So what is the problem?

People have benefited unevenly from these yield increases across regions, in part because of different institutional and policy environments

Emphasis on increasing yields and productivity has in some cases had negative consequences on environmental sustainability – soils, water, biodiversity, climate change

Uneven production gains

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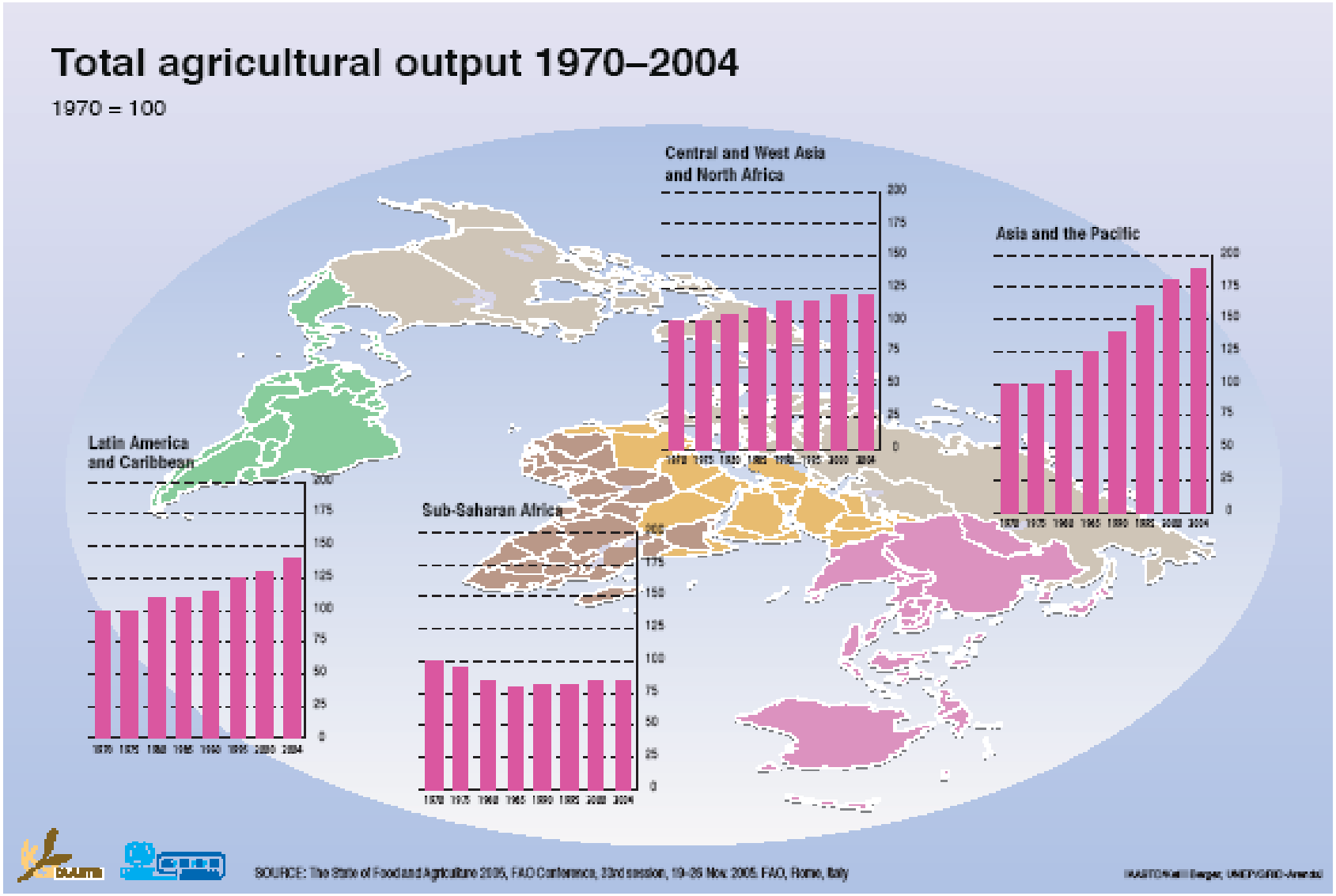

Child malnutrition

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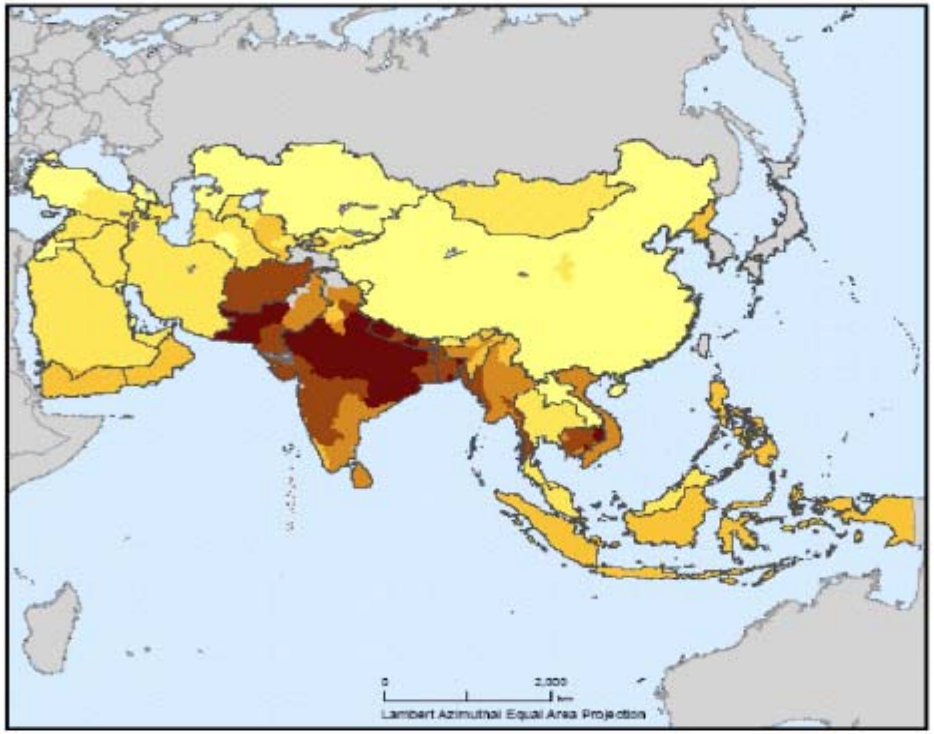

Asia
By Subnational Administrative Level

Measures of Poverty
Child Malnutrition
Children are defined as underweight if their weight-for-age z-scores are more than two standard deviations (2 SD) below the median of the NCHS/CDC/WHO International Reference Population.

Percent of Children Age 0-5 Underweight
less than 10.0
10.1 - 20.0
20.1 - 30.0
30.1 - 40.0
40.1 - 50.0
more than 50.0
No Data
National boundary

Subnational boundaries have been removed from countries for clarity.

Underlying causes of recent food price increases

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- Increased demand and changing diets from rapidly developing countries, e.g., China
- Poor harvests due to variable weather - possibly related to human-induced climate change
- Increased use of biofuels, especially maize in the US
- High energy prices, hence fertilizer prices
- Export bans from some large exporting countries
- Speculation on the commodity markets

Key question is whether these factors will continue to be important in the future?

Future Challenges

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- 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 (crops, livestock, fisheries, forests, biomass, and commodities):
  - to feed the world
  - to enhance rural livelihoods
  - to stimulate economic growth

- Meet food safety standards
  - **environmentally and socially sustainable manner**

Food demand is changing

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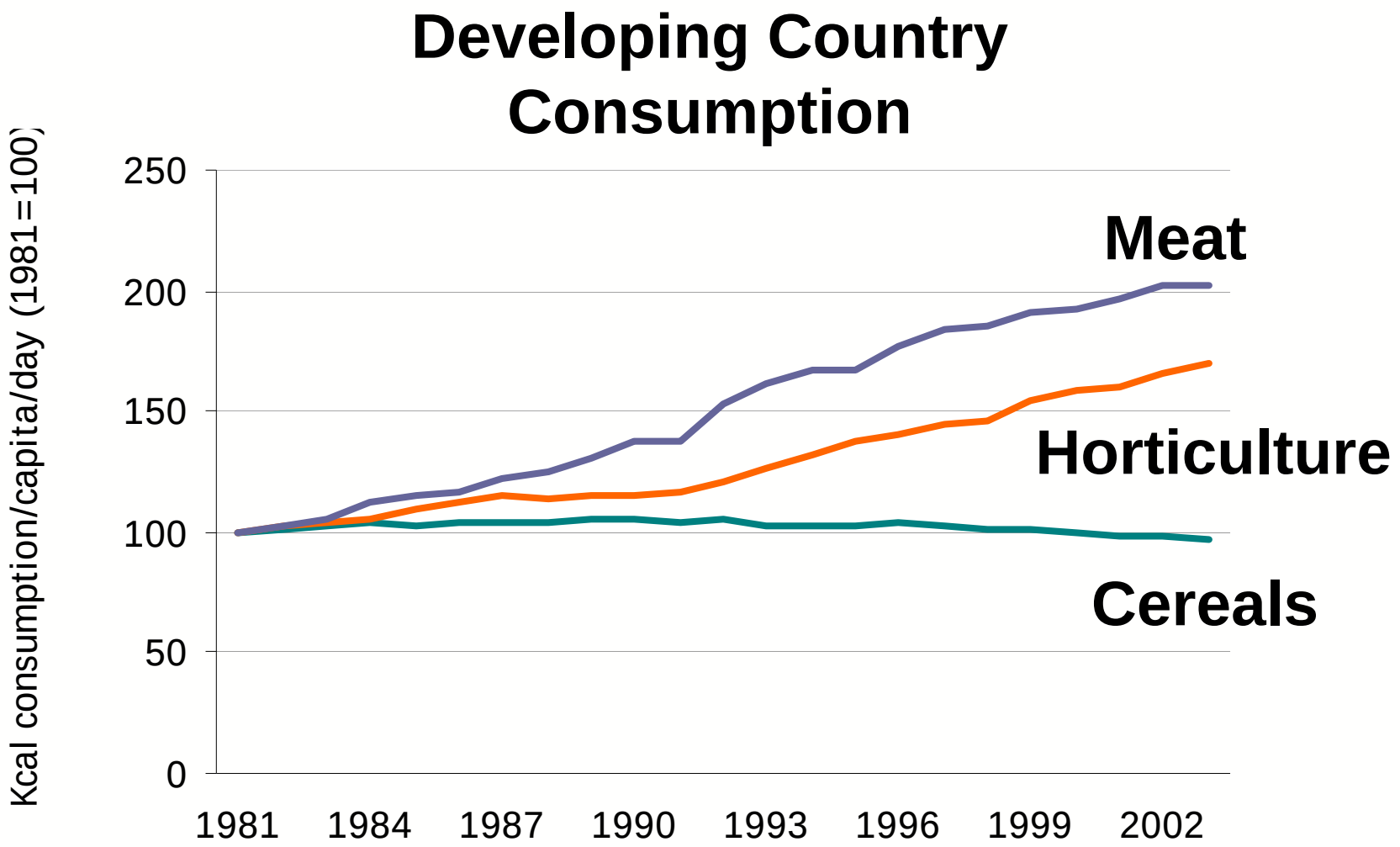
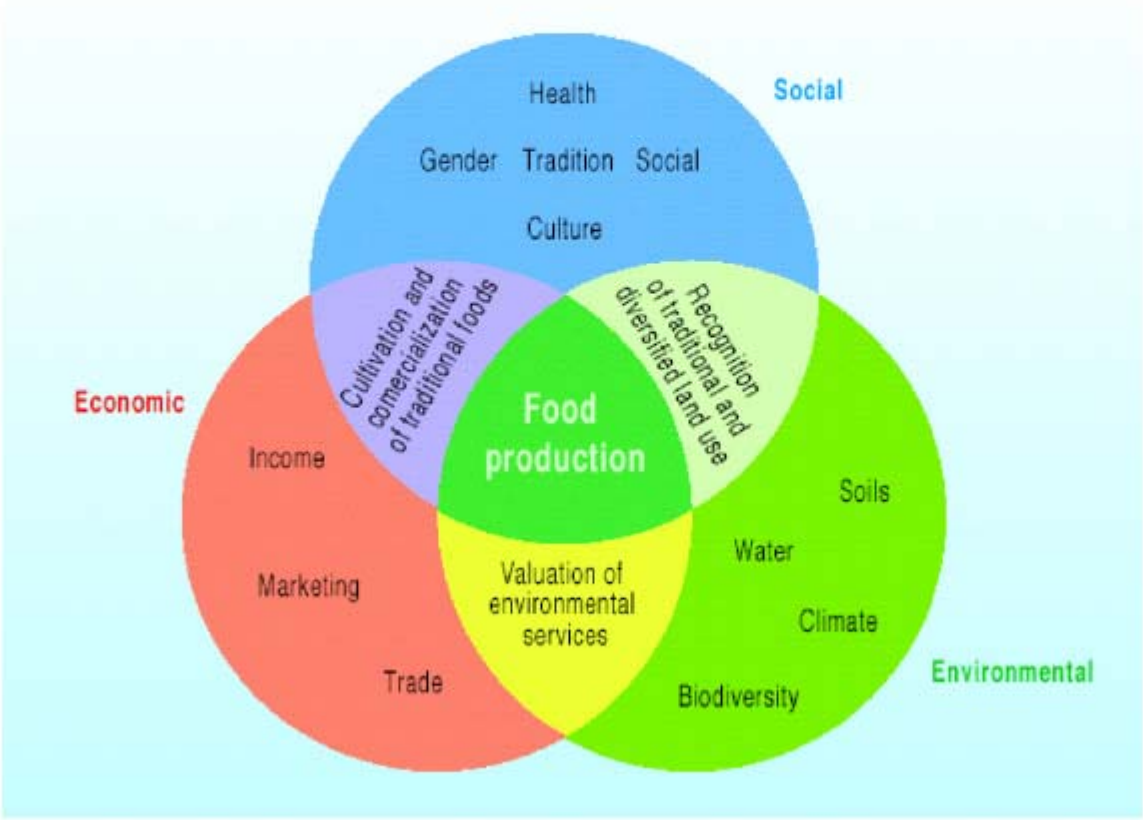


Multi-functional Agriculture

The inescapable interconnectedness of agriculture's different roles and functions



The Context - Limitations

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- **Less labor - diseases and rural to urban migration**
- **Less water – competition from other sectors**
- **Less arable land – competition, e.g., bio-energy**
- **Yield increases are slowing dramatically**
- **Increasing land policy conflicts**
- **Loss of biodiversity: genetic, species and ecosystem**
- **Increasing levels of pollution – ozone and acid deposition**
- **A changing climate**

Can 1st Generation Biofuels be Sustainable?

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- **Two major sources of biofuels**
  - Bioethanol from sugar and maize
  - Biodiesel from palm oil, soy and rapeseed
- **Rarely economic - normally heavily subsidized – issue of co-products key**
- **Serious questions regarding environmental sustainability**
  - Greenhouse gas emissions - direct and indirect emissions
  - Loss of biodiversity, soil and water degradation
- **Serious Questions regarding social sustainability**
  - Competition for land - food price increases
  - Involuntary displacement of small-scale farmers by large-scale plantations

Need enforeable sustainability criteria for first generation biofuels and an aggressive R&D program in second and third generation biofuels to assess their economic, environmental and social sustainability

Cereal Yield Increases

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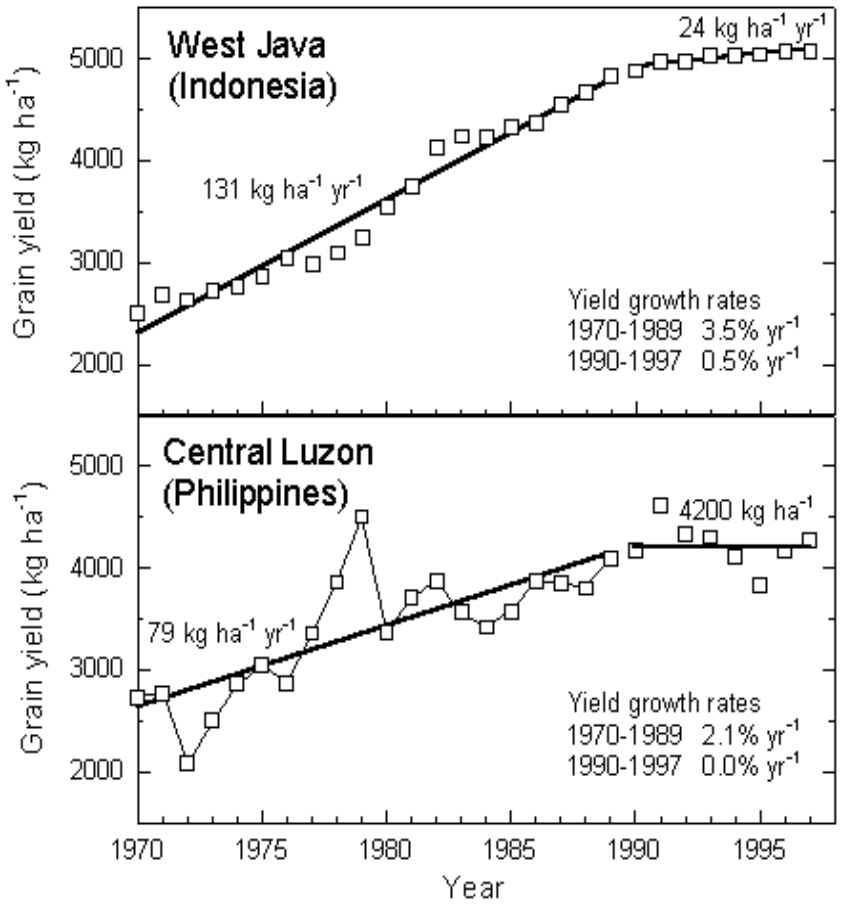

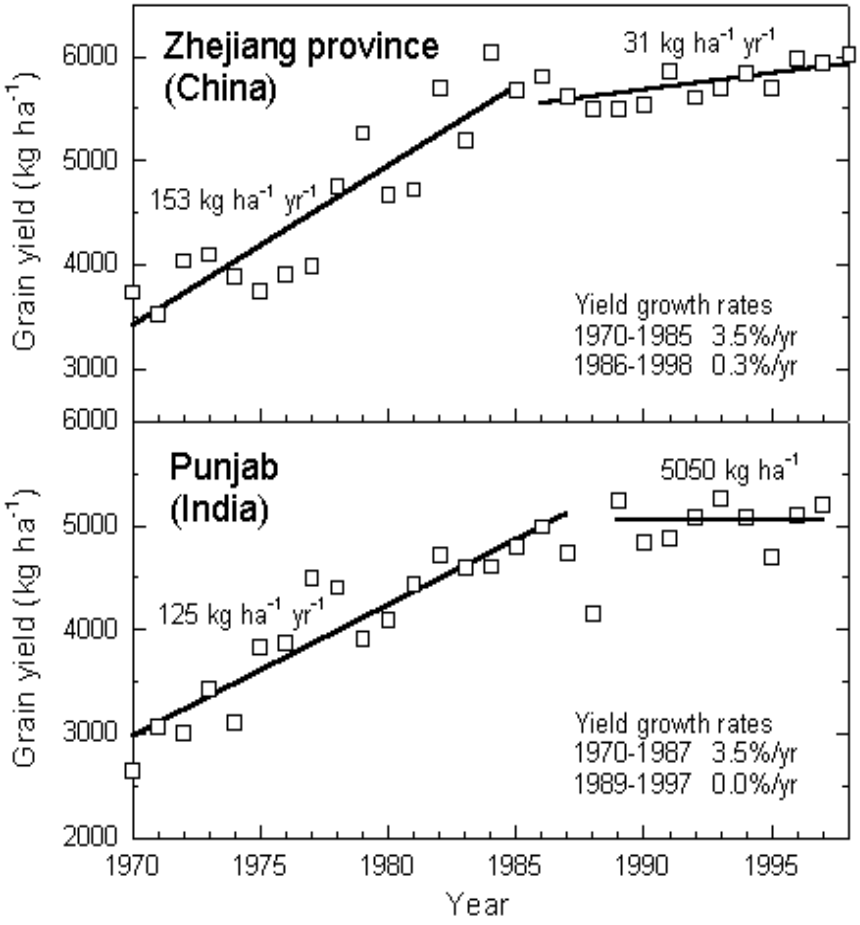

Fisheries Collapse

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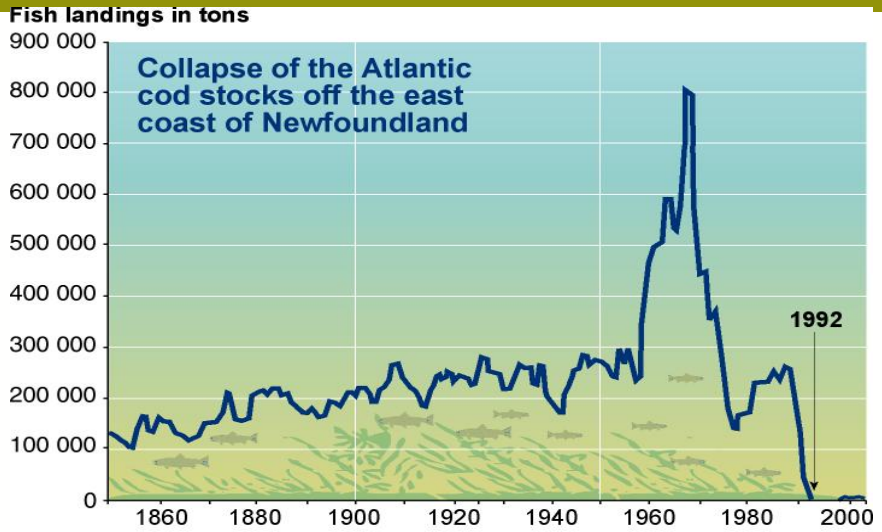
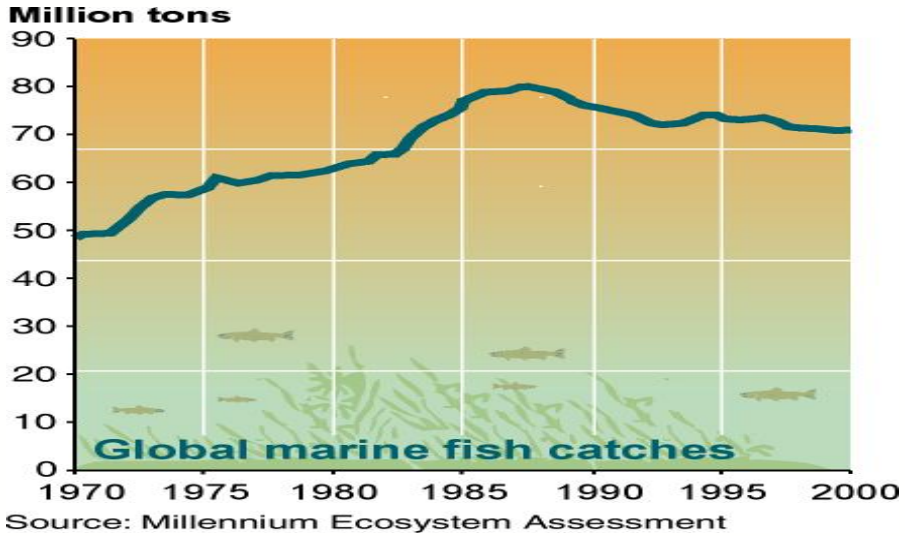
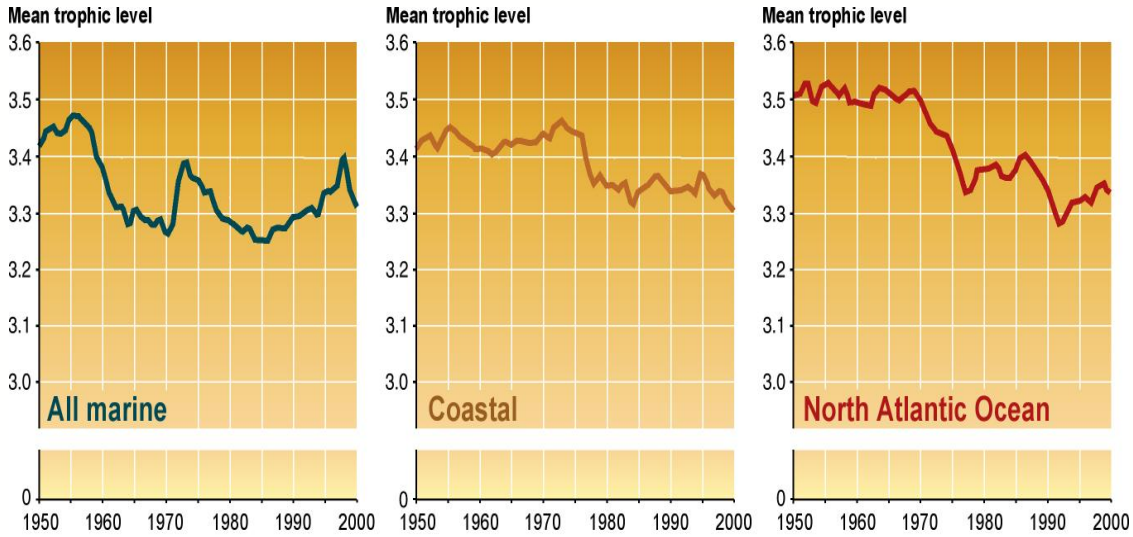


Source: Millennium Ecosystem Assessment

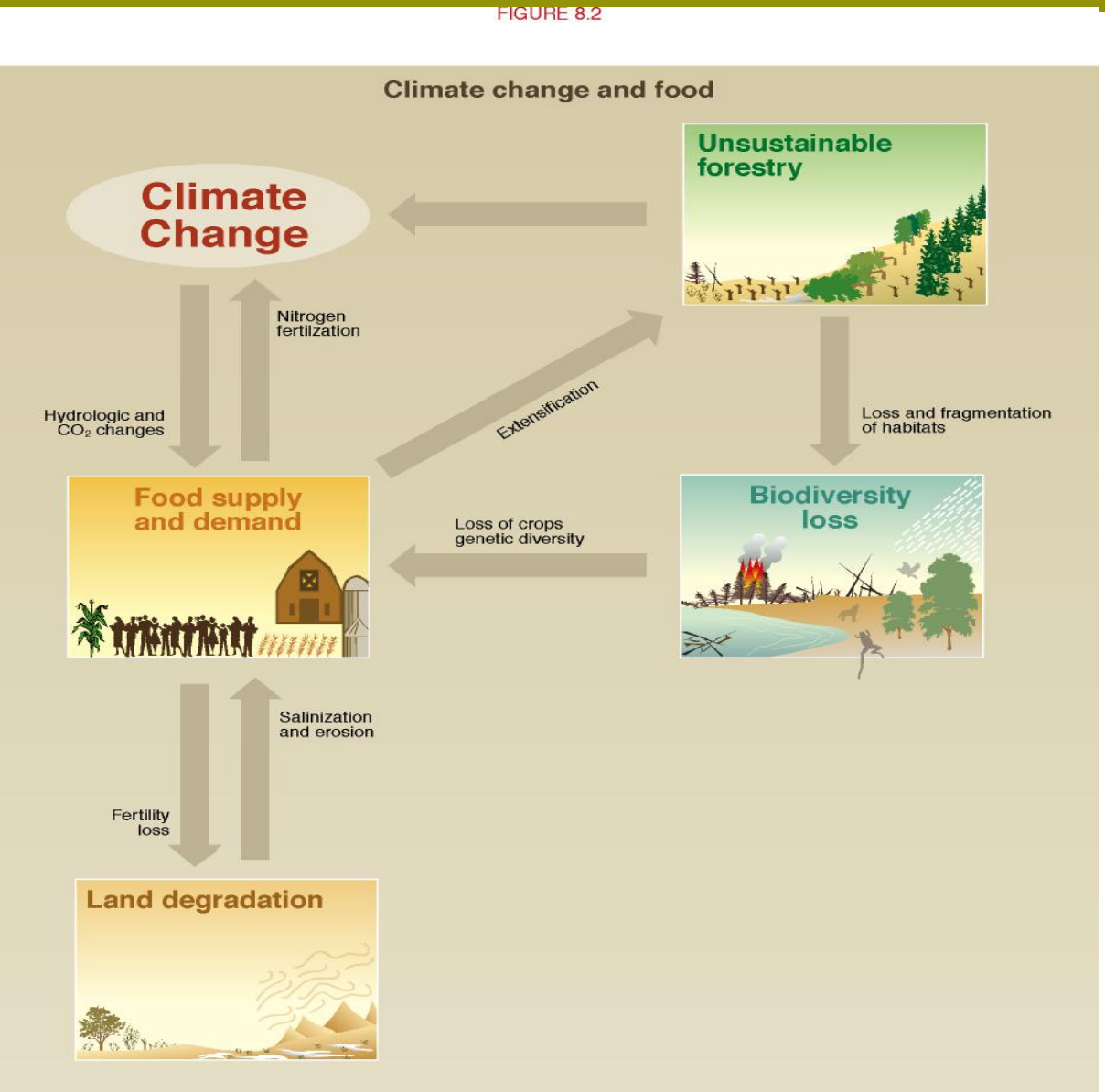


Source: Millennium Ecosystem Assessment



Source: Millennium Ecosystem Assessment

Agriculture and Environmental Degradation



Can crop, animal and fish traits be improved to address the projected changes in climate – what are the roles of traditional breeding and modern forms of biotechnology?

How will the loss of genetic diversity affect future agriculture?

Can soil degradation be reversed and productivity enhanced?

Food Security: The Big Challenges

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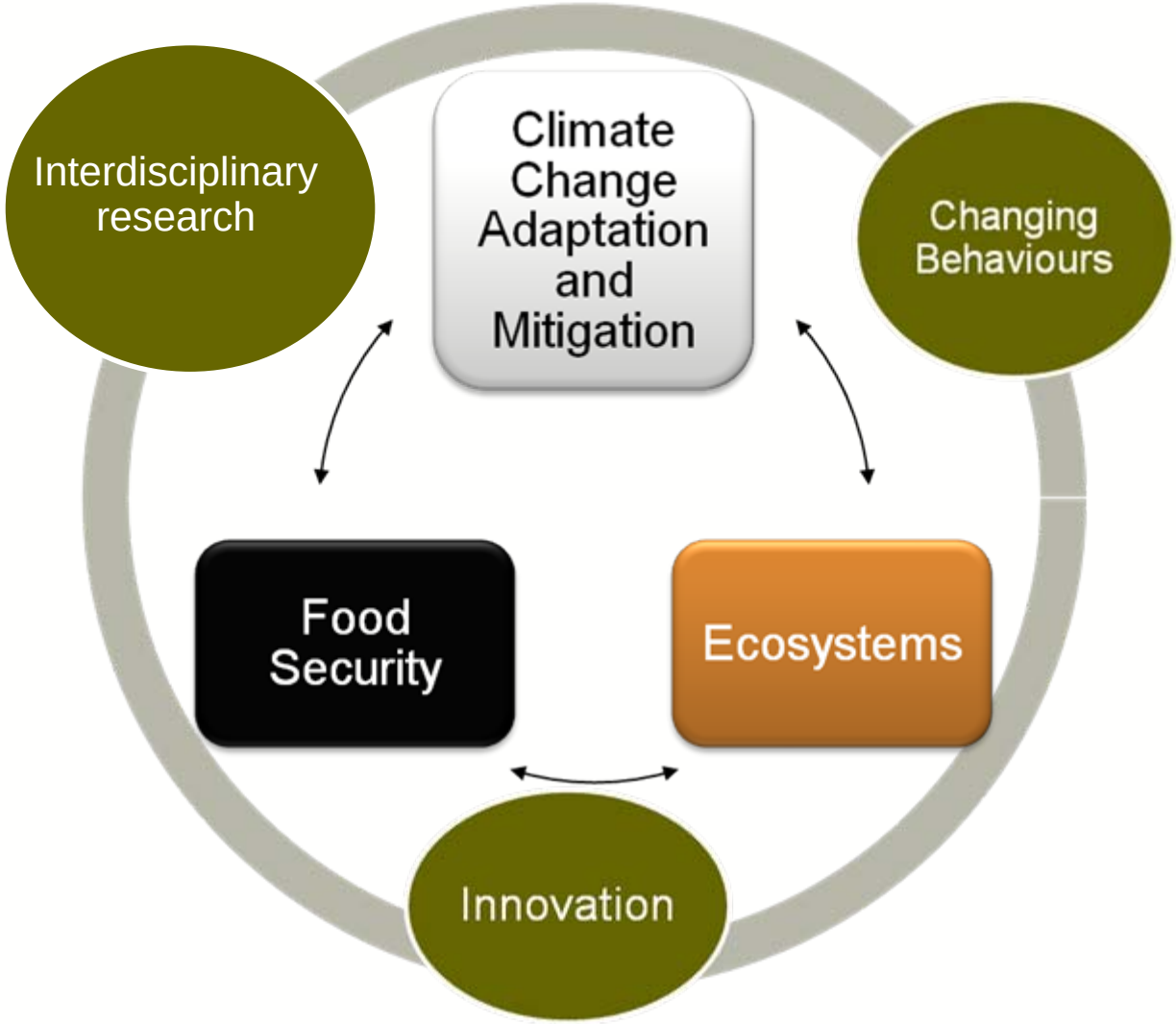
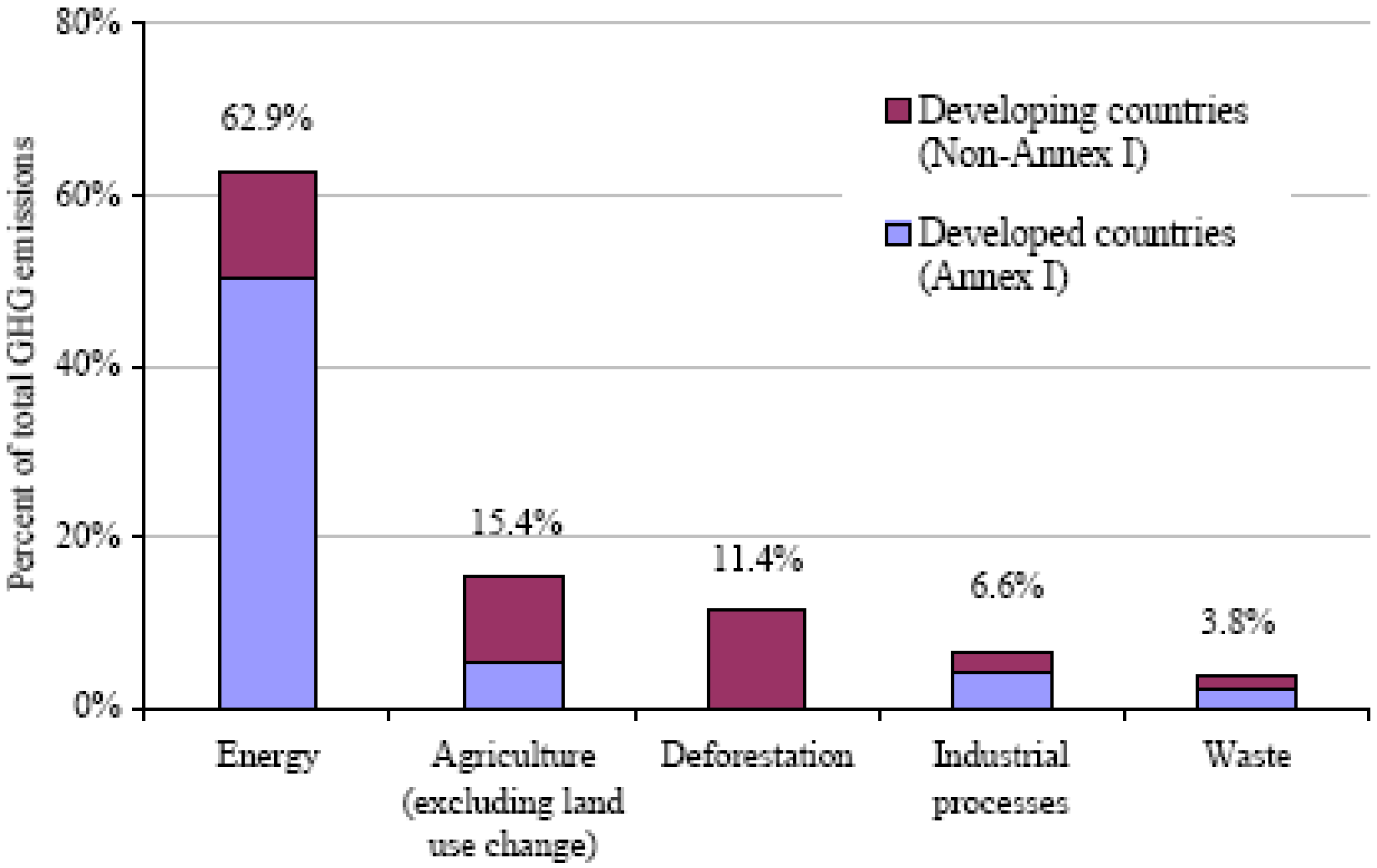


Agricultural emissions are significant in developing countries



Unprecedented change: Ecosystems

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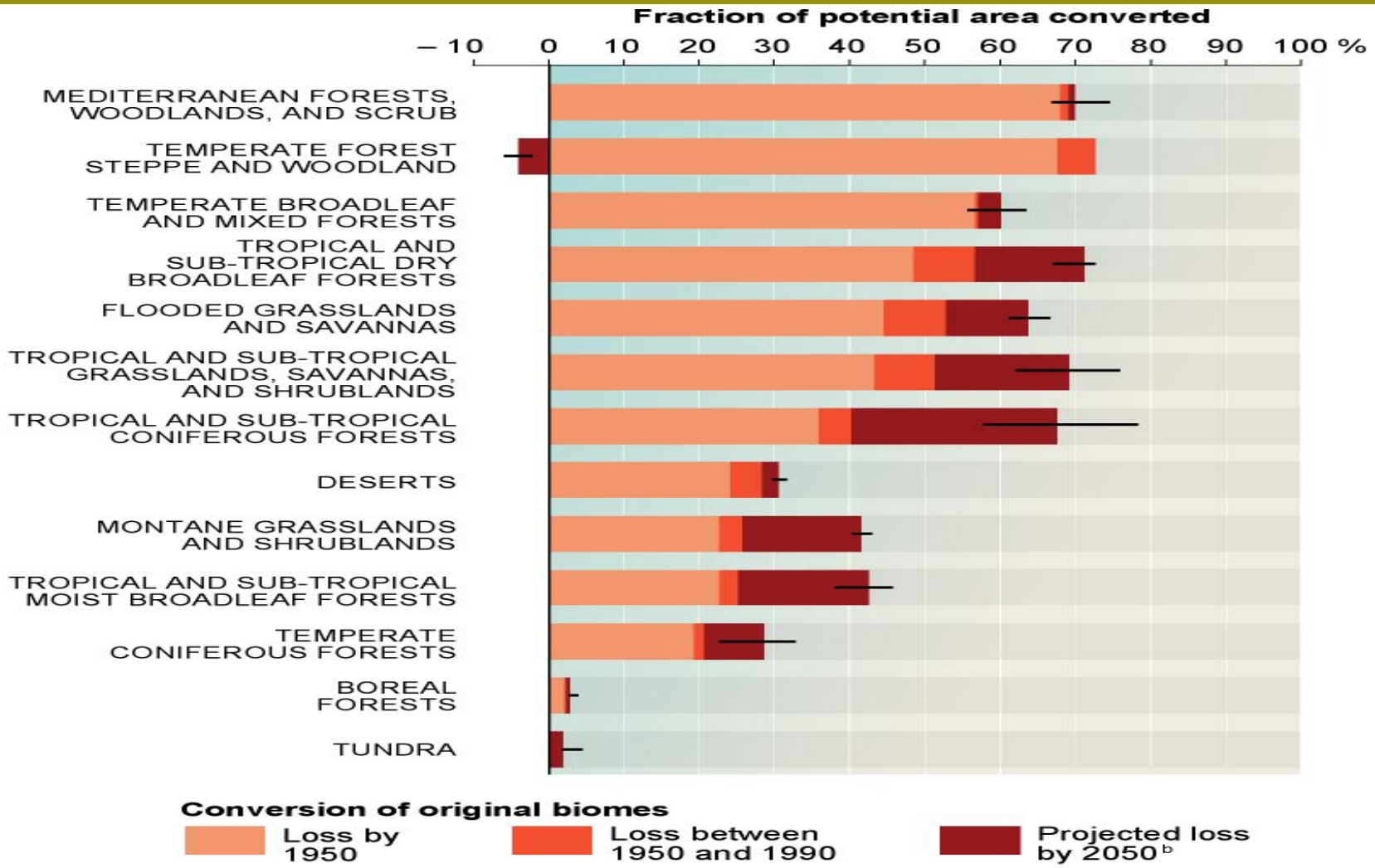

Surface Temperature

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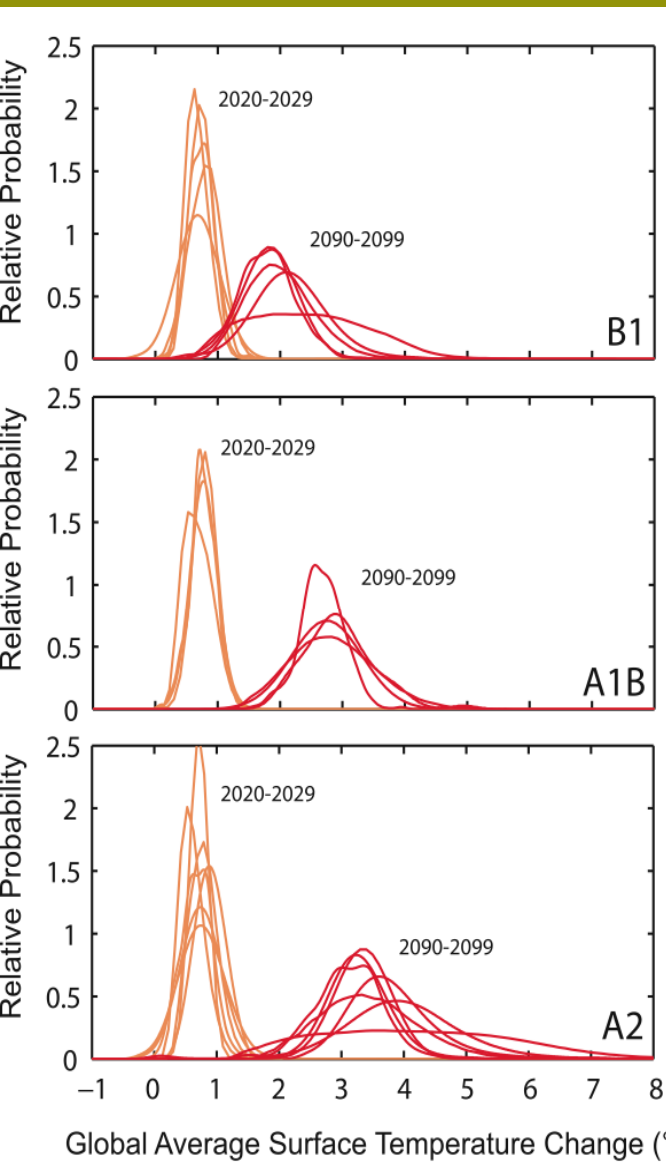

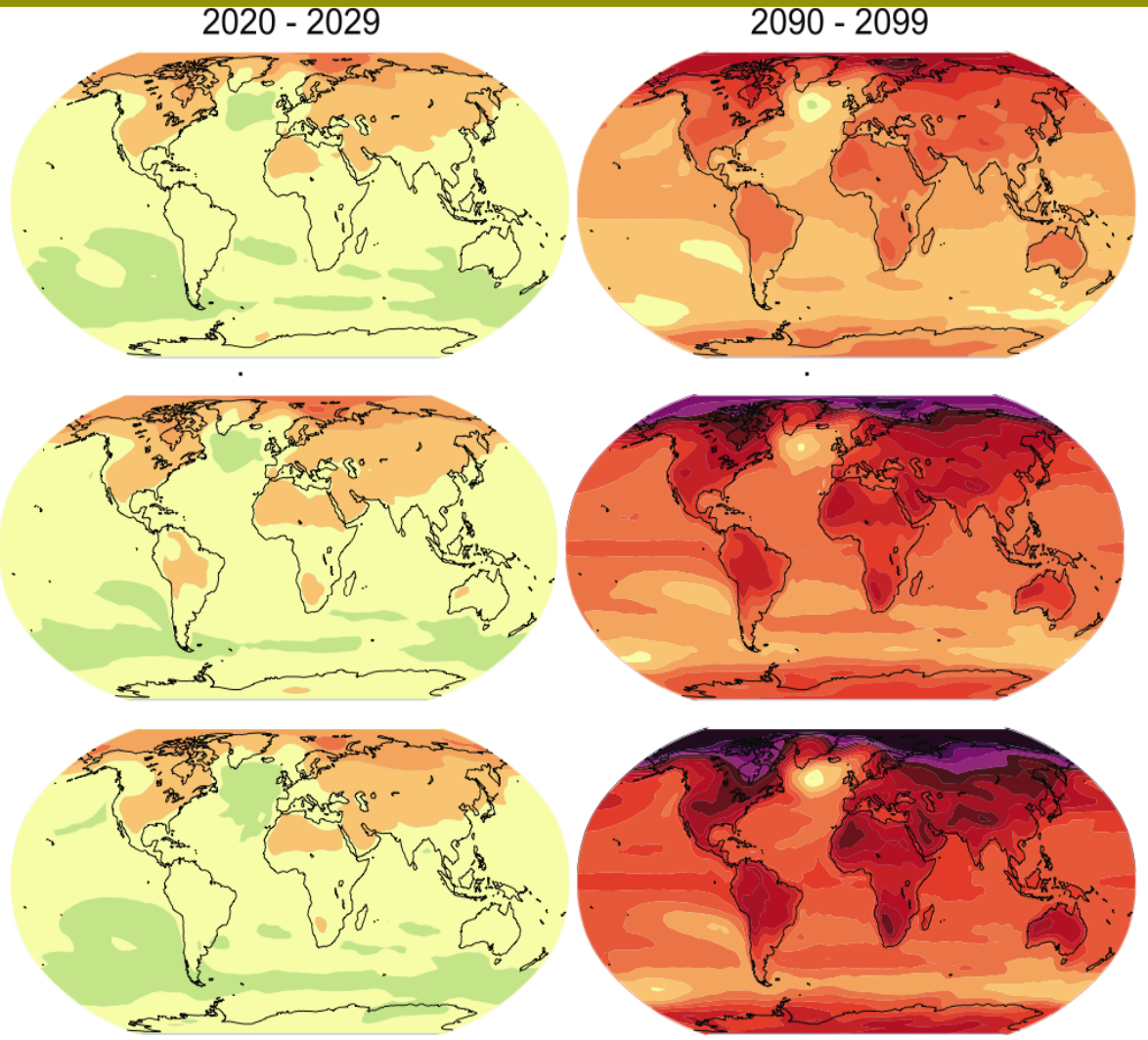

Precipitation

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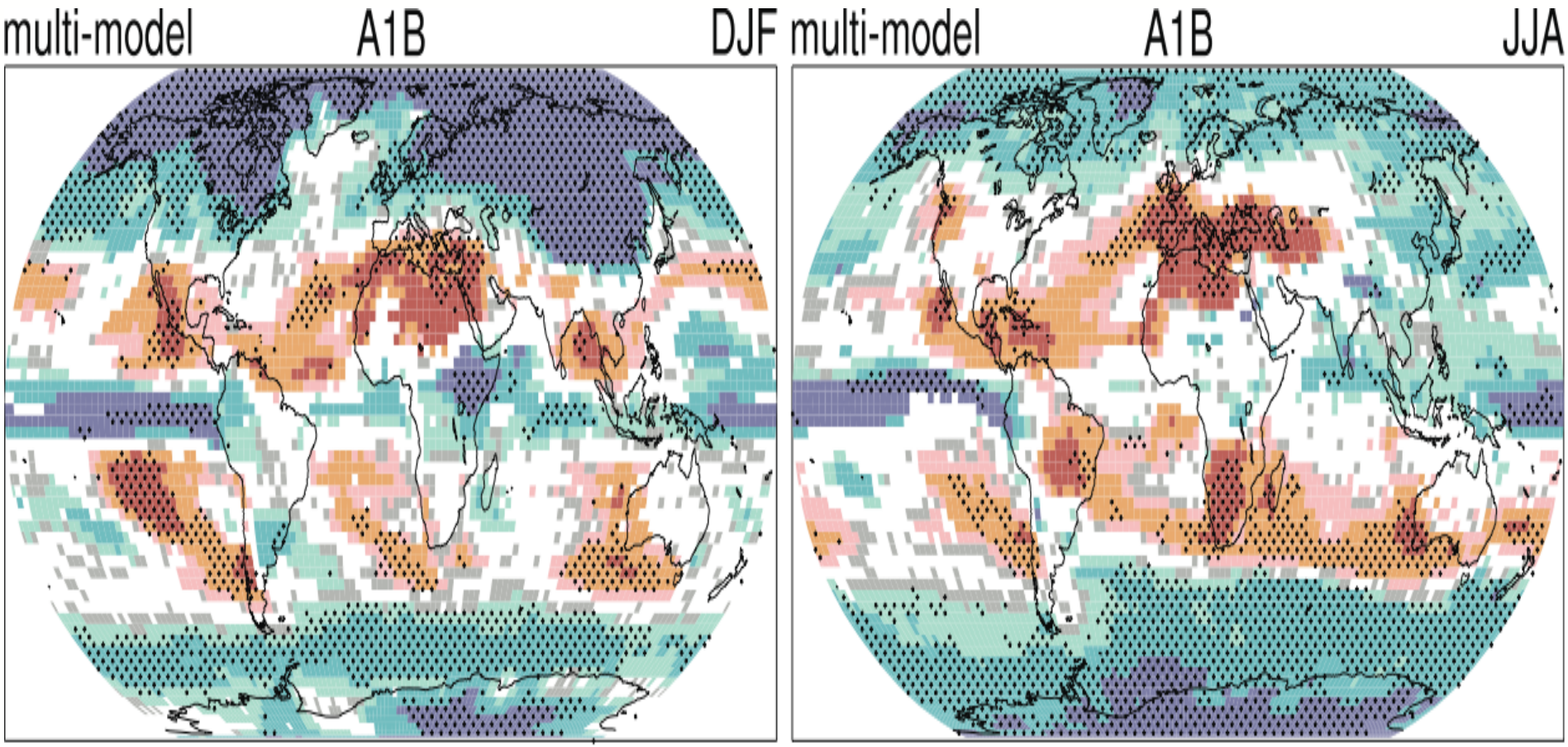
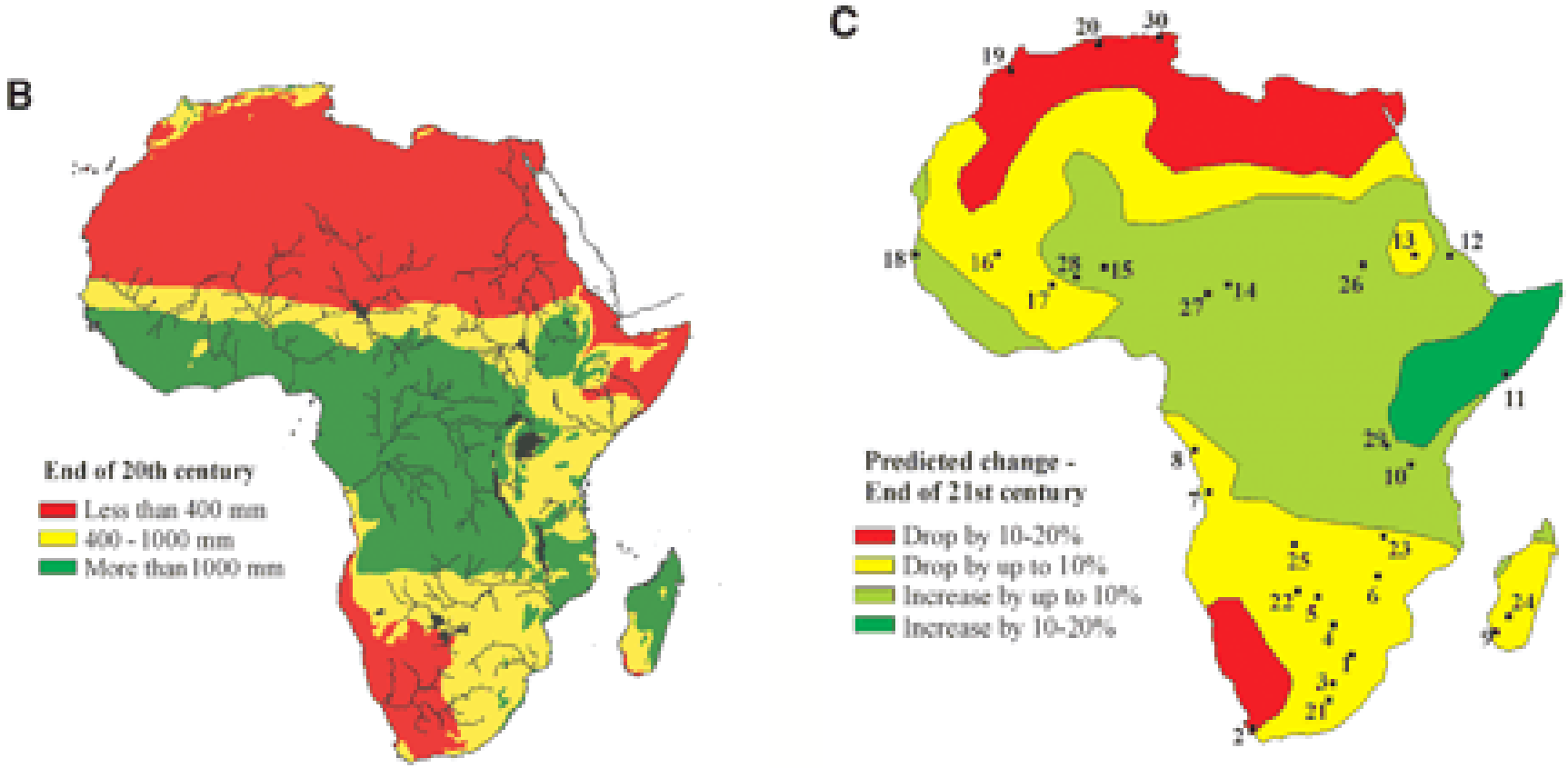


Changes in precipitation



Source: Maarten de Wit and Jacek Stankiewicz, *Science* 31 March 2006,
http://www.sciencemag.org/cgi/content/figsonly/311/5769/1917

Shrinking Per Capita Freshwater Availability (independent of climate change)

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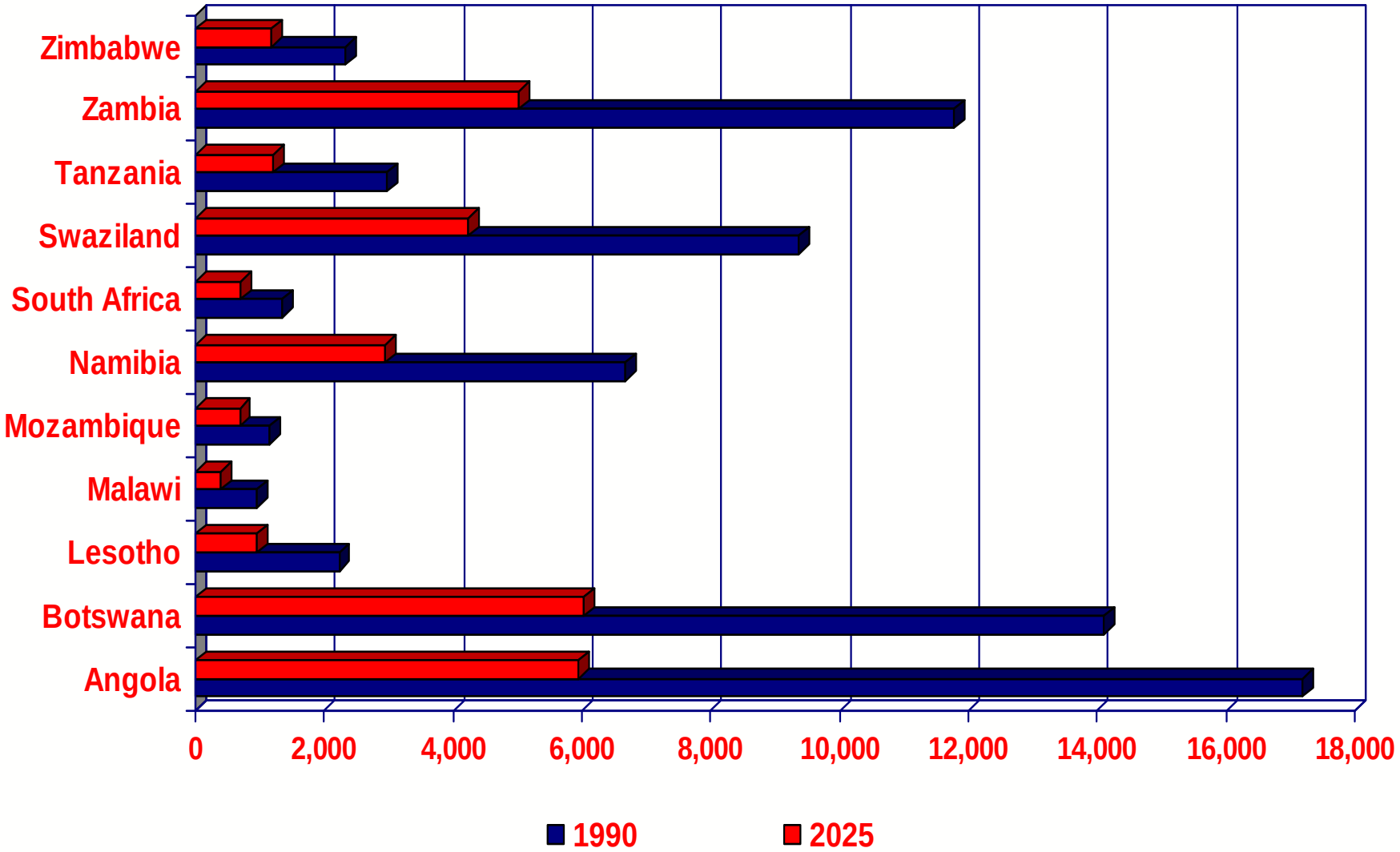
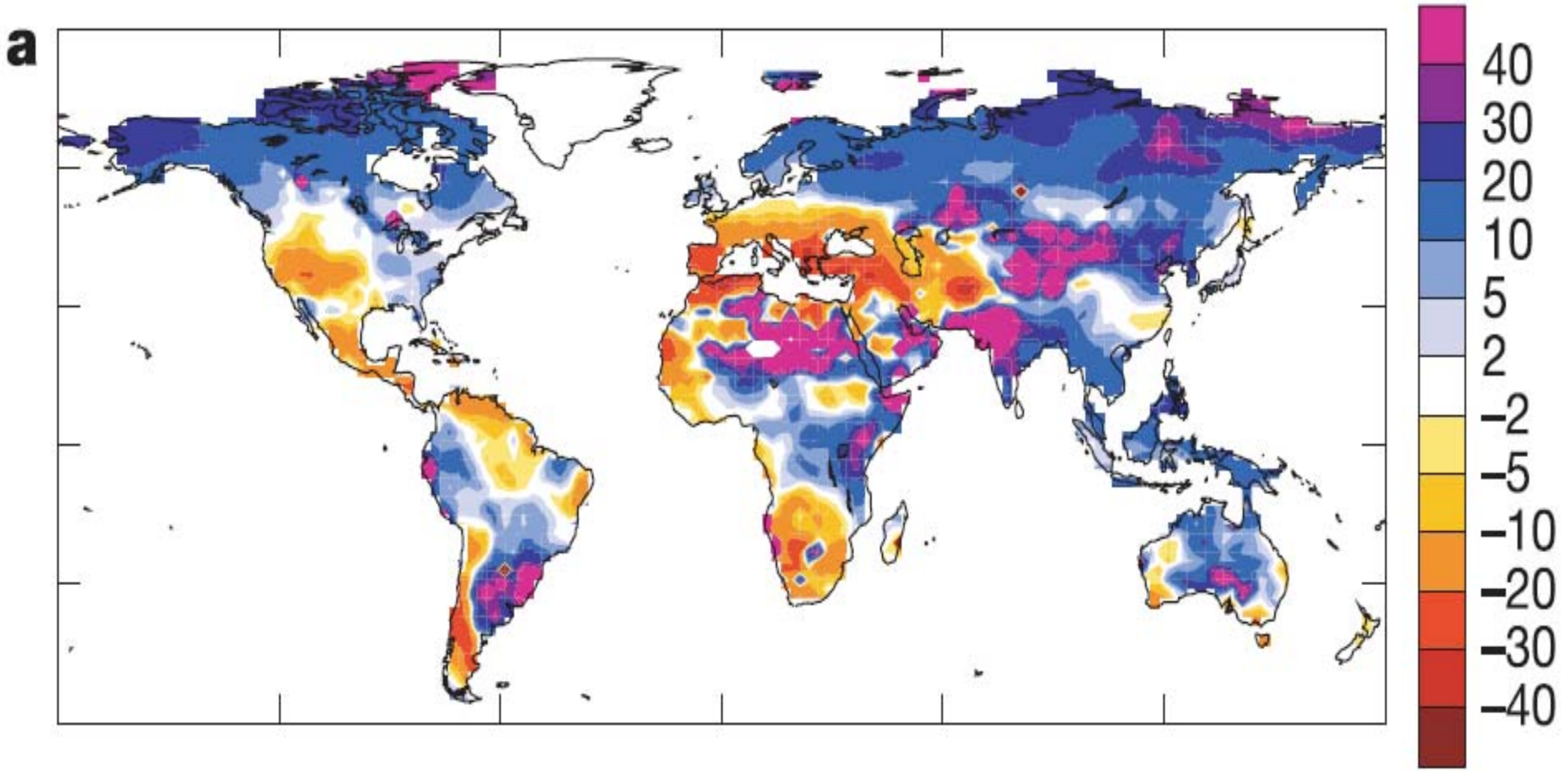


Percent change in runoff by 2050



Many of the major “food-bowls” of the world are projected to become significantly drier

Water withdrawal for agriculture

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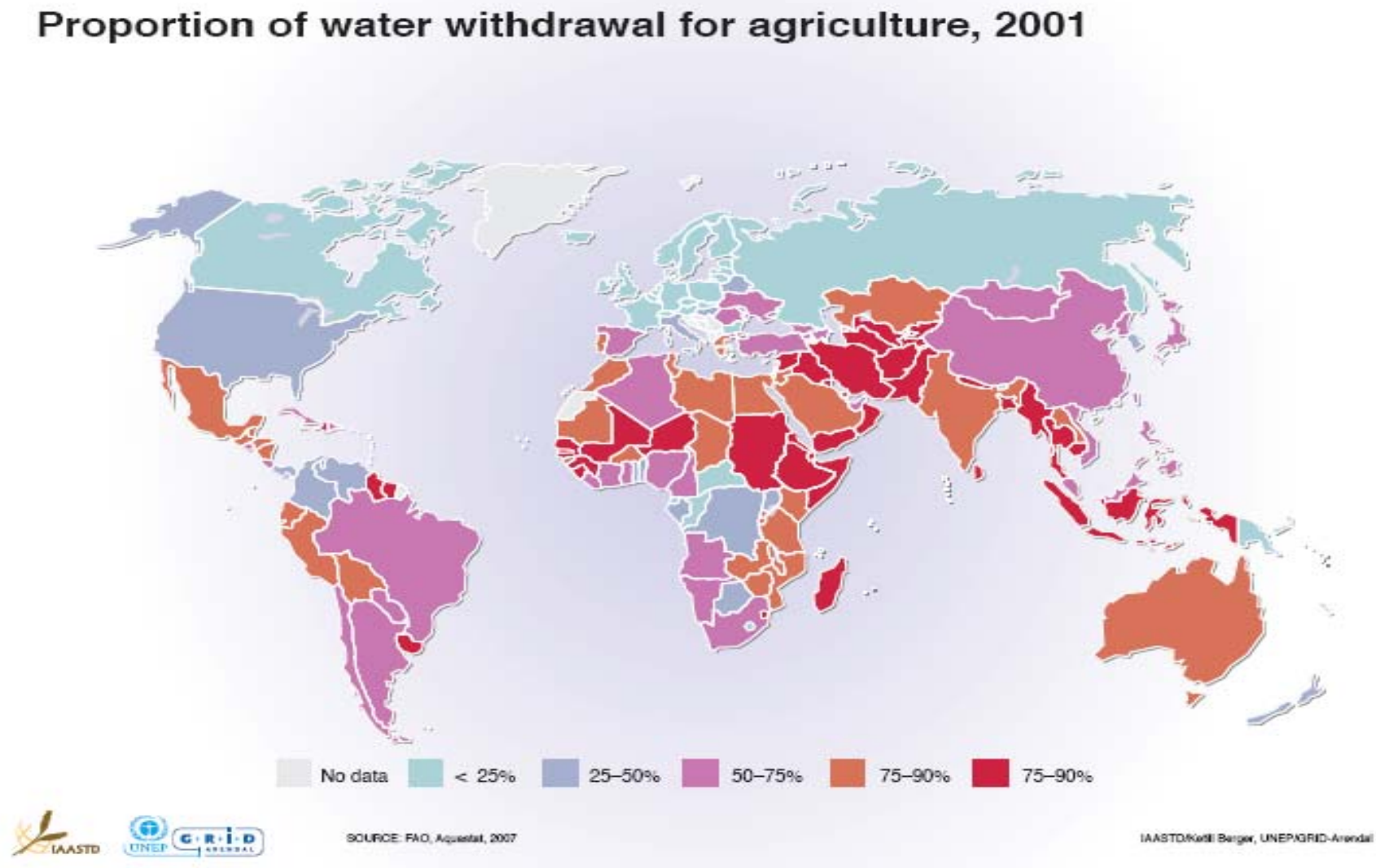

Crop yields decrease in the tropics and sub-tropics, but increase at high latitudes

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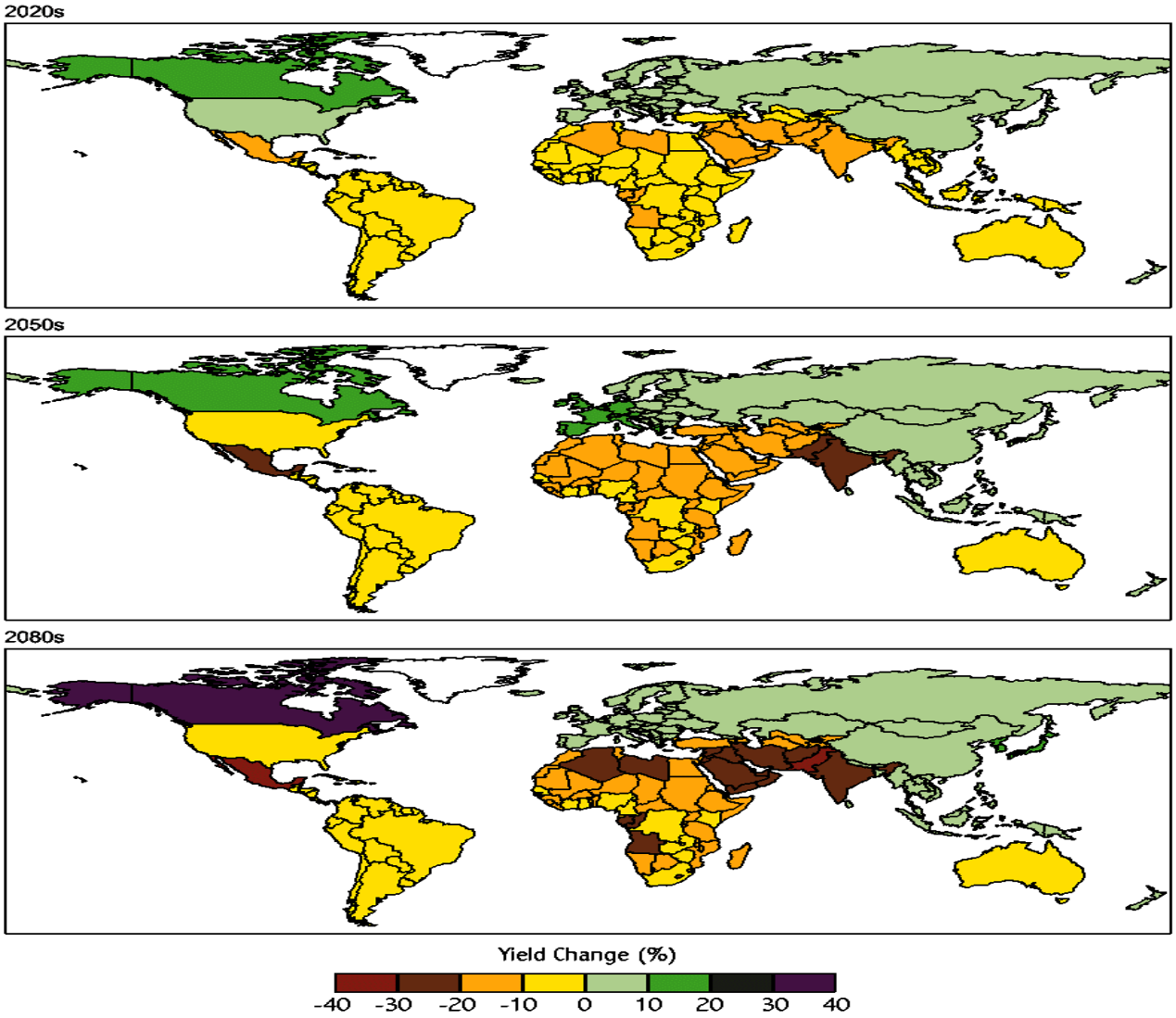
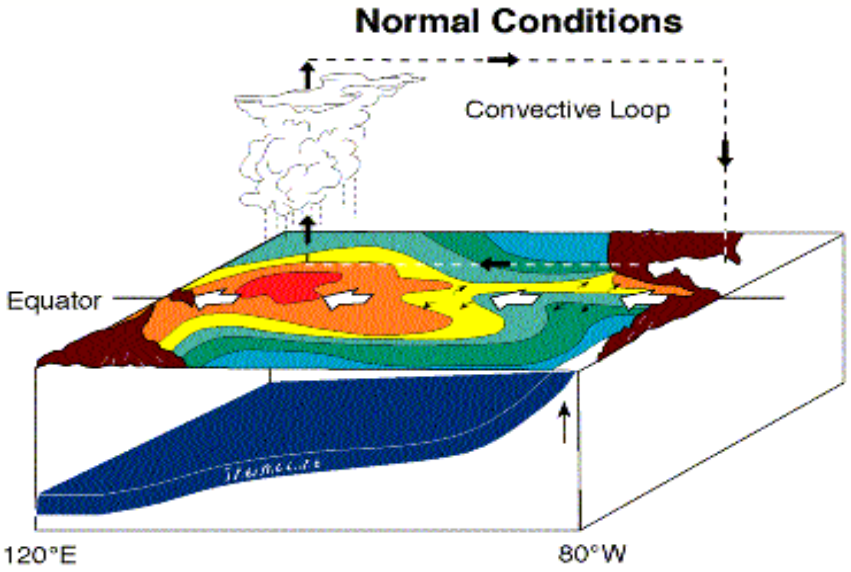
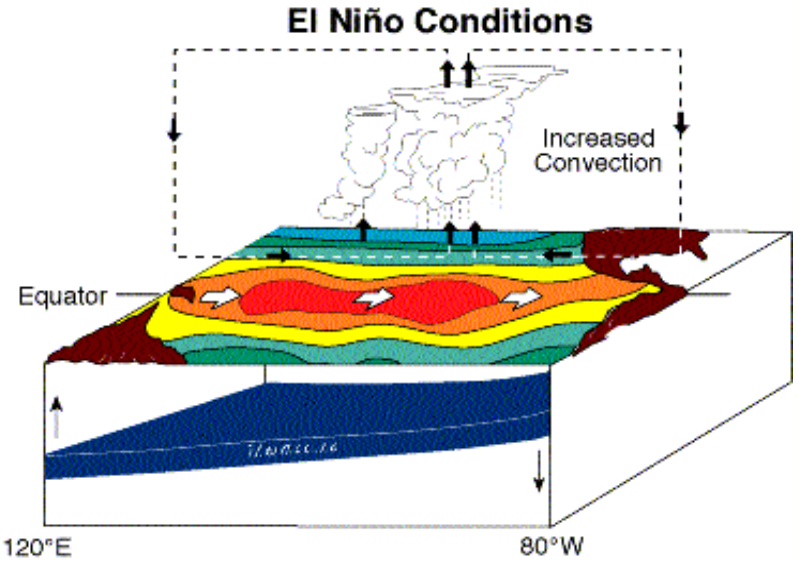


Percentage change in average crop yields for a mid-range climate change scenario

Even as soon as 2020 crop yields in SSA and parts of Asia are projected to decrease by up to 20%

El-Nino





El-Nino conditions lead to floods and droughts throughout the tropics and sub-tropics

The climate is projected to become more El-Nino like

Zimbabwe's Rainfall Record: 1980-1993

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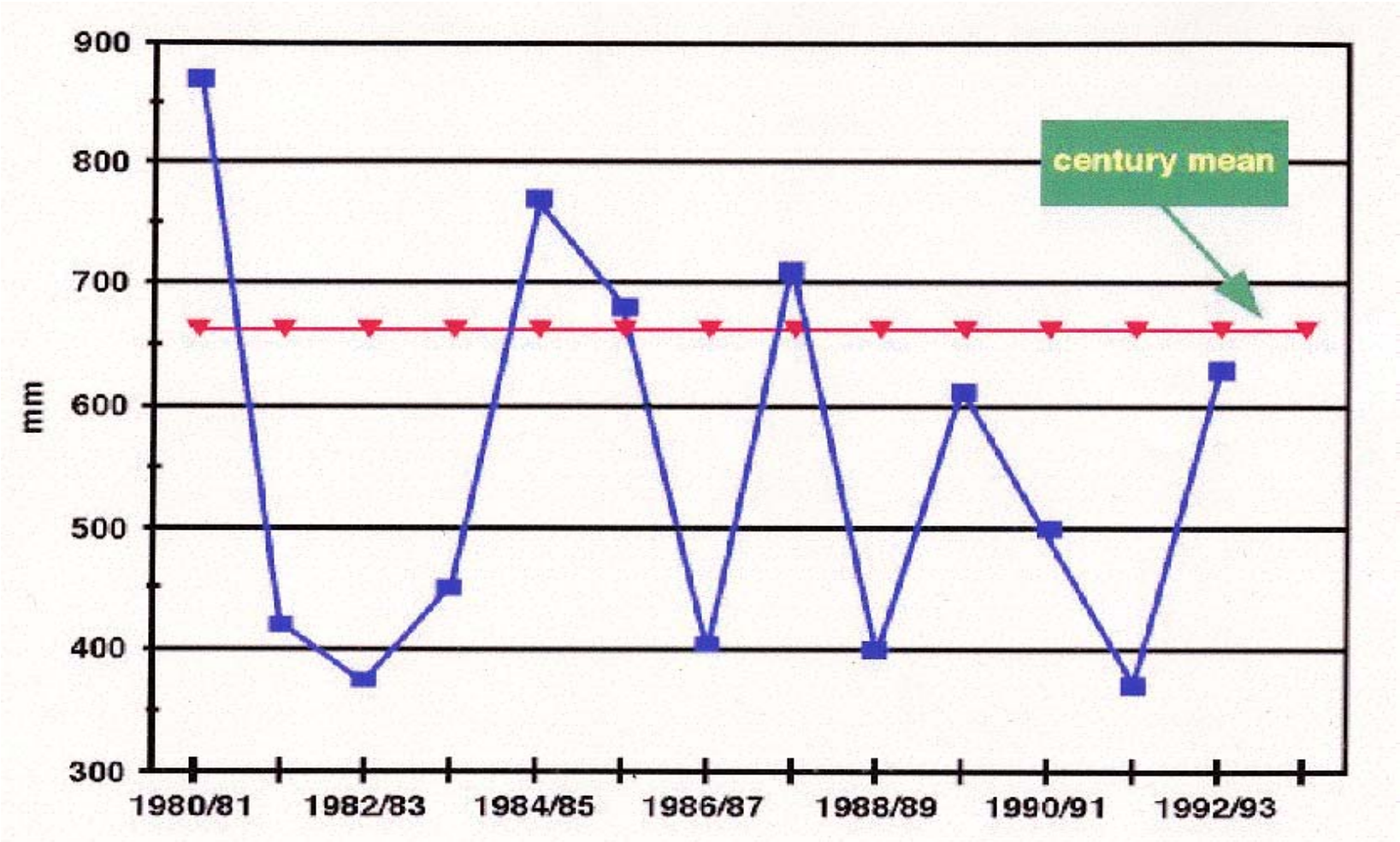

Note the year to year variability and the long-term downward trend

Variability in Agricultural Production

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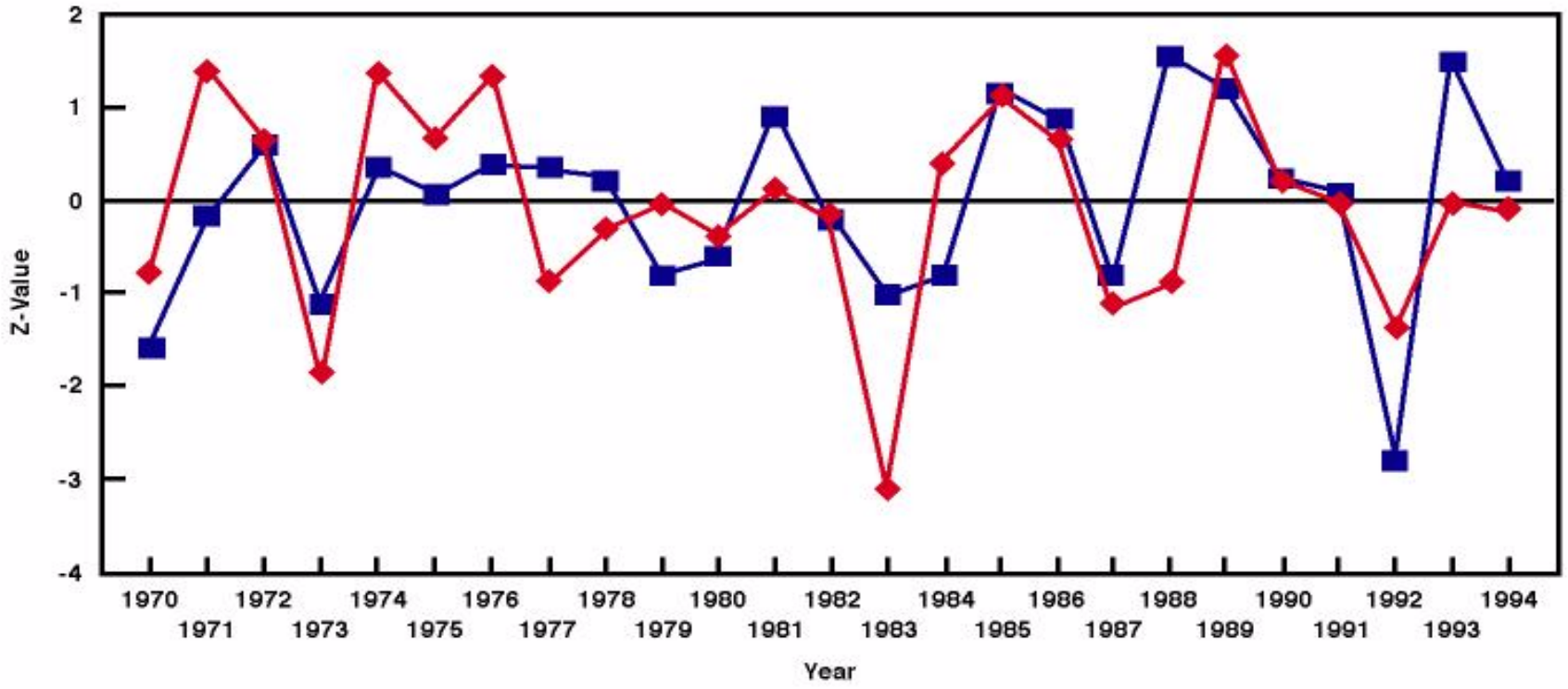
Maize Production in Selected Southern African Countries* versus Niño 3 Data
Malwai, Zimbabwe, Zambia, 1970 - 1994

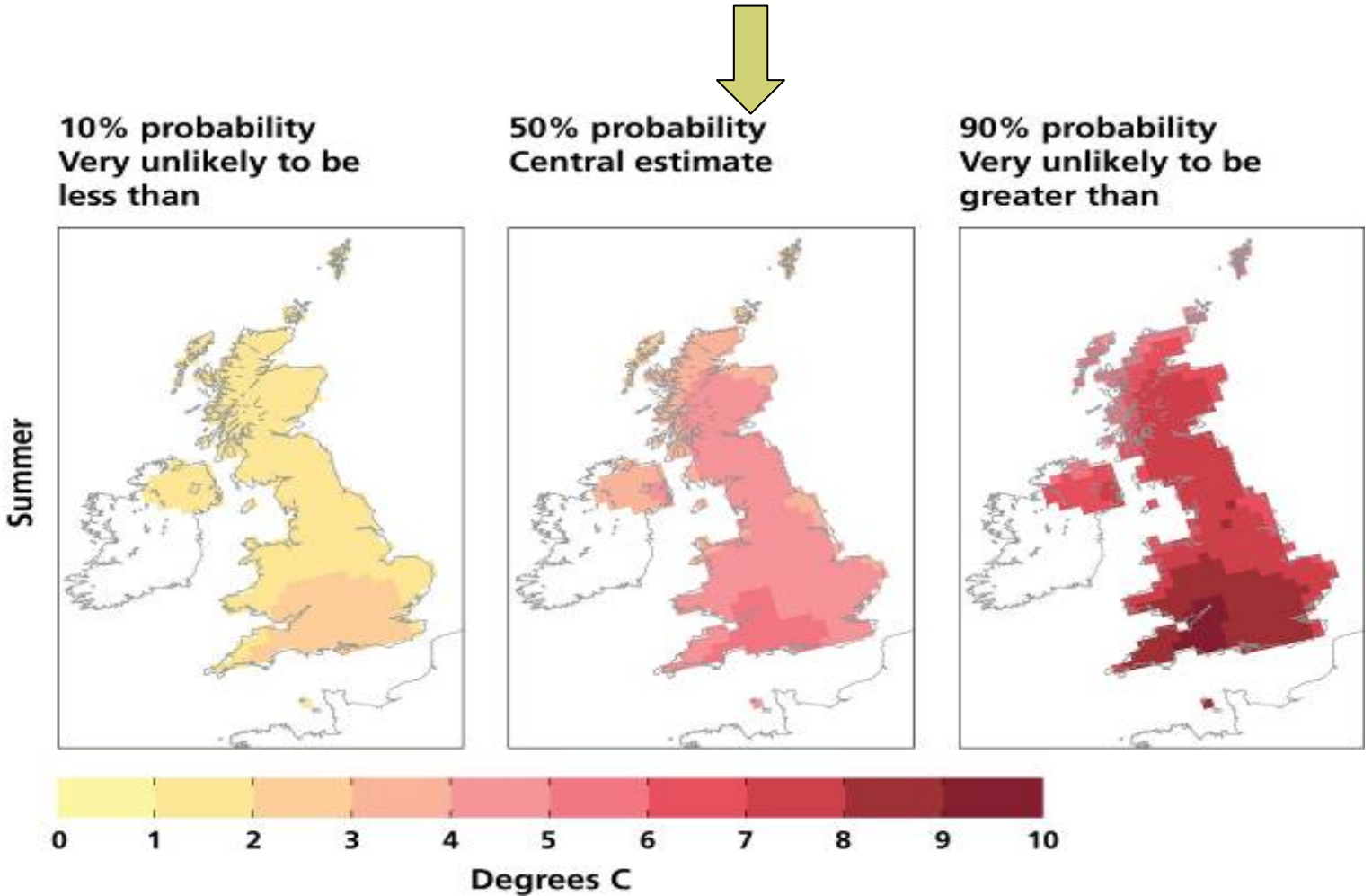


*The selected countries are agriculturally based economies.

Source: USAID/BHR/OFDA

Regional temperature variations (2080, medium emissions)

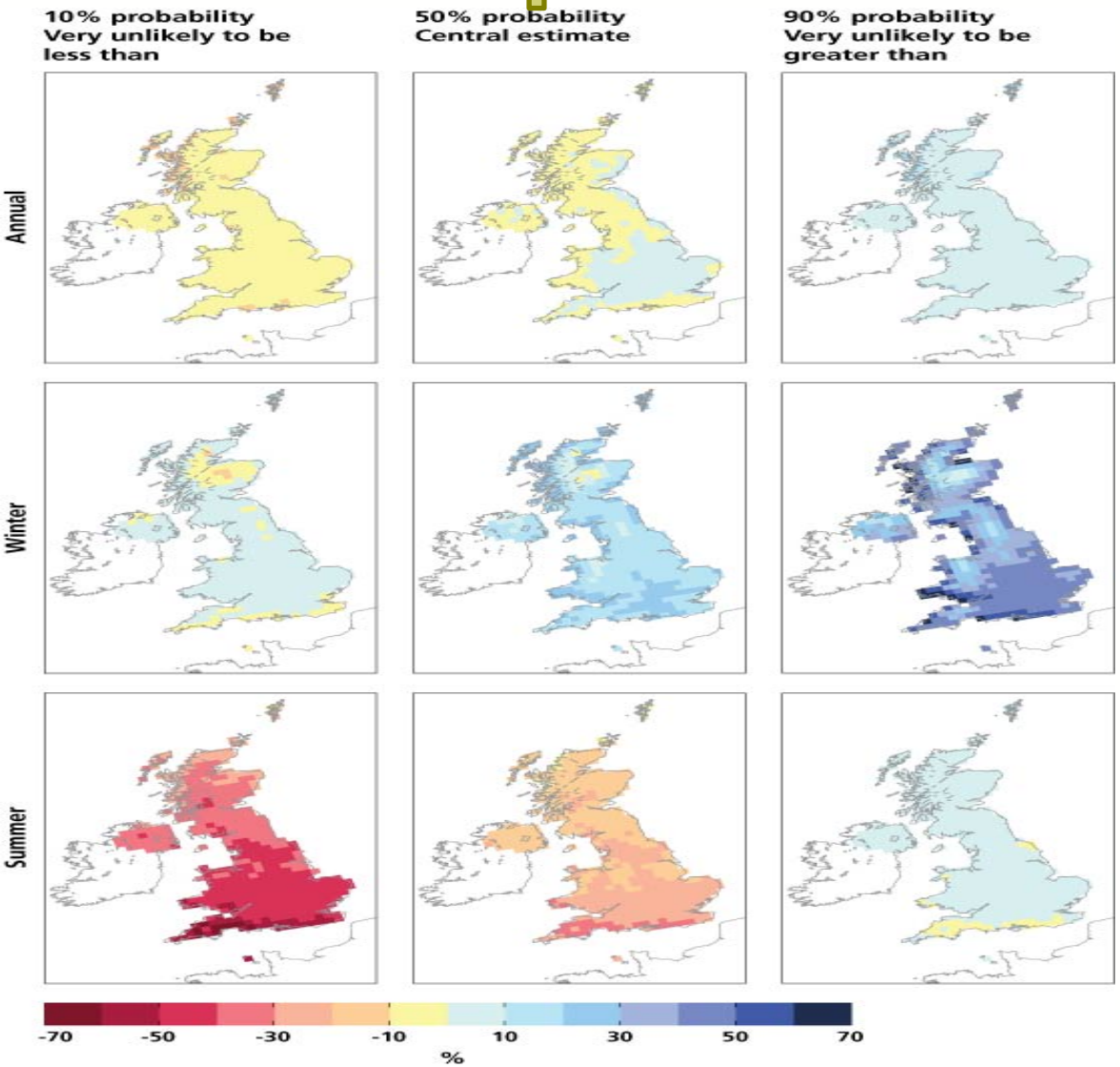
Even central estimates of changes to average summer temperature are significant: Maps show a gradient between parts of southern of England, where they can be 5ºC or more, and northern Scotland, where they can be somewhat less than 3ºC.



Change relative to 1961-1990 average

Maps are of probability not 'forecasts'

Changes to annual, winter and summer mean precipitation (medium emissions, 2080s)



The central estimate of changes in annual mean precipitation are within a few percent of zero everywhere.

In winter, precipitation increases are in the range +10% to +30% over the majority of the country. Increases are smaller than this in some parts of the country, generally on higher ground.

In summer, there is a general south to north gradient, from decreases of almost 40% in SW England to almost no change in Shetland.

Change relative to 1961-1990 average

Climate Change likely to increase the spread of animal diseases

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- ***Ectoparasite infections***
- ***Arthropod vector-borne diseases***
- ***Diseases caused by anaerobic spore-forming bacteria***
- ***Avian diseases***
- ***Liver flukes and parasites***

Agriculture and climate change: adaptation and mitigation

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Adaptation

Reduce the vulnerability and increase resilience to increased incidence of extreme events and greater climate variability

•Breed new varieties (temperature, drought, pest, salinity tolerant traits)

- Water harvesting, irrigation
- Agricultural practices, e.g., change crops and planting times

Mitigation

Reduce greenhouse gas emissions from especially methane and nitrous oxide

- Non exceedance of crop N requirements
- Appropriate timing/conditions for manure application
- Increase livestock nutrient use efficiency
- Anaerobic digestion technology for manures/slurries
- Nitrification inhibitors
- Feed supplements

Agricultural S&T Challenges

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- 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
  - to address water deficit problems, e.g., through improved drought tolerant crops, irrigation technologies, etc
  - to address soil fertility and salinzation of soils
  - to improve the nutritional quality of food
  - to improve the temperature tolerance of crops
  - to combat new or emerging agricultural pests or diseases
  - to reduce external and energy-intensive inputs
  - to reduce post harvest losses
  - to improve nutrient cycling
  - to improve food safety

Agricultural Knowledge, Science and Technology

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Knowledge, Science and Technology

- Many technologies already exist
- Need for appropriate and complementary integration of local and traditional knowledge with formal AKST

However some challenges will primarily depend on development of new and emerging AKST – e.g. Biotechnology

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Options to increase production

- 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
  - Small-scale farmers need access to the best seeds, financing and access to markets

- 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

Biotechnology

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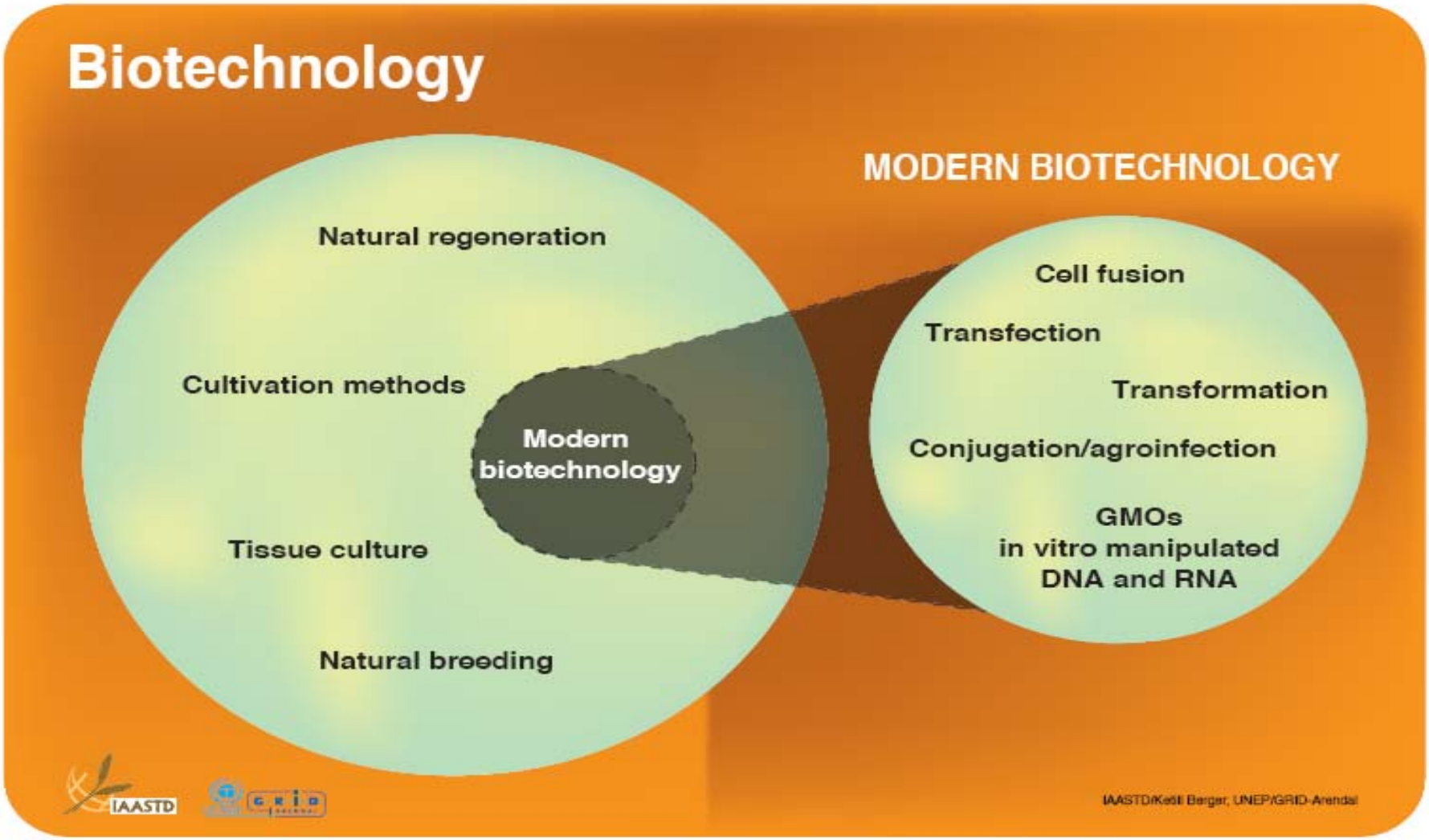

Current issues – Role of GM

- Potential to improve productivity, drought, temperature and pest tolerance and enhanced nitrogen use efficiency

- However, insertion of genes is continuing to cause concern for some consumers and governments even though GM plants undergo extensive testing
  - Health risks – little evidence, robust EU safety processes in place
  - Environmental risks – need to understand gene transfer and manage
  - Role of companies – some lack consumer trust
  - Potential negative impact on poor farmers in developing countries – reliance on large multi-nationals

Adaptation to Climate Change

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Genes

Maize
C_4

Rice
(C_3 → C_4)

C_4 and C_3 comparison for current CO_2 conditions. WUE (transpiration) is water-use efficiency, RUE is radiation-use efficiency, PNUE is photosynthetic nitrogen-use effectiveness

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	WUE g DW/kg H_2O	RUE g DW/MJ	PNUE mg DW s^{-1}/gN
Zea Maize	2.9 [a]	3.3 [b]	1.6 [d]
Oryza Sativa	1.6 [a,c]	2.2 [b]	0.6 [d]
C_4/C_3	1.8	1.5	2.7

Maize is C_4 --- Rice is C_3

Basis for Policy

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- Safety must be the top priority
- Evidence-based approach and case-by-case assessment
- Open to the potential benefits – therefore research, coupled with open and transparent field trials, is needed to assess the potential risks and benefits
- Support proportionate and enforceable GM labelling rules to facilitate consumer choice
- Need to develop measures to manage the coexistence of GM and non-GM crops to minimise unwanted GM cross-pollination
- Consumers will need to see real benefits before they are accepted

The small-scale farmer

A major challenge: The small scale farmer

Pro-poor progress requires:

- creating opportunities for innovation and entrepreneurship which targets this group
- Increased public research and extension investment

Small scale farm sustainability – poses difficult policy choices

- Payment for ecological services

Global trade policy

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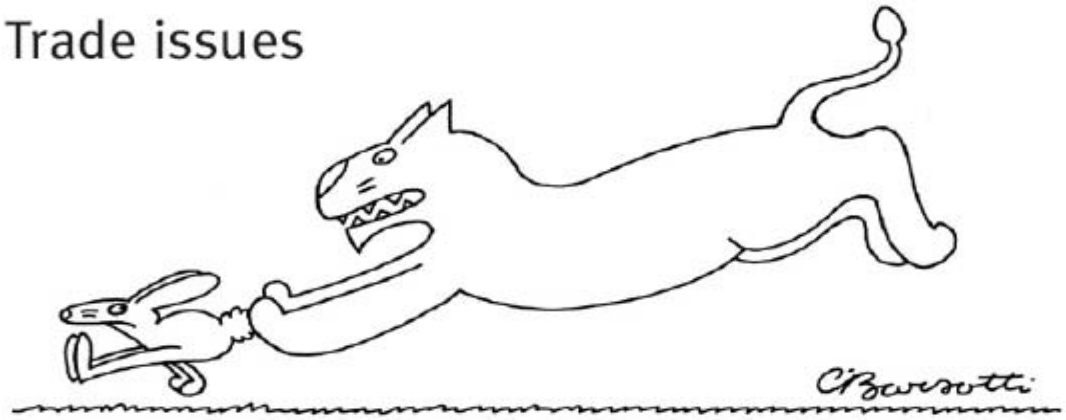
Trade issues



"What are you complaining about? It's a level playing field."

Opening national agricultural markets to international competition can offer economic benefits, but can lead to long term negative effects on poverty alleviation, food security and the environment without basic national institutions and infrastructure being in place

AKST Investments

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AKST Investments

Shifts in funding levels and sources for agriculture

- Public sector research funding, especially that relevant to developing countries has been irregular and has not increased with time
- Private sector funding growing, but the focus is primarily on OECD markets
- Targeted investments in S&T can yield enormous benefits –but are the current public and private sector research activities adequate and effective?

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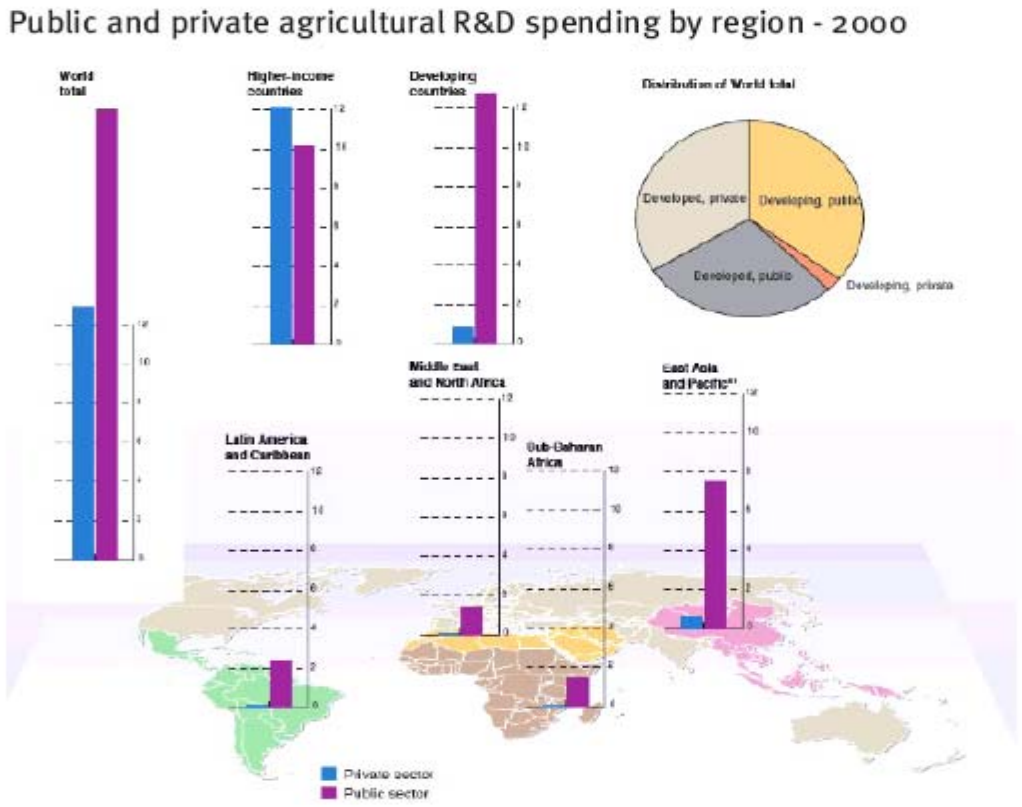
AKST Investments



In Summary: Options for Action

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- Embed economic, environmental and social sustainability into agricultural policies, practices and technologies
- Address today's hunger problems 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
- Provide payments to the farmer for maintaining and enhancing ecosystem services

In Summary: Options for Action

- 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
- Increase public and private sector investment in research and development, extension services, and weather and market information
- Improve public-private-CSO involvement in AKST with accountability for social and environmental outcomes
- Build and reform AKST skill base (basic sciences, social, political and legal knowledge) and innovation capacities of rural communities and consumers

Conclusions

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- Food availability needs double in the next 25-50 years to alleviate hunger and poverty
- Global food security is achievable but business-as-usual policies, practices and technologies will not work
- Climate change poses challenges to the agricultural sector – reducing GHG emissions and adapting to climate change
- Innovation along the whole food chain, involving all relevant stakeholders, is critical
- The farmer must be in the middle – especially the small-scale farmer – participatory processes are critical
- Science and technology is critical – the risks and benefits of all technologies must be evaluated