How to Adapt to Climate Change(s)
Face Reality and Take Action
Resilient Society against Climate Change

Climate Change Now and Future

Regional Action on Climate Change and Future Earth (RACC/FE)

Kyoto International Conference Center
6th October, 2018

Prof. Dr. Adel EL-BELTAGY
Chair of the International Dryland Development Commission (IDDC)
ALARI, Ain Shams University

Challenges

The Changing Environment

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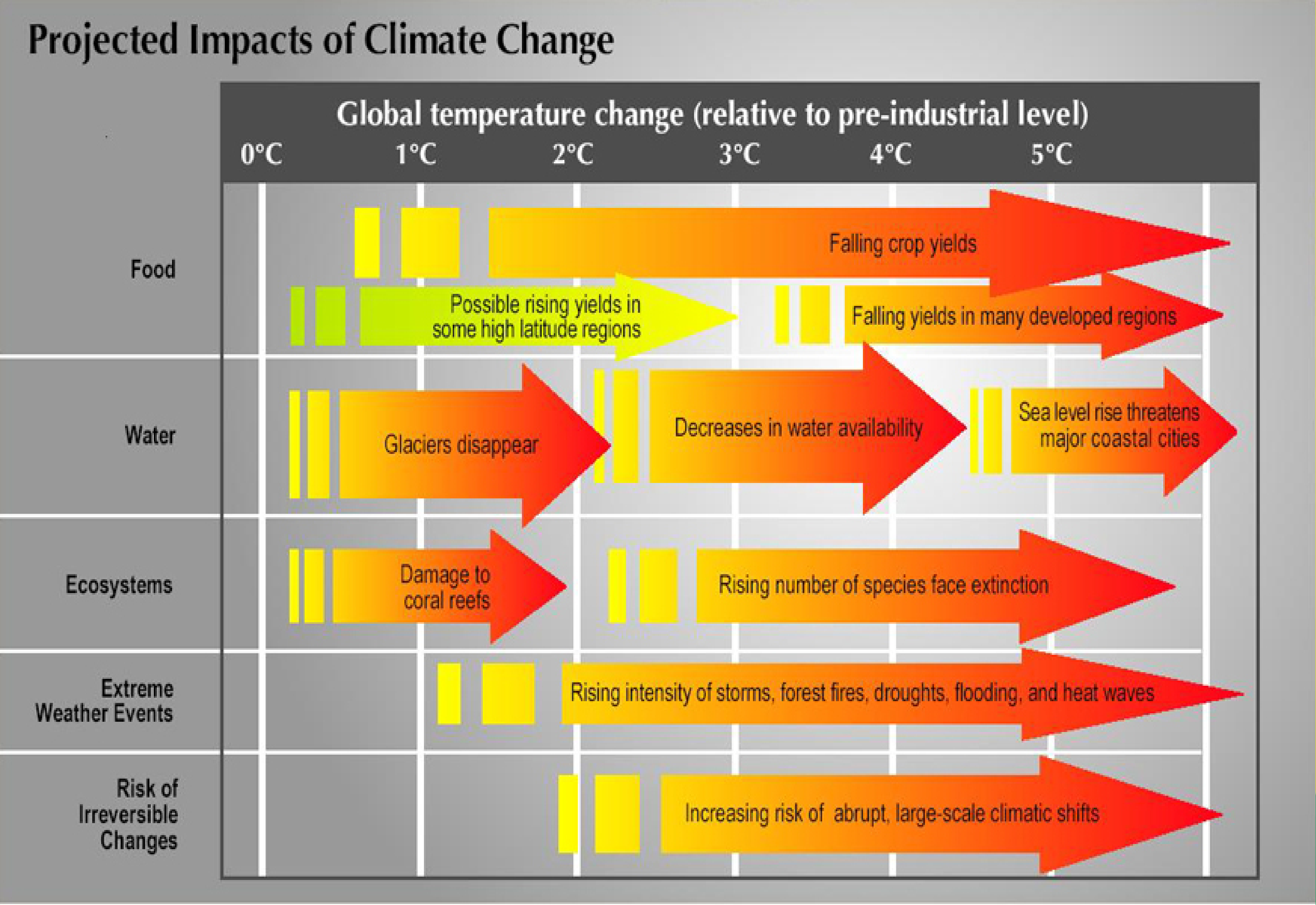
Turn Down the Heat

Why a 4°C Warmer World Must be Avoided

THE WORLD BANK

NOV 2012



C = Celsius; CO_2 = Carbon Dioxide

Source: Adapted from the *Stern Review on the Economics of Climate Change.*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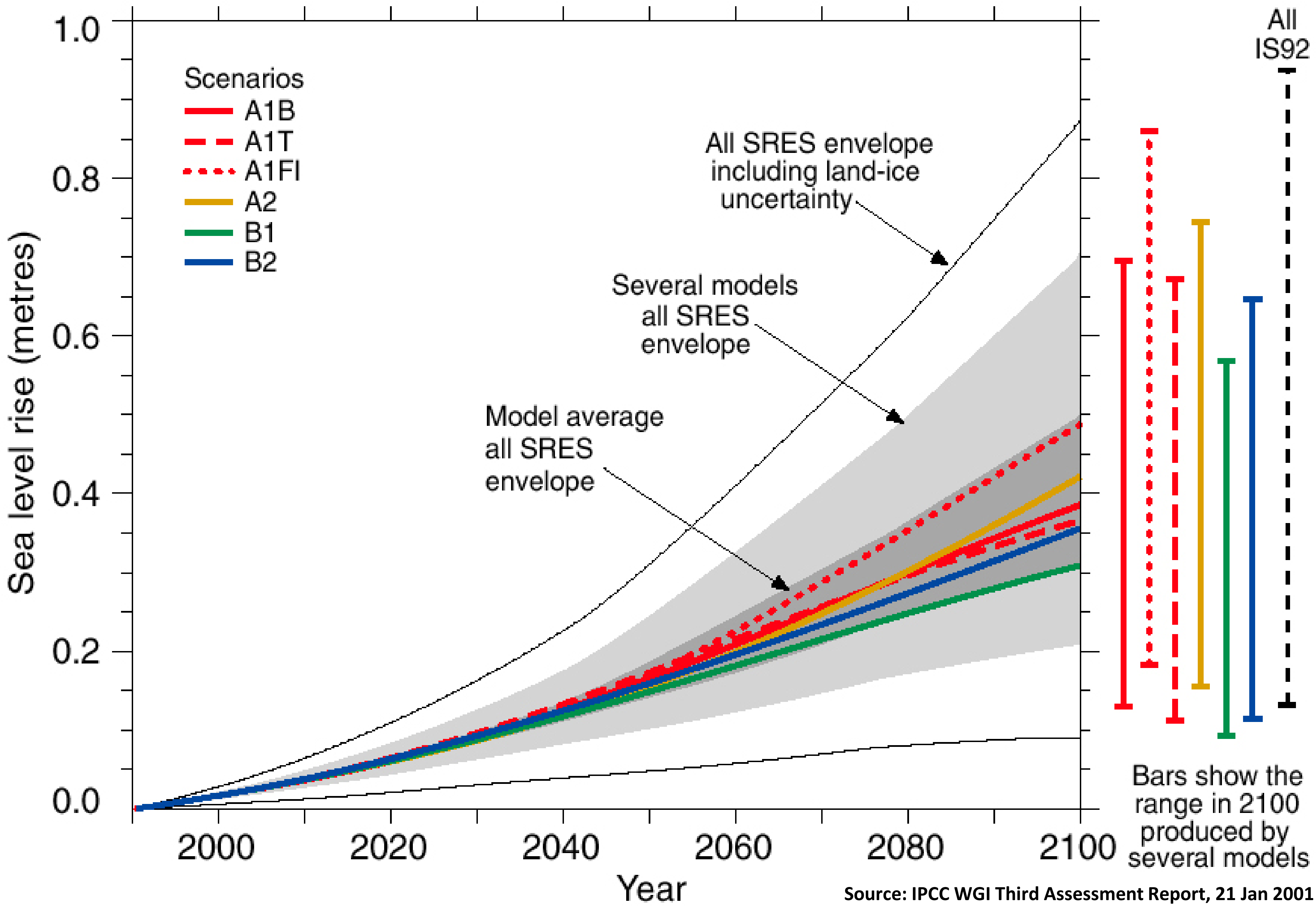
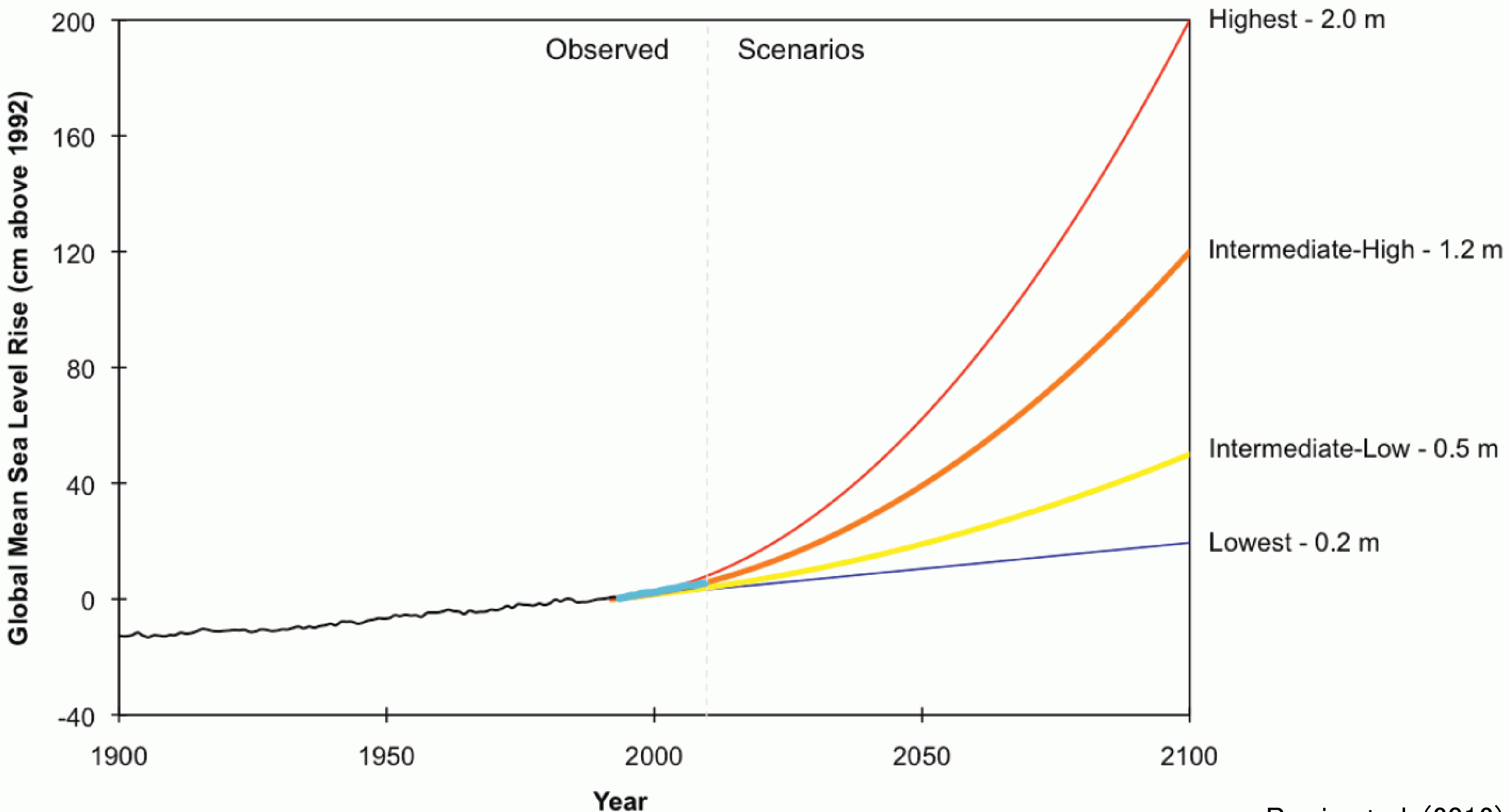
Sea level rise



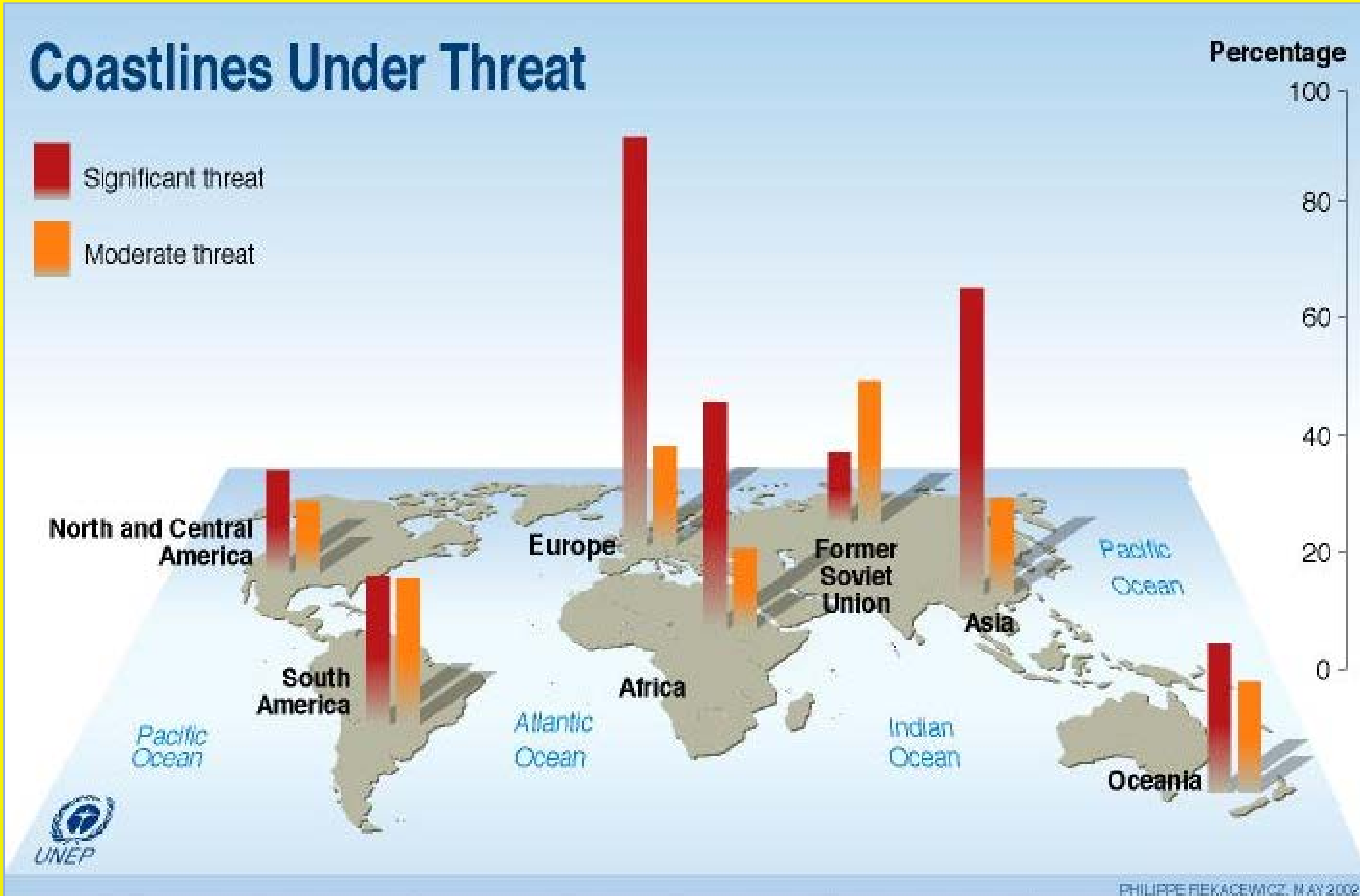
Source: IPCC WGI Third Assessment Report, 21 Jan 2001

Projections of global mean sea level rise



Parris et al. (2012)

Global Sea Level Rise Scenarios for the United States National Climate Assessment December 2012



Source: D. Bryant, E. Rodenburg, T. Cox and D. Nielsen, *Coastlines at Risk: An Index of Potential Development-Related Threats to Coastal Ecosystems*, World Resources Institute, Washington DC, 1996.

Threatened deltas

Indicative population potentially displaced by current sea-level trends to 2050:

Extreme ≥1 million people displaced

High 1 million to 50,000 people displaced

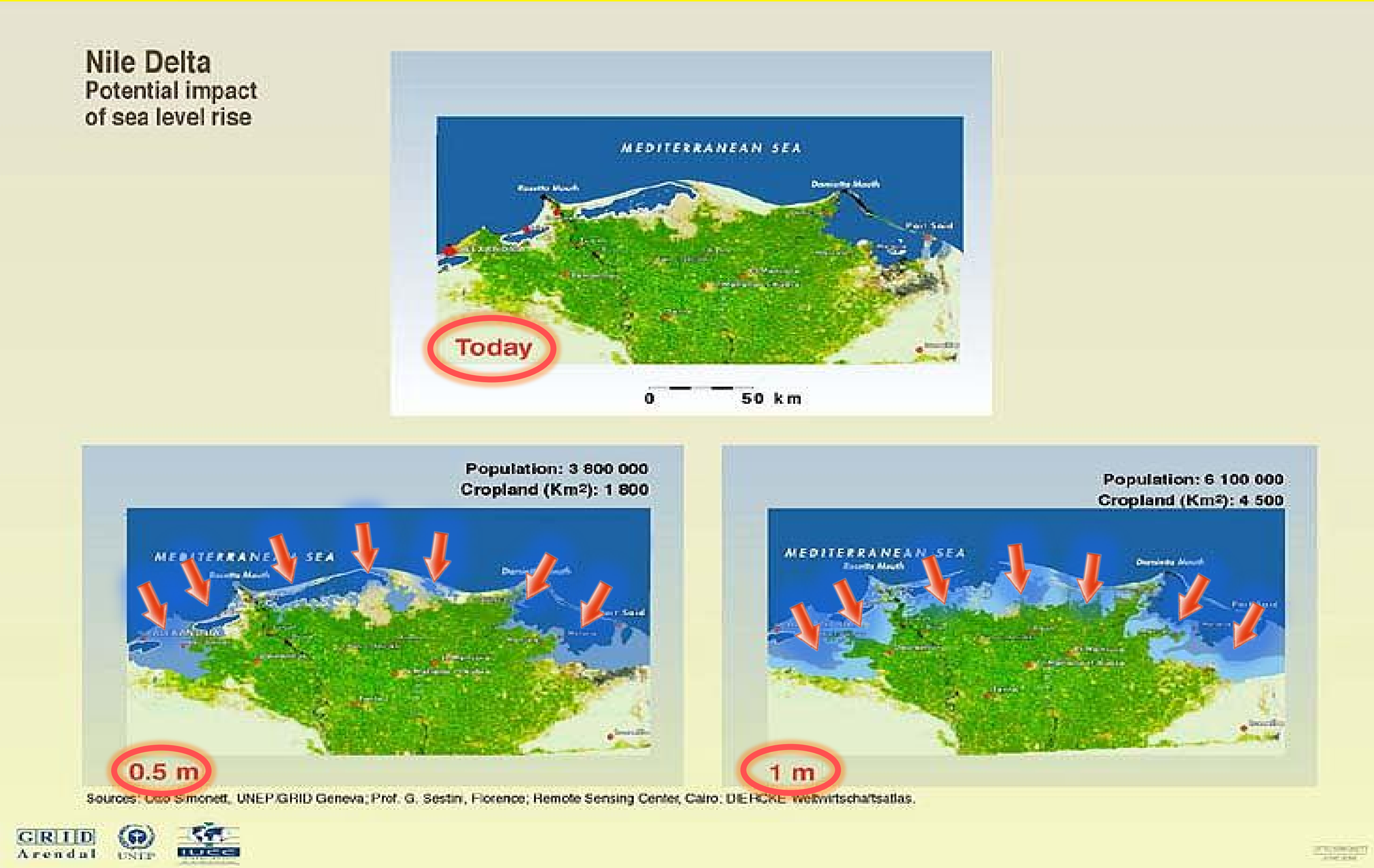
Medium 50,000 to 5,000 people displaced

UNEP

Regional Seas

ارتفاع مستوي سطح البحر المتوقع في مصر وعلاقتها بالفقد في دلتا النيل

Sea Level Raise



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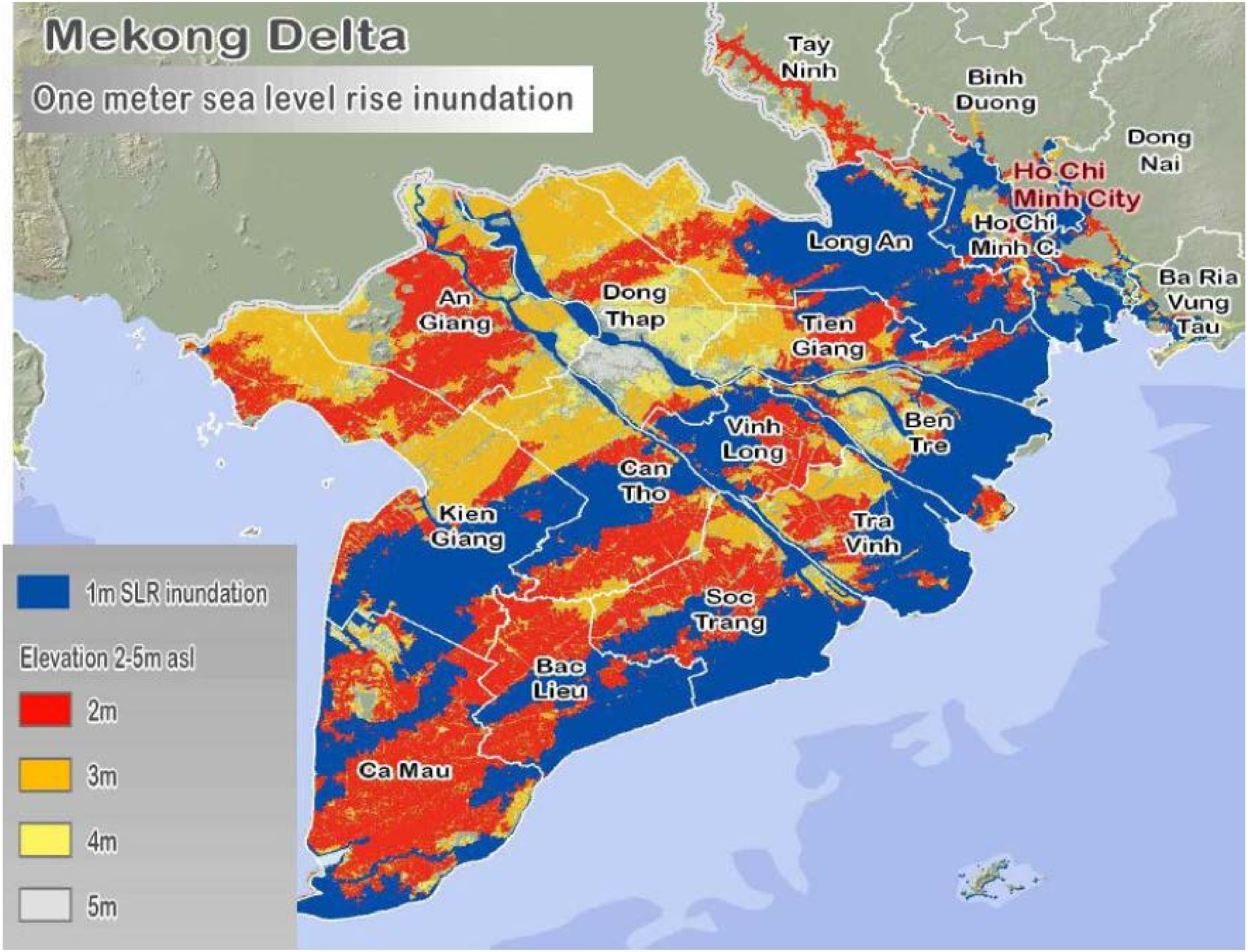
Mekong Delta
One meter sea level rise inundation
Tay Ninh
Binh Duong
Dong Nai
Ho Chi Minh City
Ho Chi Minh C.
Long An
Ba Ria Vung Tau
An Giang
Dong Thap
Tien Giang
Ben Tre
Vinh Long
Can Tho
Tra Vinh
Kien Giang
Soc Trang
Bac Lieu
Ca Mau
1m SLR inundation
Elevation 2-5m asl
2m
3m
4m
5m

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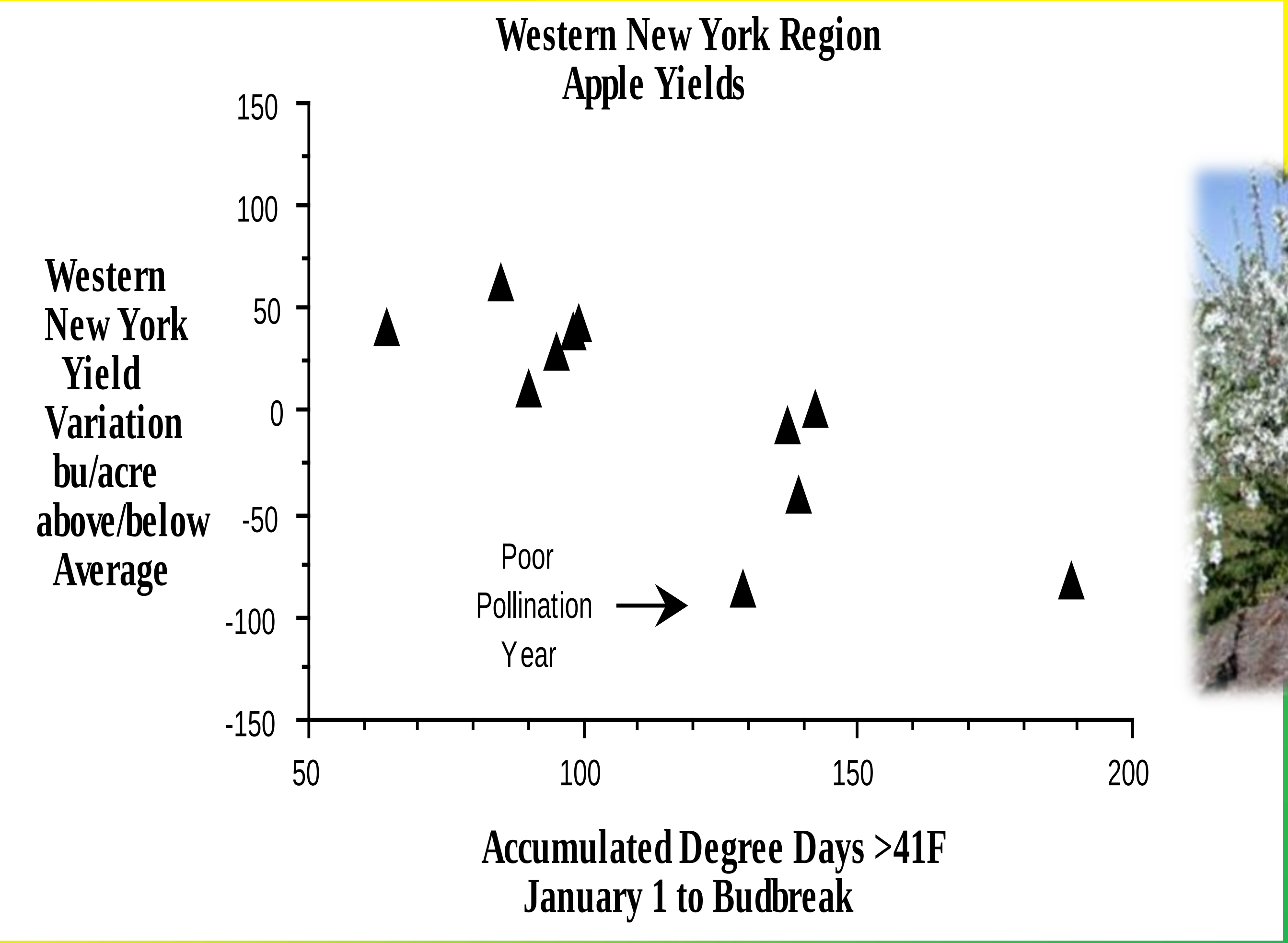
Apple fruit set and yield negatively affected by warmer winters and early springs



Source: A. Lakso, Cornell

Crops vulnerable to rising temperature

Insect Pests

Warmer conditions can allow or worsen a variety of pest infestations:

- European slugs: New to Alaska, now flourishing from Kenai to Interior
- Aphids: Growth increases exponentially with temperature
- Birch leaf roller, birch leaf miner, larch saw fly, aspen leaf miner (Glenn Juday, Professor of Forest Ecology, UAF)
- Woolly sawfly: Longer growing season can allow two life cycles within one year

Plants stressed by heat or drought are more susceptible (Michael Rasy, IPM, UAF Coop. Ext.)

How will beneficials and pests respond to climate change and CO_2?

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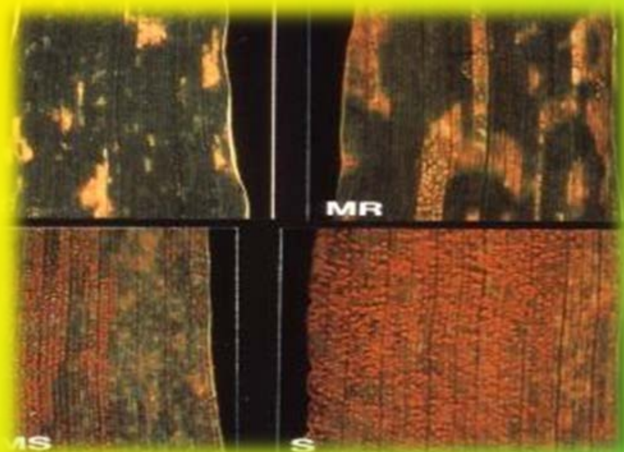
Potential Effects of Rising Temperature on Plant Disease

Wheat has been found to be more susceptible to rusts at higher temperatures



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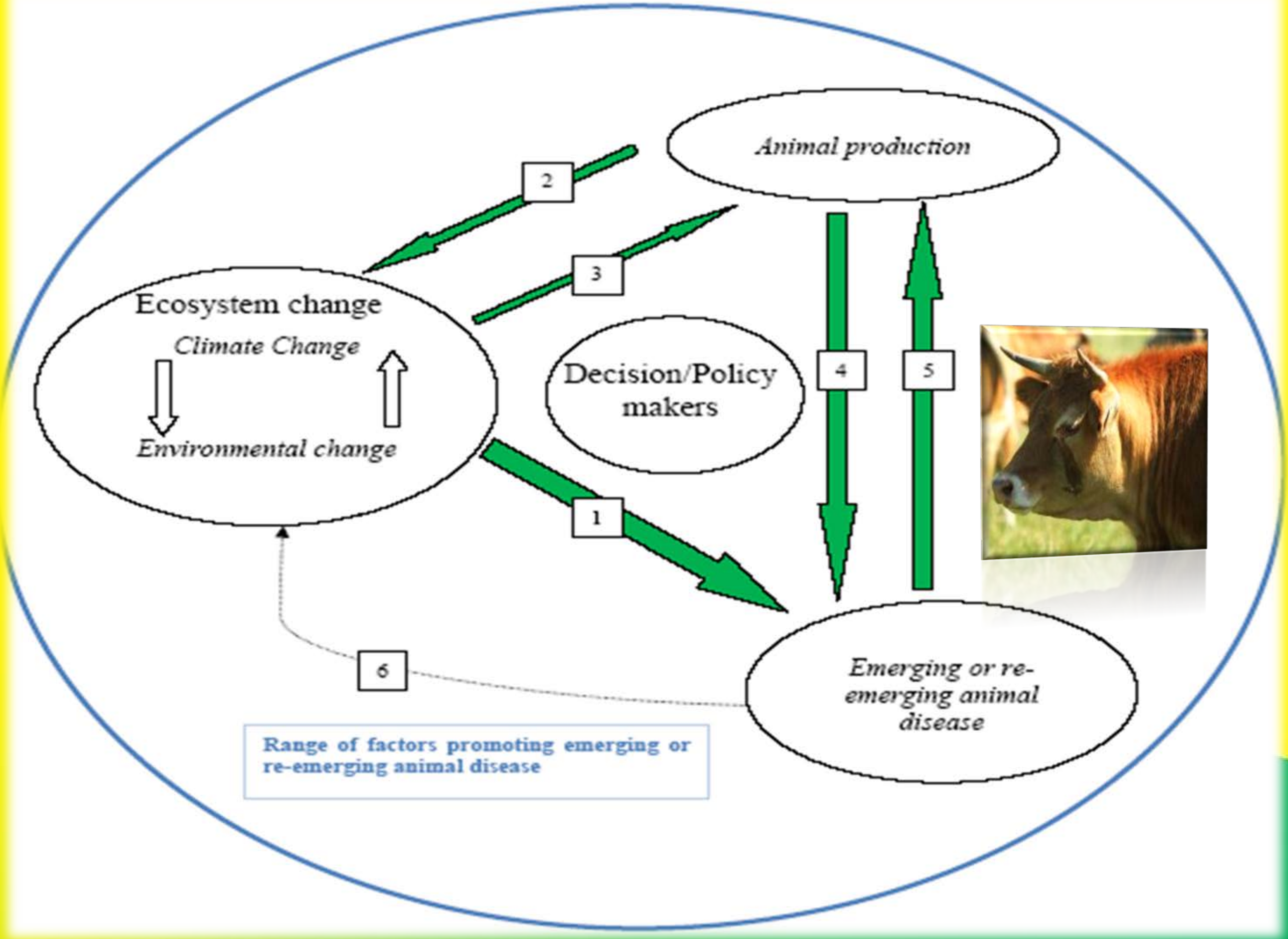
Climate change impacts on Aquaculture

uaculture
e fastest growing food
oducing sector in the world.

ghly diverse - 442 cultured
pecies in different systems.

Higher Water Temperatures

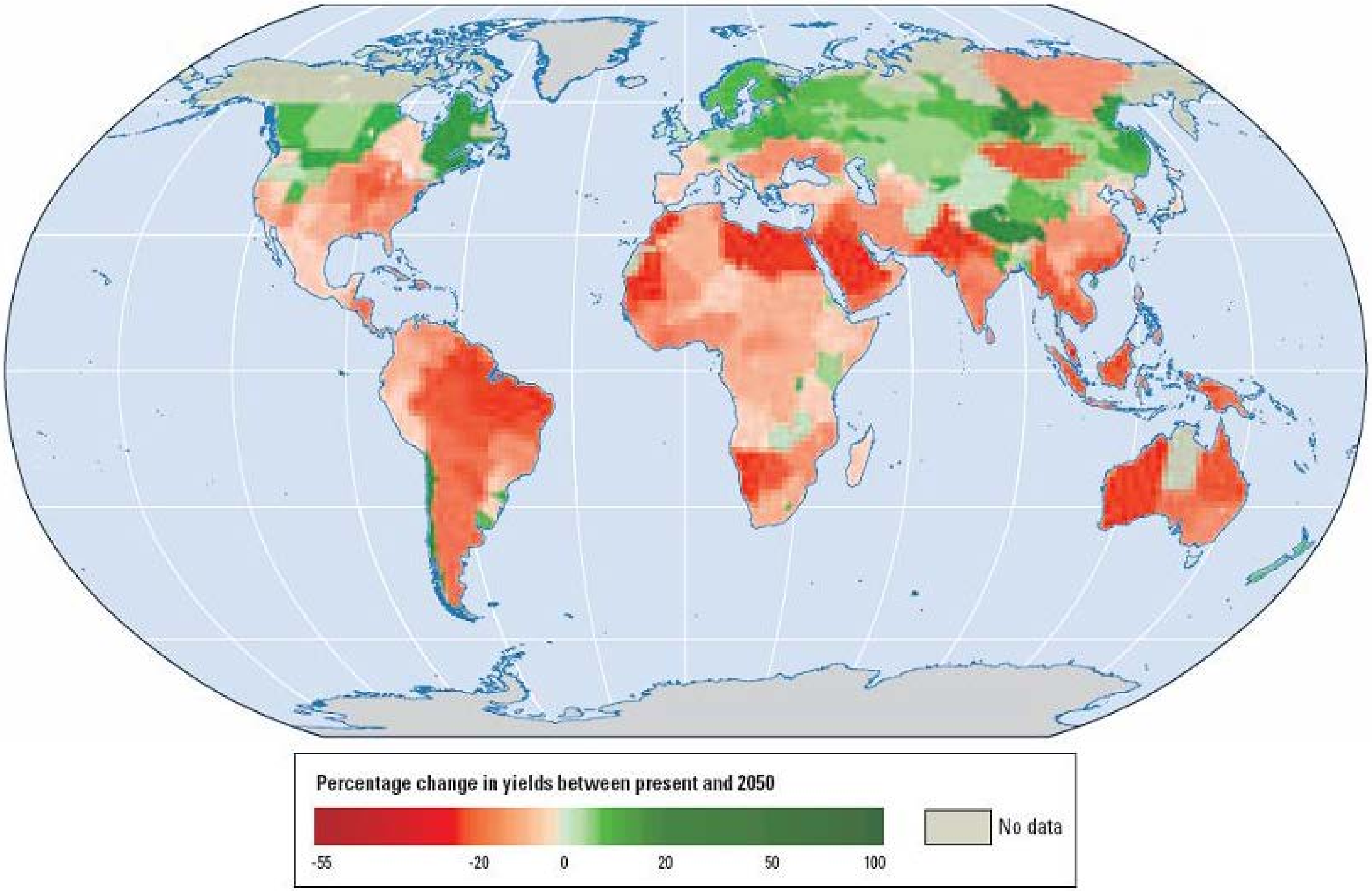
“ Higher inland water temperatures may reduce the availability of wild fish stocks by harming water quality, worsening dry season mortality, bringing new predators and pathogens and changing the abundance of food available….”(WorldFish 2007)


Animal production
2
3
Ecosystem change
Climate Change
Environmental change
Decision/Policy makers
4
5
1
6
Emerging or re-emerging animal disease
Range of factors promoting emerging or re-emerging animal disease

Native plants under threat

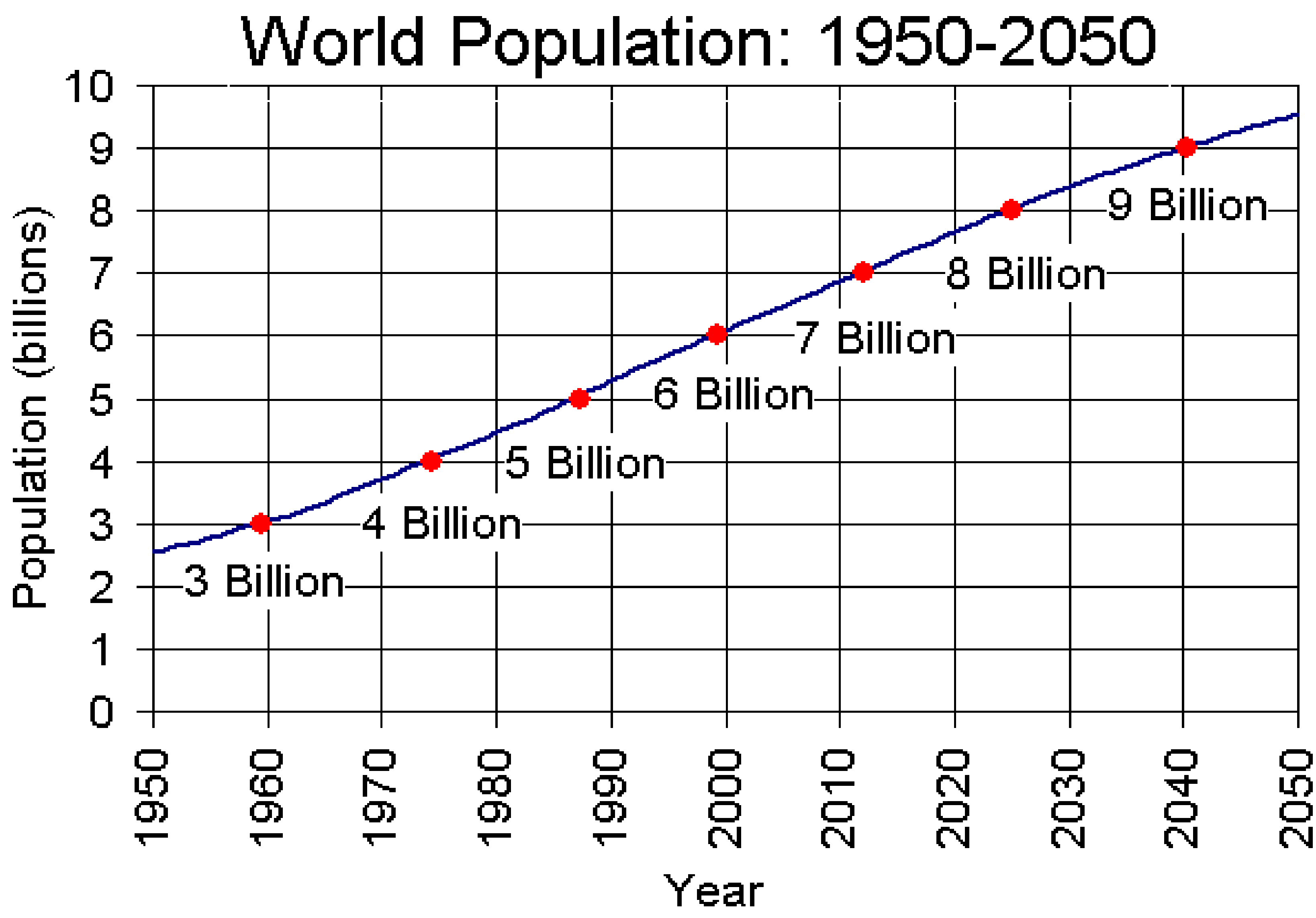
Climate change and land clearing threatens 800 native plant types

Percentage global crop yield loss (present to 2050)



Sources: Müller and others 2009; World Bank 2008c.

Note: The figure shows the projected percentage change in yields of 11 major crops (wheat, rice, maize, millet, field pea, sugar beet, sweet potato, soybean, groundnut, sunflower, and rapeseed) from 2046 to 2055, compared with 1996–2005. The values are the mean of three emission scenarios across five global climate models, assuming no CO_2 fertilization (a possible boost—of uncertain magnitude—to plant growth and water-use efficiency from higher ambient CO_2 concentrations). Large negative yield impacts are projected in many areas that are highly dependent on agriculture.



Source: U.S. Census Bureau, International Data Base, December 2008 Update.

World Population

Present = 7.7 billion

2050 = 9.7 billion

2100 = 11 – 17 billion

More than 70 % of the world population growth between 2010 – 2050 will occur in 24 of the world poorest countries

Climate Migrants

- **Professor Myers of Oxford University. Looking ahead to 2050 he has argued that "when global warming takes hold there could be as many as 200 million people [displaced] (climate migrants)**
- **This would mean that by 2050 one in every 45 people in the world would have been displaced by climate change**
- **Other estimates suggest a range between 200 Million to One Billion.**

Environment and Security in the Mediterranean: Migration

- Emigration country
- Immigration country
- Schengen area (associated with EU except United Kingdom and Ireland; plus Iceland, Norway and Switzerland)
- Main migration routes
- Refugee camp
- Migration hub

Citizenship of foreign population (> 10%)

Others, Egypt, Albania, Syria, Former-Yugoslavia, Turkey, Algeria, Italy, Palestine, Morocco

Total of foreign population

7 Mio
3 Mio
1 Mio
0.4 Mio

medsec

Sources: Frontex, Eurostat, Plan Bleu, Migreurop, Philippe Rekacewicz


Mediterranean sea

Climate change

Environmental Refugees

Global Ethical Responsibility

What does the future hold?

- Issue will be brought up later this year at COP21 in Paris
- UN Advisory Group on Climate Change and Human Mobility has pledged to provide technical assistance to countries
- Current refugee crisis in Europe a ‘rehearsal’ for the climate refugee crisis?

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New Tools of Science & Technology

- Remote sensing, GIS/GPS
- Biotechnology/genetic engineering.
- Genetic and Proteomics (Gene mining …etc).
- Simulation modeling
- Information Technology/ Expert System/ Advanced artificial intelligence
- Renewable energy: solar, wind, biofuel
- New energy-saving techniques for desalination and water transportation
- Nanotechnology, (Biosensors – Bioprocessing – Nanomaterials).

Adaptation

Knowledge

A. New Genetic Makeup

- **Varieties etc. (Heat & Drought Tolerance)**
- **Tolerance to biotec and abiotec stresses**

B. New Agro management Techniques on farm

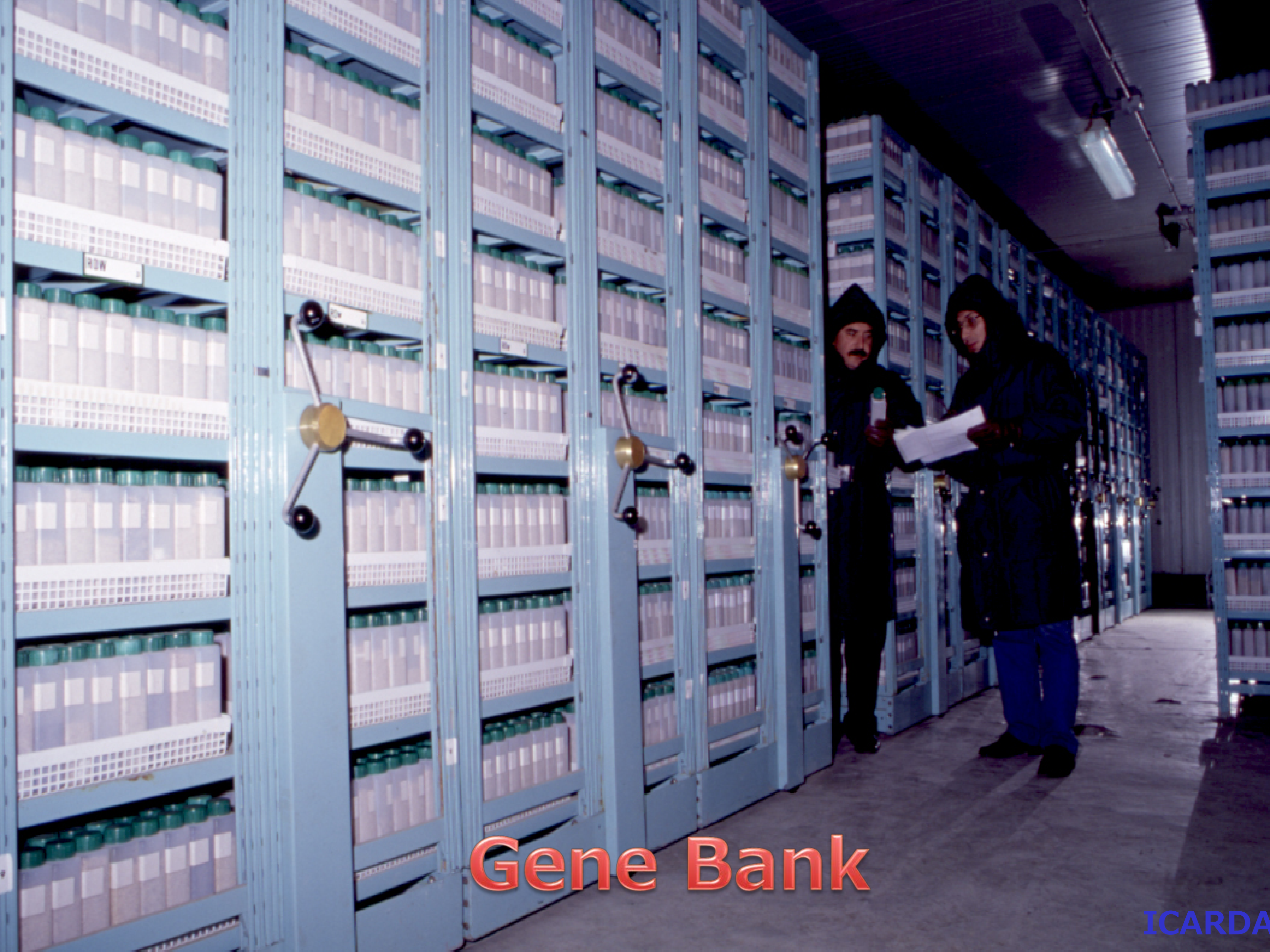
- **Irrigation & Nutrition etc..**

Knowledge

Massive Program of HRD
Capacity Building

IDDC

Elbeltagy, 2010


Gene Bank
ICARDA

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NORDIC GENE BANK
SAFETY BASE
COLLECTION

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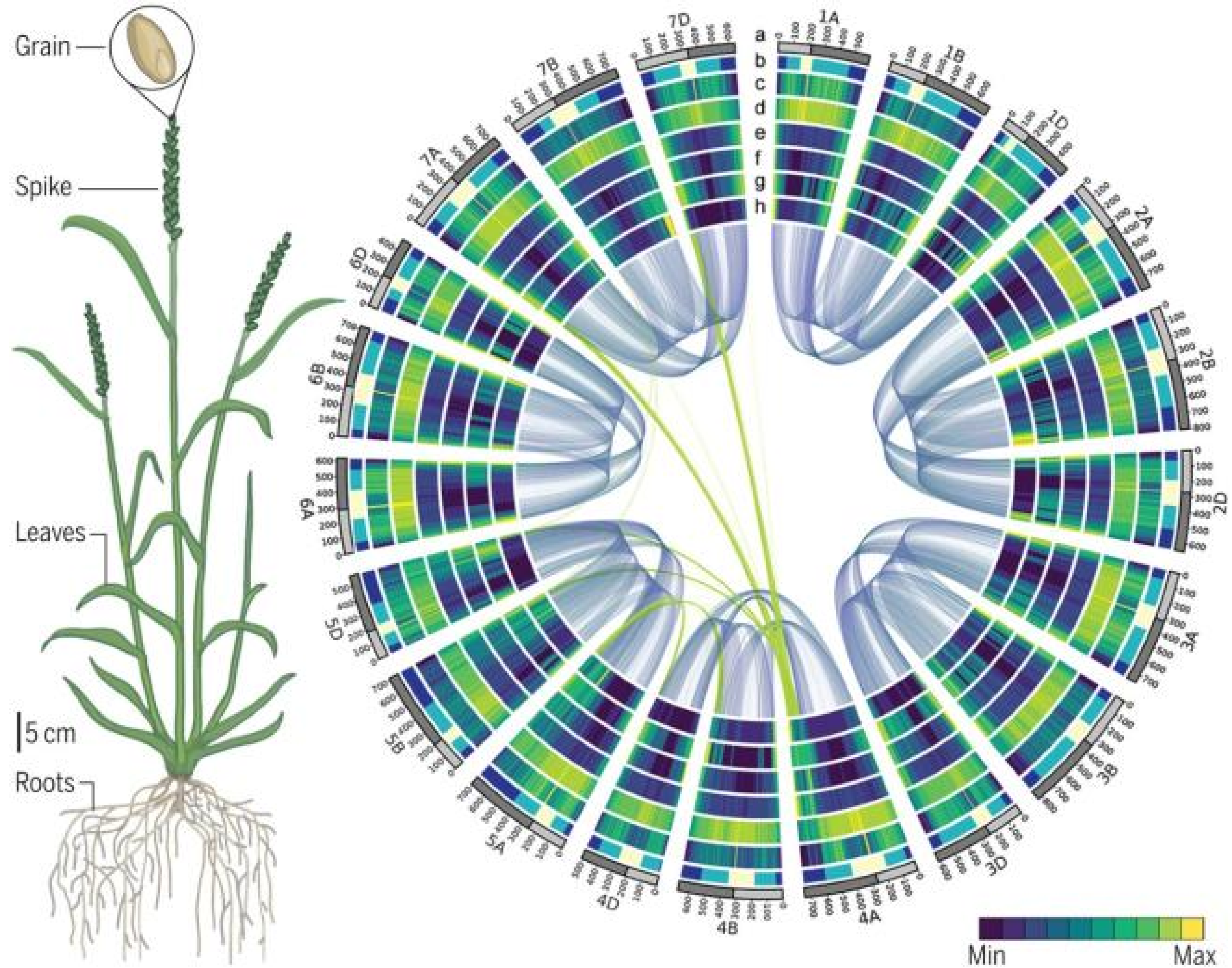
G × E + P = Y

(G) Genotype

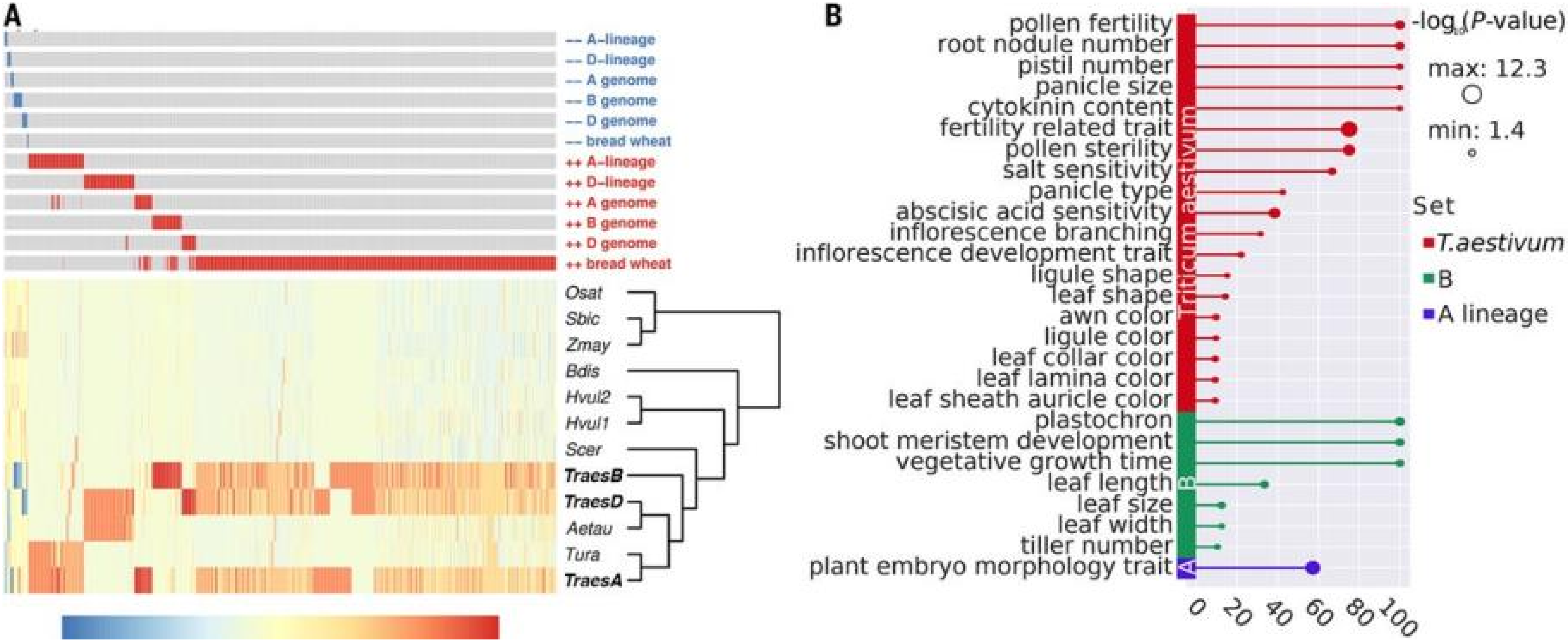
(E) Environment

(P) People
Agromanagement tech.

(Y) Yield
Productivity



With complete access to the ordered sequence of all 21 wheat chromosomes, the context of regulatory sequences, and the interaction network of expressed genes, breeders and researchers now have the ability to rewrite the story of wheat crop improvement.



Gene families of wheat.

(A)Heatmap of expanded and contracted gene families. Columns correspond to the individual gene families. Rows in the top panel illustrate the sets of gene-family expansions (++, red) and contractions (—, blue) found for the wheat A lineage (*Triticum urartu* and A subgenome); the D lineage (*Aegilops tauschii* and D subgenome); the A, B, or D subgenomes; or bread wheat (expanded and contracted in all subgenomes).

(B)All enriched TO terms for the gene families depicted in (A). Overrepresented TO terms were found for expanded families in bread wheat (all subgenomes, red), the B subgenome (green), and the A lineage (*T. urartu* and A subgenome, blue) only, respectively. The *x* axis represents the percentage of genes annotated with the respective TO term that were contained in the gene set in question. The size of the bubbles corresponds to the *P* ($-\log_{10}$) significance of expansion.

Bread wheat: combining yield potential and drought tolerance

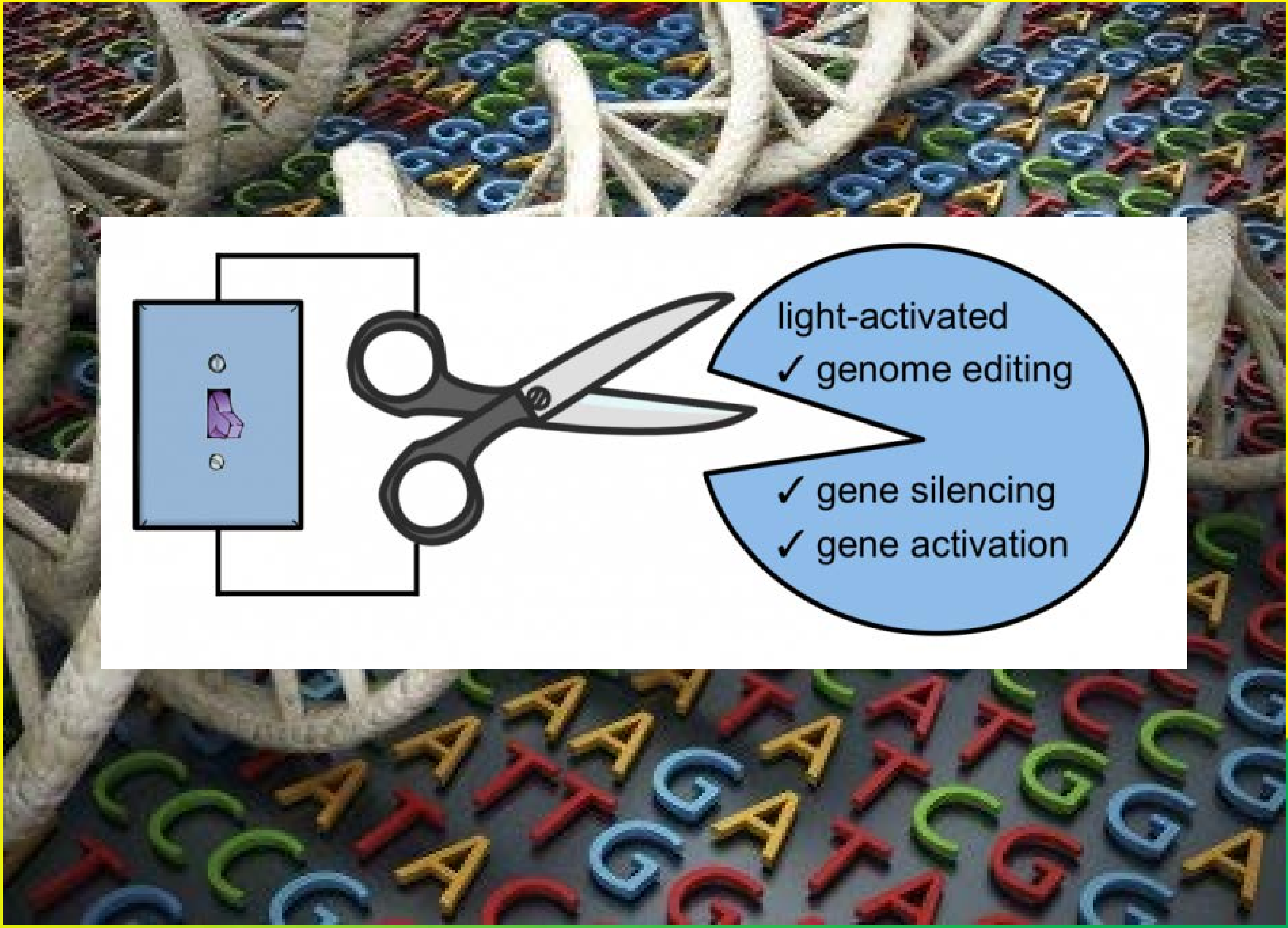
> These genotypes yielded 6.5 tons/ha under irrigation and 2.5 tons/ha under rainfed conditions

Wheat trials at Tel Hadya: new genotypes that combine drought tolerance with high yield potential and input responsiveness, 2010/2011

Egyptian scientists produce drought-tolerant GM wheat at (AGERI)

Drought resistance corn (US)

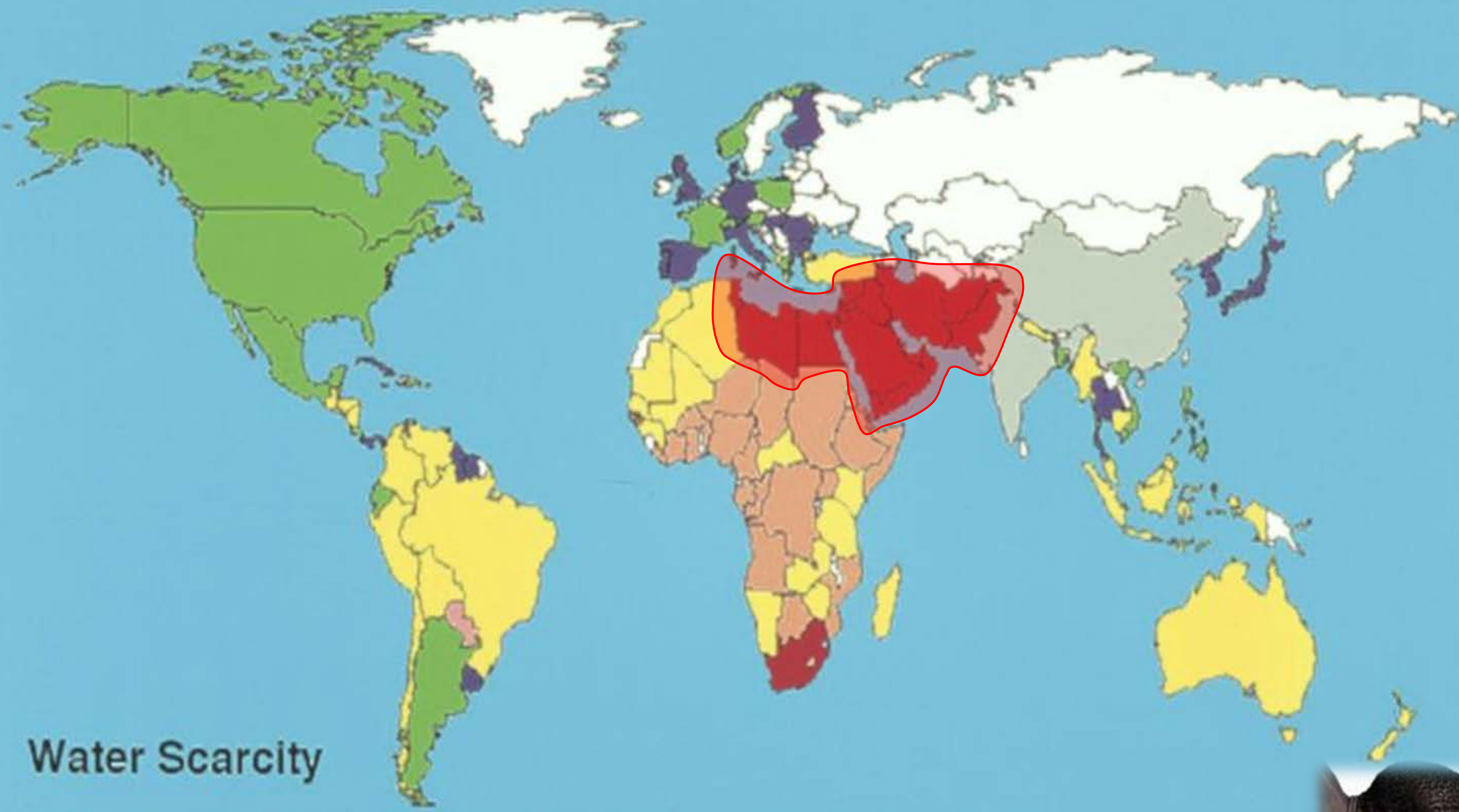
Dekalb/Pioneer hybrid, August 2011


light-activated
✓ genome editing
✓ gene silencing
✓ gene activation

Topics in Agricultural NanoTechnology

- Agricultural and food system security, Food quality control
- Smart delivery system (pesticides, nutrition, drugs)
- Biological labels and imaging
- New tools for molecular and new cellular biology
- New materials for pathogen detection and environment protection
- Microarrays: genes and proteins
- Nanoparticle complexes of DNA, peptides, ATP,...
- Molecular machines and devices

Relative water scarcity projections to 2025



Water Scarcity

Group 1 (mainly West Asia and North Africa)

Group 2 (mainly Sub-Saharan Africa)

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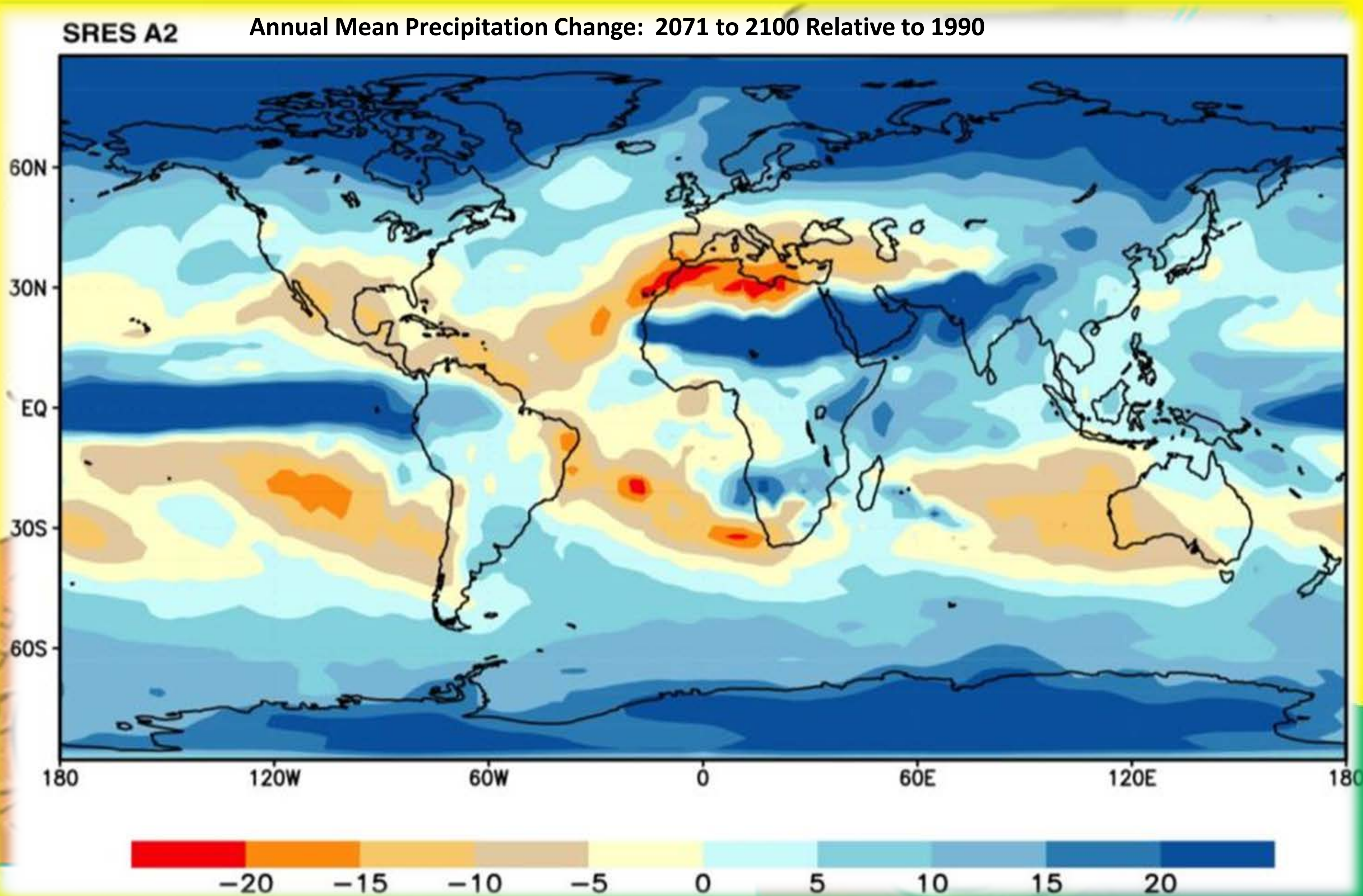
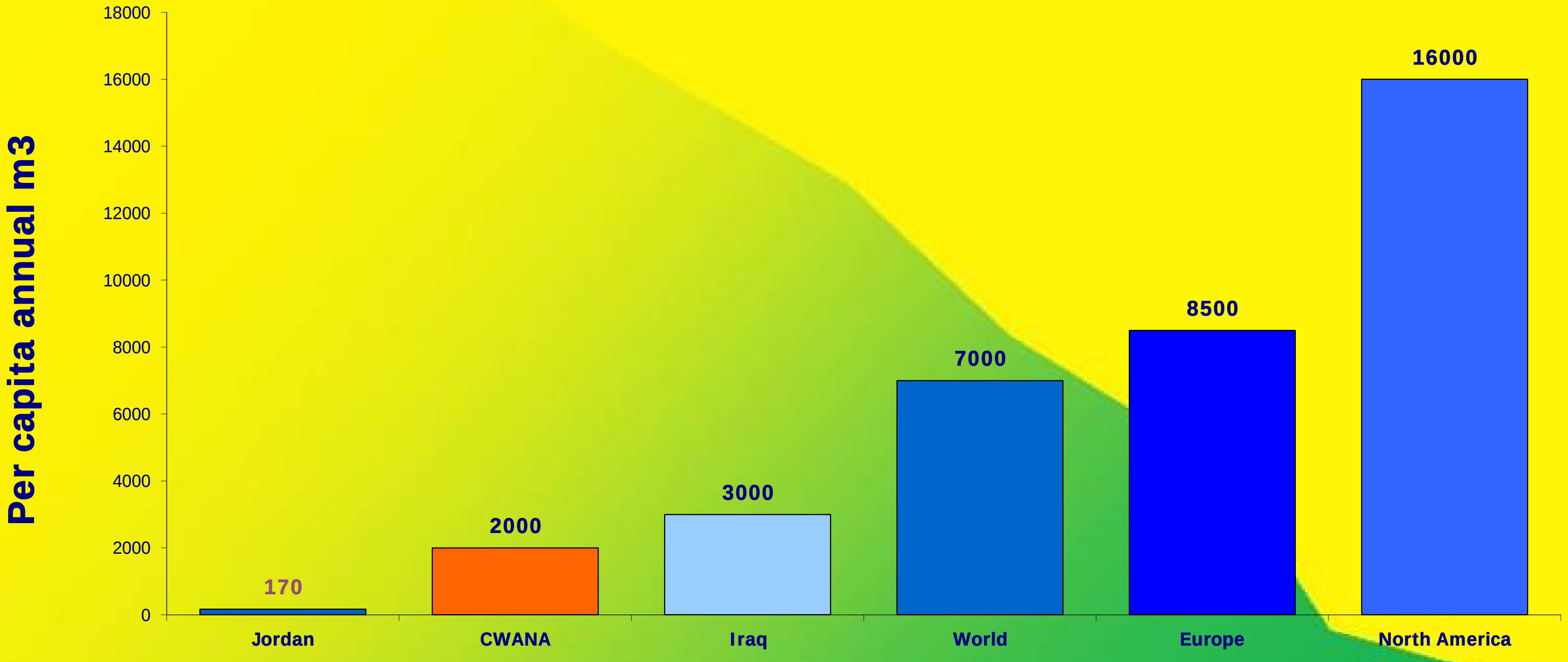
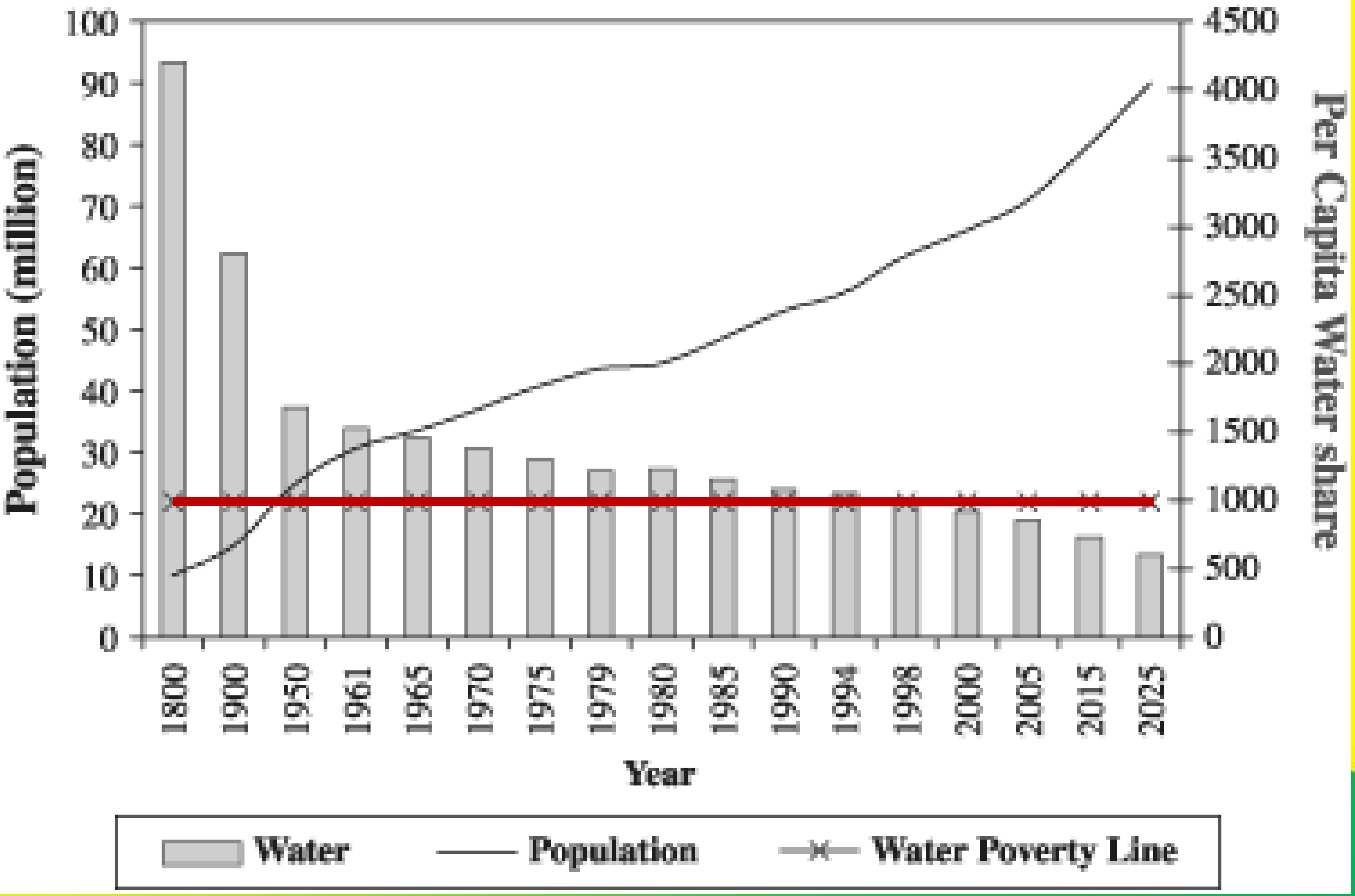
More wetter & more drier



Water management under scarcity

Annual renewable water share





Population growth and per capita water share in Egypt (m3/year)

* http://www.idrc.ca/

Modern irrigation systems

Central pivot

Sprinkler irrigation

Drip irrigation

NFT and hydroponics

Fodder production in hydroponics

The future of food and farming: 2050s

By 2050, climatic impacts on food security will be unmistakable. There are likely to be 9 billion people on the planet, most people will live in cities and demand for food will increase significantly.

Widespread impacts on food and farming are highly likely

Average decline in yields for eight major crops across Africa and South Asia

Marine fisheries will also be affected

Heat and water may pass critical thresholds

Temperature increases of more than 4°C will endanger the ability of farms and ecosystems to adapt

Water cycles will be very different and less predictable

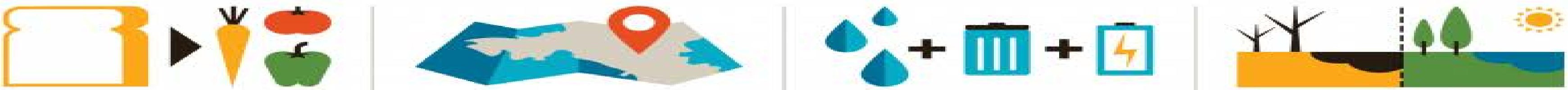
Changes in the intensity, frequency and seasonality of precipitation

Sea level rises and melting glaciers

Changes in groundwater and river flows

We will need major innovations in how we eat and farm

To cope with climatic changes, we may need to consider:



Completely different diets

Shifting production areas for familiar crops, livestock and fisheries

New approaches to managing waste, water and energy in food supply chains

Restoring degraded farmlands, wetlands and forests

SOURCES: Porter, J. R., Xie, L., Challinor, A., Cochrane, K., Howden, M., Iqbal, M. M., Lobell, D., Travasso, M. I. 2014. Food Security and Food Production Systems. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. http://www.ipcc-wg2.gov/ With data from Cheung et al 2010, Cochrane et al 2009, Knox et al 2012

CGIAR
RESEARCH PROGRAM ON Climate Change, Agriculture and Food Security
CCAFS


SDG's
Sendai
Paris
2015

Sendai Framework and the Paris Agreement

In Paris, countries agreed to:

Hold the increase in the global average temperature to well below 2 °C above pre-industrial levels and to pursue efforts to limit the increase to 1.5 °C – recognizing that this would significantly reduce the risks and impacts of climate change

a first ever global goal for adaptation. The goal considers enhancing adaptive capacity, strengthening resilience and reducing vulnerability to climate change – building on the 2010 Cancun Adaptation Framework which is anchored in DRR

UNISDR

SENDAI FRAMEWORK

Scope and Purpose

1 Global Outcome

1 Goal

7 Global Targets

13 Guiding Principles

4 Priorities for Action

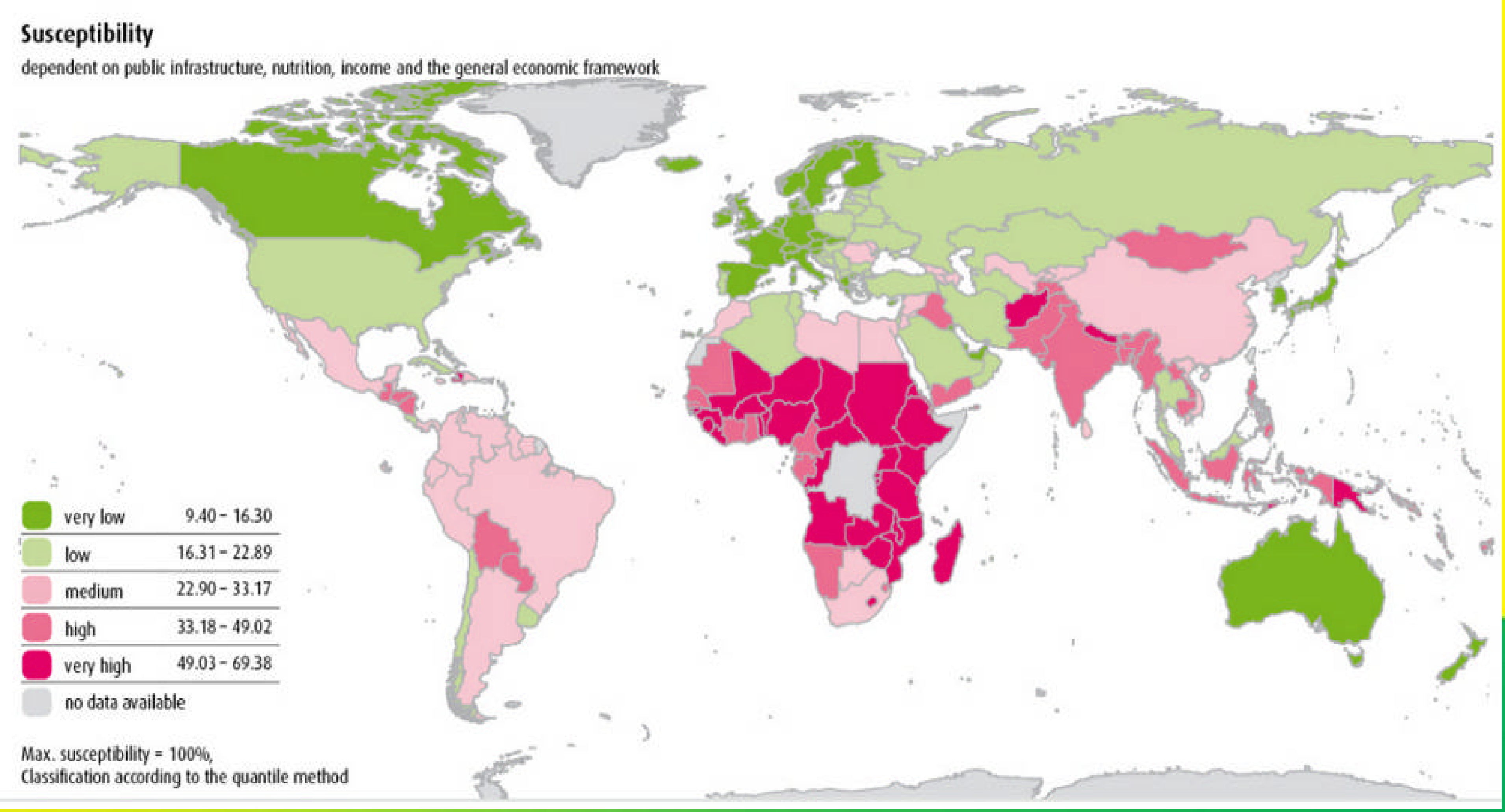
at 4 Levels
Local, National, Regional and Global

Role of Stakeholders

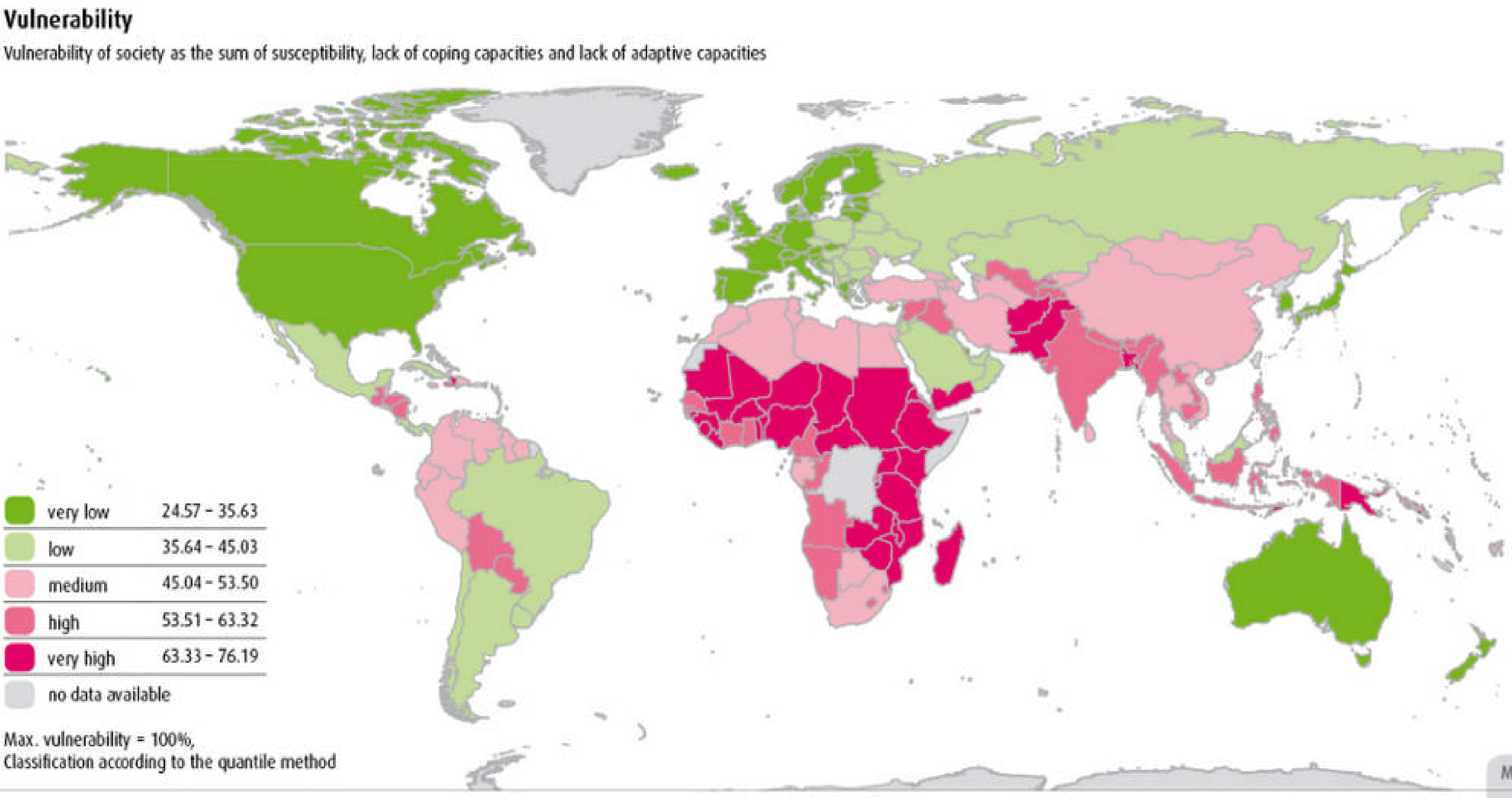
International Cooperation and Global Partnerships


Regional Platforms for
Disaster Risk Reduction
unisdr.org/we/coordinate/regional-platforms

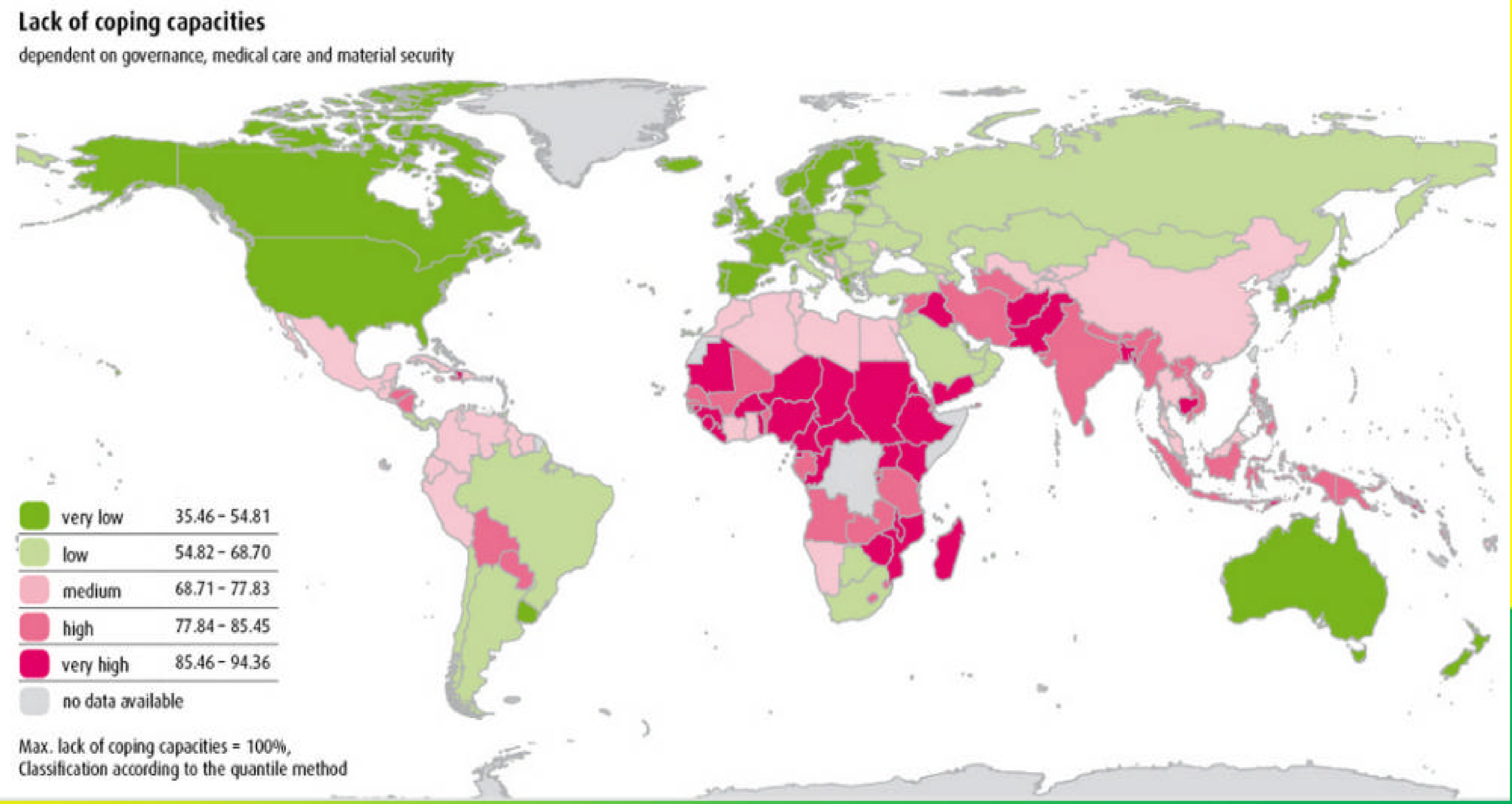
Susceptibility



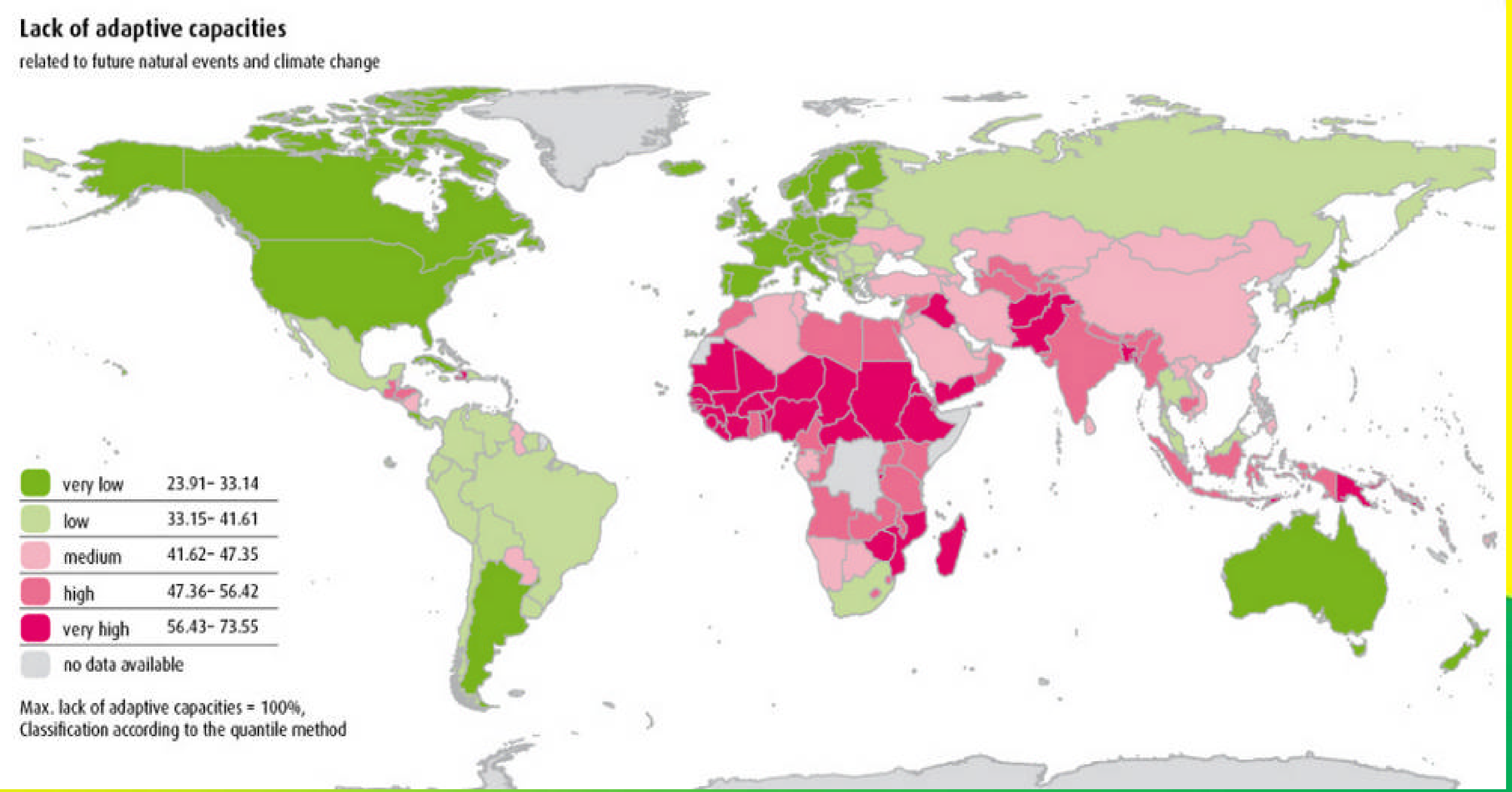
Vulnerability



Lack of Coping Capacities



Lack of Adaptive Capacities

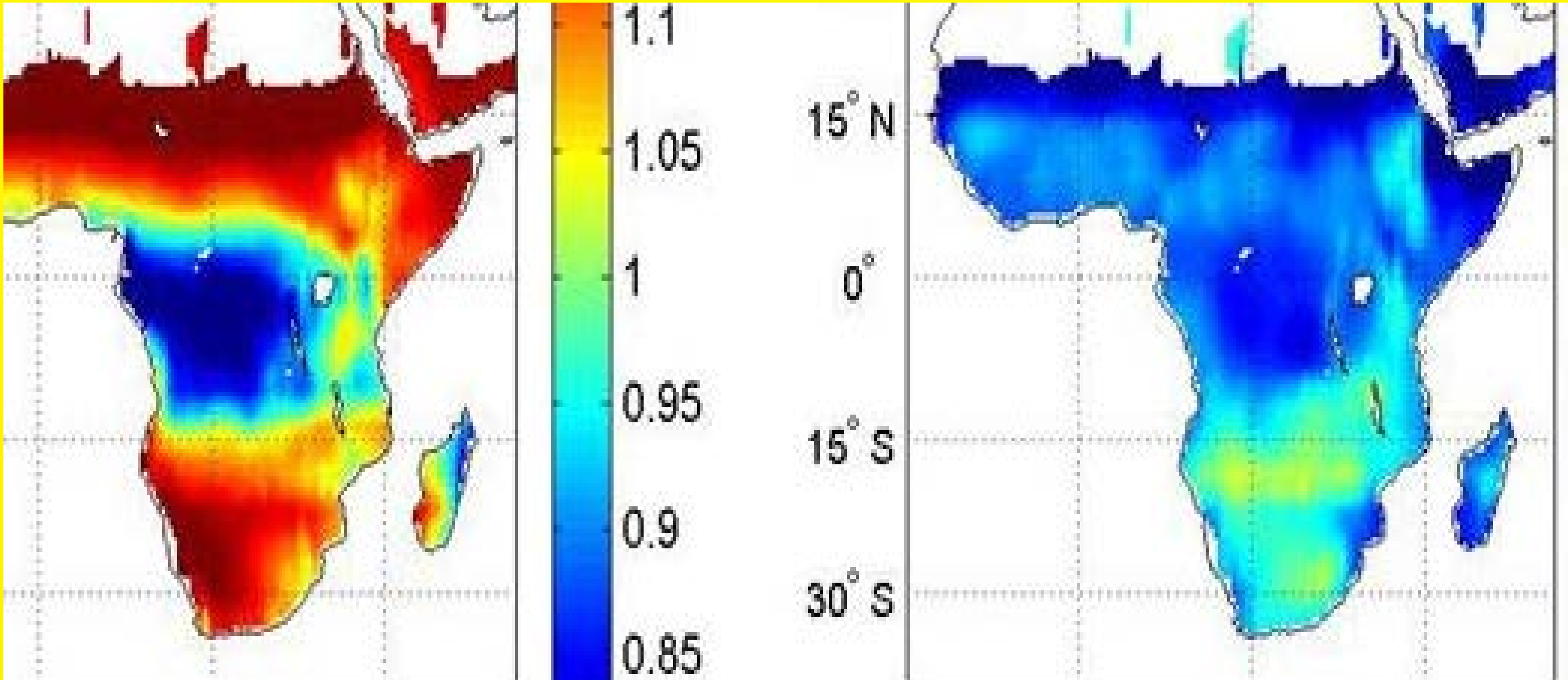


Disaster risk reduction cuts across the 2030 Sustainable Development Agenda

There are **25 targets, directly and indirectly,** related to disaster risk reduction in **10 of the 17 SDGs**, firmly establishing the role of **disaster risk reduction as a core development strategy.**

UNISDR

Geographic patterns of cropland sensitivity to precipitation and temperature



Cumulative marginal effects for precipitation and temperature across all seasons (winter, spring, summer, fall) were evaluated at long-term (1961–2000) mean conditions for each location (grid cell). Changes in the odds ratio per unit change in seasonal precipitation (10mm/month) and temperature (°C) are averaged across all six cropland models. Positive marginal effects (Q > 1) are shown in yellow-to-red colors, and negative marginal effects (Q < 1) in green-to-blue colors. For instance, Q = 1.1 indicates that the odds of land being used for cropping increases by 10% if the long-term mean monthly precipitation increases by 10mm (120mm/year). Increases in precipitation have a positive effect on croplands (left) in subtropical regions (10–20° N and 20–30° S) whereas they are neutral or negative in tropical regions. For temperature, increases in seasonal temperature have negative effects for most of the African continent, with the exception of mild positive effects in parts of southern Africa.

Policy Research Working Paper 4289, World Bank 2007

Regional Impacts of Climate Change

Impacts on Africa

- Africa may be the most vulnerable continent to climate variability and change because of multiple existing stresses and low adaptive capacity. Existing stresses include poverty, food insecurity, political conflicts, and ecosystem degradation.
- By 2050, between 350 million and 600 million people are projected to experience increased water stress due to climate change. Urban population is also projected to triple, increasing by 800 million people, complicating urban poverty and access to basic services.
- Climate variability and change is projected to severely compromise agricultural production, including access to food, in many African countries and regions.
- Toward the end of the 21st century, projected sea level rise will likely affect low-lying coastal areas with large populations, including Senegal, Liberia, and Mozambique.
- Climate variability and change can negatively impact human health. In many African countries, existing health threats – such as malnutrition, malaria and other vector-borne diseases -- can be exacerbated by climate change.

Source: International Panel on Climate Change 2014 www.ipcc.ch

Regional Impacts of Climate Change

Impacts on Asia

- Glaciers in Asia are retreating at faster rates than ever documented in historical records. Some glaciers currently cover 20% of the land that they covered a century ago. Melting glaciers increase the risks of flooding and rock avalanches from destabilized slopes.
- Climate change is projected to decrease freshwater availability, especially in central and southeast Asia, particularly in large river basins. With population growth and increasing demand from higher standards of living, this decrease could adversely affect more than a billion people by 2050.
- Increased flooding from the sea and, in some cases, from rivers threatens coastal areas, especially heavily populated delta regions in south and southeast Asia.
- The impacts of climate change on crop yields are likely to vary drastically depending on region, crop type, and regional changes in temperature and precipitation. For example, by the mid-21st century, climate change could increase crop yield up to 20% in east and southeast Asia, while decreasing yield up to 30% in central and south Asia.
- Sickness and death due to diarrheal disease will likely increase in east, south, and southeast Asia due to projected changes in the hydrological cycle associated with climate change.

Source: International Panel on Climate Change 2014 www.ipcc.ch

Regional Impacts of Climate Change

Impacts on Europe

- Wide-ranging impacts of climate change are already being documented in Europe, including retreating glaciers, sea level rise, longer growing seasons, species range shifts, and heat wave-related health impacts.
- Future impacts of climate change will likely negatively affect nearly all European regions, with adverse social, health, and infrastructure effects. Many economic sectors, such as agriculture and energy, could face challenges.
- In southern Europe, higher temperatures and drought may reduce water availability, hydropower potential, summer tourism, and crop productivity, hampering economic activity more than other European regions.
- In central and eastern Europe, summer precipitation is projected to decrease, causing higher water stress. Forest productivity is projected to decline. The frequency of peatland fires is projected to increase.
- In northern Europe, climate change is initially projected to bring mixed effects, including some benefits such as reduced demand for heating, increased crop yields, and increased forest growth. However, as climate change continues, negative impacts are likely to outweigh benefits. These include more frequent winter floods, endangered ecosystems, and increasing ground instability from thawing permafrost.

Source: International Panel on Climate Change 2014 www.ipcc.ch

Regional Impacts of Climate Change

Impacts on Australia and New Zealand

- Water security problems are projected to intensify with a 1°C global average warming in southwestern and southeastern Australia, and in the northern and some eastern parts of New Zealand.
- Biodiversity within some ecologically rich sites, including the Great Barrier Reef and Queensland Wet Tropics, will be at significant risk by 2050.
- Sea level rise and more severe storms and coastal flooding will continue to affect coastal areas. Coastal development and population growth in areas such as Cairns and Southeast Queensland (Australia) and Northland to Bay of Plenty (New Zealand), would place more people and infrastructure at risk.
- Increased drought and fire are projected to cause declines in agricultural and forestry production over much of southern Australia and the northern and eastern parts of New Zealand.
- Cascading and interacting economic, social, and daily life circumstances have accompanied prolonged drought in rural regions. Drought-related worry and psychological distress increased in drought-declared Australian regions, particularly for those experiencing loss of livelihood and industry. Long-term drought has been linked to increased incidence of suicide among male farmers in Australia.
- Extreme storm events are likely to increase the failure of dikes, levees, drainage, and sewerage systems. They are also likely to increase the damage from storms and fires.
- More heat waves are likely to cause more deaths and more electrical blackouts.
- Indigenous populations are more exposed the risks of climate change than most other Australians and New Zealanders.

Source: International Panel on Climate Change 2014 www.ipcc.ch

Regional Impacts of Climate Change

Impacts on Central and South America

- By mid-century, increases in temperature and decreases in soil moisture are projected to cause savanna to gradually replace tropical forest in eastern Amazonia.
- In drier areas, climate change will likely worsen drought, leading to salinization (increased salt content) and desertification (land degradation) of agricultural land. The productivity of livestock and some important crops such as maize and coffee is projected to decrease in some areas, with adverse consequences for food security. In temperate zones, soybean yields are projected to increase.
- Sea level rise is projected to increase risk of flooding, displacement of people, salinization of drinking water resources, and coastal erosion in low-lying areas. These risks threaten fish stocks, recreation, and tourism.
- Changes in precipitation patterns and the melting of glaciers are projected to significantly affect water availability for human consumption, agriculture, and energy generation.
- Climate change and land use changes are expected to increase the rates of species extinction.
- Warmer weather, milder winters, and changes in precipitation may increase incidence of some vector-borne diseases, such as the chikungunya virus, which is transmitted by mosquitoes.

Source: International Panel on Climate Change 2014 www.ipcc.ch

Regional Impacts of Climate Change

Impacts on North America

- Warming in western mountains will decrease snowpack, increase winter flooding, and reduce summer flows, exacerbating competition for over-allocated water resources.
- Disturbances from pests, diseases, and fire are projected to increasingly affect forests, with extended periods of high fire risk and large increases in area burned.
- Moderate climate change in the early decades of the century is projected to increase aggregate yields of rain-fed agriculture in northern areas, but temperature increases will reduce corn, soy, and cotton yields in the Midwest and South by 2020. Crops that are near the warm end of their suitable range or that depend on highly utilized water resources will likely face major challenges. High emissions scenarios project reductions in yields by as much as 80% by the end of the century.
- Increases in the number, intensity, and duration of heat waves during the course of the century are projected to further challenge cities that currently experience heat waves, with potential for adverse health impacts and increased stress on energy systems. Older populations are most at risk.
- Climate change will likely increasingly stress coastal communities and habitats, worsening the existing stresses of population, development, and pollution on infrastructure, human health, and the ecosystem.

Source: International Panel on Climate Change 2014 www.ipcc.ch

Regional Impacts of Climate Change

Impacts on Polar Regions

- Climate changes will likely reduce the thickness and extent of glaciers and ice sheets.
- Changes in natural ecosystems will likely have detrimental effects on many organisms including migratory birds, mammals, and higher predators as marine species shift their ranges.
- In the Arctic, climate changes will likely reduce the extent of sea ice and permafrost, which can have mixed effects on human settlements. Negative impacts could include damage to infrastructure and changes to winter activities such as ice fishing and ice road transportation. Positive impacts could include more navigable northern sea routes.
- The reduction and thawing of permafrost, sea level rise, and stronger storms may worsen coastal erosion and disrupt both natural and social systems.
- Climate change effects—such as increases in coastal erosion, changes in the ranges of some fish, increased weather unpredictability—are already disrupting traditional hunting and subsistence practices of indigenous Arctic communities, and may force relocation of villages.
- Terrestrial and marine ecosystems and habitats are projected to be at risk to invasive species, as climatic barriers are lowered in both polar regions.

Source: International Panel on Climate Change 2014 www.ipcc.ch

Regional Impacts of Climate Change

Impacts on Small Islands

- Small islands, whether located in the tropics or higher latitudes, are highly vulnerable to extreme weather events, changes in sea level, increases in air and surface temperatures, and changing rainfall patterns.
- Deterioration in coastal conditions, such as beach erosion and coral bleaching, will likely affect local resources such as fisheries, as well as the value of tourism destinations.
- Sea level rise is projected to worsen inundation, storm surge, erosion, and other coastal hazards. These impacts would threaten vital infrastructure, settlements, and facilities that support the livelihood of island communities.
- By mid-century, on many small islands (such as the Caribbean and Pacific), climate change is projected to reduce already limited water resources to the point that they become insufficient to meet demand during low-rainfall periods.
- Invasion by non-native species is projected to increase with higher temperatures, particularly in mid- and high-latitude islands.

Source: International Panel on Climate Change 2014 www.ipcc.ch

Table SPM.6: Examples of potential tradeoffs among adaptation objectives. [Table 16-2]

Sector	Strategy	Adaptation Objective	Real or Perceived Externality
Agriculture	Biotechnology and genetically modified crops	Enhance drought and pest resistance; enhance yields	Perceived risk to public health and safety; ecological risks associated with introduction of new genetic variants to natural environments
	Subsidized drought assistance; crop insurance	Provide financial safety net for farmers to ensure continuation of farming enterprises	Creates moral hazard and inequality if not appropriately administered
	Increased use of chemical fertilizer and pesticides	Maintain or enhance crop yields; suppress opportunistic agricultural pests and invasive species	Increased discharge of nutrients and chemical pollution to the environment; increased emissions of greenhouse gases; increased human exposure to pollutants
Biodiversity	Migration corridors; expansion of conservation areas	Enable natural adaptation and migration to changing climatic conditions	Unknown efficacy; concerns over property rights regarding land acquisition; governance challenges
	Anticipatory endangerment listings	Enhance regulatory protections for species potentially at-risk due to climate change	Addresses secondary rather than primary pressures on species; concerns over property rights; regulatory barriers to economic development
	Assisted migration	Facilitate conservation of valued species	Potential for externalities for ecological and human systems due to species relocation
Coasts	Sea walls	Protect assets from inundation and/or erosion	High direct and opportunity costs; equity concerns; ecological impacts to coastal wetlands
	Managed retreat	Allow natural coastal and ecological processes; reduce long-term risk to property and assets	Undermines private property rights; significant governance challenges associated with implementation
	Migration out of low-lying areas	Preserve public health and safety; minimize property damage and risk of stranded assets	Loss of sense of place and cultural identity; erosion of kinship and familial ties; impacts to receiving communities
Water resources management	Desalination	Increase water resource reliability and drought resilience	Ecological risk of saline discharge; high energy demand and associated carbon emissions; creates disincentives for conservation
	Water trading	Maximize efficiency of water management and use; increases flexibility	Undermines public good/social aspects of water
	Water recycling/reuse	Enhance efficiency of available water resources	Perceived risk to public health and safety

Source: 46th session of IPCC, Montreal, Canada. Sep. 2017(AR6 Report)

Table SPM.3: Entry points, strategies, measures, and options for managing the risks of climate change. These approaches should be considered overlapping rather than discrete, and they are often pursued simultaneously. Examples given can be relevant to more than one category.

Entry Point	Category			Examples	Chapter Reference(s)
Vulnerability reduction through development and planning	Forms of sectoral integration	Human development	Specific measures	Low regrets options to reduce structural inequalities: improved access to education, nutrition, health facilities, energy, safe settlement structures, social support structures; reduced gender inequality and marginalization in other forms.	13.1.2, 13.3.1, 13.4.1, 13.4.2, 22.3.1
		Poverty alleviation		Insurance schemes, social protection programs, disaster risk reduction. Improved access to and control of local resources, land tenure, and storage facilities. Low regrets options to reduce structural inequalities.	13.1.2, 13.3.1, 13.3.2, 13.4.1
		Livelihood security		Income and asset diversification. Improved infrastructure. Access to technology and decision-making fora, enhanced agency.	13.1.1, 13.3.1, 13.4.1
		Disaster risk reduction and management		Early warning systems.	11.7.3, 22.4.5, 26.9.1
		Ecosystem management		Maintaining wetlands and urban green spaces, coastal afforestation.	8.3.3, Box 8.1, 15.3.1, Box CC-EA
		Spatial or land-use planning		Provisioning of adequate housing, infrastructure, and services. Managing development in flood prone and other high risk areas.	8.1.4, 8.4.3, 8.5.3

Source: 46th session of IPCC, Montreal, Canada. Sep. 2017(AR6 Report)

Adaptation	Structural/ concrete	Engineered	Specific options	Sea walls, water storage, improved drainage, beach nourishment, flood shelters. Improved infrastructure.	14.3.1, Table 14-2
		Technological		New crop and animal varieties, efficient irrigation and water use, hazard mapping and monitoring, early warning systems, home insulation.	14.3.1, Table 14-2
		Ecosystem-based		Wetland reestablishment, reestablishment of floodplains, bushfire fuel-reduction actions.	14.3.1, Table 14-2
		Services		Social safety nets, food banks, vaccination programs, municipal services.	14.3.1, Table 14-2
	Institutional	Economic	Specific options	Financial incentives, insurance and other risk spreading.	13.3.2, 14.3.2, Table 14-2
		Laws and regulations		Land zoning laws, building standards, easements.	14.3.2, Table 14-2
		Government policies and programs		National and local adaptation plans, urban upgrading programs, municipal water conservation programs, disaster planning and preparedness.	14.3.2, Table 14-2
	Social	Educational	Specific options	Awareness raising, extension services.	14.3.3, Table 14.2
		Informational		Hazard mapping and monitoring, early warning, community support groups.	14.3.3, Table 14-2
		Behavioral		Household preparation, evacuation planning, retreat and migration, water conservation, storm drain clearance.	14.3.3, Table 14-2
Transformation	Spheres of change	Practical	Specific strategies	Social and technical innovations, behavioral shifts, or institutional and managerial changes that produce measurable outcomes.	20.5.2
		Political		Changes in the political, social, cultural, and ecological systems or structures that currently contribute to risk and vulnerability or impede practical transformations.	20.5.2
		Personal		Changes in individual and collective assumptions, beliefs, values, and worldviews that influence climate change responses.	20.5.2

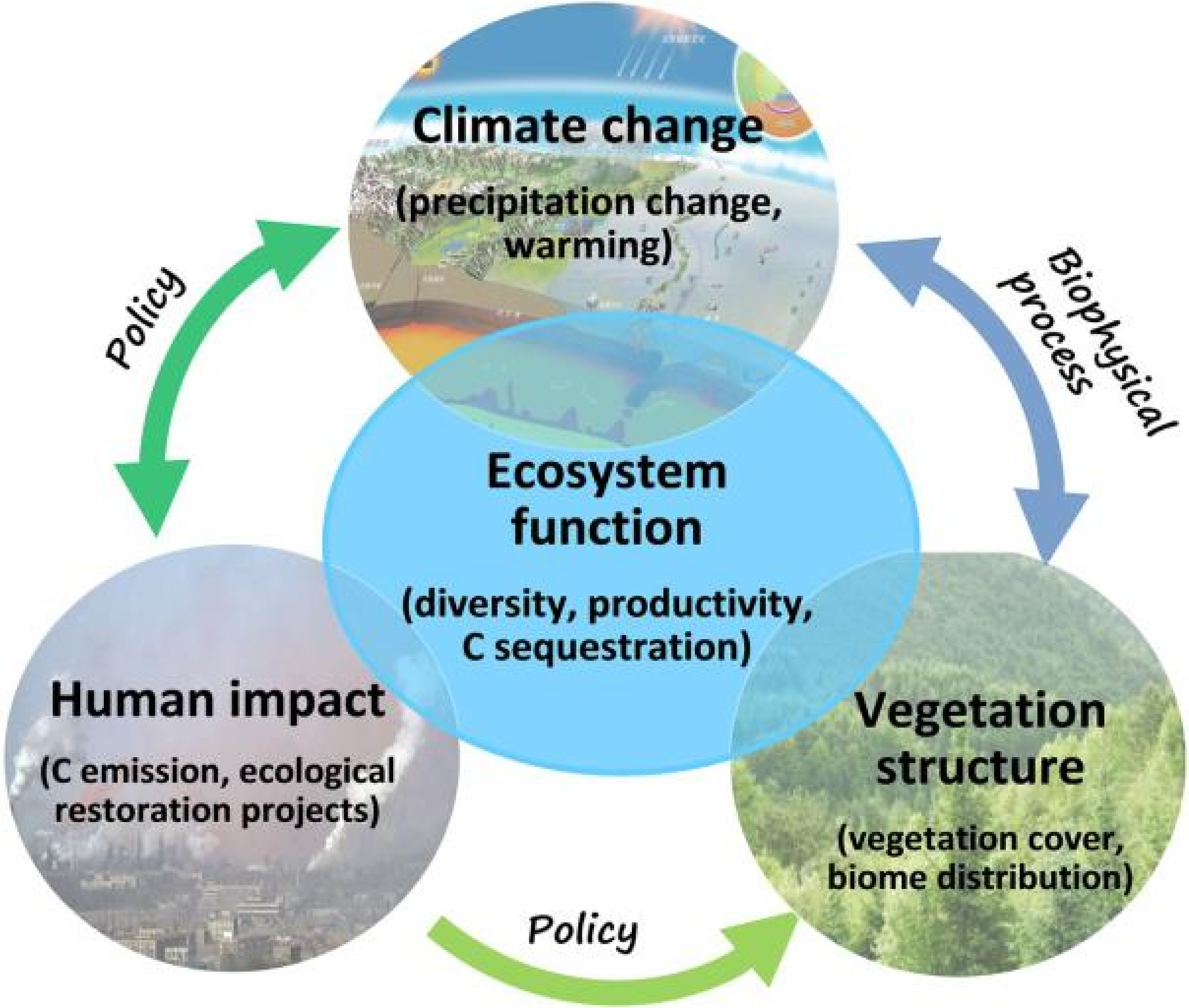
Source: 46th session of IPCC, Montreal, Canada. Sep. 2017(AR6 Report)

Jet Propulsion Laboratory
California Institute of Technology

Eye’s On Earth (NASA)

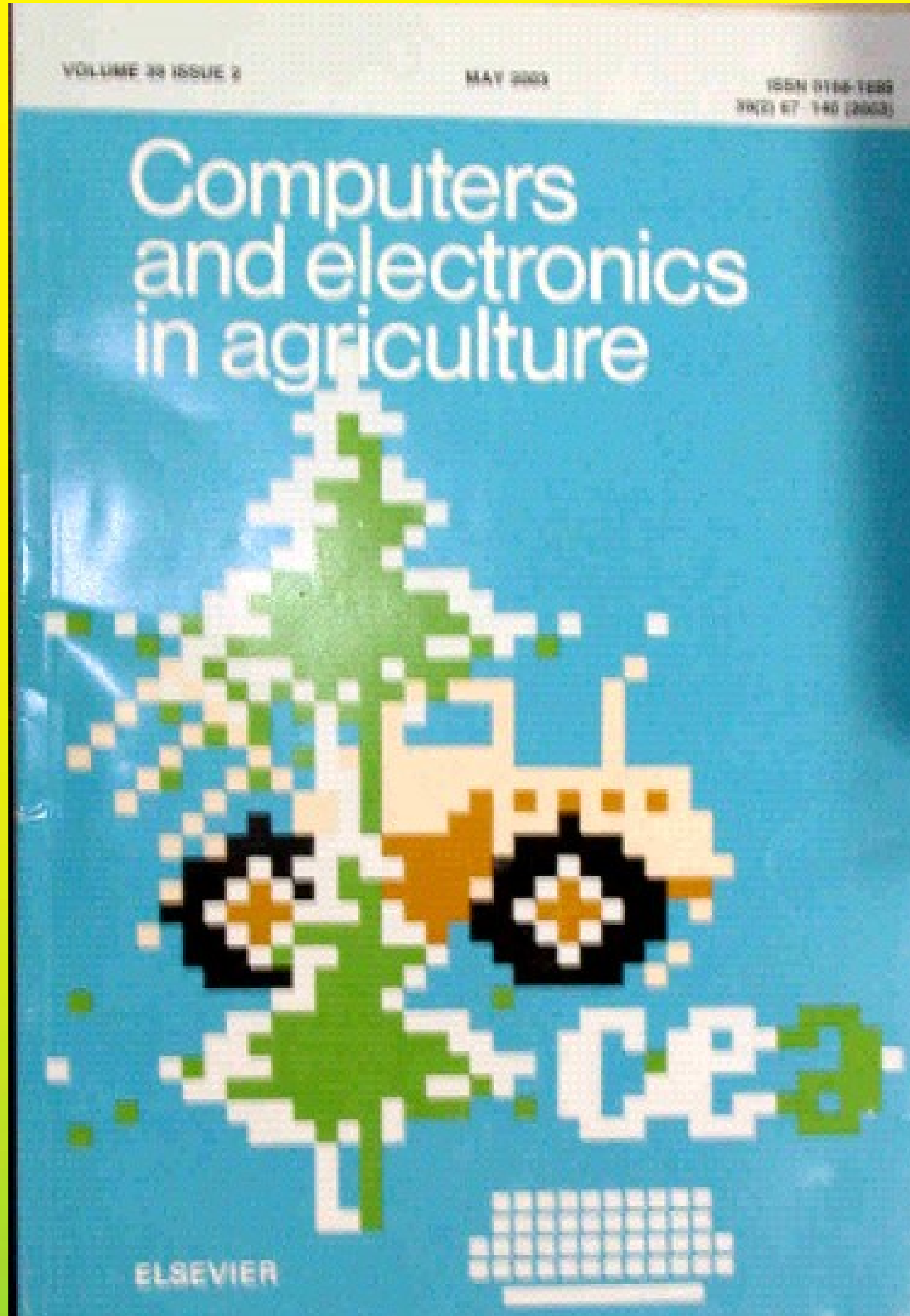
Monitor our planet's vital signs, such as sea level height, atmospheric carbon dioxide concentration and Antarctic ozone. Trace the movement of water around the globe using the gravity map from NASA's GRACE satellites. Spot volcanic eruptions and forest fires using the carbon monoxide vital sign. Check out the hottest and coldest locations on Earth with the global surface temperature map.

Conceptual diagram showing how vegetation structures, climate changes, and human activities influence ecosystem functioning (e.g., productivity, carbon sequestration, and biodiversity), which are the foci of this special feature.



Jingyun Fang et al. PNAS doi:10.1073/pnas.1700304115

PNAS


VOLUME 39 ISSUE 2
MAY 2003
Computers
and electronics
in agriculture
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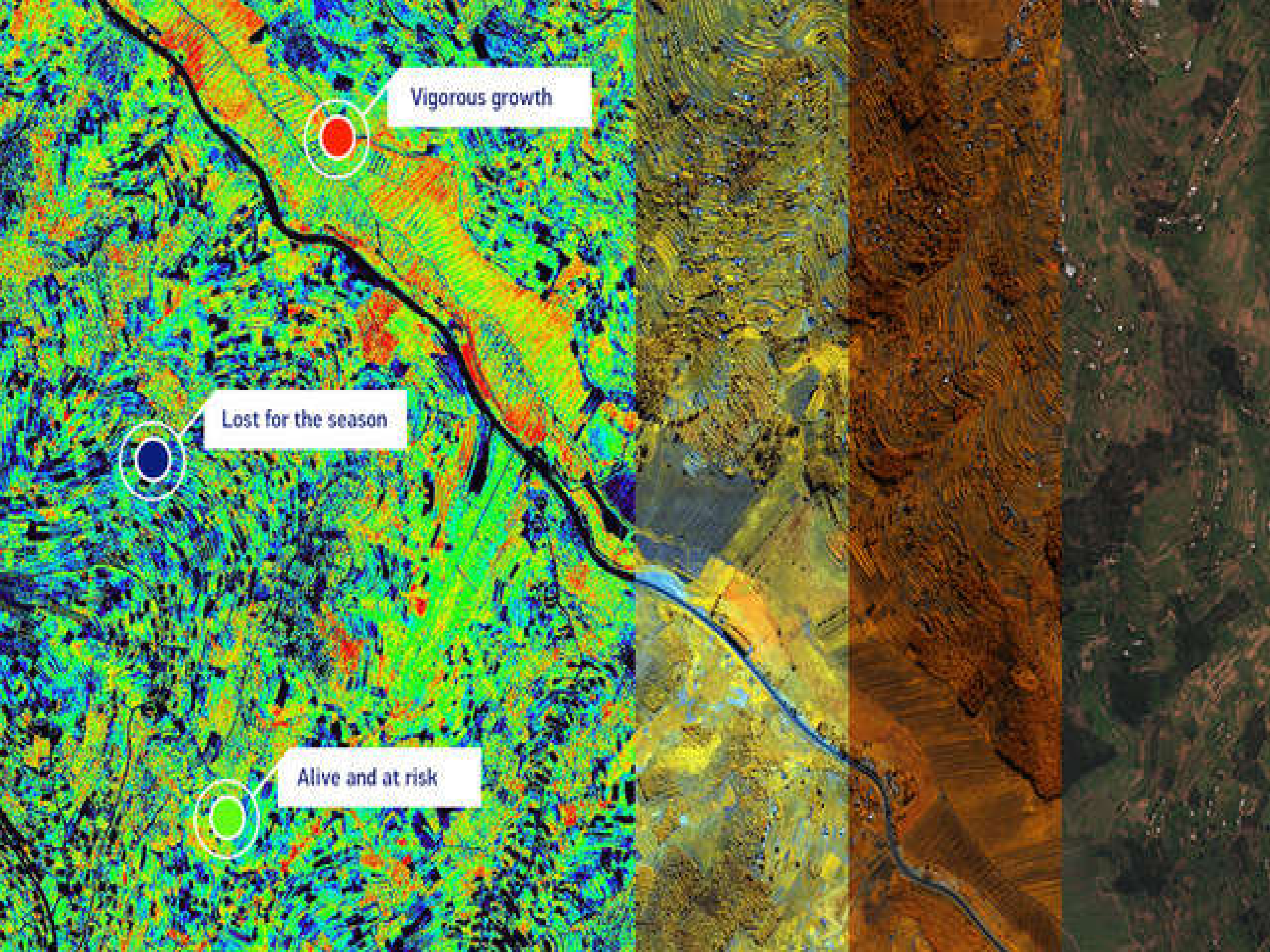
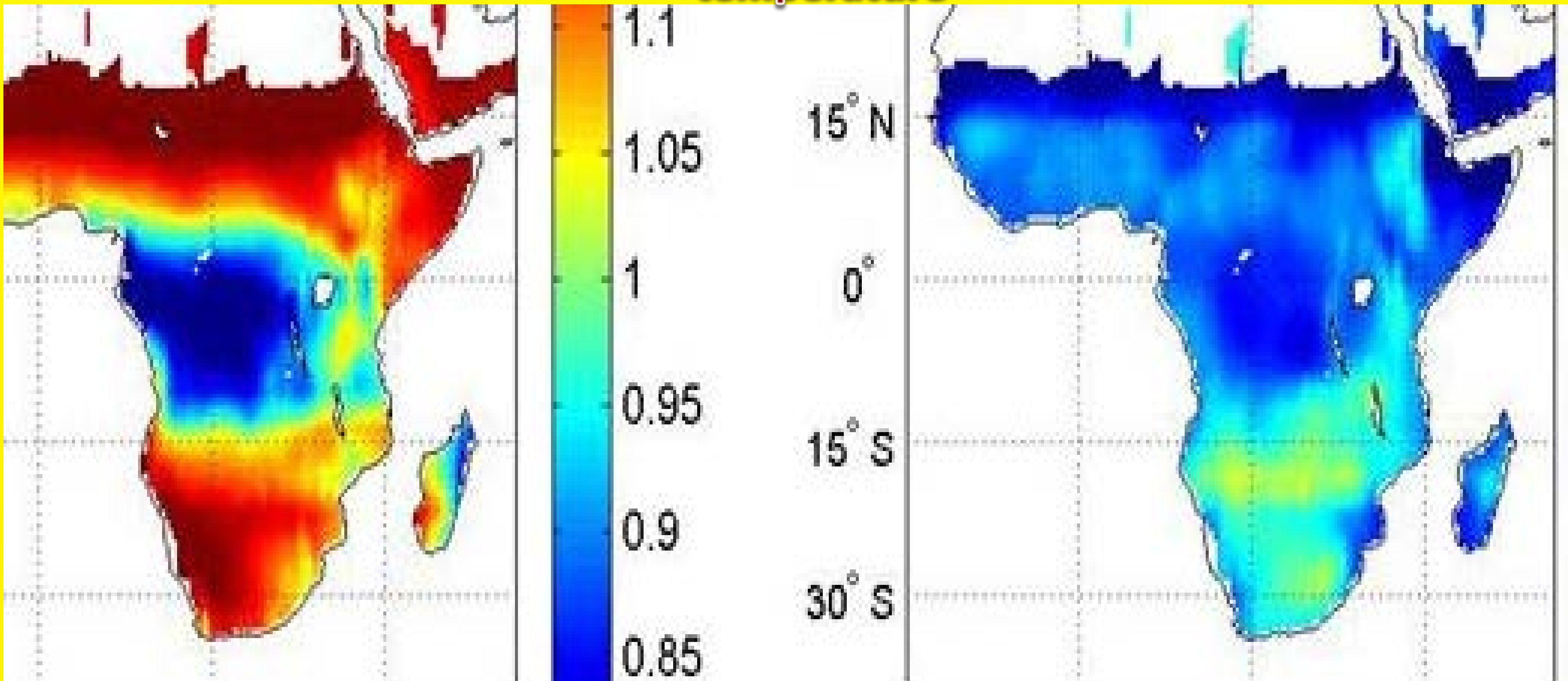
AI In Agriculture


Vigorous growth
Lost for the season
Alive and at risk

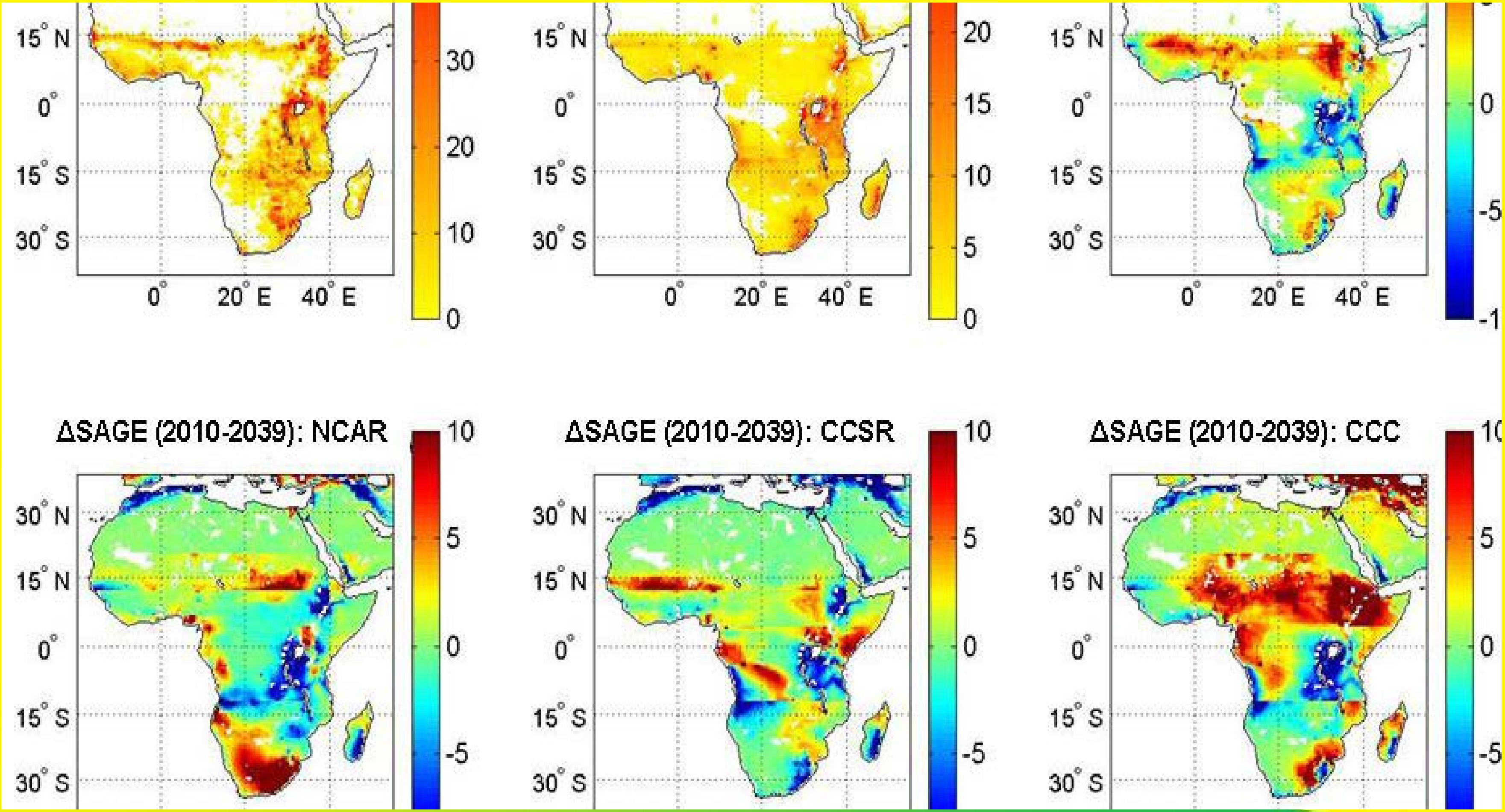
Geographic patterns of cropland sensitivity to precipitation and temperature



Cumulative marginal effects for precipitation and temperature across all seasons (winter, spring, summer, fall) were evaluated at long-term (1961–2000) mean conditions for each location (grid cell). Changes in the odds ratio per unit change in seasonal precipitation (10mm/month) and temperature (°C) are averaged across all six cropland models. Positive marginal effects (Q > 1) are shown in yellow-to-red colors, and negative marginal effects (Q < 1) in green-to-blue colors. For instance, Q = 1.1 indicates that the odds of land being used for cropping increases by 10% if the long-term mean monthly precipitation increases by 10mm (120mm/year). Increases in precipitation have a positive effect on croplands (left) in subtropical regions (10–20° N and 20–30° S) whereas they are neutral or negative in tropical regions. For temperature, increases in seasonal temperature have negative effects for most of the African continent, with the exception of mild positive effects in parts of southern Africa.

Policy Research Working Paper 4289, World Bank 2007

Changes in cropland share predicted by climate models



Long-term (2010–2039) changes in cropland share (in percent) arising from changes in seasonal temperature and precipitation patterns are estimated from an ensemble of seven AOGCMs (top right panel). Cropland sensitivities are based on the SAGE cropland model (for summary of other cropland models see Table 4). Actual (current) and modeled distribution of cropland share (percent) based on the SAGE data are shown in the left and center panels, respectively. Cropland share in subtropical regions (10–15° N and 15–30° S) is expected to increase, whereas croplands in tropical regions are expected to decrease, in particular in tropical eastern Africa (Great Lakes region).

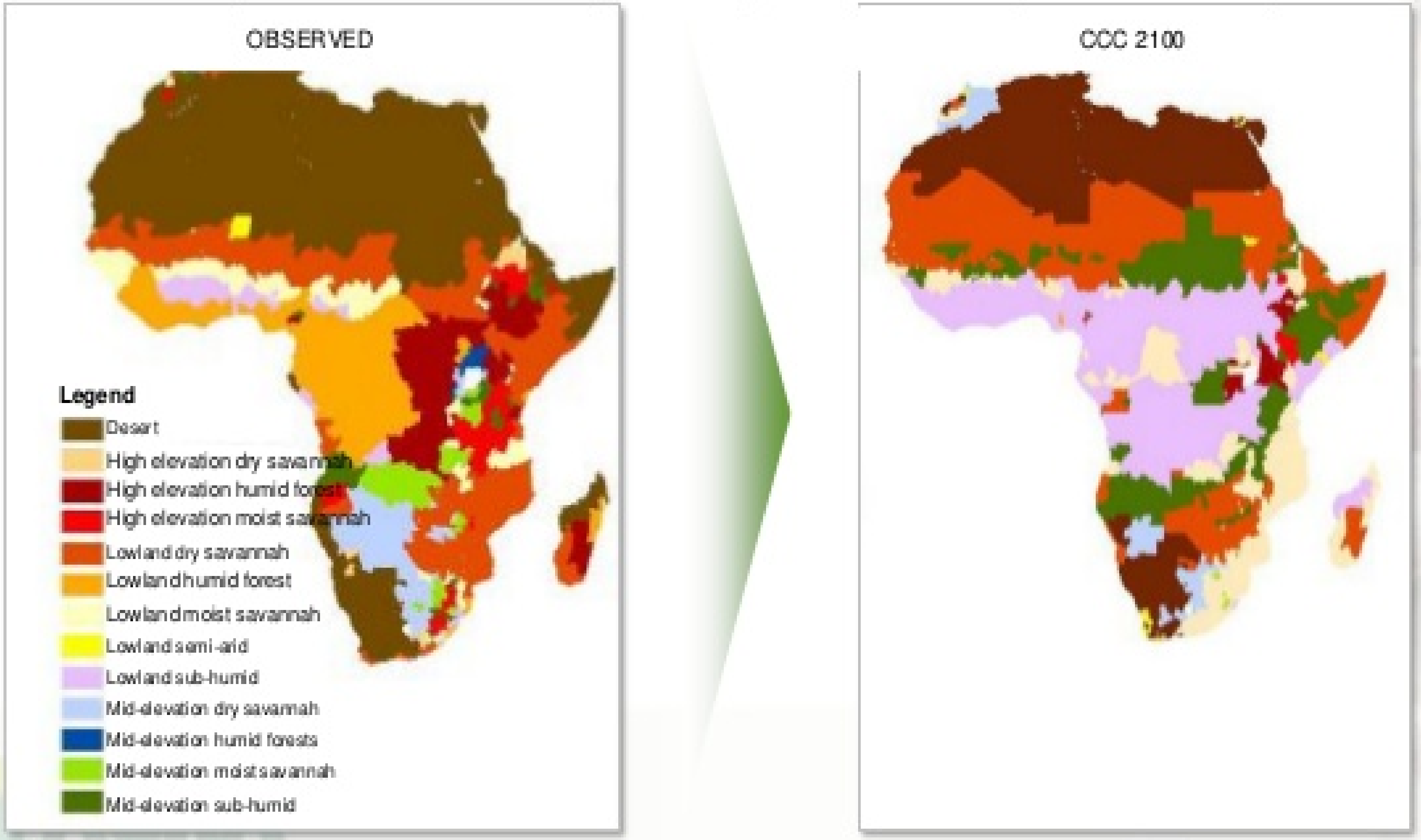
Policy Research Working Paper 4289, World Bank 2007

Magnitude of Predicted Climate Change

Maps Depicting Predicted Climate Change

The agro-ecological landscape is forecasted to exhibit significant changes over the course of the century; this results in shifts in the profitability per hectare of cropland

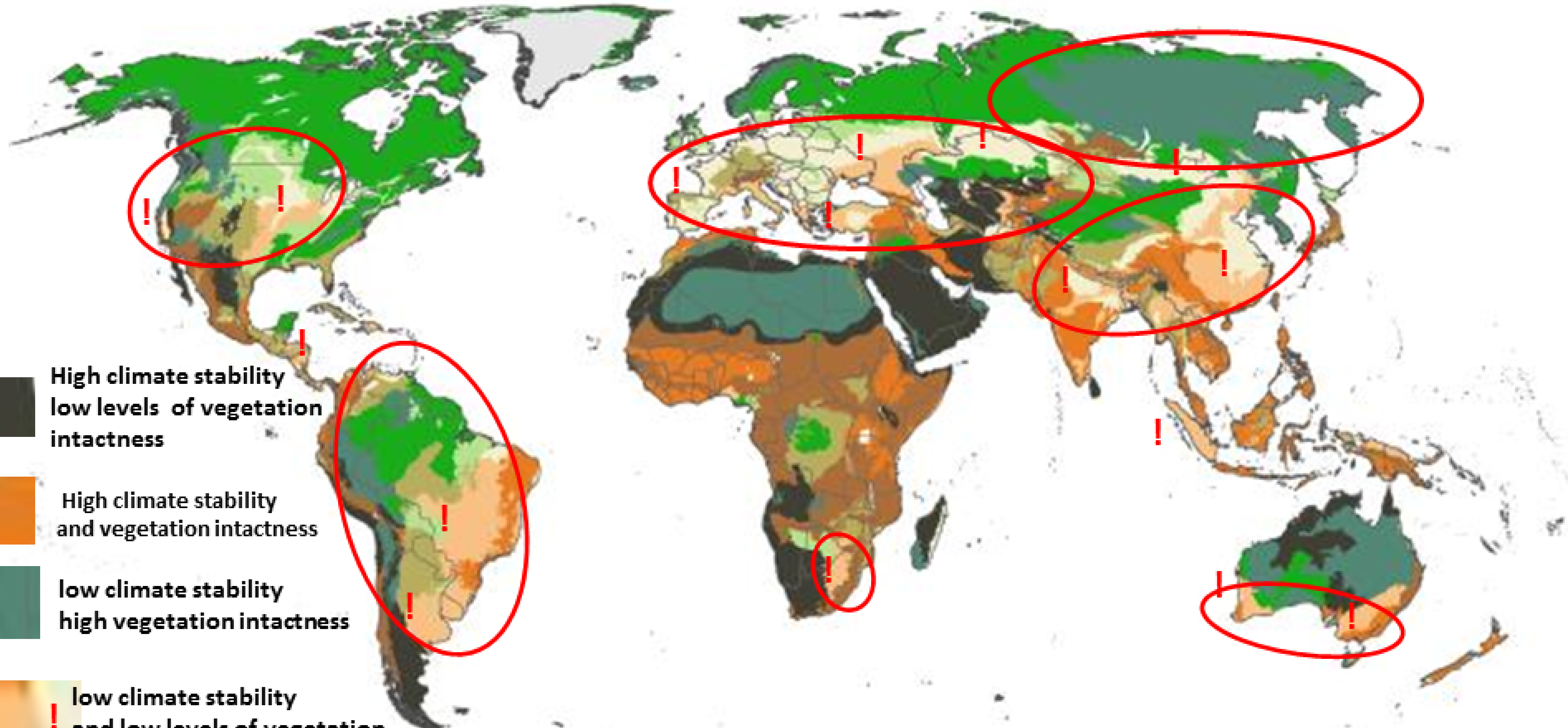
Predicted Change in Distribution of Agro-ecological Zones with (CCC Scenario), 2003 – 2100e



Source: "How Will Climate Change Shift Agro-Ecological Zones and Impact African Agriculture?" , P.Kurukulasuriya & R. Mendelsohn

Ecosystem climate change vulnerability and conservation

Mapping vulnerability and conservation adaptation strategies under climate change James E. M. Watson, Nature Climate Change September 2013



High climate stability low levels of vegetation intactness

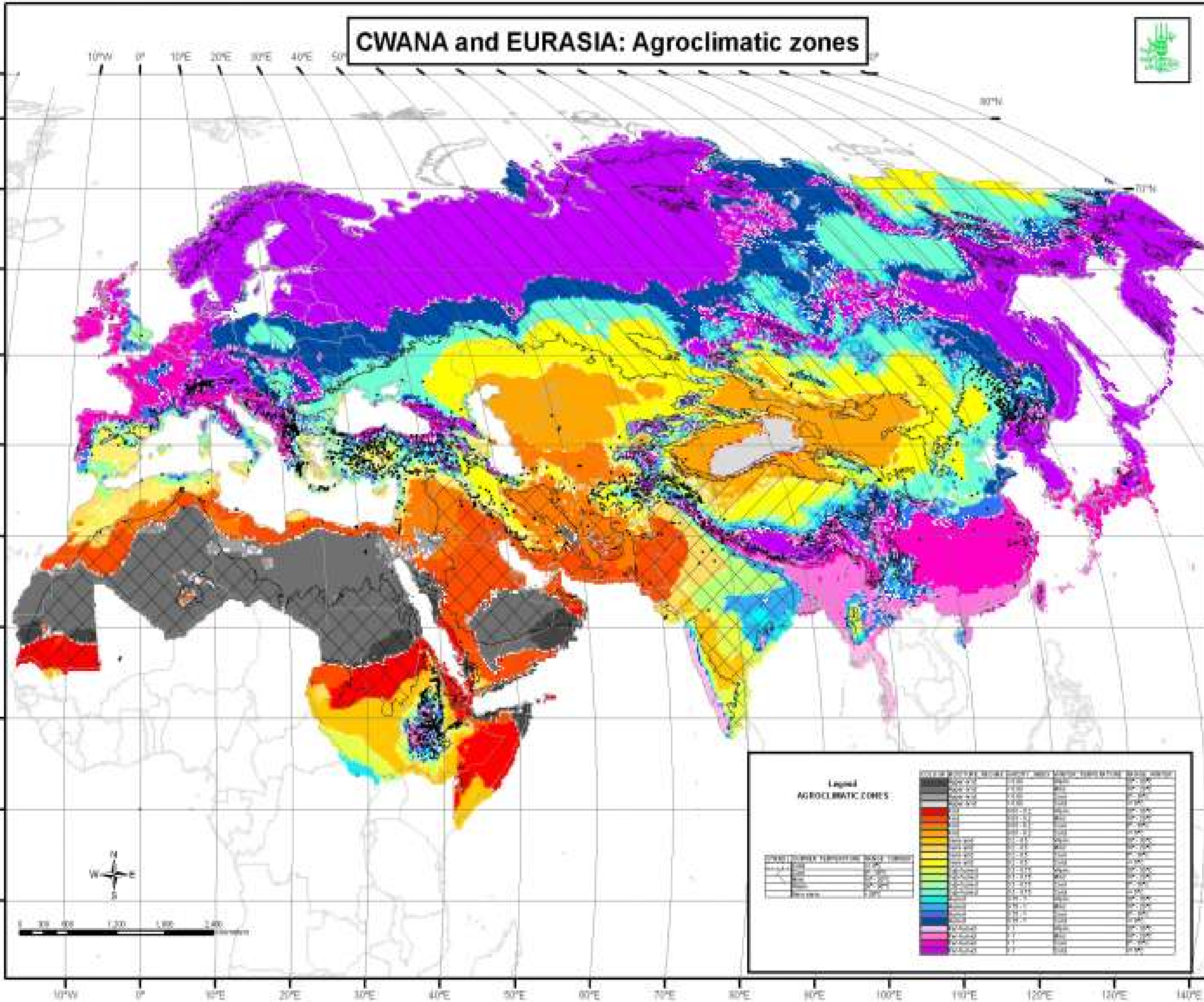
High climate stability and vegetation intactness

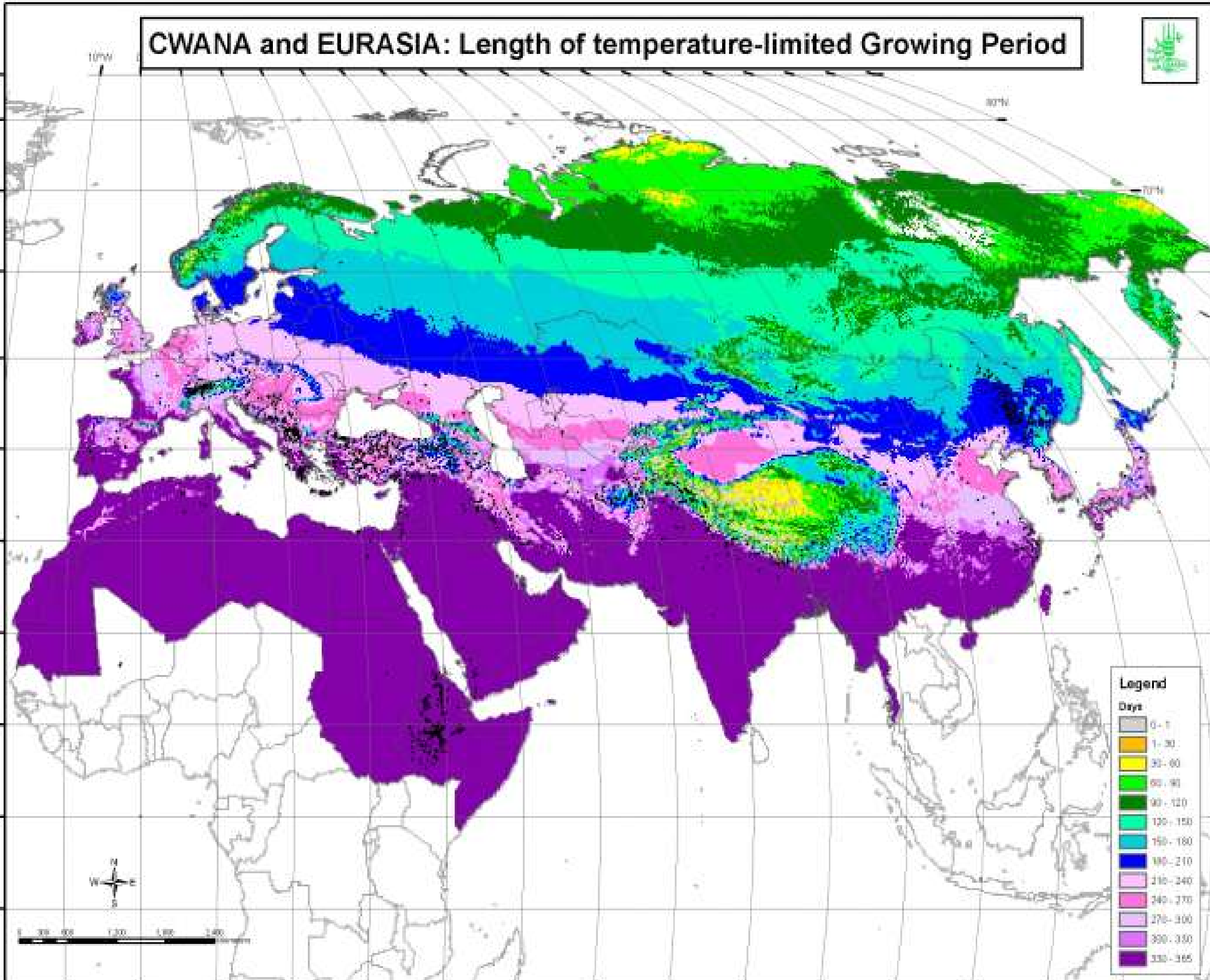
low climate stability high vegetation intactness

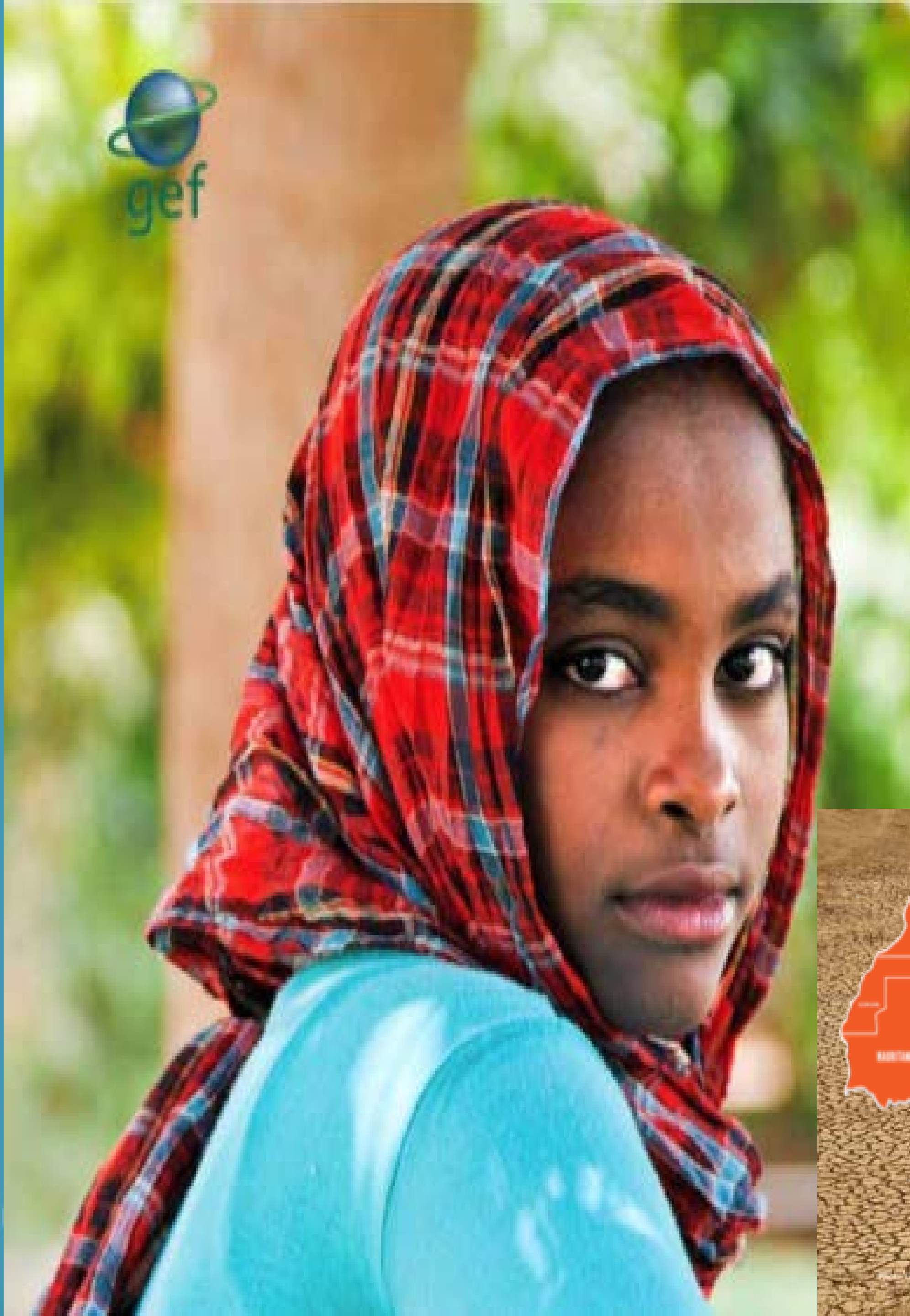
! low climate stability and low levels of vegetation intactness

Climate change vulnerable regions

The map illustrates the global distribution of the climate stability/ecoregional intactness relationship. Ecoregions with both high climate stability and vegetation intactness are dark grey. Ecoregions with high climate stability but low levels of vegetation intactness are dark orange. Ecoregions with low climate stability but high vegetation intactness are dark green. Ecoregions that have both low climate stability and low levels of vegetation intactness are pale cream.


CWANA and EURASIA: Agroclimatic zones
Legend
AGROCLIMATIC ZONES


CWANA and EURASIA: Length of temperature-limited Growing Period
Legend
Days
0 - 1
1 - 30
30 - 60
60 - 90
90 - 120
120 - 150
150 - 180
180 - 210
210 - 240
240 - 270
270 - 300
300 - 330
330 - 365



UNDP

Empowered lives.
Resilient nations.

gef

United Nations
July 2018

Coping with Climate Change in the Middle East and North Africa (MENA) Region

MEETING FUTURE FOOD DEMAND THROUGH SCIENCE & INNOVATION

Ensuring climate resilience of agro-ecosystems and sustainable management of natural resources

Dr. Rachid MRABET

Research Director

INRA Rabat

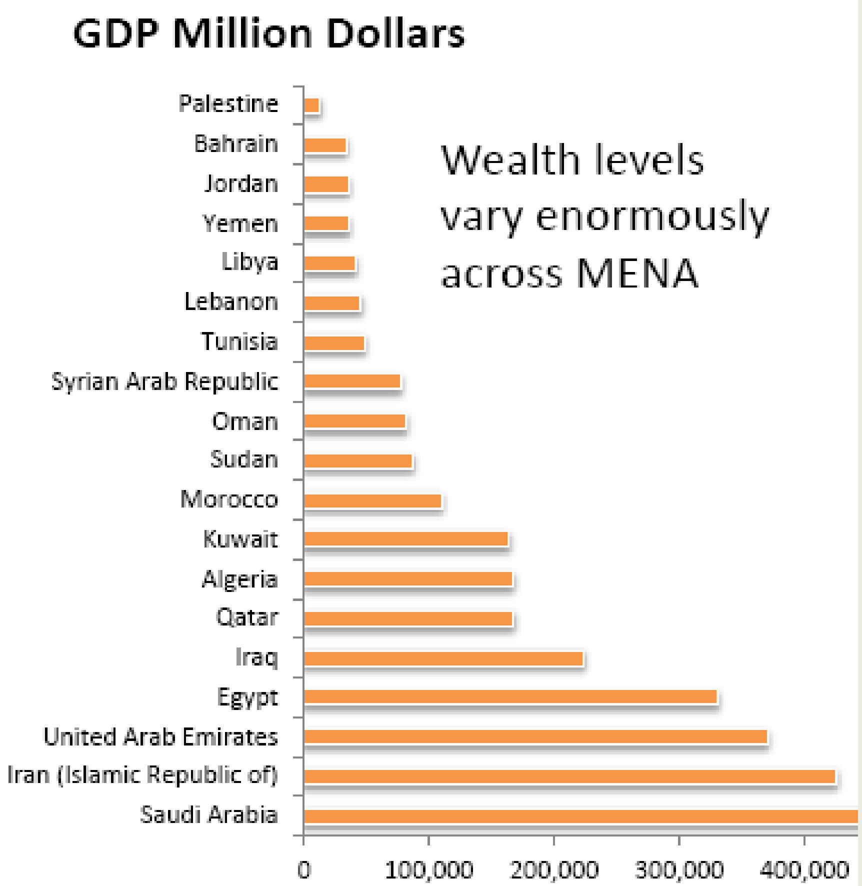
MARRAKECH
COP22|2016|CMP12
UN CLIMATE CHANGE CONFERENCE

ICARDA
Science for Better Livelihoods in Dry Areas

المعهد الوطني للبحث الزراعي
Institut National de la Recherche Agronomique

November 16, 2016

Setting the Scene: Geostrategic position in need of environmental sustainability



① At the crossroads of Europe, Africa and Asia.
② 14 million km² of which more than 87 per cent is desert.
③471 millions inhabitants (6% of the world's population) – High Youth population (PGR=1.7).
④ 4.5% of the world's GDP.
⑤ 60% of oil and 45% of natural gas reserves in the world.
⑥ Great potential for the development of Concentrated Solar Power in the world.
⑦ Home to important diverse landraces and wild relatives of major food crops.
⑧ 1.2 percent of the world's renewable water resources.

MENA is the world's most water-scarce region and Heavy reliance on food import!

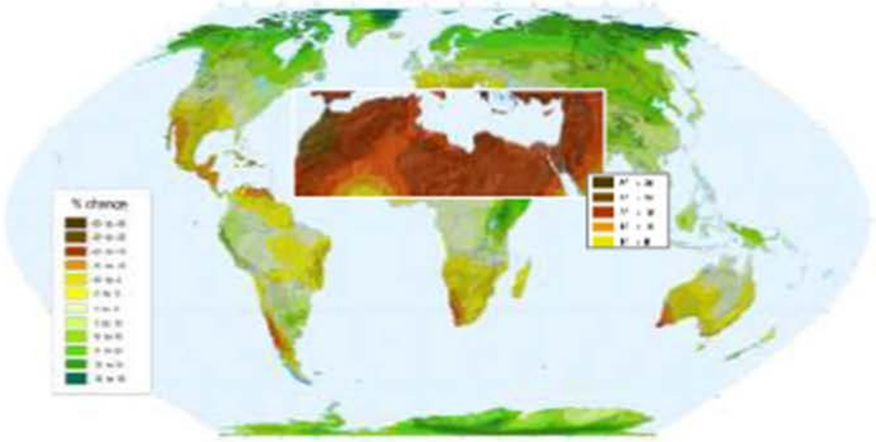
Setting the Scene: MENA is faced with a set of complex interrelated problems

① IPCC report (AR5) converges on an increase in time-space rainfall variations (heighten and worsen extreme climate extremes), sudden temperature variations and long period of droughts.

② Water scarcity presents an immediate threat to agricultural development and sustainability in MENA.

③ Climate change brings new uncertainties, and adds new risks and changes to already existing risks.

Climate Change in MENA



According to IPCC computer modeling, an estimated additional 80 million to 100 million people will be exposed to water stress by 2025, putting more pressure on already depleted groundwater resources.

SDGs in nexus

- World's most water scarce and food-important dependent region
- Climate change regarded as a root cause in the resurgence of poverty, social vulnerability, conflicts and migration in recent years.

Biophysical Climate Change Effects on Agro-ecosystems

U.S. EPA/DOE Workshop

Research on Climate Change Impacts and Associated Economic Damages

January 27-28, 2011

Cynthia Rosenzweig

NASA/Goddard Institute for Space Studies

Outline

- Estimates of current and likely impact of climate change on biophysical response of agricultural crops
- Data and models used to make projections
- Modulation of biophysical impacts via adaptation
- Gaps and uncertainties

Expert System Approach

• Uses soil capability, climate, crop calendar, and simple productivity relationships to estimate production potential of agricultural systems.

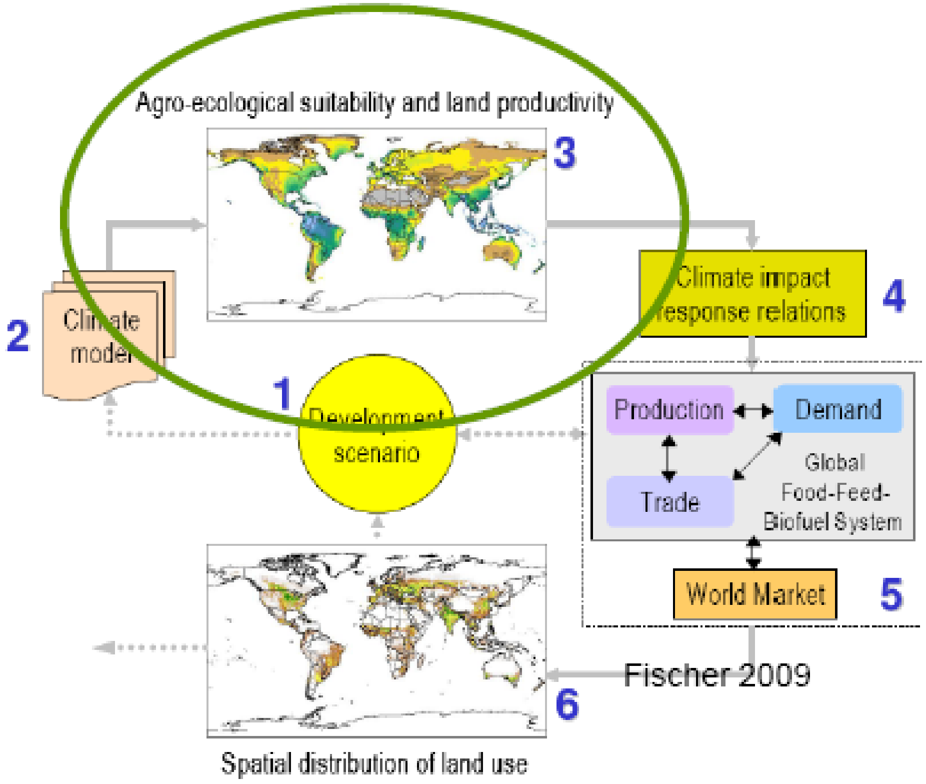
• Use calculator to project effect of changes in climate on production potential.

Advantages

Projects changes in both production potential and spatial extent of cropping systems; global extent.

Disadvantages

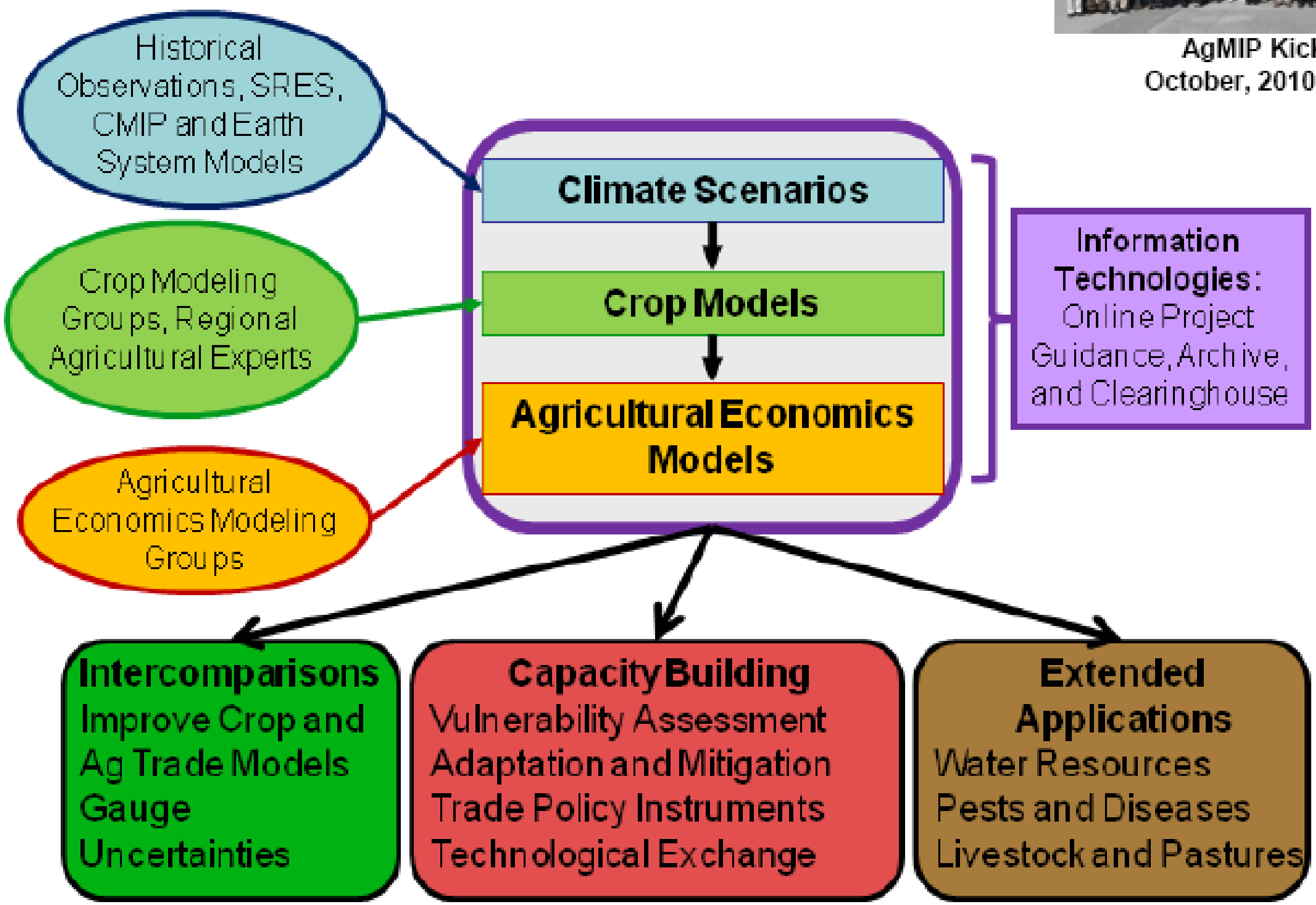
Results not easily validated in current climate.
Processes are represented by simplified relationships.



GAEZ Data: yearly yield/monthly climate; soils; crop calendars; ag systems;
Spatial resolution 5'x5' lat/long

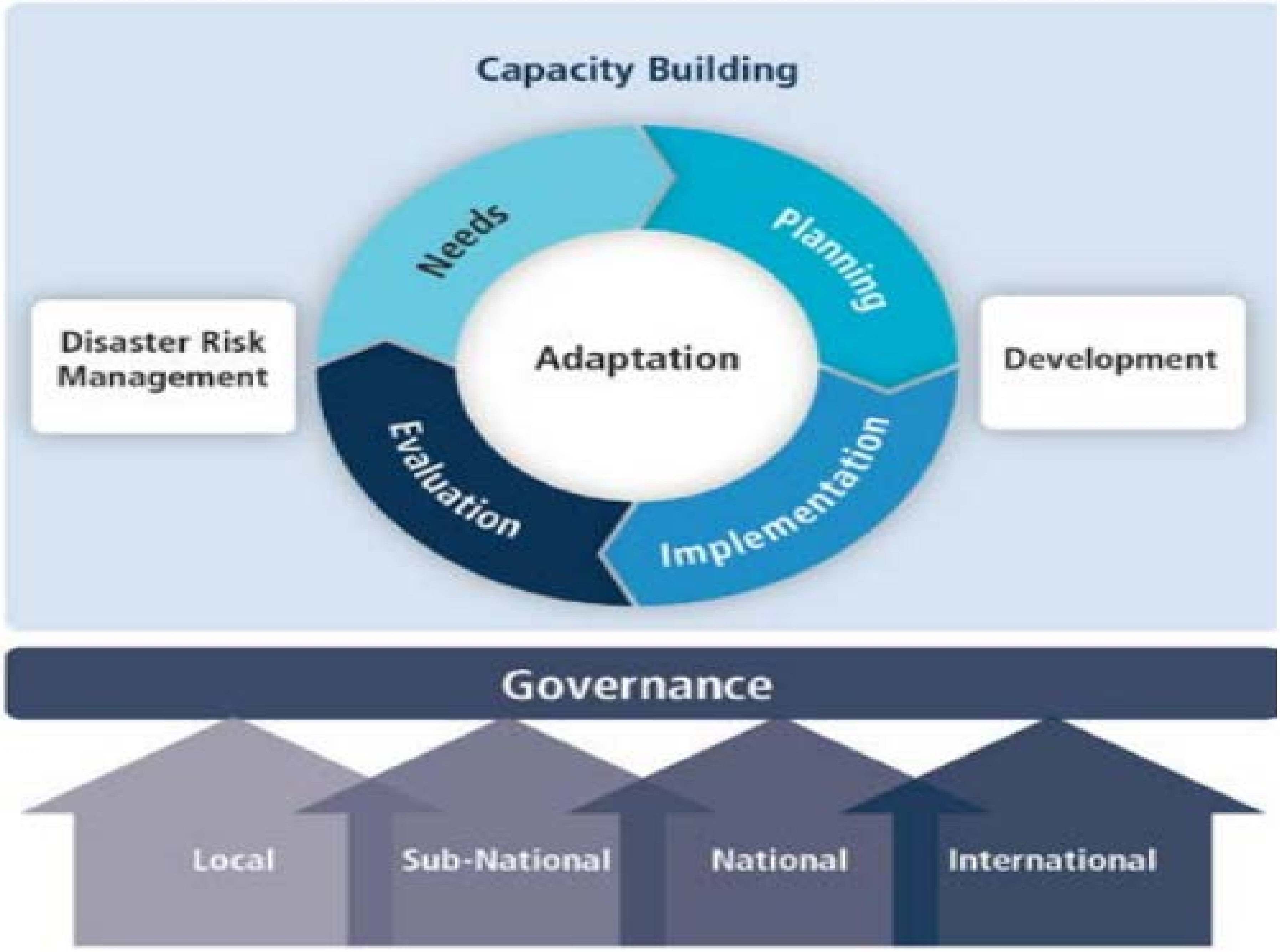
AgMIP The Agricultural Model Intercomparison and Improvement Project

AgMIP Kickoff Workshop
October, 2010 Long Beach, CA



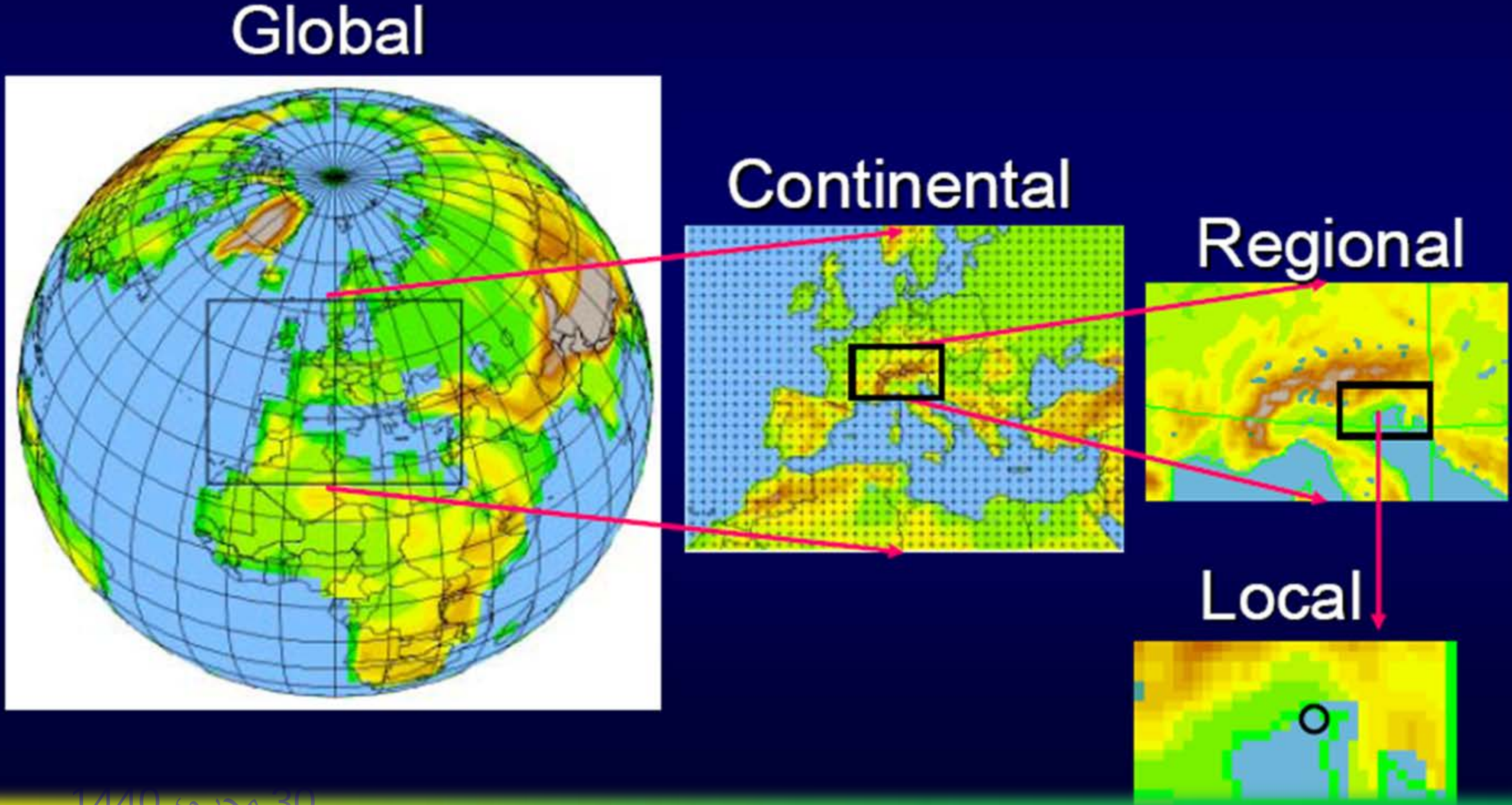
AgMIP components and expected outcomes

Aggregation, Uncertainty, Agricultural Pathways



Source: 46th session of IPCC, Montreal, Canada. Sep. 2017(AR6 Report)

Regional to local information is needed for adaptation studies

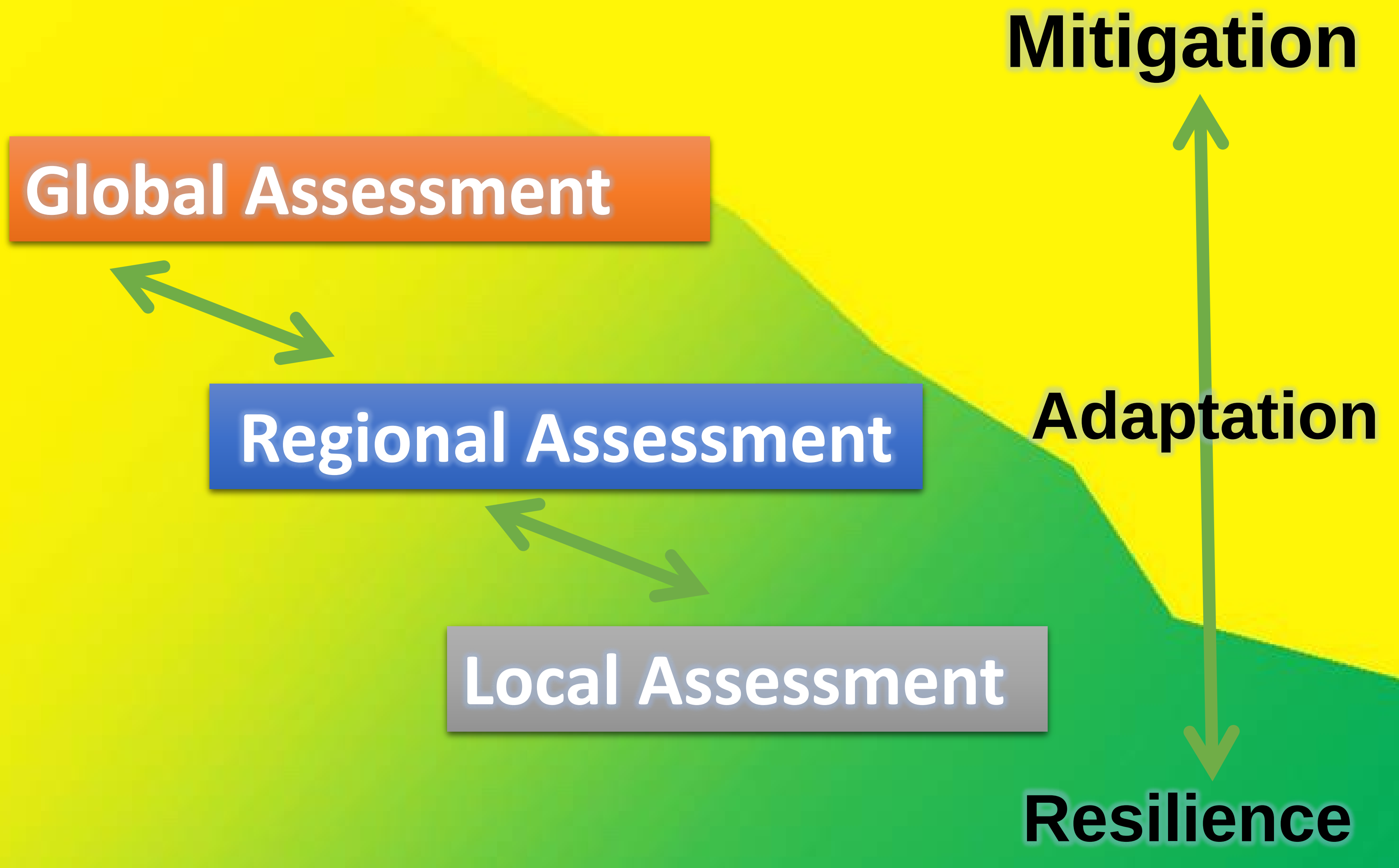


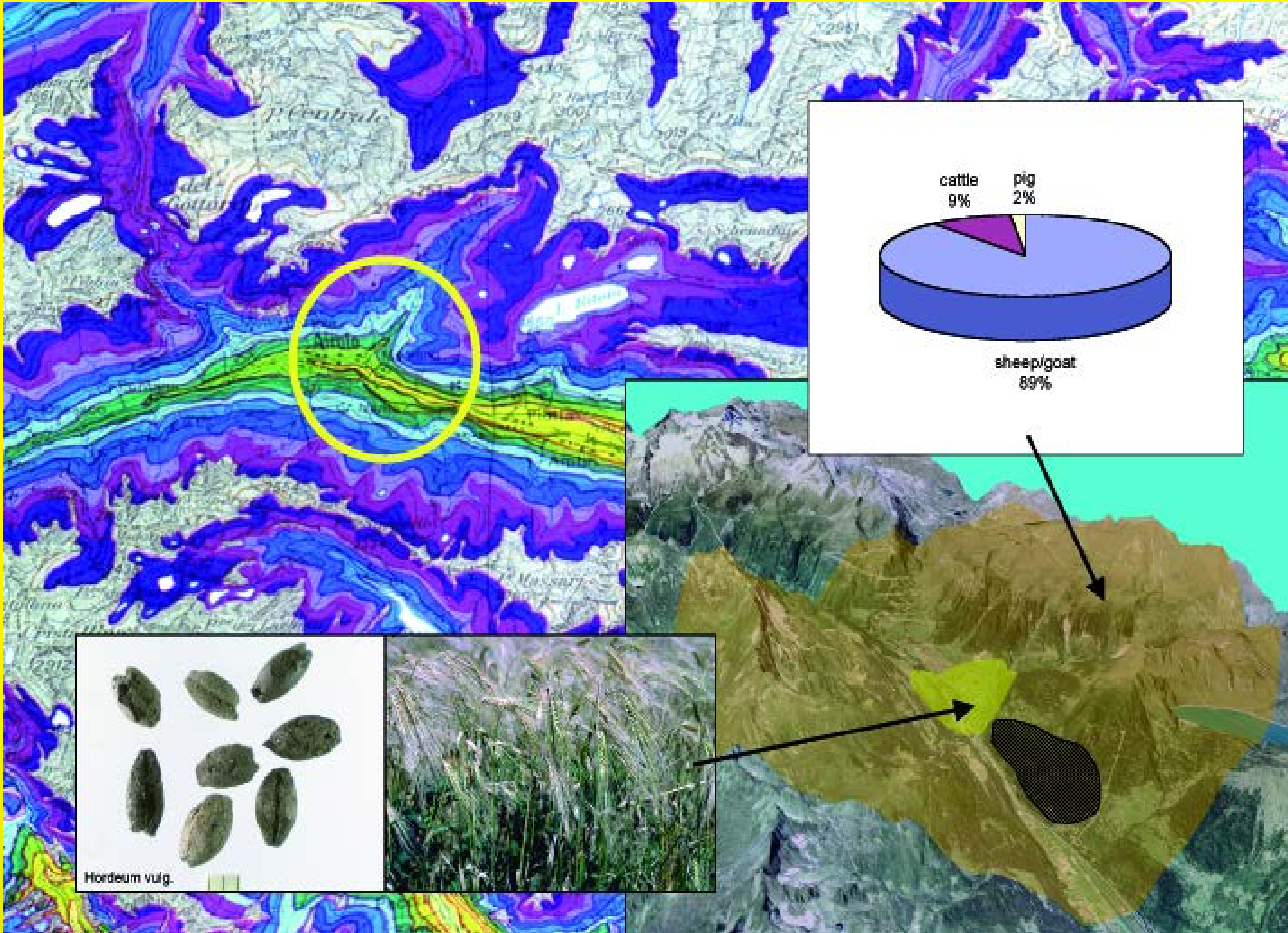
CLIMATE CHANGE AND SUSTAINABLE DEVELOPMENT

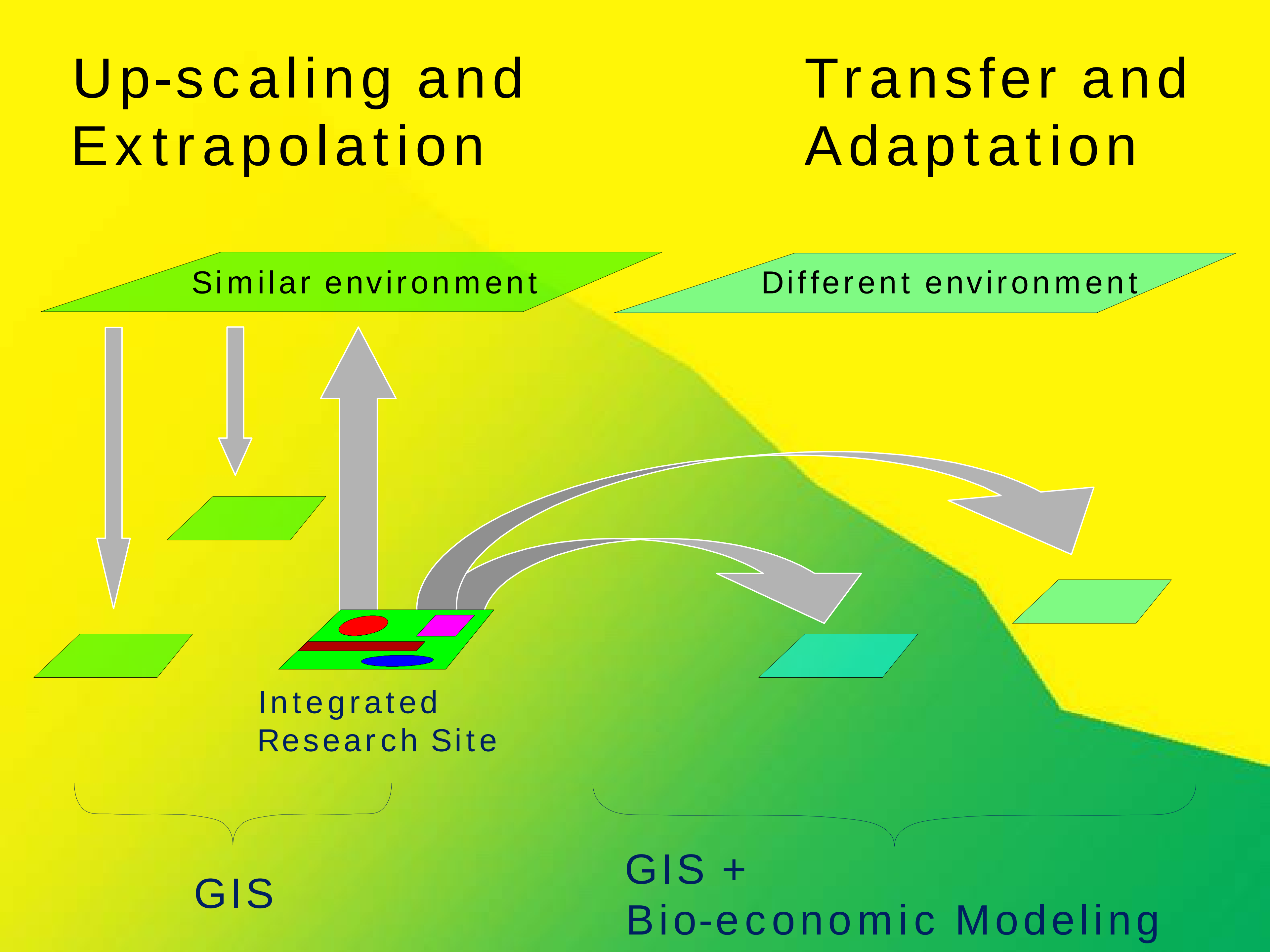
- **Global** classification masks the regional differences.
- **Regional** classification masks the sub-regional differences.
- **National** classification masks the different agro-ecology

"Need to navigate across scales"

NEED FOR CUTTING ACROSS THE BOUNDARIES




cattle
9%
pig
2%
sheep/goat
89%
Hordeum vulg.



Up-scaling and
Extrapolation
Transfer and
Adaptation
Similar environment
Different environment
Integrated
Research Site
GIS
GIS +
Bio-economic Modeling

Linking global to regional climate change

- Regional phenomena, drivers, feedbacks and teleconnections
- Regional scale observations and reanalysis
- Interplay between internal variability and forced change at the regional scale, including attribution
- Evaluation of model improvements, methods, including downscaling and bias adjustment and regional specificities
- Confidence in regional climate information, including quantification of uncertainties
- Scale specific methodologies e.g. urban, mountains, coastal, catchments, small islands
- Approaches to synthesizing information from multiple lines of evidence

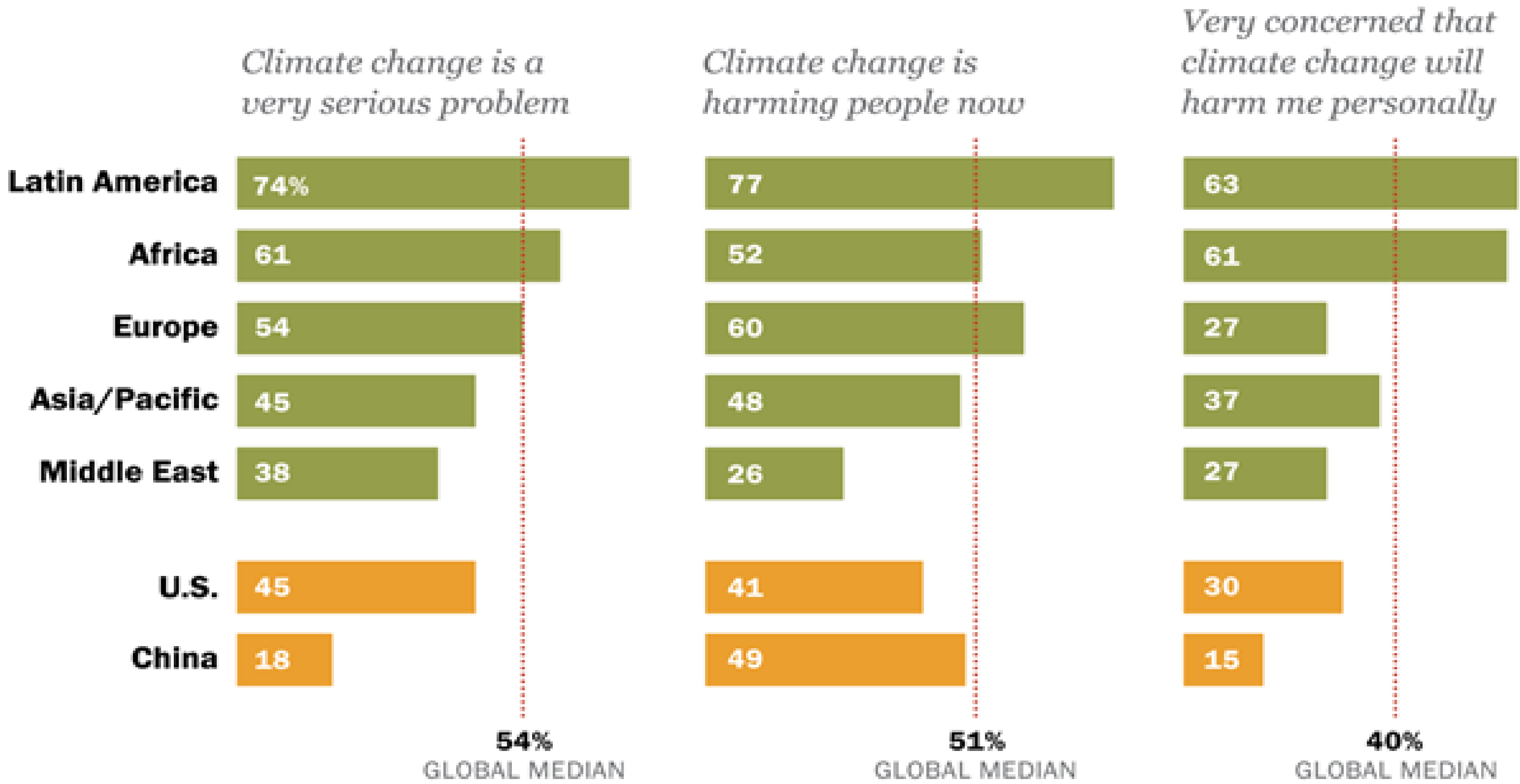
Source: 46th session of IPCC, Montreal, Canada. Sep. 2017(AR6 Report)

IPCC will meet in Korea on 1-5 October 2018.
It is projected that IPCC AR6 Synthesis Report will be finalized by the first half of 2022.

CLIMATE CHANGE ADAPTATION: WHAT CAN WE DO?

Latin America, Africa More Concerned about Climate Change Compared with Other Regions

Regional medians



Note: Russia and Ukraine not included in Europe median. Asia-Pacific median includes China.
Source: Spring 2015 Global Attitudes survey. Q32, Q41 & Q42.

PEW RESEARCH CENTER

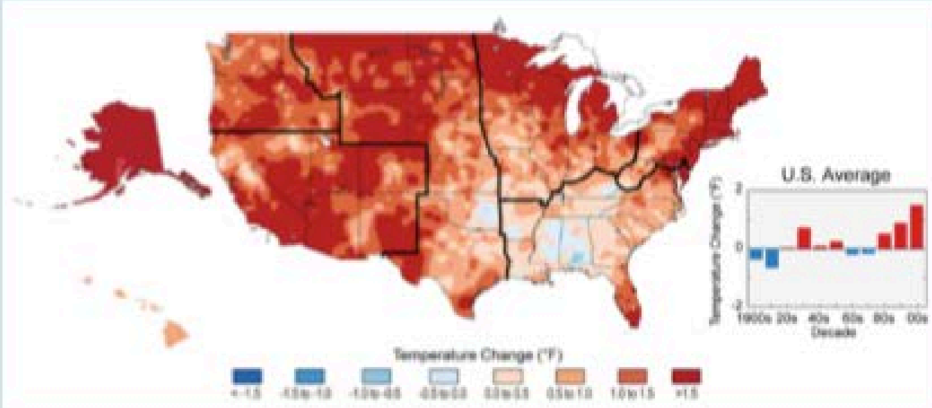
Movie: An Inconvenient truth

Movie: The day after tomorrow

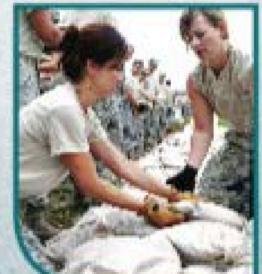

BARACK OBAMA
2020
"I'M SORRY.
WE COULD HAVE STOPPED CATASTROPHIC CLIMATE CHANGE... WE DIDN'T."
COPENHAGEN 2009 ACT NOW - CHANGE THE FUTURE
tcktcktck
GREENPEACE

Climate Change Impacts in the United States

Observed U.S. Temperature Change

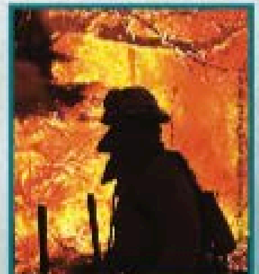


The colors on the map show temperature changes over the past 22 years (1991-2012) compared to the 1901-1960 average for the contiguous U.S., and to the 1951-1980 average for Alaska and Hawaii. The bars on the graph show the average temperature changes for the U.S. by decade for 1901-2012 (relative to the 1901-1960 average). The far right bar (2000s decade) includes 2011 and 2012. The period from 2001 to 2012 was warmer than any previous decade in every region. (Figure source: NOAA NCDC / CICS-NC).

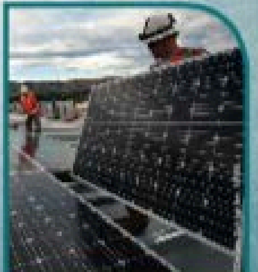


Members of the National Guard lay sandbags to protect against Missouri River flooding.

Energy choices will affect the amount of future climate change.



Climate change is contributing to an increase in wildfires across the U.S. West.



Solar power use is increasing and is part of the solution to climate change.

May 2014

Members of Congress:

On behalf of the National Science and Technology Council and the U.S. Global Change Research Program, we are pleased to transmit the report of the Third National Climate Assessment: *Climate Change Impacts in the United States*. As required by the Global Change Research Act of 1990, this report has collected, evaluated, and integrated observations and research on climate change in the United States. It focuses both on changes that are happening now and further changes that we can expect to see throughout this century.

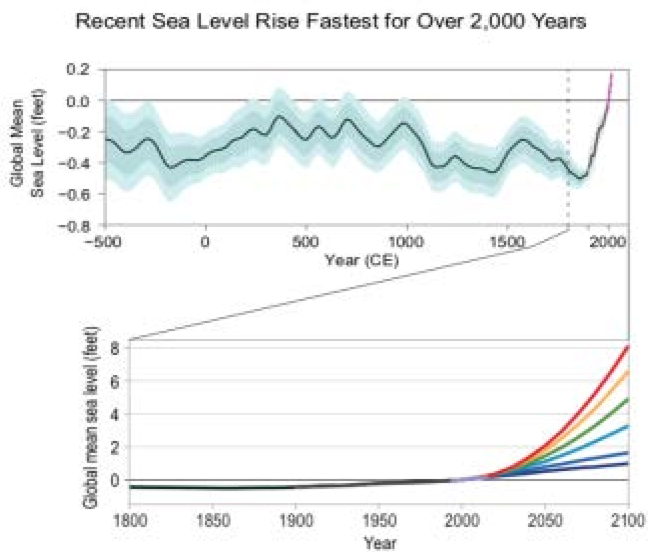


Figure ES.8: The top panel shows observed and reconstructed mean sea level for the last 2,500 years. The bottom panel shows projected mean sea level for six future scenarios. The six scenarios—spanning a range designed to inform a variety of decision makers—extend from a low scenario, consistent with continuation of the rate of sea level rise over the last quarter century, to an extreme scenario, assuming rapid mass loss from the Antarctic ice sheet. Note that the range on the vertical axis in the bottom graph is approximately ten times greater than in the top graph. *Based on Figure 12.2 and 12.4 in Chapter 12. See the main report for more details.*

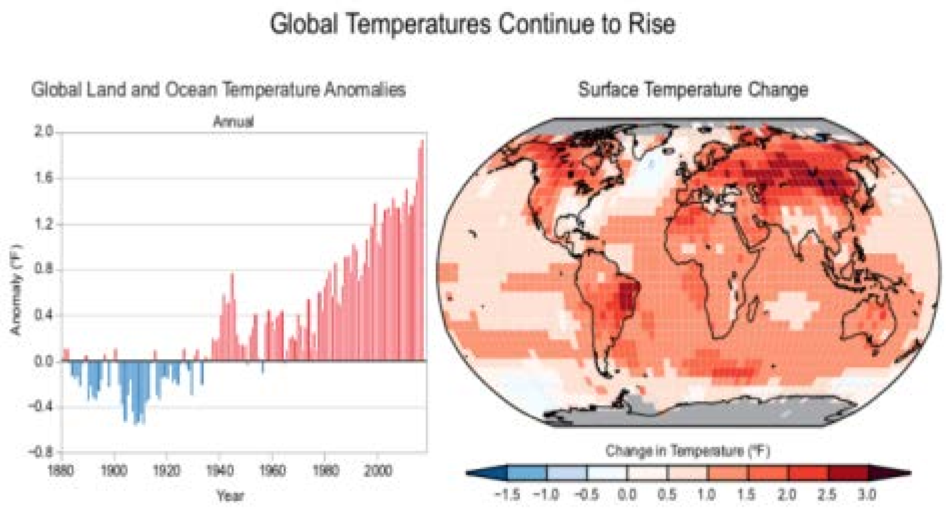
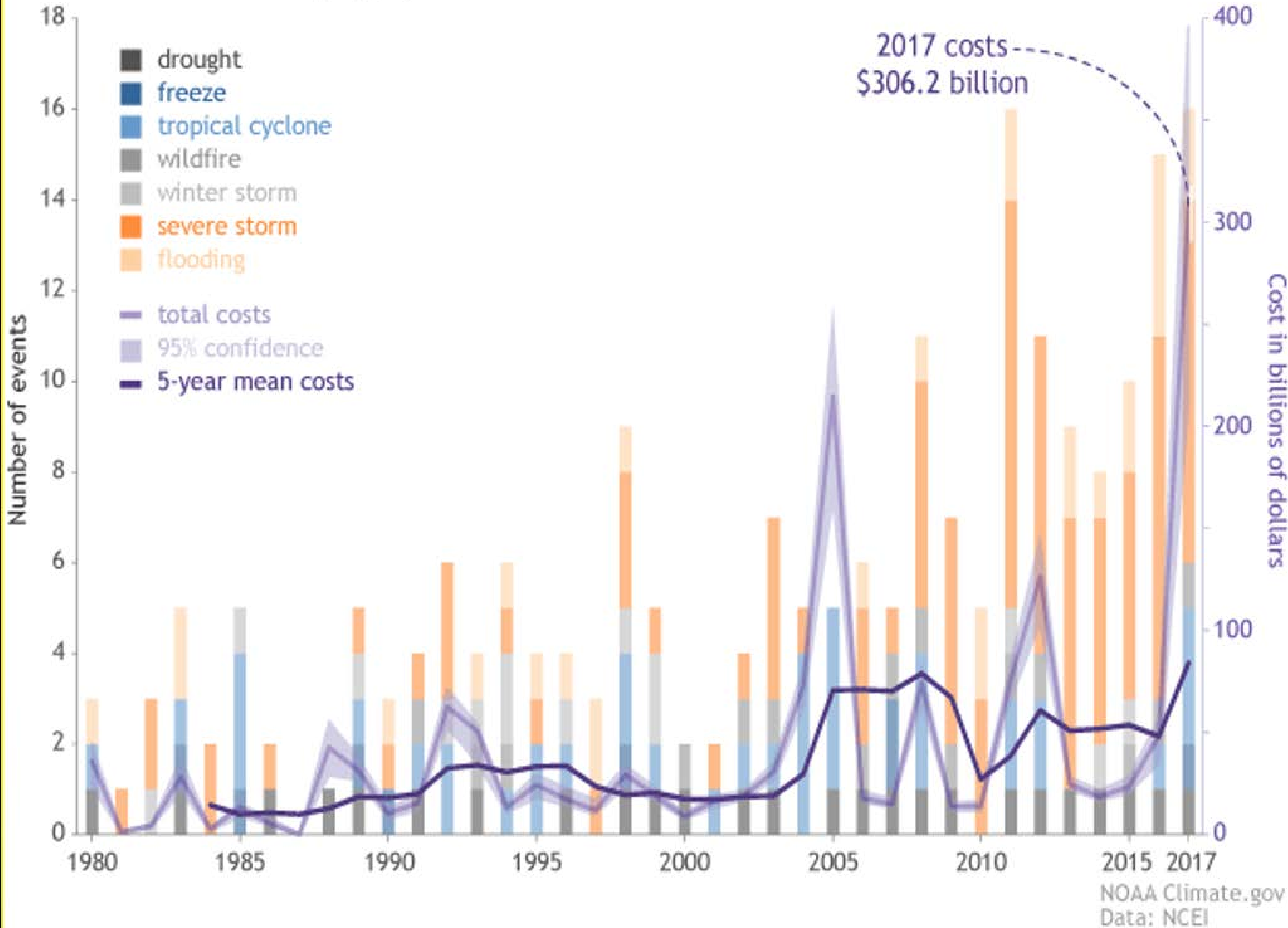


Figure ES.1: (left) Global annual average temperature has increased by more than 1.2°F (0.7°C) for the period 1986–2016 relative to 1901–1960. Red bars show temperatures that were above the 1901–1960 average, and blue bars indicate temperatures below the average. (right) Surface temperature change (in °F) for the period 1986–2016 relative to 1901–1960. Gray indicates missing data. *From Figures 1.2. and 1.3 in Chapter 1.*

Billion-dollar disasters by type, from 1980-2017



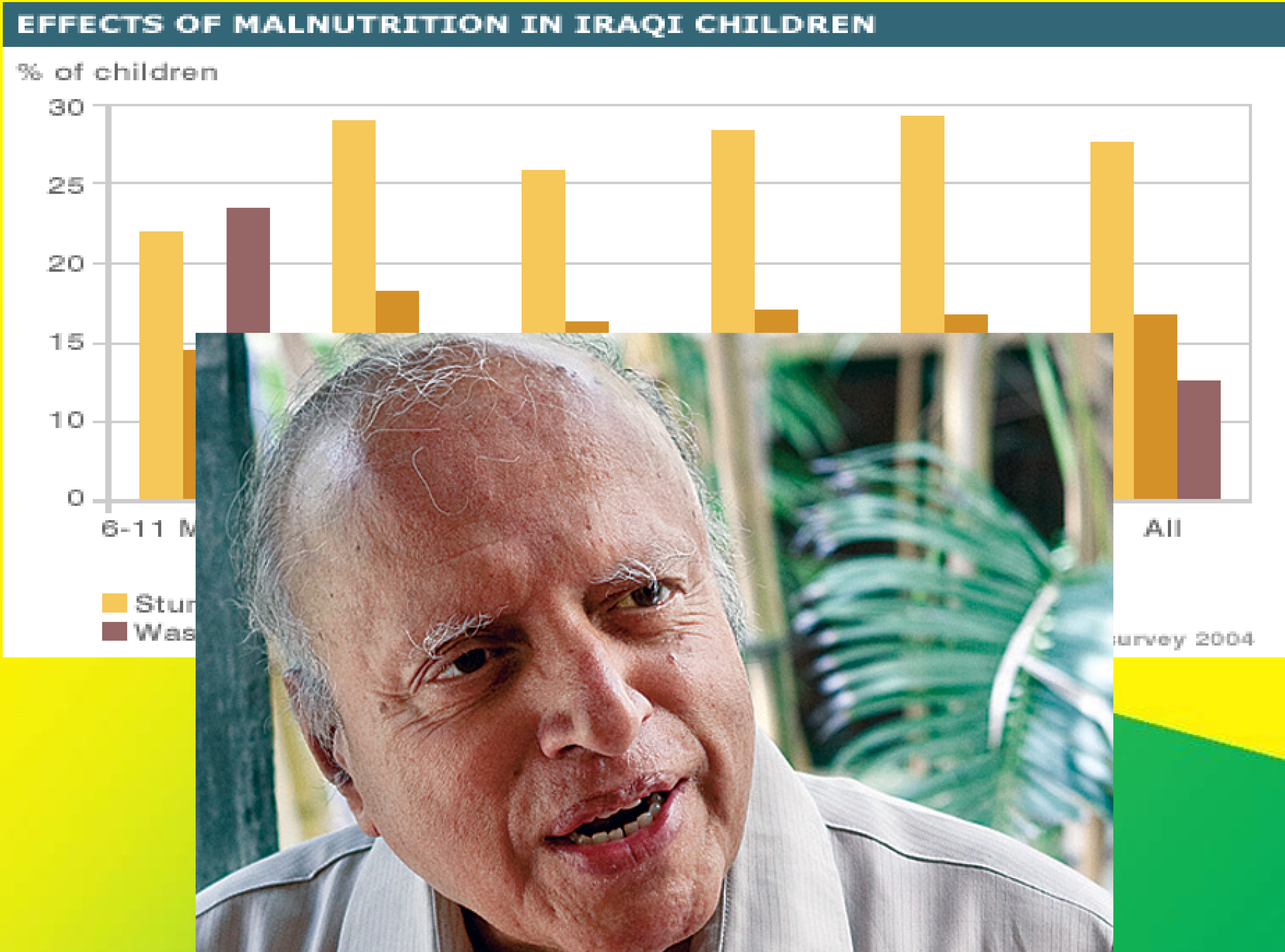
Billion-dollar events to affect the U.S. from 1980 to 2017 (CPI-Adjusted)

DISASTER TYPE	NUMBER OF EVENTS	PERCENT FREQUENCY	CPI-ADJUSTED LOSSES *(BILLIONS OF DOLLARS)*	PERCENT OF TOTAL LOSSES	AVERAGE EVENT COST *(BILLIONS OF DOLLARS)*	DEATHS
Drought	25	11.4%	$236.6 CI	15.4%	$9.5	2,993†
Flooding	28	12.8%	$119.9 CI	7.8%	$4.3	540
Freeze	8	3.7%	$27.6 CI	1.8%	$3.5	162
Severe Storm	91	41.6%	$206.1 CI	13.4%	$2.3	1,578
Tropical Cyclone	38	17.4%	$850.5 CI	55.3%	$22.4	3,461
Wildfire	15	6.8%	$53.6 CI	3.5%	$3.6	238
Winter Storm	14	6.4%	$43.1 CI	2.8%	$3.1	1,013
All Disasters	**219**	**100.0%**	**$1,537.4** CI	**100.0%**	**$7.0**	**9,985**

Emperor and Empress of Japan

9 - 11, 2006, New Delhi
auguration by
Abdul Kala
esident
dia
PRESIDENT OF INDIA
ADEL EL - BELTAGY


Dr
N.E. Borlaug
2005


EFFECTS OF MALNUTRITION IN IRAQI CHILDREN
% of children
30
25
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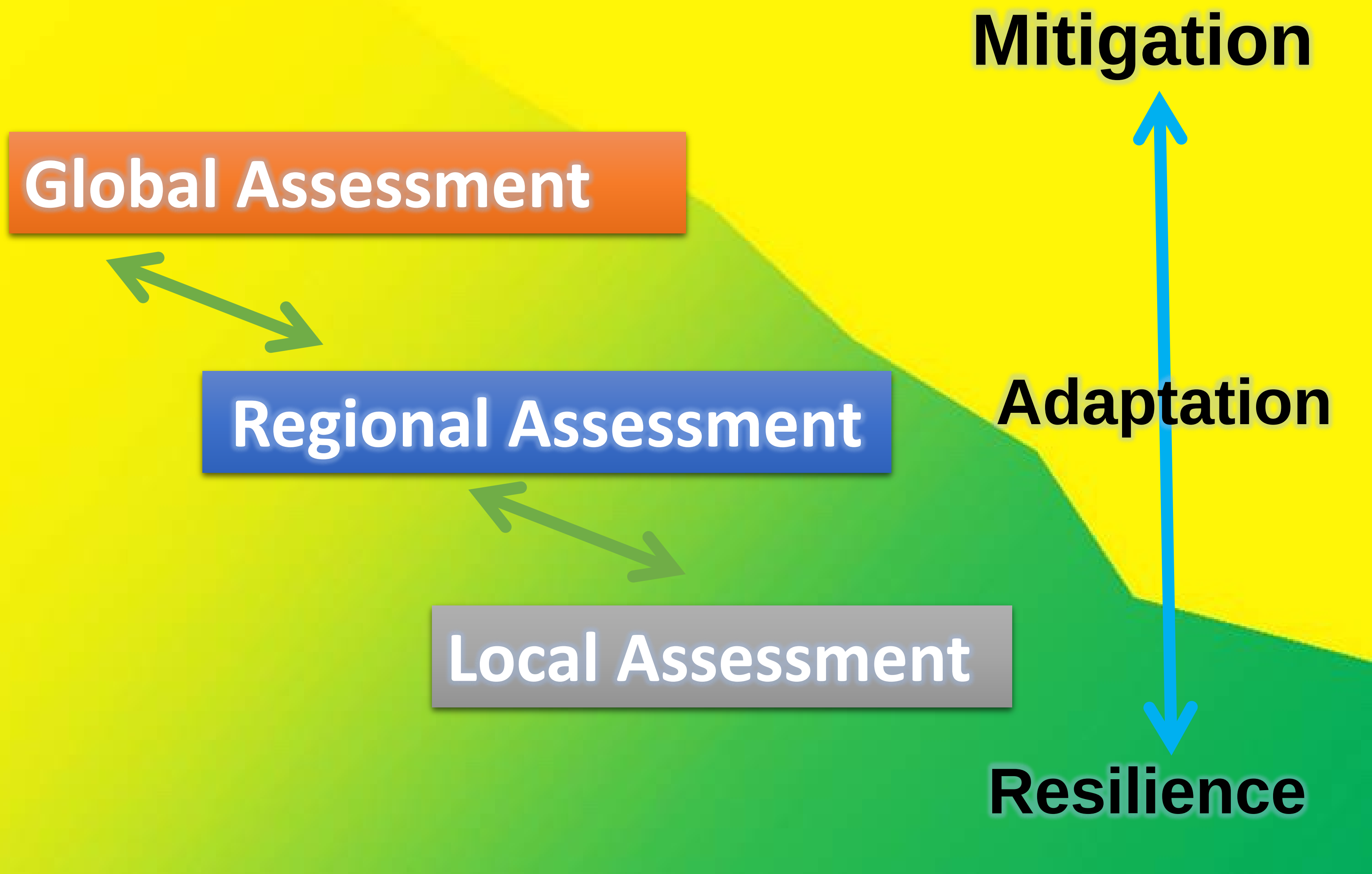
IT ALWAYS SEEMS
IMPOSSIBLE
UNTIL IT'S DONE.
-NELSON MANDELA

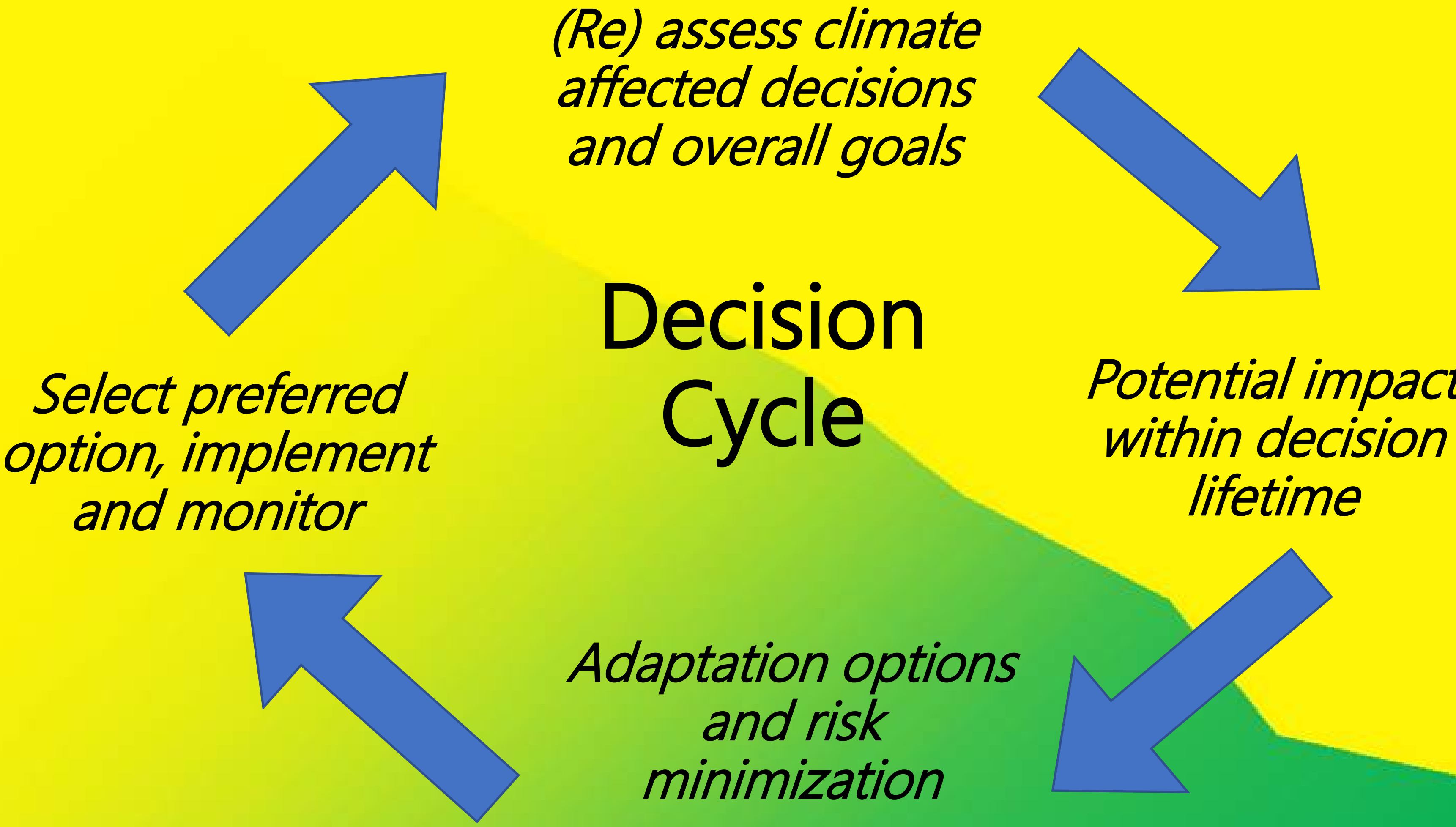
NEED FOR CUTTING ACROSS THE BOUNDARIES



THE WAY FORWARD

- Assessment of climate change scenarios on regional & local levels (Navigation through/and across scale.
- Rapid transition to intersectoral thinking institution building. Planning, and policymaking for responsible sustainable [agricultural aquaculture, fisheries, etc].
- Coping with uncertainty – 'shifting baselines'.
- Increased investment in research and information system.

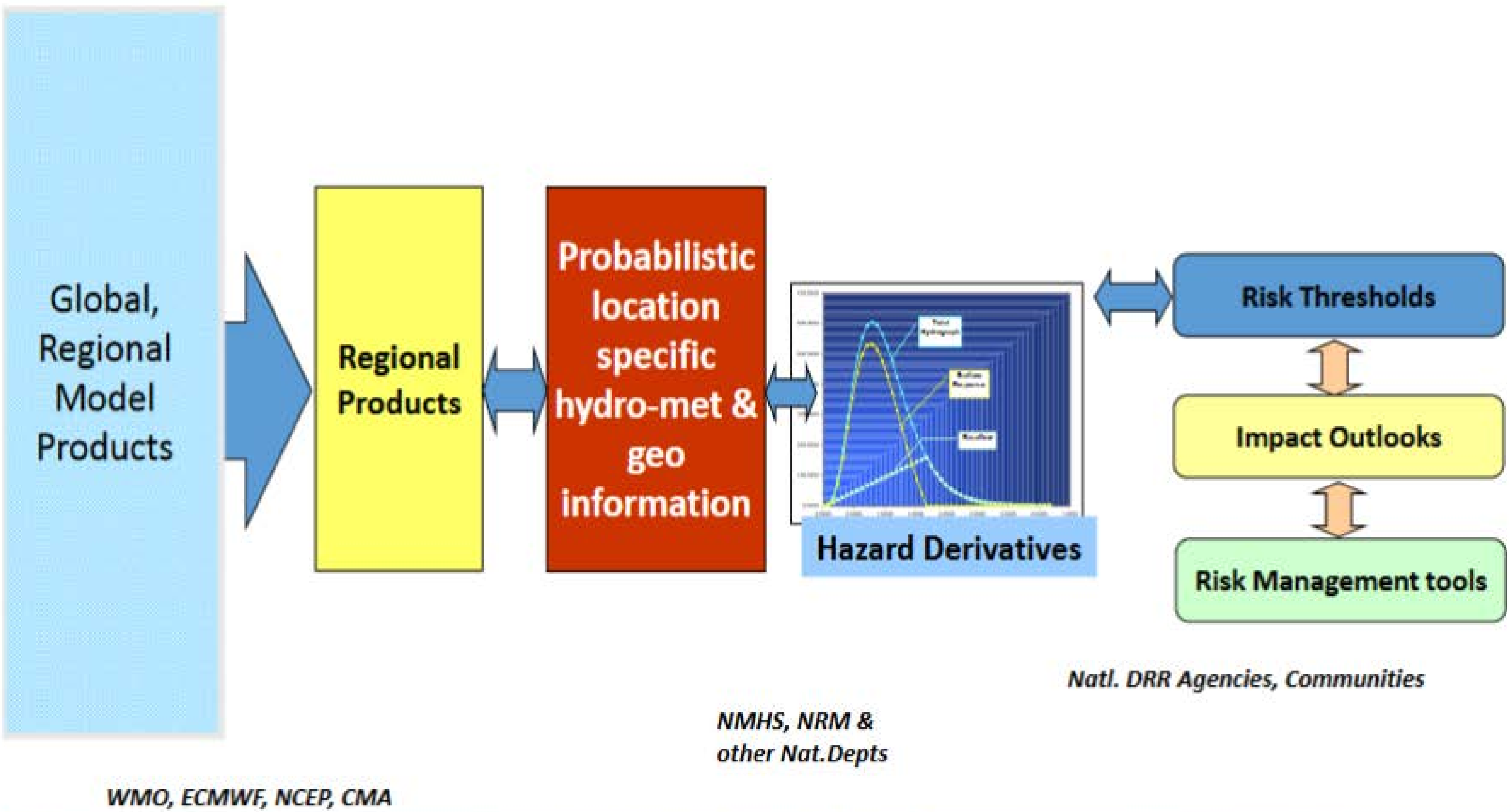
The Decision Cycle



Source: 46th session of IPCC, Montreal, Canada. Sep. 2017(AR6 Report)

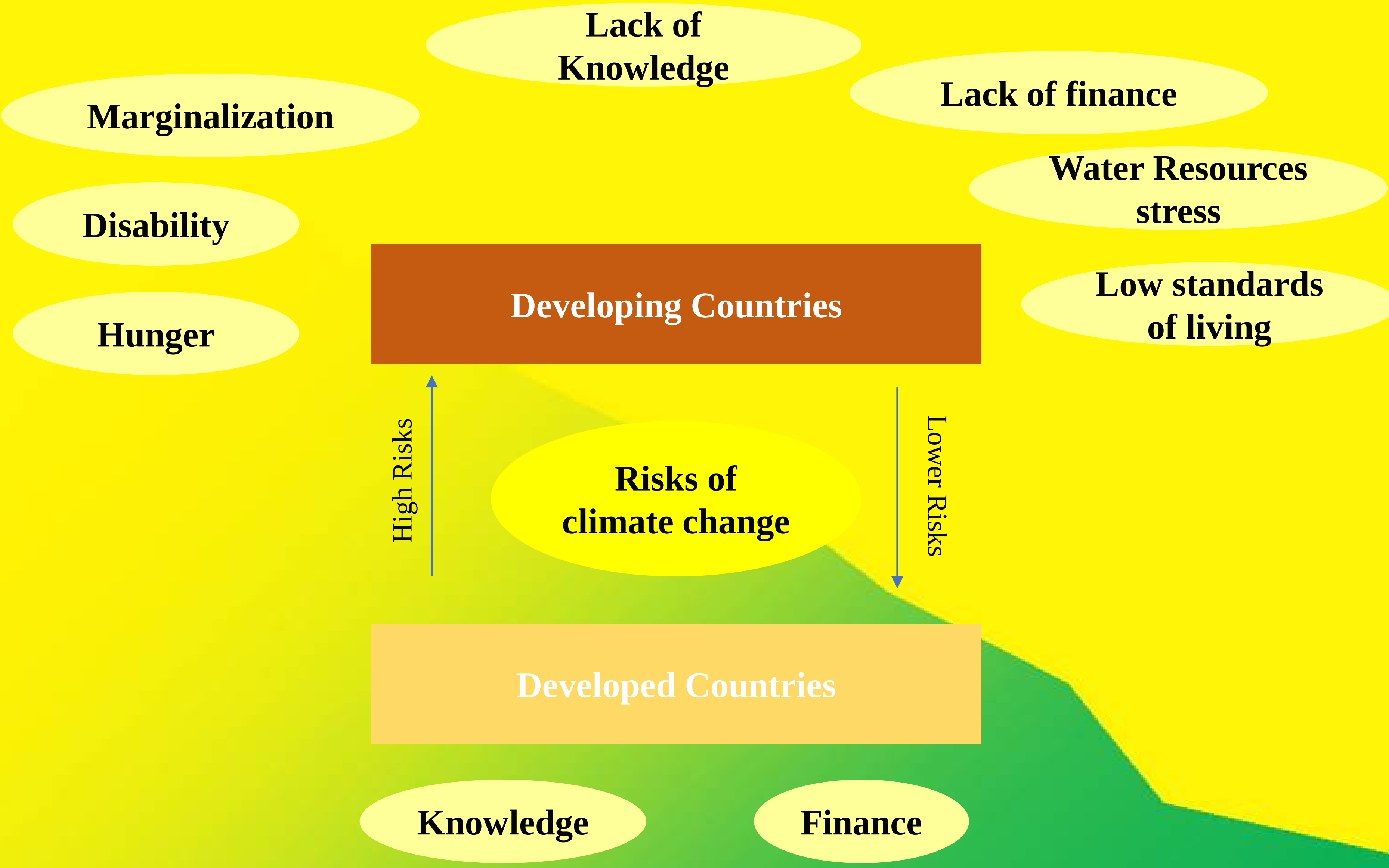
Tonkin+Taylor

Connecting Science, Institutions and Society for an Integrated DRR

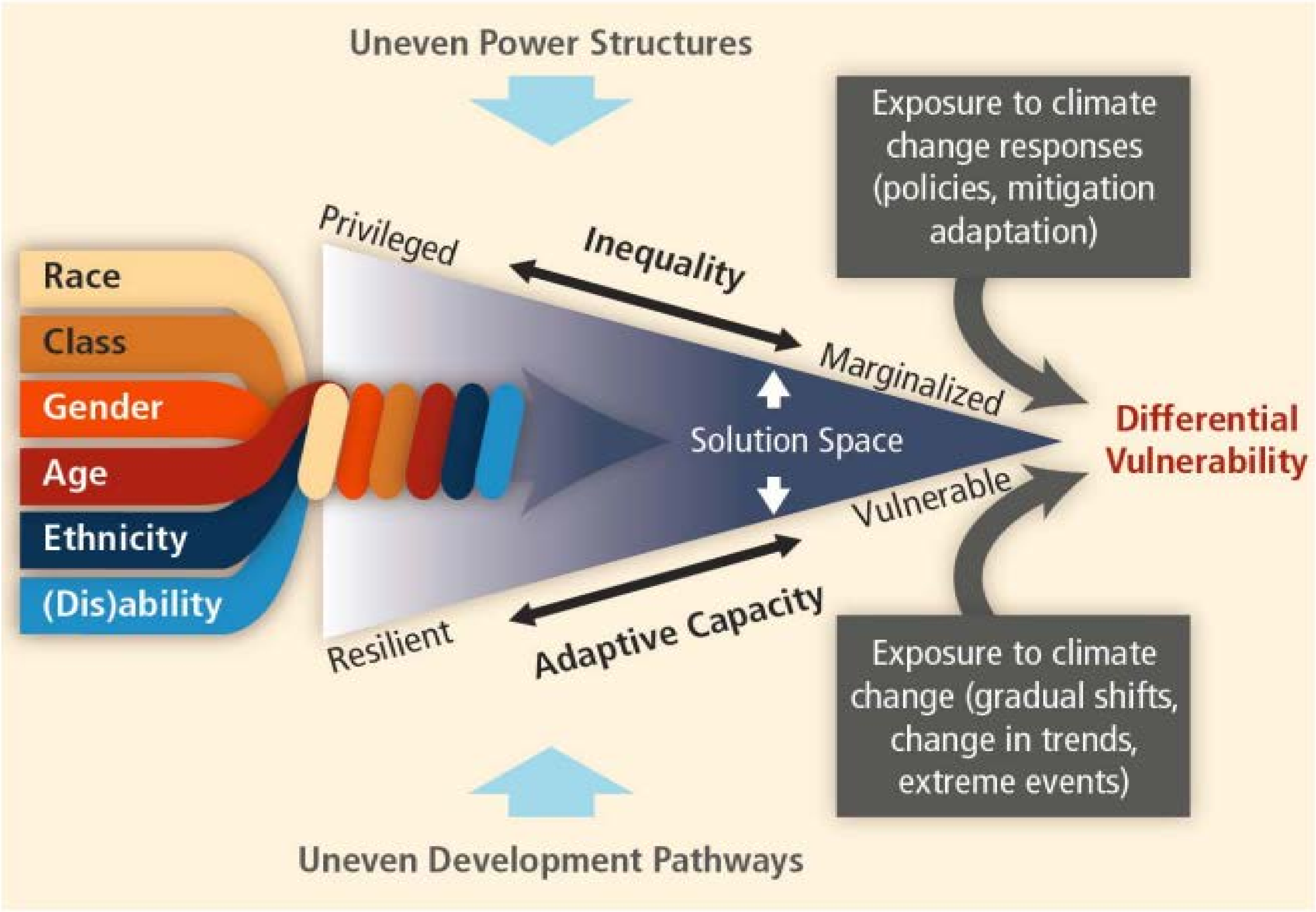



Ms. Mizutori, "…Not all countries have the necessary capacity to fulfill their responsibilities under the Sendai Framework in accessing, compiling and reporting back on the data necessary to measure our achievement.

1. A. In collaboration with existing platforms and mechanisms, RACC aims at encouraging, supporting, initiating local and regional assessments for the impact of climate change in the developing world. B. Helps through its networks and the means to identify the gaps and shed light on the way to bridge it.
1. Work with advanced institutions and leading entities in this field to support and interact with the developing countries in order to enhance and enrich the capacity building processes. In order to enable them to participate effectively in developing and continuously revising the regional and local assessment.
2. Finding the means to enhance the establishment of regional platforms for disaster risk reduction.
3. Support and empower, through its network, the enhancement of coping and adaptive capacities in the developing world.
4. Within the context of science and technology global platform of STS, RACC will play a role in accelerating the use of science and technology innovative results in strengthening the coping and adaptive actions and plans in the framework of regional assessments.



Cooperation is the way forward for stability and prosperity for humanity



Source: 46th session of IPCC, Montreal, Canada. Sep. 2017(AR6 Report)

IDDC
INTERNATIONAL DRYLAND DEVELOPMENT COMMISSION