

Climate change and agricultural life

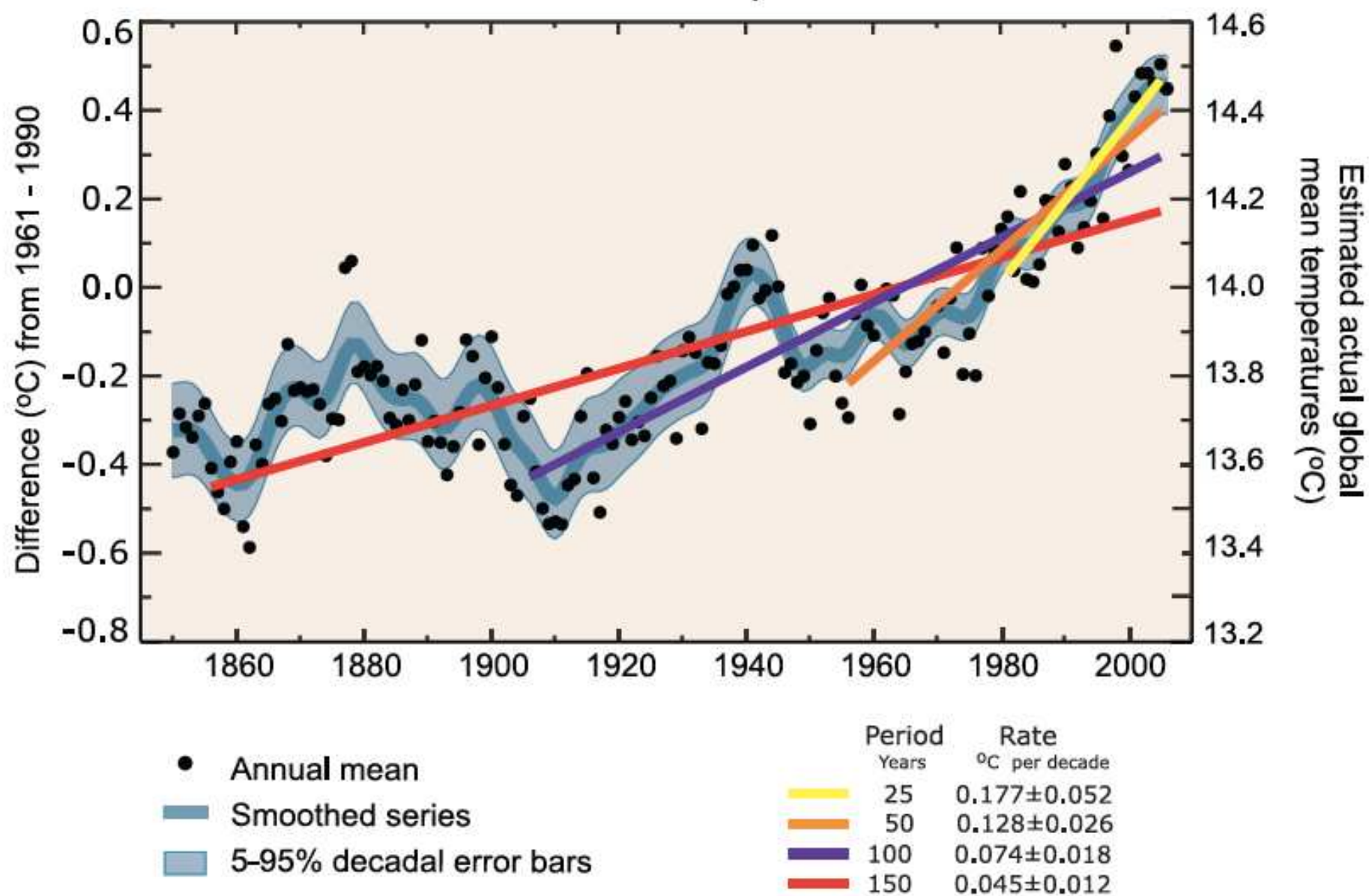
4th World Meeting of Catholics on Rural Life:
"Evolution and Problems of Rural World facing Challenges of Globalization"
Rome, 25-27 June 2012

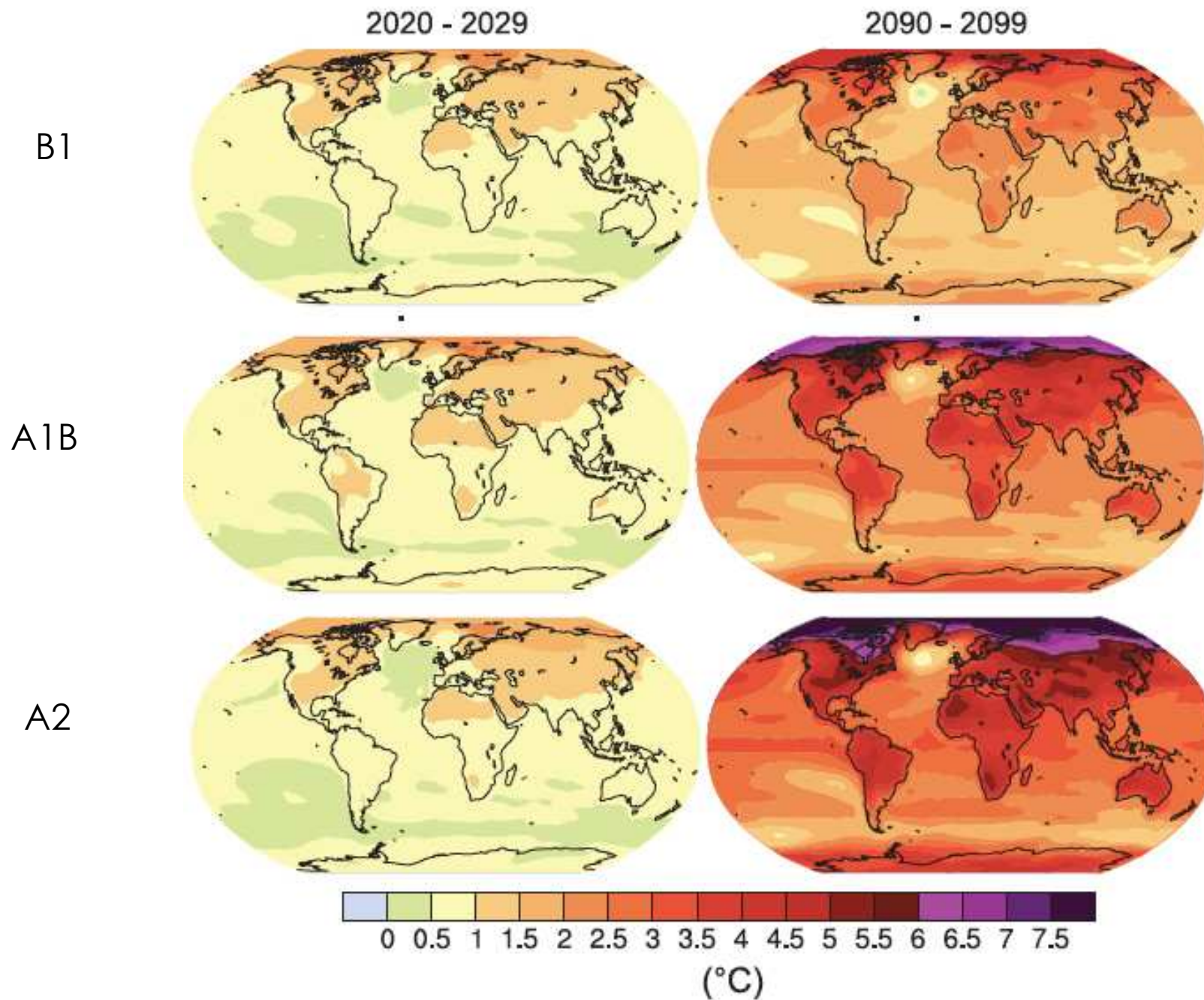
Jose Ramon T Villarin SJ
Ateneo de Manila University, Philippines

Outline

- Intro: climate change
- Contribution of agriculture to rising GHG levels
- Response: mitigation options
- Climate change impacts on agriculture
- Response: adaptation options
- Questions for discussion

Global Mean Temperature





Source: NASA Earth Observatory, based on IPCC Fourth Assessment Report (2007)

GHG from Agriculture

- Agricultural lands (cropland, managed grassland and permanent crops including agro-forestry and bio-energy crops) occupy about 40- 50% of the Earth's land surface
- 2005 Agriculture emissions: 5.1 to 6.1 GtCO₂-eq/yr (or 10-12% of total anthropogenic GHG emissions).
 - CH₄ contributes 3.3 GtCO₂-eq/yr and N₂O 2.8 GtCO₂-eq/yr.
 - In 2005, agriculture accounts for about 60% of N₂O and about 50% of CH₄
 - CO₂ net is minimal
- CH₄ and N₂O increased 17% from 1990 to 2005 (about 60 MtCO₂-eq/yr)
 - Non-Annex I countries: 32% increase (3/4 of total agricultural emissions)
 - Annex I countries: 12% decrease

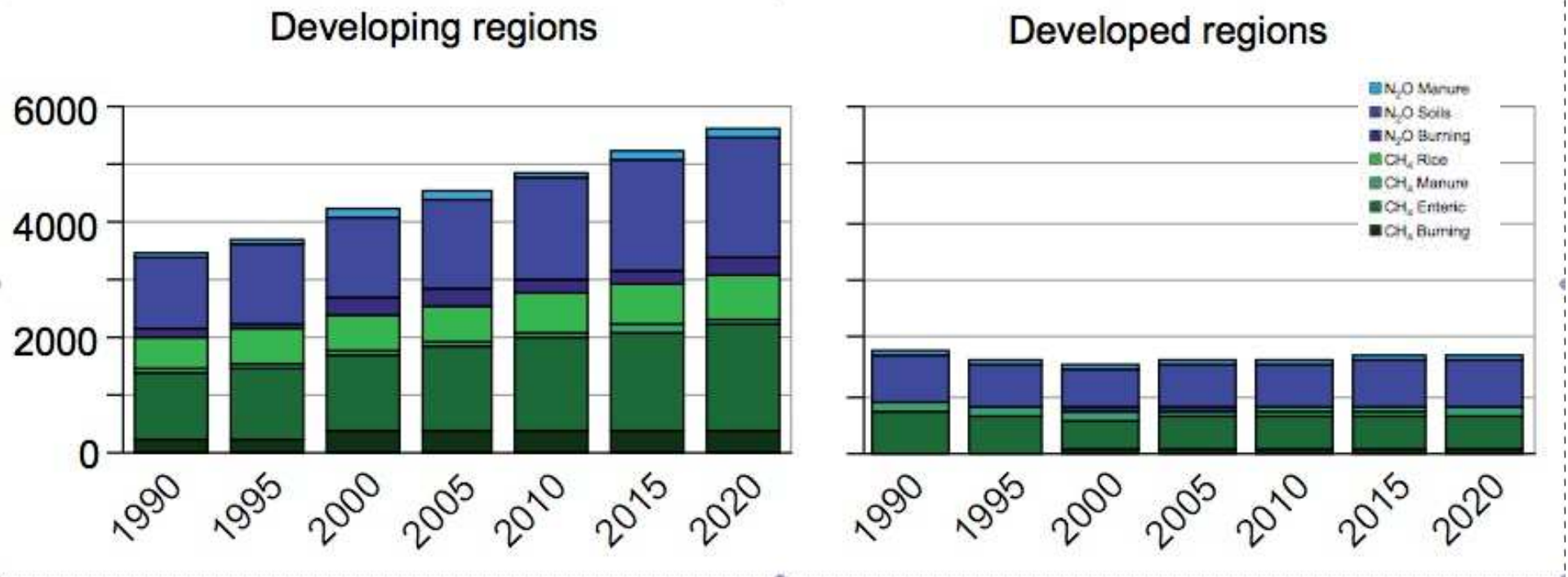
Agricultural land use

Table 8.1. *Agricultural land use in the last four decades.*

	Area (Mha)					Change 2000s/1960s	
	1961-70	1971-80	1981-90	1991-00	2001-02	%	Mha
1. World							
Agricultural land	4,562	4,684	4,632	4,985	5,023	+10	461
Arable land	1,297	1,331	1,376	1,393	1,405	+8	107
Permanent crops	82	92	104	123	130	+59	49
Permanent pasture	3,182	3,261	3,353	3,469	3,498	+10	306
2. Developed countries							
Agricultural land	1,879	1,883	1,877	1,866	1,838	-2	-41
Arable land	648	649	652	633	613	-5	-35
Permanent crops	23	24	24	24	24	+4	1
Permanent pasture	1,209	1,210	1,201	1,209	1,202	-1	-7
3. Developing countries							
Agricultural land	2,682	2,801	2,955	3,119	3,184	+19	502
Arable land	650	682	724	760	792	+22	142
Permanent crops	59	66	80	99	106	+81	48
Permanent pasture	1,973	2,051	2,152	2,260	2,286	+16	313

Source: FAOSTAT, 2005.

Trend in Agri GHG emissions



Estimated historical and projected N₂O and CH₄ emissions (MtCO₂-eq) in agriculture (1990-2020). (Adapted from US-EPA 2006)

Agriculture GHG mitigation

Table 8.3: Proposed measures for mitigating greenhouse gas emissions from agricultural ecosystems, their apparent effects on reducing emissions of individual gases where adopted (mitigative effect), and an estimate of scientific confidence that the proposed practice can reduce overall net emissions at the site of adoption.

Measure	Examples	Mitigative effects ^a			Net mitigation ^b (confidence)	
		CO ₂	CH ₄	N ₂ O	Agreement	Evidence
Cropland management	Agronomy	+		+/-	***	**
	Nutrient management	+		+	***	**
	Tillage/residue management	+		+/-	**	**
	Water management (irrigation, drainage)	+/-		+	+	+
	Rice management	+/-	+	+/-	**	**
	Agro-forestry	+		+/-	***	+
	Set-aside, land-use change	+	+	+	***	***
Grazing land management/ pasture improvement	Grazing intensity	+/-	+/-	+/-	+	+
	Increased productivity (e.g., fertilization)	+		+/-	**	+
	Nutrient management	+		+/-	**	**
	Fire management	+	+	+/-	+	+
	Species introduction (including legumes)	+		+/-	+	**
Management of organic soils	Avoid drainage of wetlands	+	-	+/-	**	**
Restoration of degraded lands	Erosion control, organic amendments, nutrient amendments	+		+/-	***	**
Livestock management	Improved feeding practices		+	+	***	***
	Specific agents and dietary additives		+		**	***
	Longer term structural and management changes and animal breeding		+	+	**	+
Manure/biosolid management	Improved storage and handling		+	+/-	***	**
	Anaerobic digestion		+	+/-	***	+
	More efficient use as nutrient source	+		+	***	**
Bio-energy	Energy crops, solid, liquid, biogas, residues	+	+/-	+/-	***	**

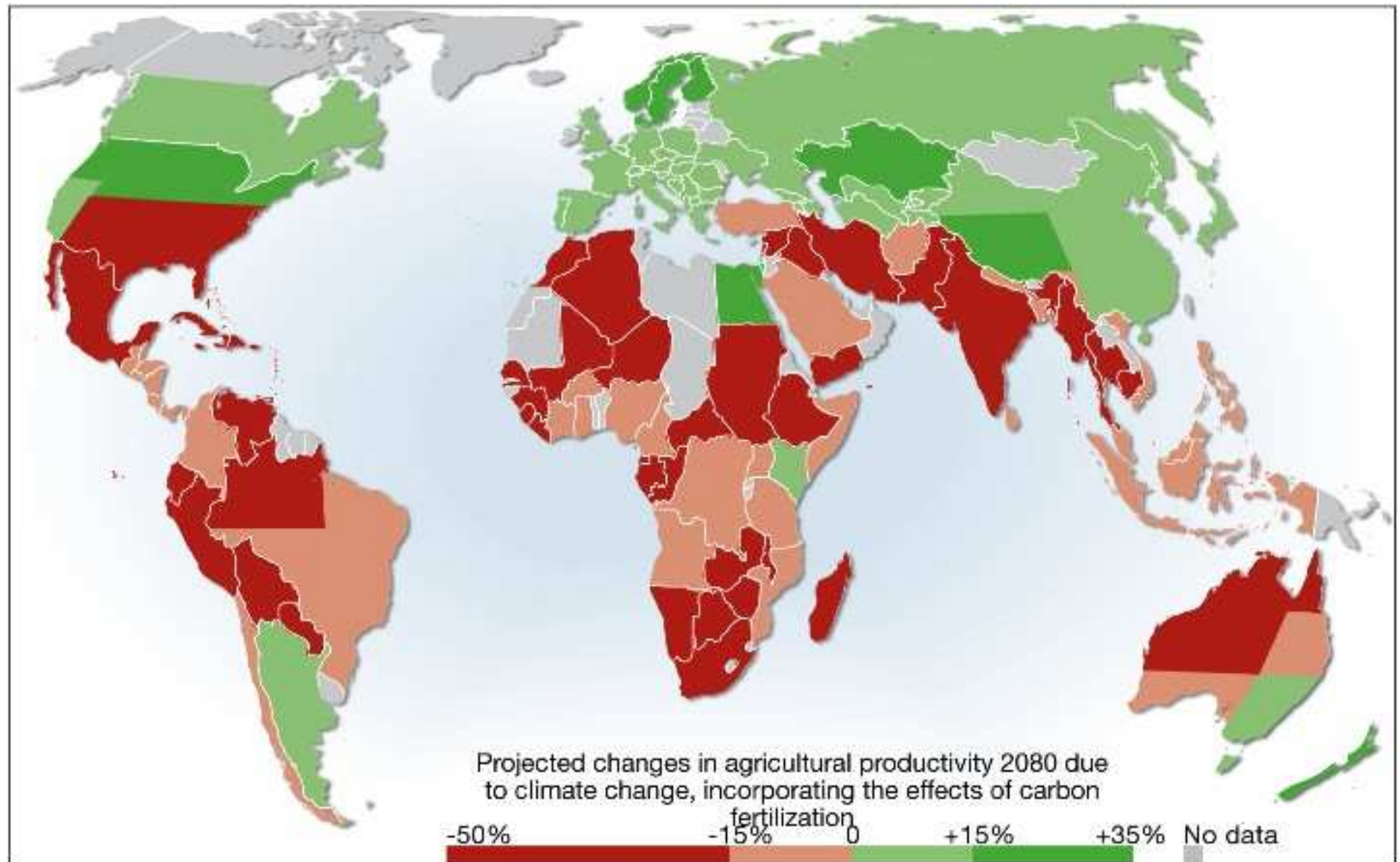
Notes:

- ^a + denotes reduced emissions or enhanced removal (positive mitigative effect);
- denotes increased emissions or suppressed removal (negative mitigative effect);
+/- denotes uncertain or variable response.
- ^b A qualitative estimate of the confidence in describing the proposed practice as a measure for reducing net emissions of greenhouse gases, expressed as CO₂-eq. Agreement refers to the relative degree of consensus in the literature (the more asterisks, the higher the agreement); Evidence refers to the relative amount of data in support of the proposed effect (the more asterisks, the more evidence).

Source: adapted from Smith et al., 2007a.

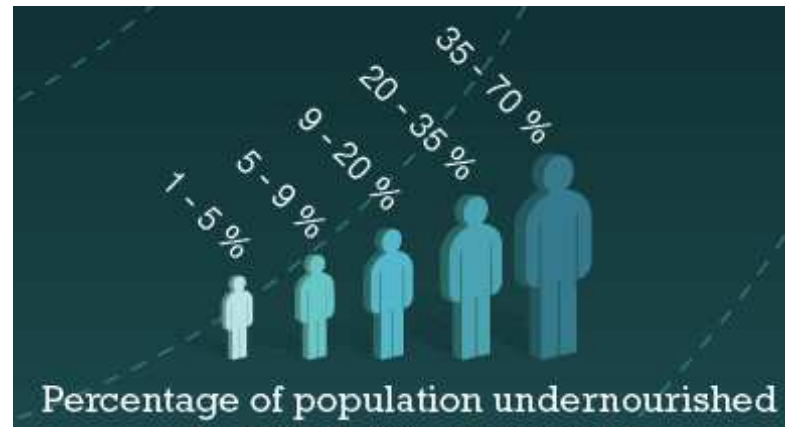
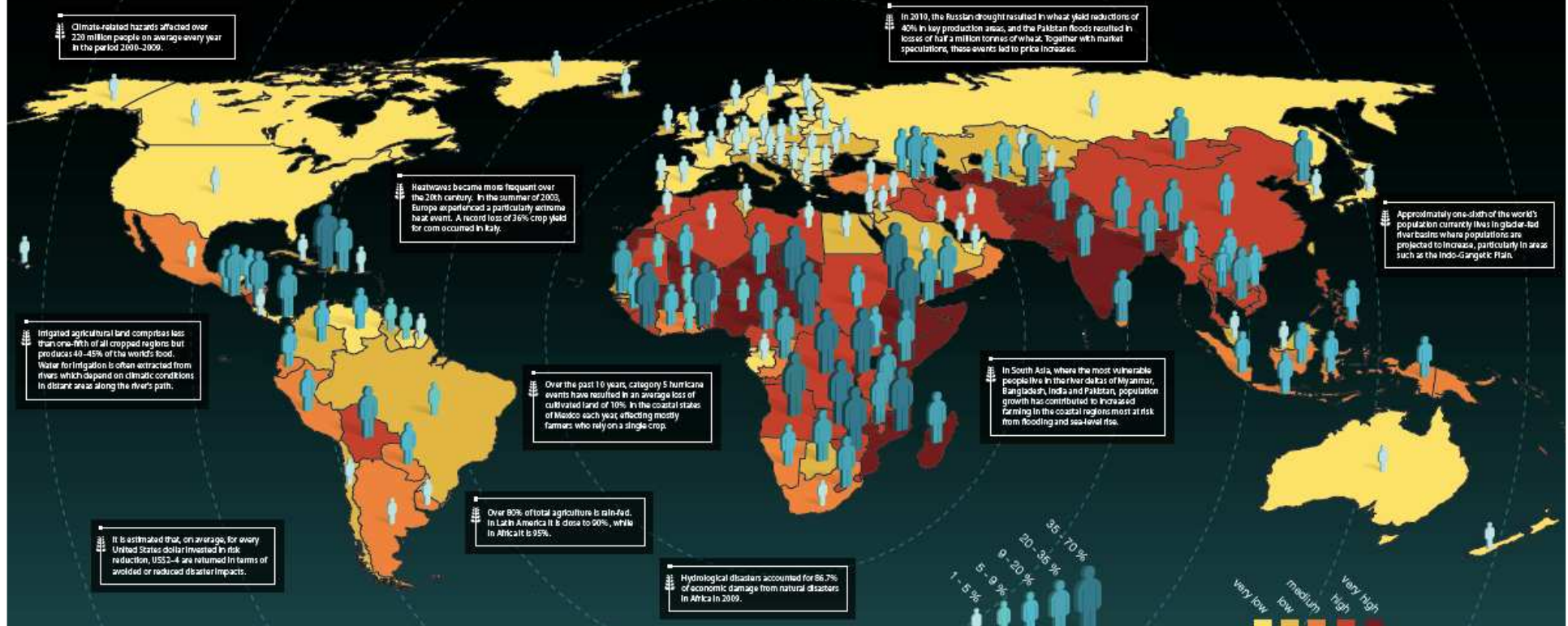
Via IPCC Fourth Assessment Report

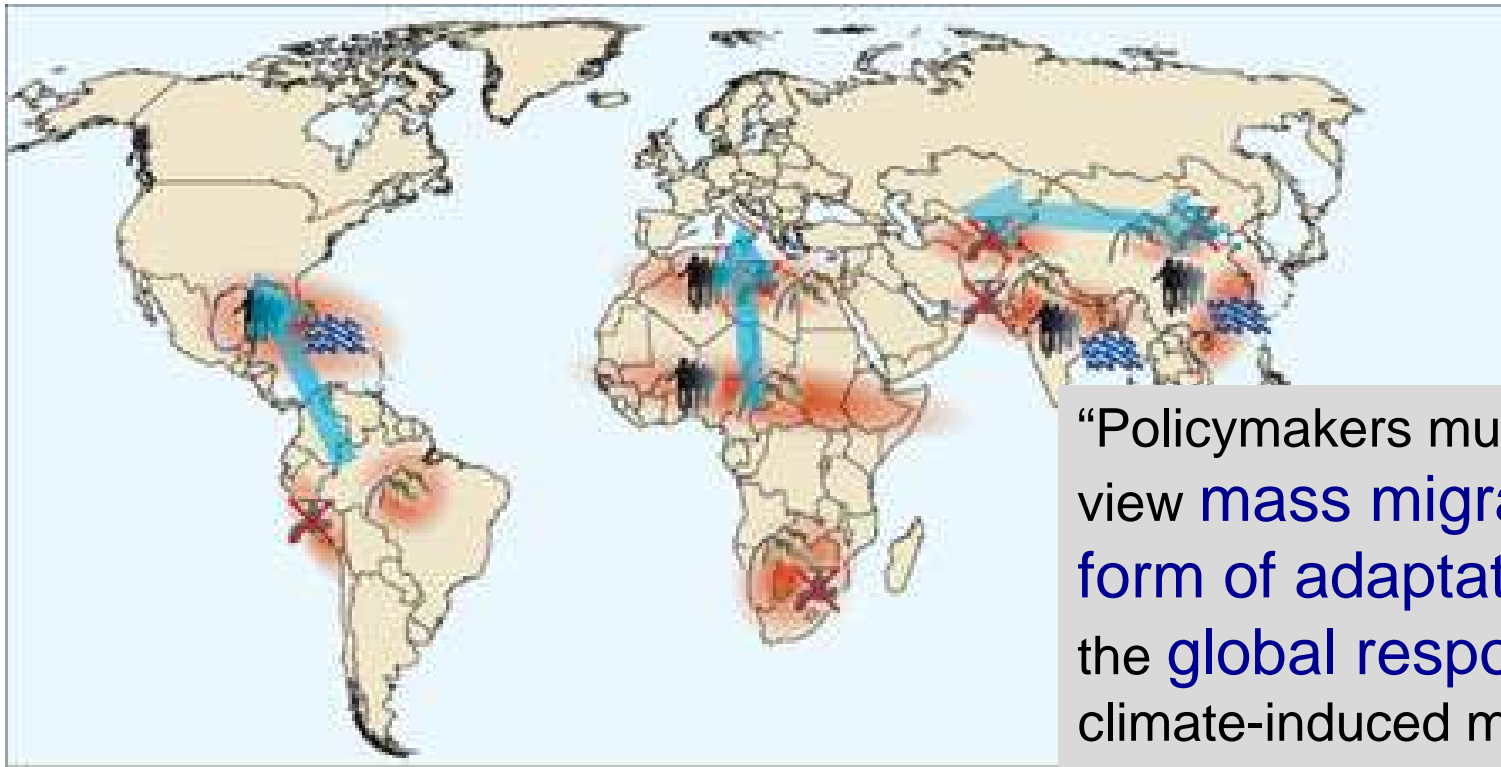
CC impacts on agriculture



<http://maps.grida.no/go/graphic/projected-agriculture-in-2080-due-to-climate-change>

Food insecurity and climate change





Conflict constellations in selected hotspots



Climate-induced degradation of freshwater resources



Climate-induced decline in food production



Hotspot



Climate-induced increase in storm and flood disasters



Environmentally-induced migration



Main trajectories

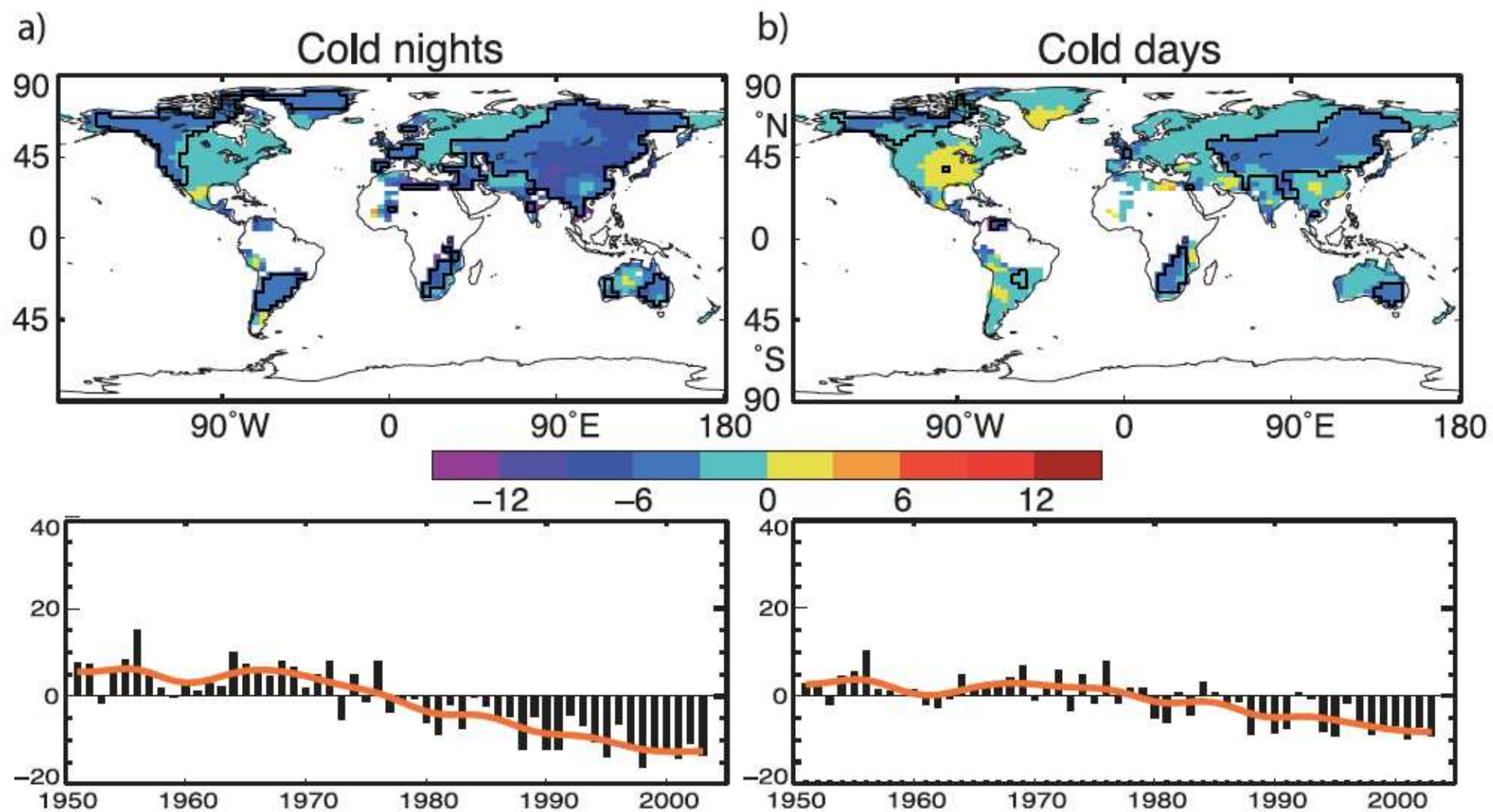
“Policymakers must start to view **mass migration as a form of adaptation** so that the **global response** to climate-induced migration is one of **facilitation rather than neglect**”

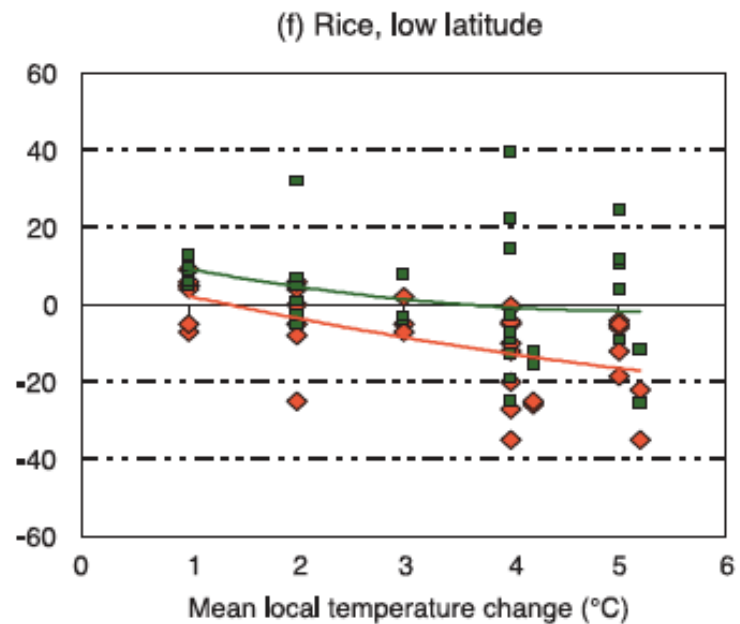
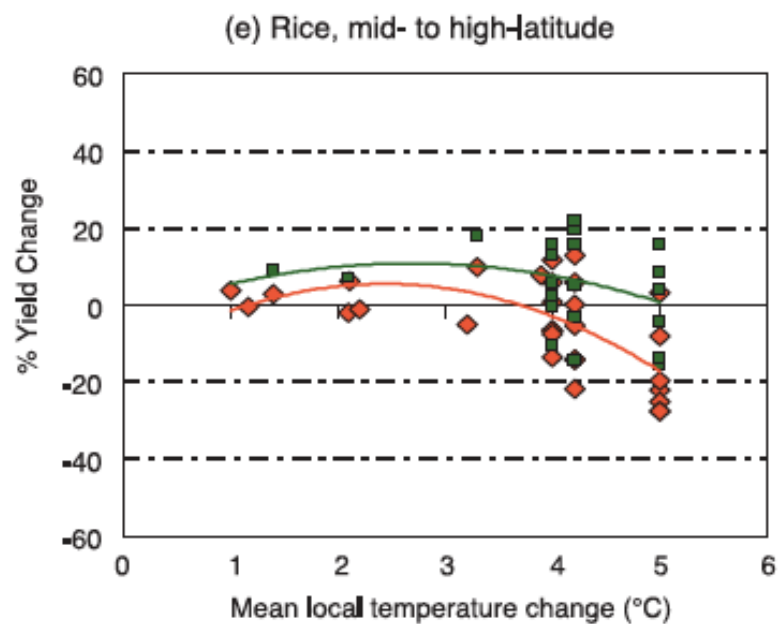
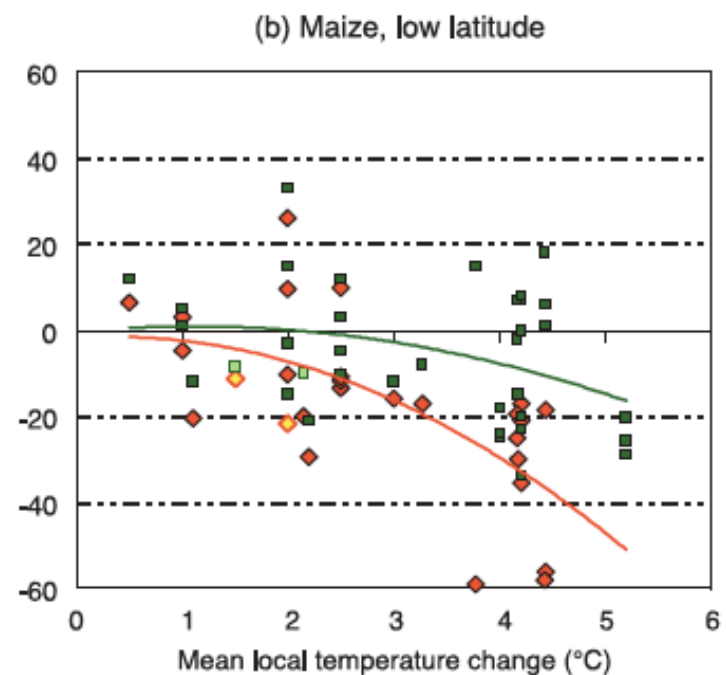
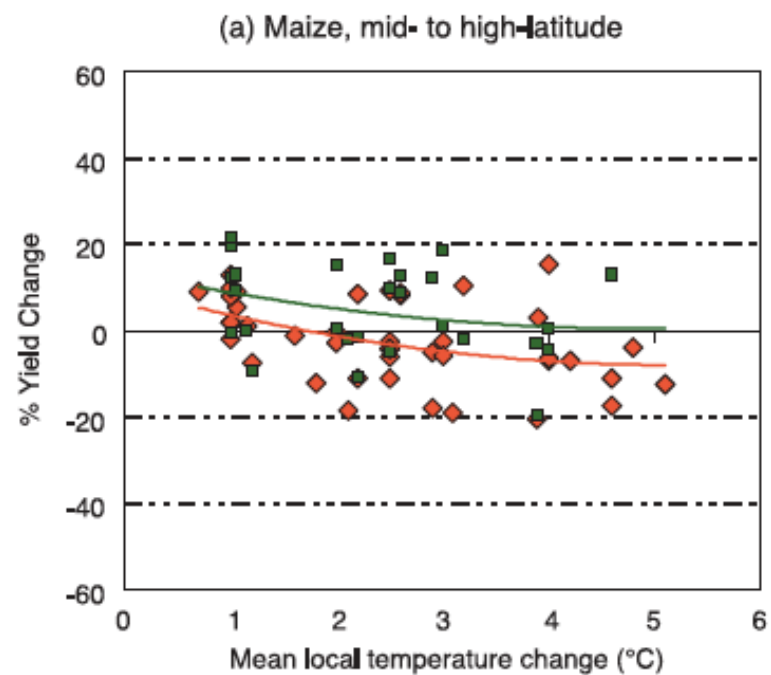
Security impacts

- By 2025 climate change will result in 1.4 billion people across 36 countries facing crop or water scarcities (WB)
- By 2050, 200 million people may be permanently displaced climate migrants
- Regional differences in agricultural production are likely to become more pronounced in developing countries by 2025
- Increasing sea levels, recurring floods or droughts could lead to a large scale displacement of population from small island states and flood prone nations.

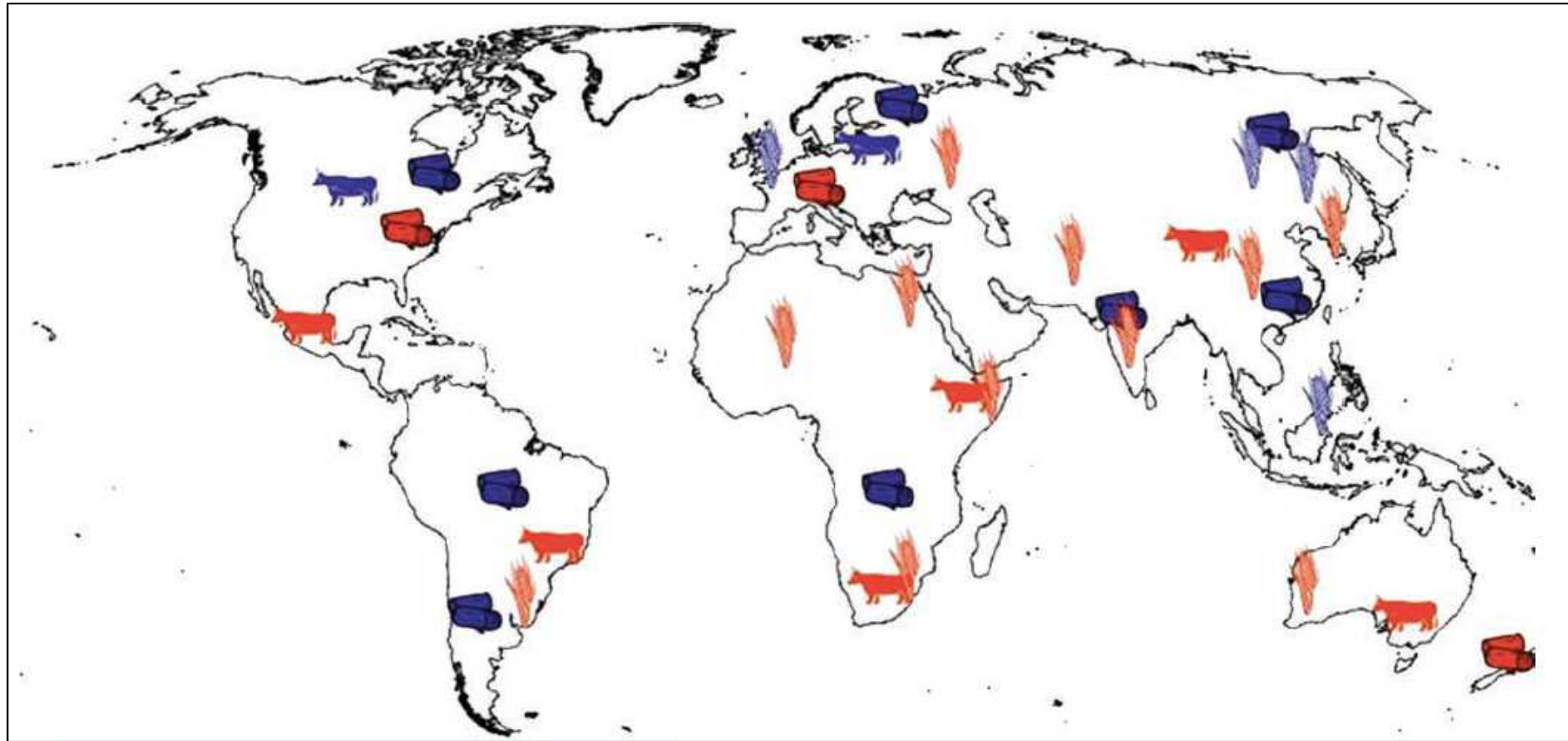
PHENOMENON, TREND DIRECTION	LIKELIHOOD *	MAJOR PROJECTED IMPACTS
Over most land areas, warmer and fewer cold days/nights, warmer and more frequent hot days/nights	Virtually certain	Increased yields in colder environments; decreased yields in warmer environments; increased insect outbreaks
Warm spells/heat waves. Freq increases over most land areas	Very likely	Reduced yields in warmer regions due to heat stress
Heavy precipitation events. Frequency increases over most areas	Very likely	Damage to crops; soil erosion, inability to cultivate land due to waterlogging of soils
Area affected by drought increases	Likely	Land degradation; lower yields/crop damage&failure; increased livestock deaths
Intense tropical cyclone activity increases	Likely	Damage to crops
Increased incidence of extreme high sea level	Likely	Irrigation water salinisation

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Major impacts of climate change on crop and livestock yields, and forestry production by 2050



Increased (blue) or decreased (red):

- | | | |
|---|---|---------------------------|
|  |  | -cereal crop productivity |
|  |  | -livestock productivity |
|  |  | -forestry production |

IMPACT: Agriculture, Food security



1979-2003 Los Baños (Philippines):
Minimum temperatures increased
by more than 1°C

Each 1°C rise led to decrease in
yield by 10% (Peng et al., 2004)

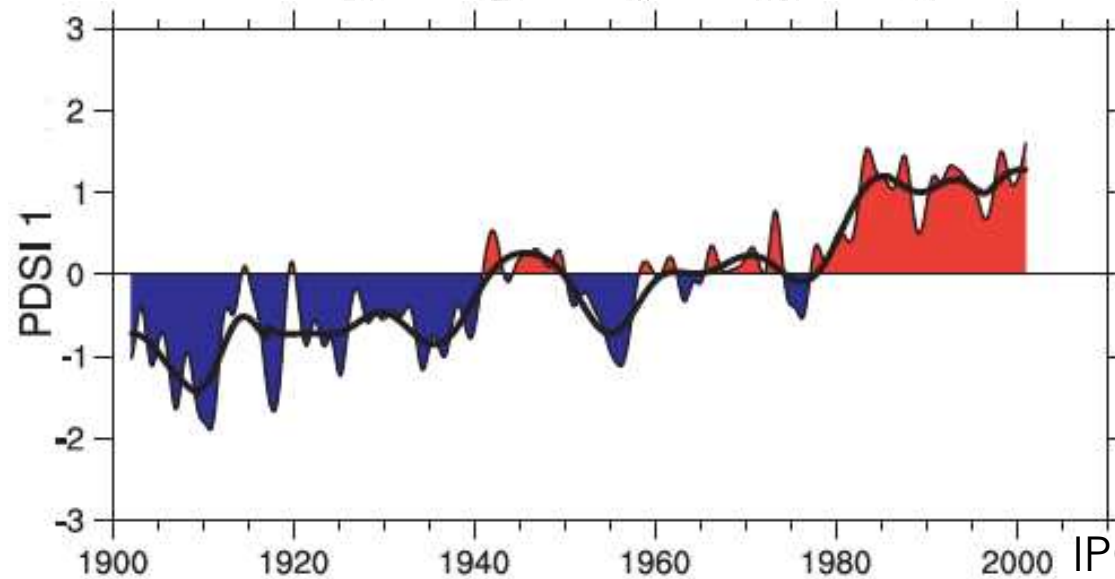
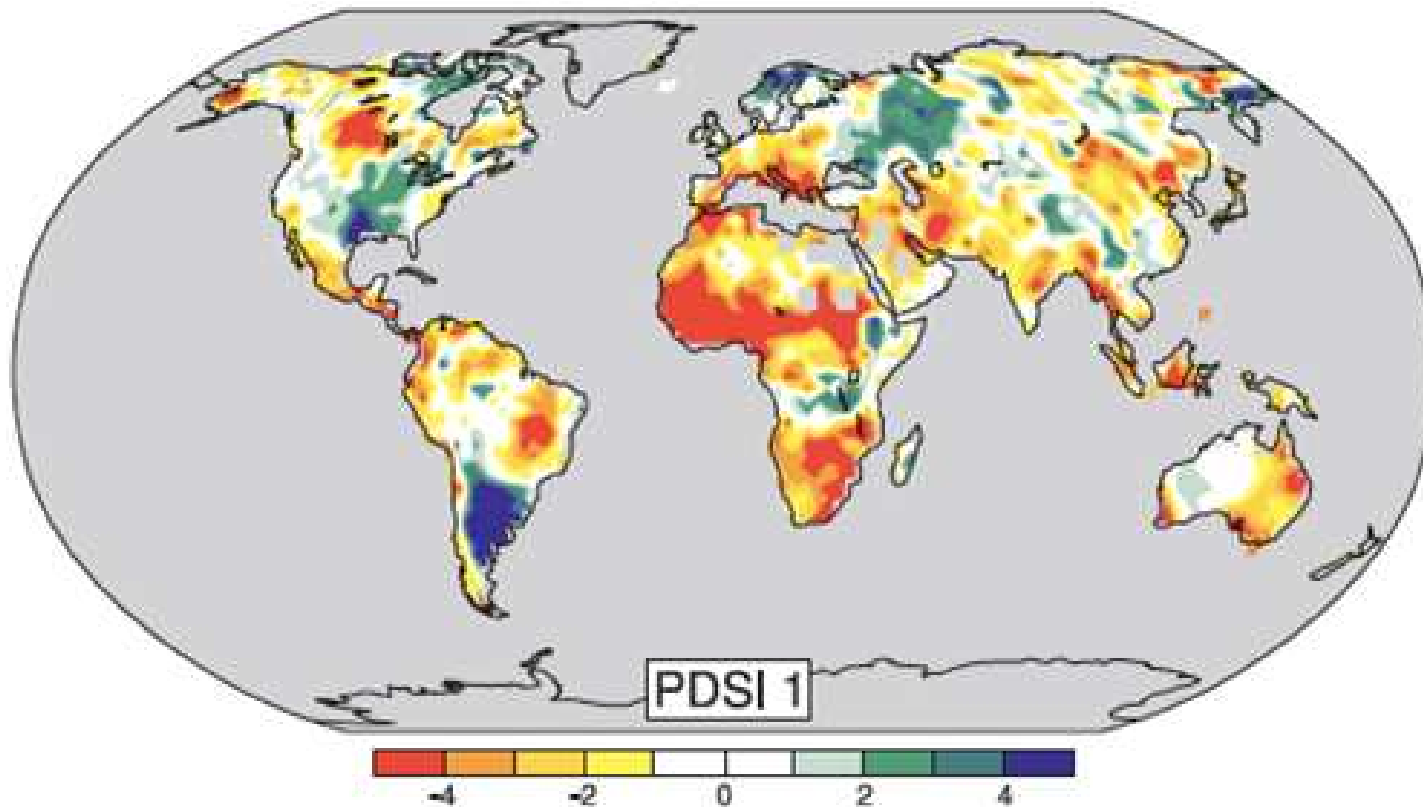
**“Human beings are not going
to adapt to climate change
unless agriculture adapts.”**

Cary Fowler Executive director
Global Crop Diversity Trust



Scott Harrison / Charity Water

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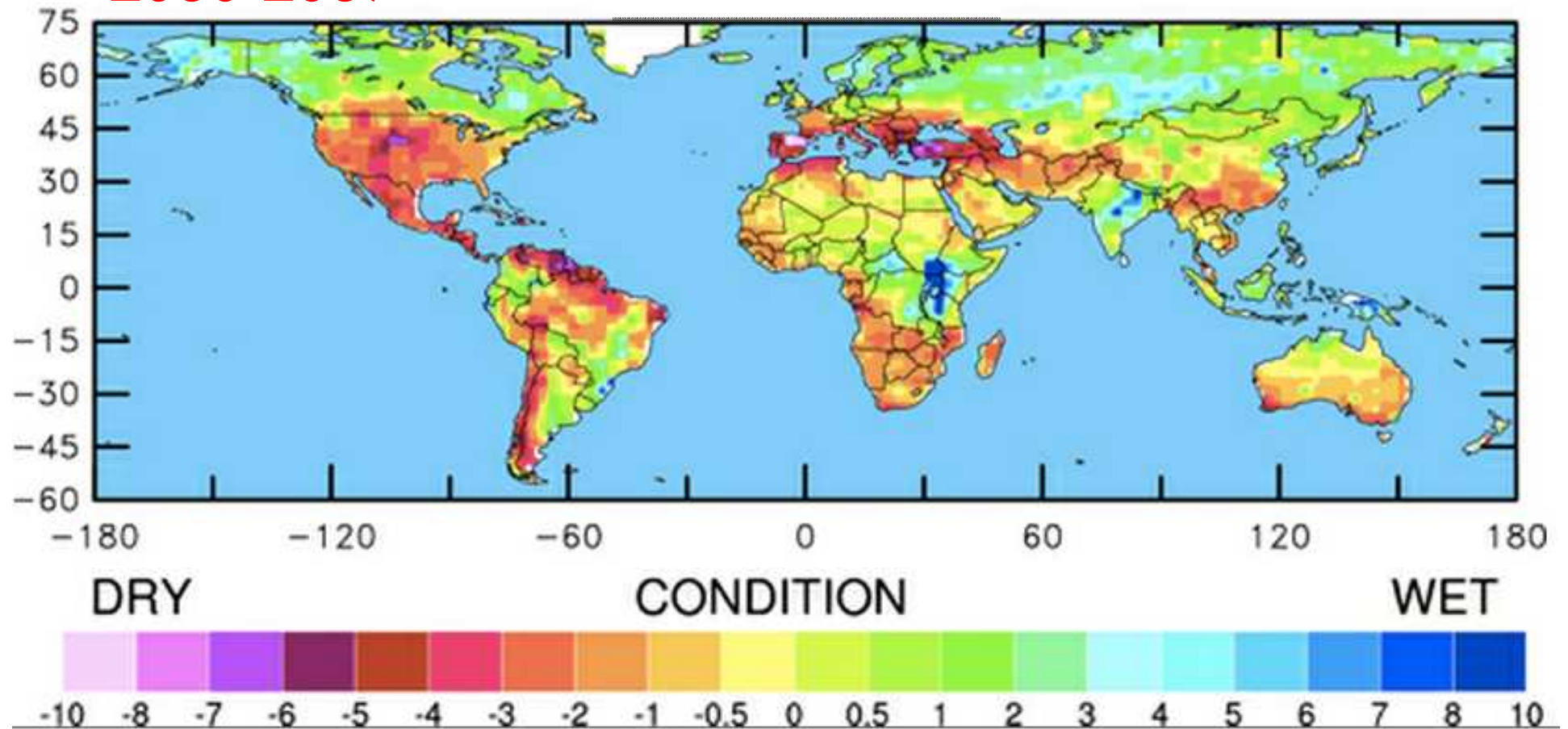


1900-2002
Palmer
Drought
Severity
Index

IPCC Fourth Assessment Report

CLIMATE CHANGE: DROUGHT MAY THREATEN MUCH OF GLOBE WITHIN DECADES

2030-2039

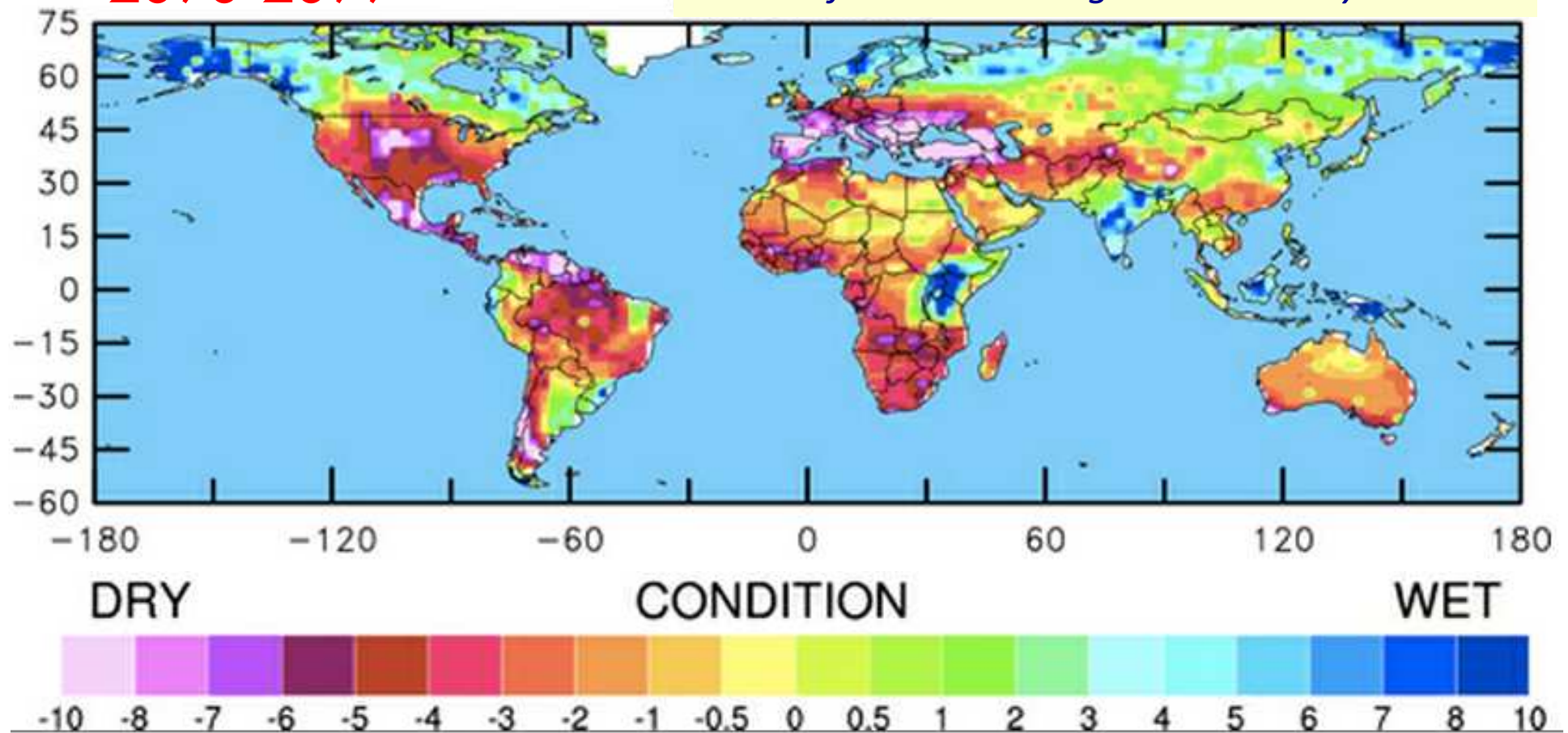


<https://www2.ucar.edu/atmosnews/news/2904/climate-change-drought-may-threaten-much-globe-within-decades>

CLIMATE CHANGE: DROUGHT MAY THREATEN MUCH OF GLOBE WITHIN DECADES

“most of the Western Hemisphere, large parts of Eurasia, Africa, and Australia, may be at threat of extreme drought this century”

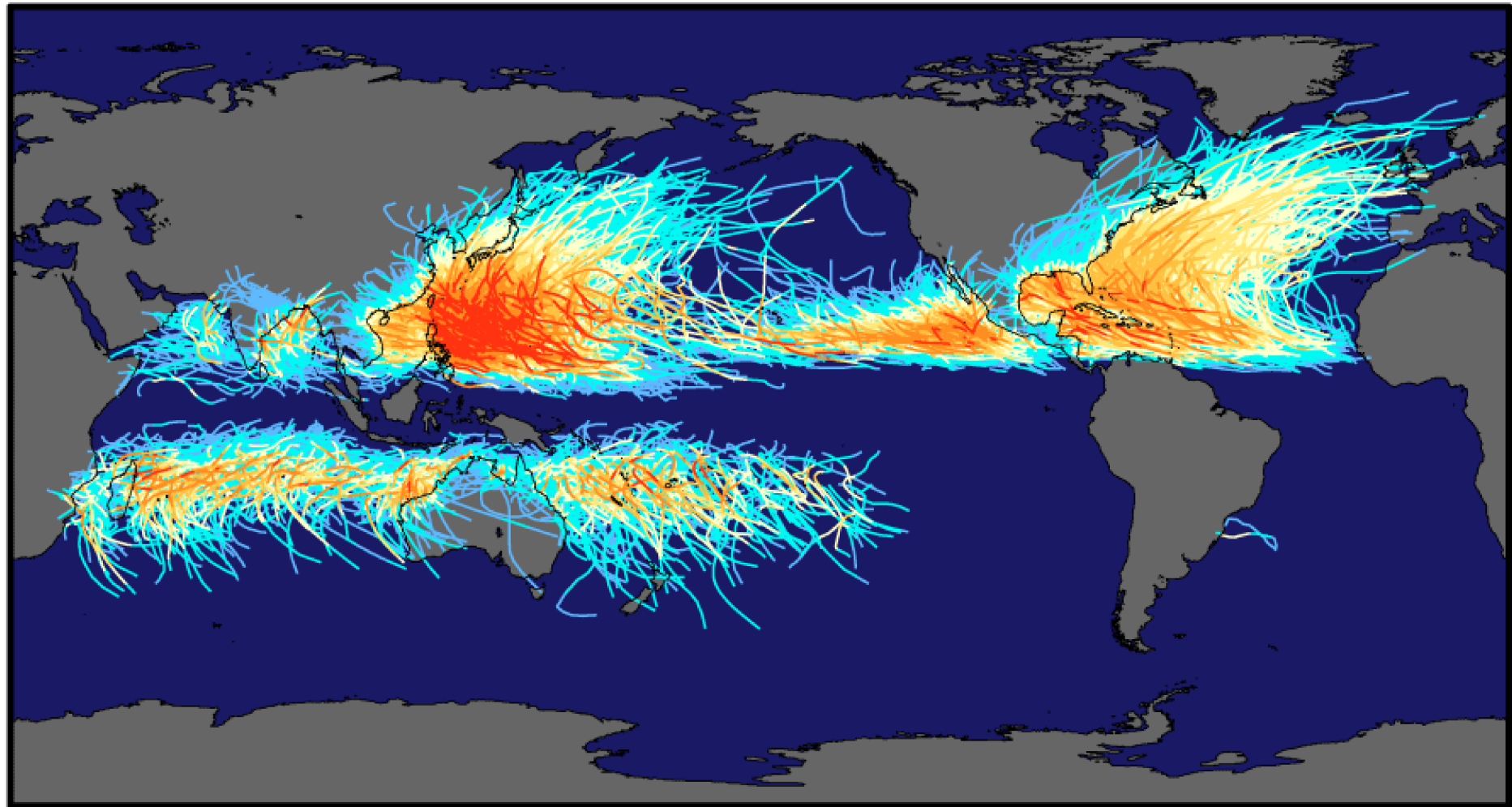
2090-2099



<https://www2.ucar.edu/atmosnews/news/2904/climate-change-drought-may-threaten-much-globe-within-decades>

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Tracks and Intensity of All Tropical Storms

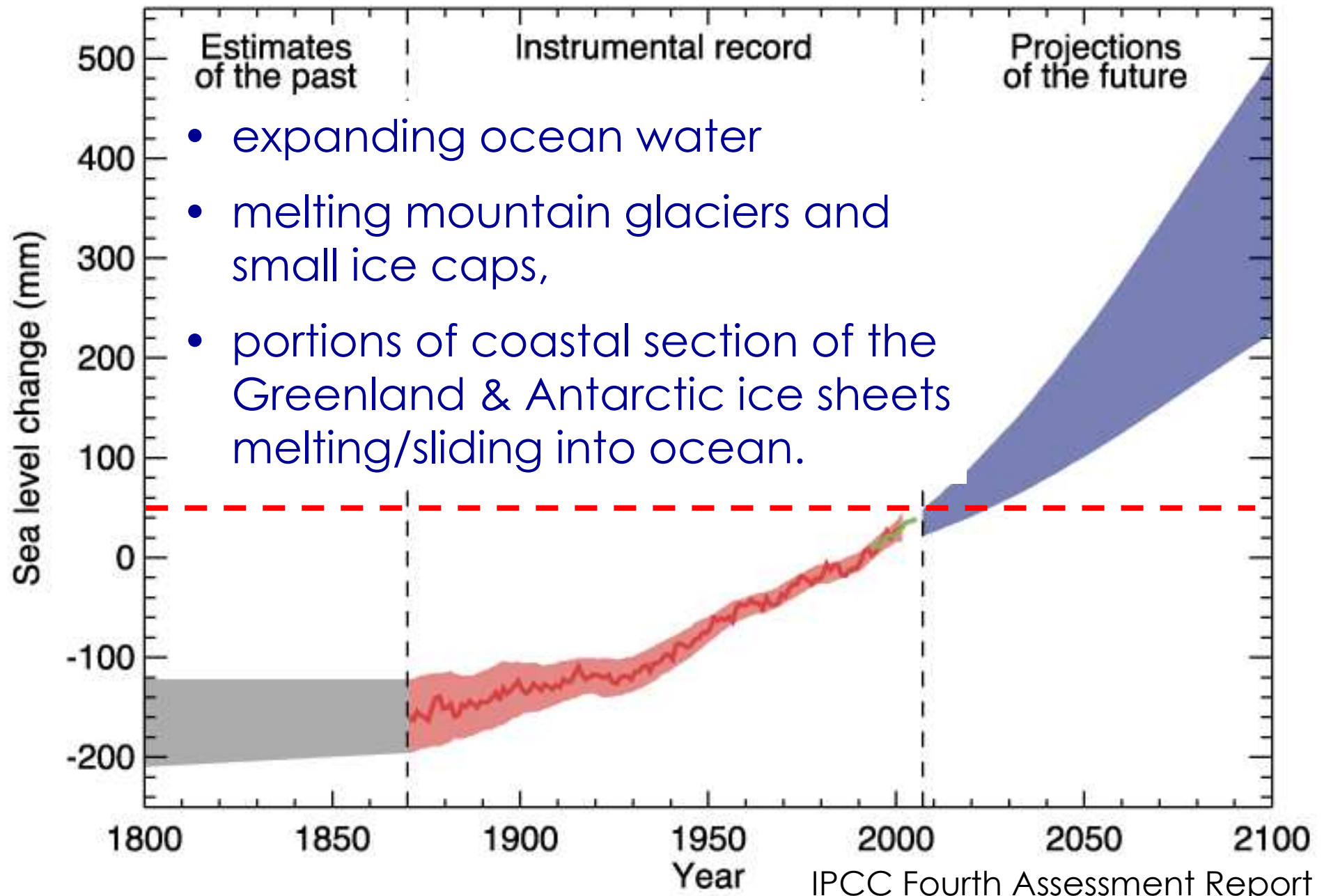


Saffir-Simpson Hurricane Intensity Scale

Source: <http://earthobservatory.nasa.gov>

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Sea Level Rise Projections to 2100



Tiwi and Malinao 2-meter Sea Level Rise and Land Use (2011)

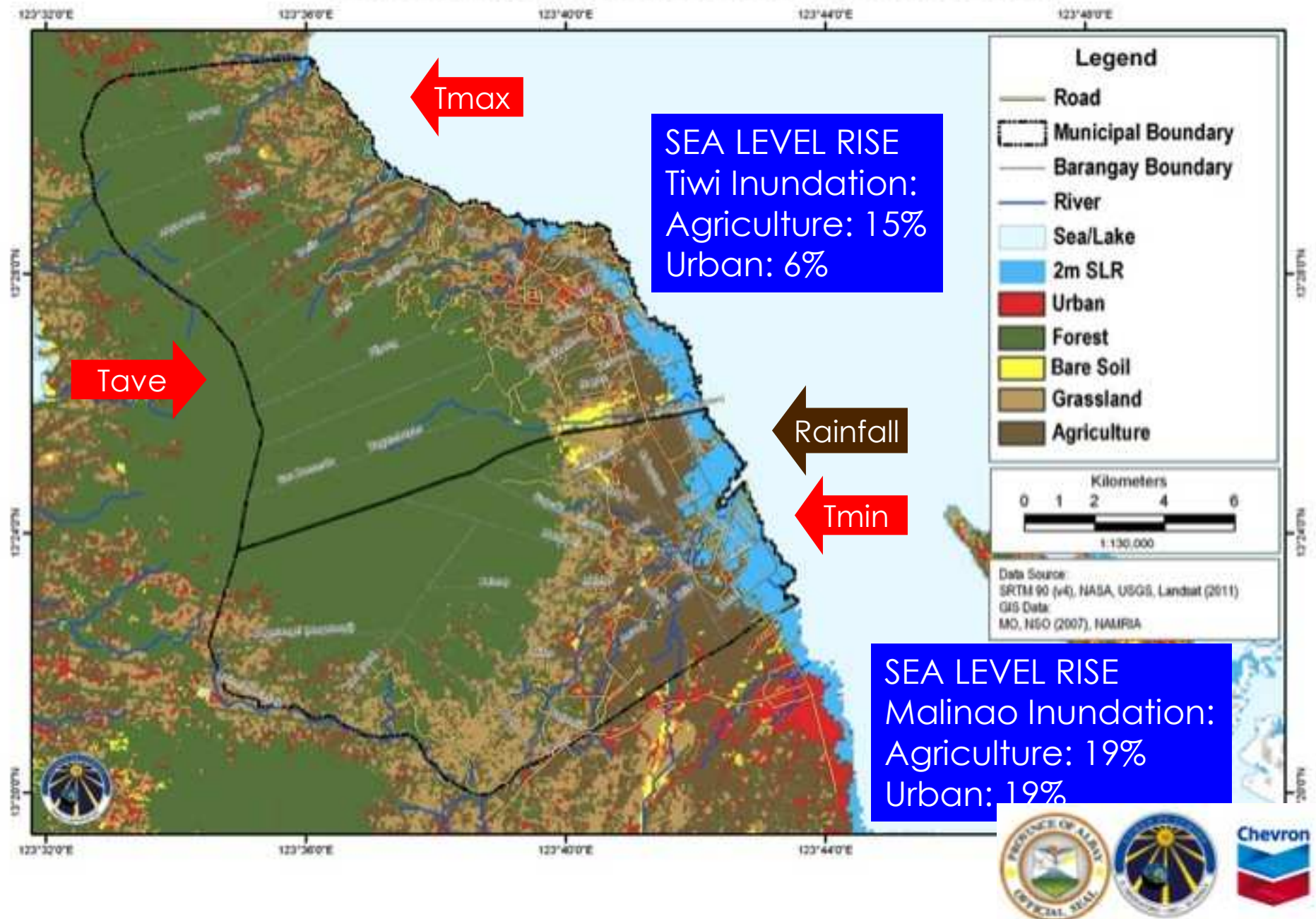
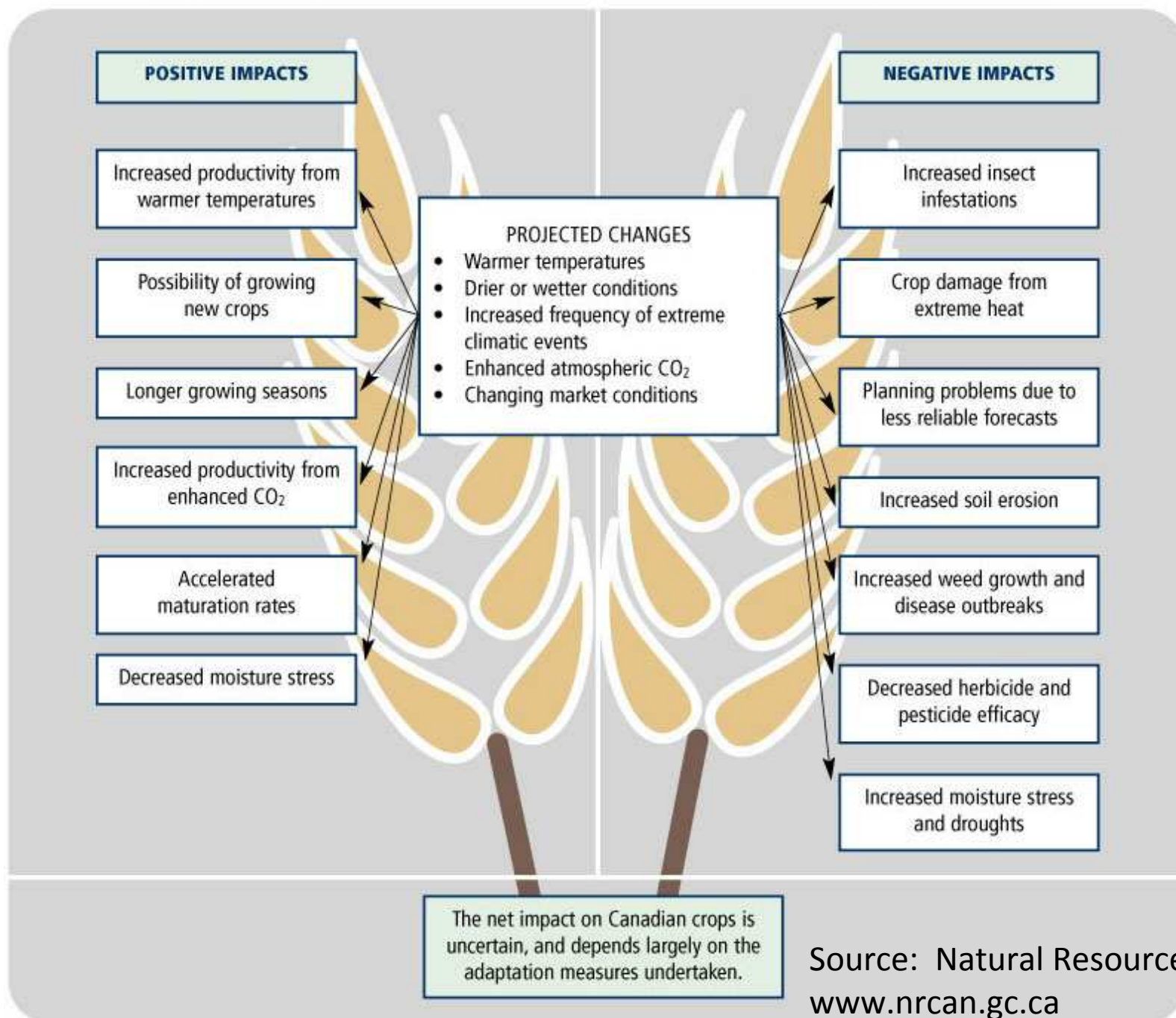


Figure 1: Potential impacts of climate change on agricultural crops in Canada



Source: Natural Resources Canada
www.nrcan.gc.ca

Autonomous adaptation: cropping systems

- Altering inputs:
 - Varieties/species
 - Fertiliser types, rates
 - Amount, timing of irrigation and other water mgt practices
- Technologies for water harvesting, soil moisture conservation, water use
- Timing or location of cropping activities
- Diversification of income (e.g other farming activities such as livestock raising)
- Improving effectiveness of pest, disease, weed mgt practices; crop resistance; quarantine capabilities, sentinel monitoring
- Seasonal climate forecasting to reduce production risk

Planned adaptation

- Capacity building of decision makers: climate change impacts are real (measurable)
- Technical and management options (e.g. biotechnology)
- Institutional support for transitions (e.g. migration), community partnerships for food and forage banks, network development, information sharing, food aid and employment
- Investment in irrigation infra, efficient water technologies, transport and storage infra, land tenure arrangements (property rights)
- Access to markets for products and inputs and financial services (including insurance)
- Capacity for adaptation analysis

Questions for discussion

- How can we increase ability of our farmers to respond and adapt to change?
 - What are the economic, institutional, cultural barriers to change?
 - How do we decrease their vulnerability and exposure to the potential hazards of climate change?
- What adaptation practices used in past climate events (e.g. droughts, flooding) have been known to work?
- How do we integrate climate change mitigation and adaptation into agricultural development planning at various levels (from rural community to national to international levels)?