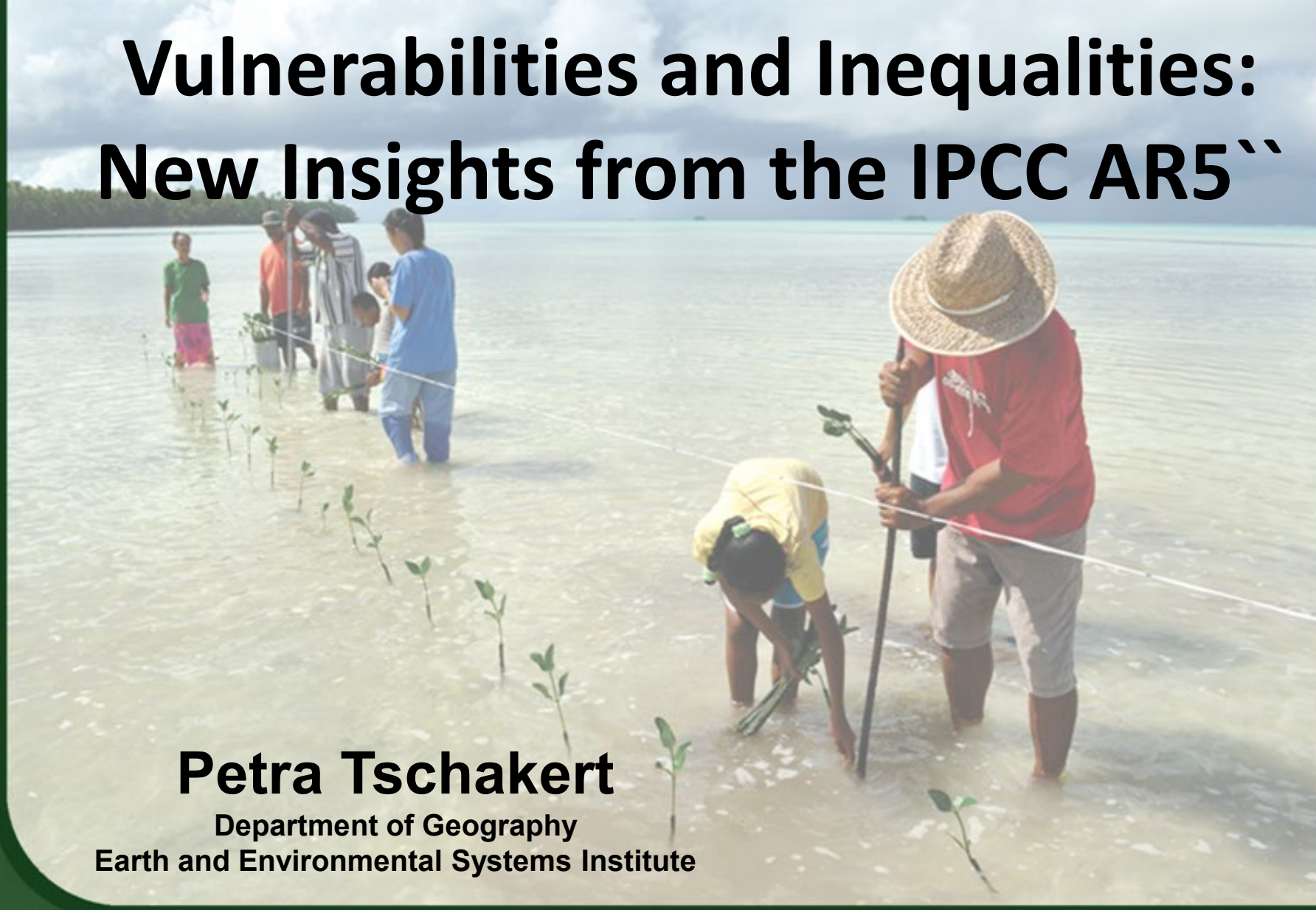
Vulnerabilities and Inequalities: New Insights from the IPCC AR5``



Petra Tschakert

Department of Geography
Earth and Environmental Systems Institute

Working Group II : Impacts, Adaptation, and Vulnerability

WMO UNEP

ipcc
INTERGOVERNMENTAL PANEL ON climate change

Understanding Vulnerability

AR4:

Vulnerability is the degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes.

Some criteria of key vulnerabilities:
- size (magnitude)
- time
- persistence of impacts.

Already in the SREX, November 2011

AR5:

Vulnerability is the propensity or predisposition to be adversely affected.

Much **stronger focus** on:
- (uneven) development processes
- inequalities in societies

Heat wave 2003, France

African agricultural lands

Proliferation of Efforts to Map Hotspots

de Sherbinin (2014)

- Early roots in biodiversity hotspot mapping in the 1990s
- Vulnerable populations, food security, water resources, conflicts etc.
- Spatial analysis, GIS, modeling (esp. for exposure mapping)
- Outcome *vs* contextual vulnerability (O'Brien et al. 2007)
- Frequent use of proxies (e.g. education for adaptive capacity)
- Difficulties with intrinsic/systemic vulnerability (e.g. marginalization)

Tschakert et al. (2013)

- Blind spots of conventional vulnerability assessments and maps
- Maps (and indices) mask dynamic dimensions of vulnerability
- Snapshots trigger overconfidence in results + premature decision making
- Overemphasis on inherent vulnerability, obscuring inequalities
- Missing out on relational aspects of inequality & marginalization

Regions and Projected Temperature Changes

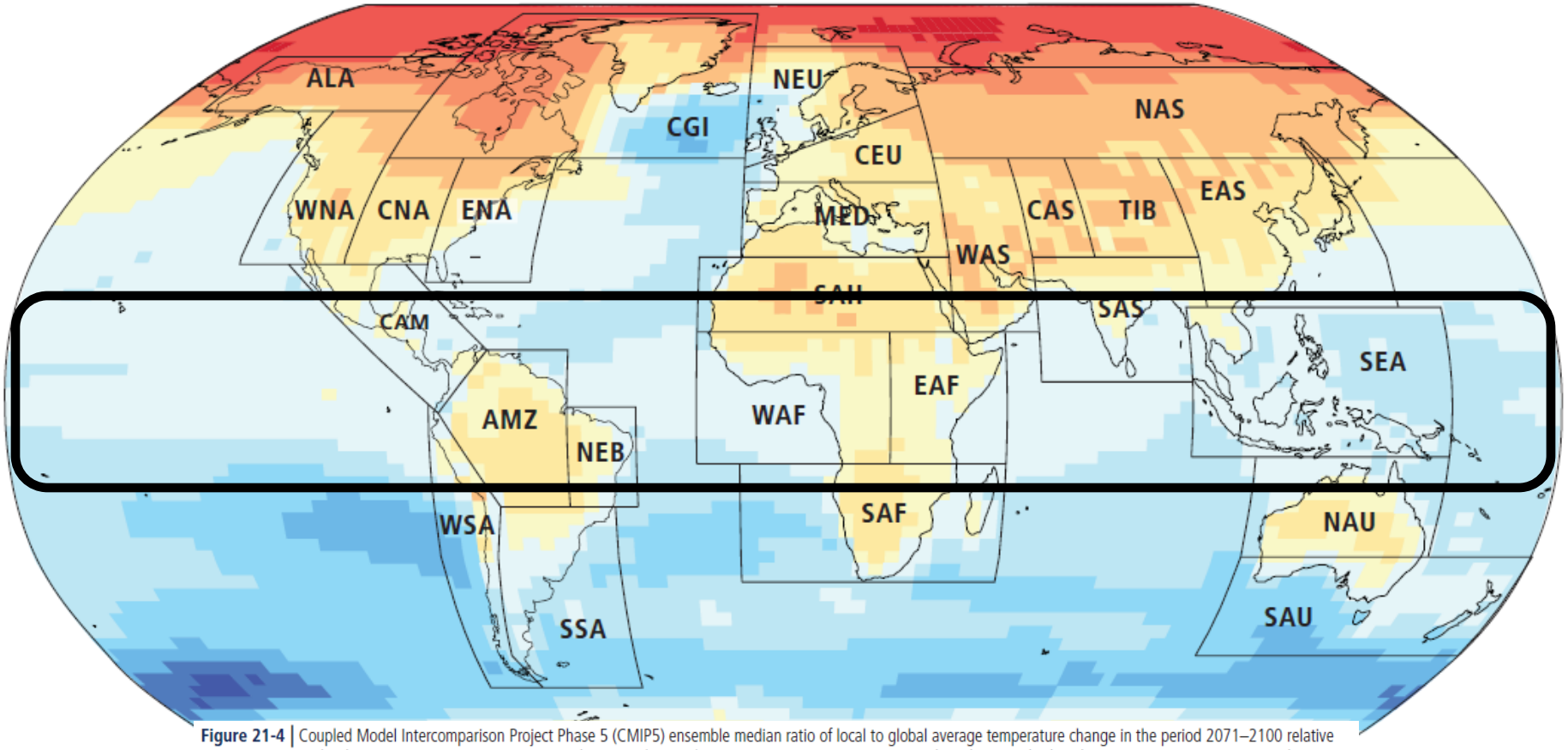
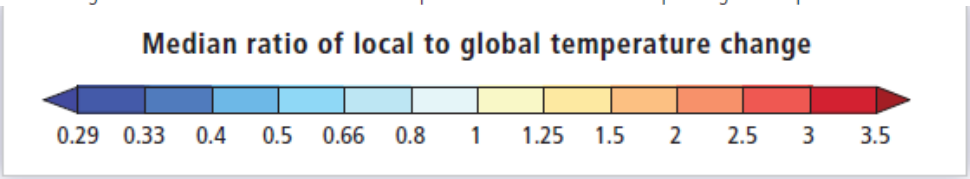


Figure 21-4 | Coupled Model Intercomparison Project Phase 5 (CMIP5) ensemble median ratio of local to global average temperature change in the period 2071–2100 relative to 1961–1990 under the Representative Concentration Pathway 8.5 (RCP8.5) emissions/concentrations scenario. The values are displayed on a common 2.5° × 3.75° grid onto which each models' data were re-gridded and they were calculated as follows: (1) for each model the local change was calculated between 1961 and 1990 at each grid cell, and is divided by the global average change in that model projection over the same period; (2) the median ratio value across all models at each grid cell is identified and shown. Data used are from the 35 CMIP5 models for which monthly projections were available under RCP8.5, as listed in Table SM21-3. Over-plotted polygons indicate the SREX regions (IPCC, 2012) used to define the sub-regions used to summarize information in Chapters 21 and some of the subsequent regional chapters.

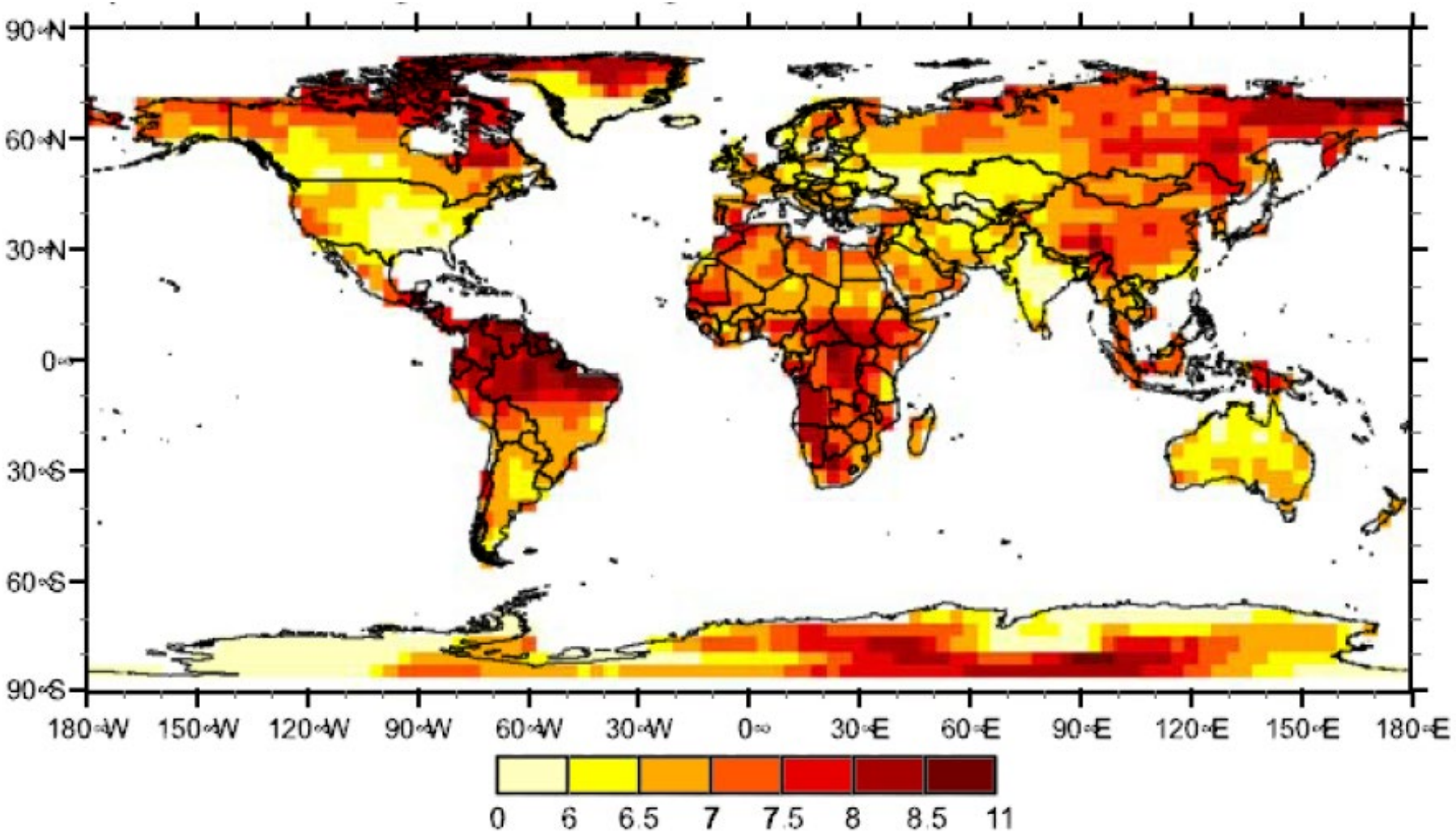


IPCC, WGII,
Ch 21, 2014

Regions that exhibit relatively high projected t changes (often > than global mean, by 50% or more)

Climate Change Index (CCI)

Increase in probability/frequency of extreme years (e.g. hottest, driest, extremely warm/wet/dry)



Source: Baettig 2007, pg. L01705

De Sherbinin. *Climatic Change* (2014) 123:23–37

Climate-Demography Vulnerability Index (CDVI)

Population density
Rapid population growth

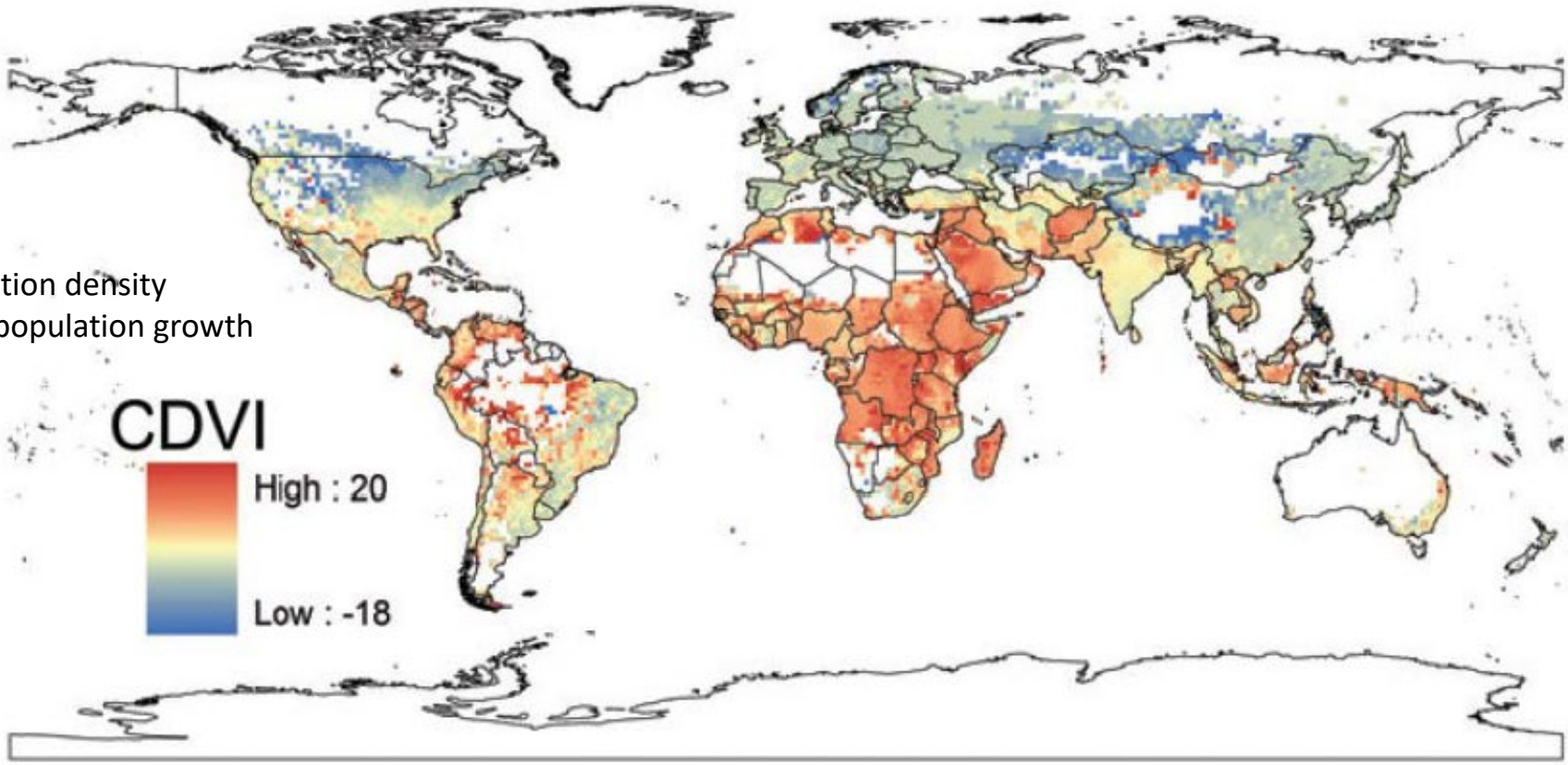
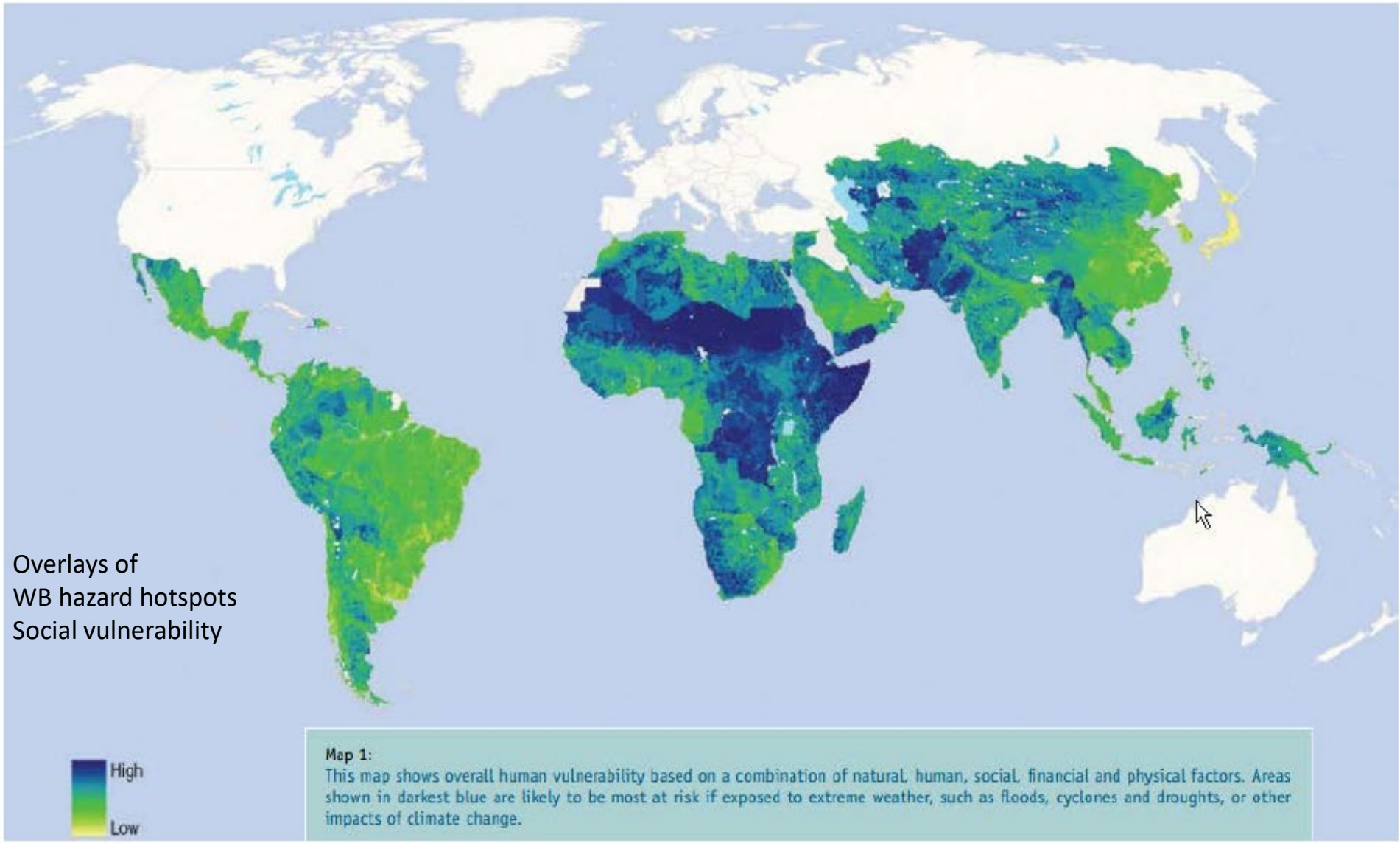


Figure 5 Global climate–demography vulnerability index (CDVI) estimated by subtracting CVI (Fig. 4) from demographic annual growth rates (Fig. S4), expressed as annual growth rates of human population density (see equation 5). Highly negative values, indicated in blue, represent low-vulnerability situations where current demographic growth is much lower than climate-consistent population growth, while highly positive values, indicated in red, represent high-vulnerability situations where current demographic growth vastly exceeds climate-consistent population growth. White regions correspond to human density values of zero in the global gridded population database.

Source: Samson et al. 2011, Figure 5

De Sherbinin. *Climatic Change* (2014) 123:23–37

Overall Human Vulnerability Index (Humanitarian Crises) Next 30 Years

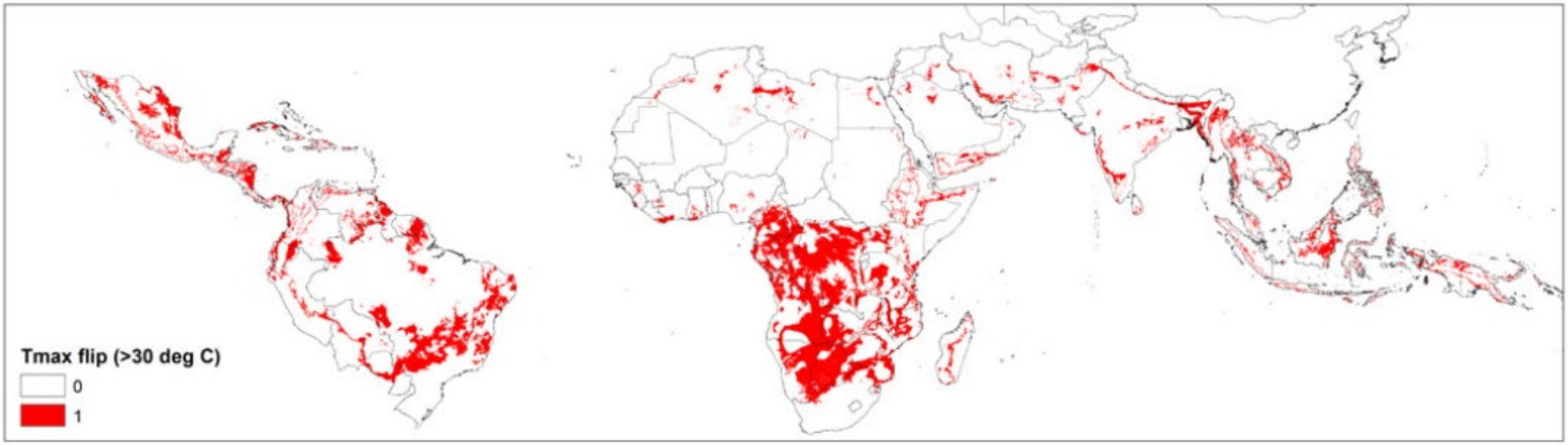


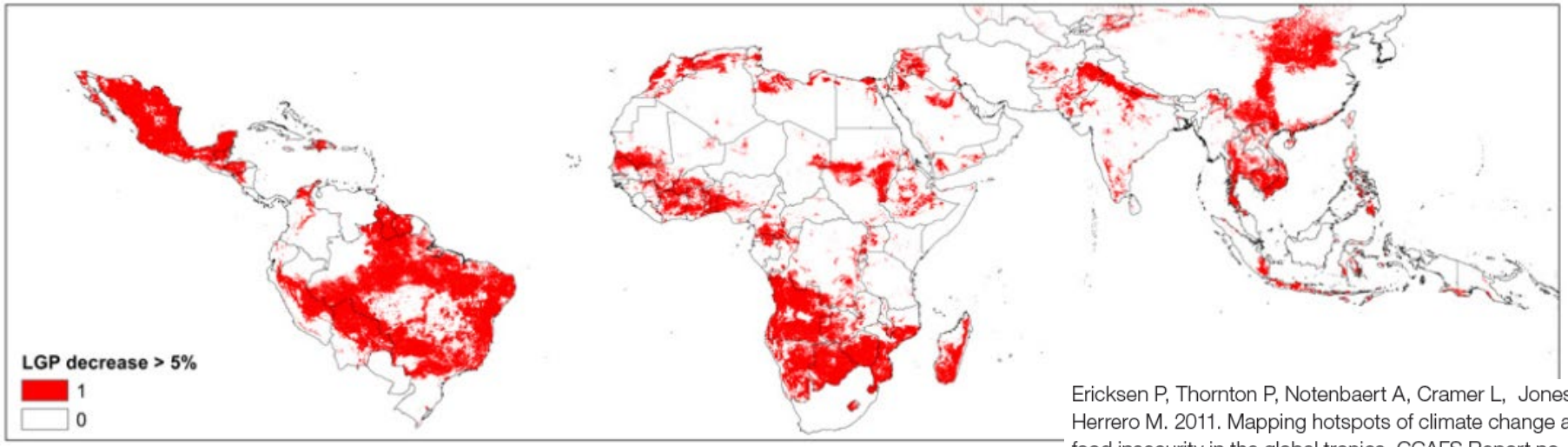
Overlays of
WB hazard hotspots
Social vulnerability

Source: CARE and Maplecroft 2008.

De Sherbinin. *Climatic Change* (2014) 123:23–37

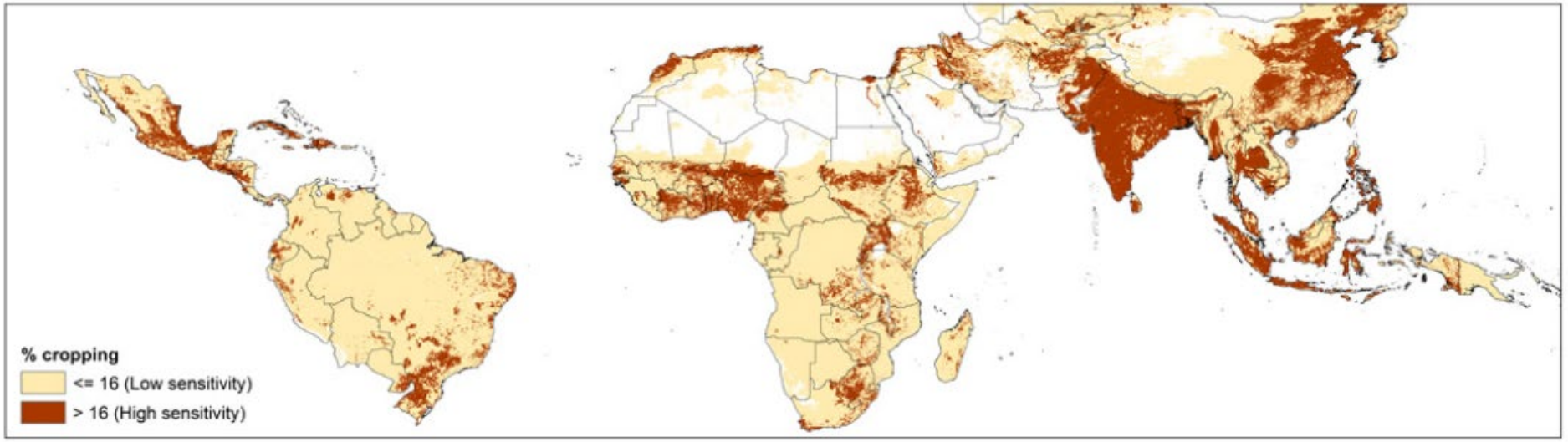
Threshold Maps for CC Hotspots

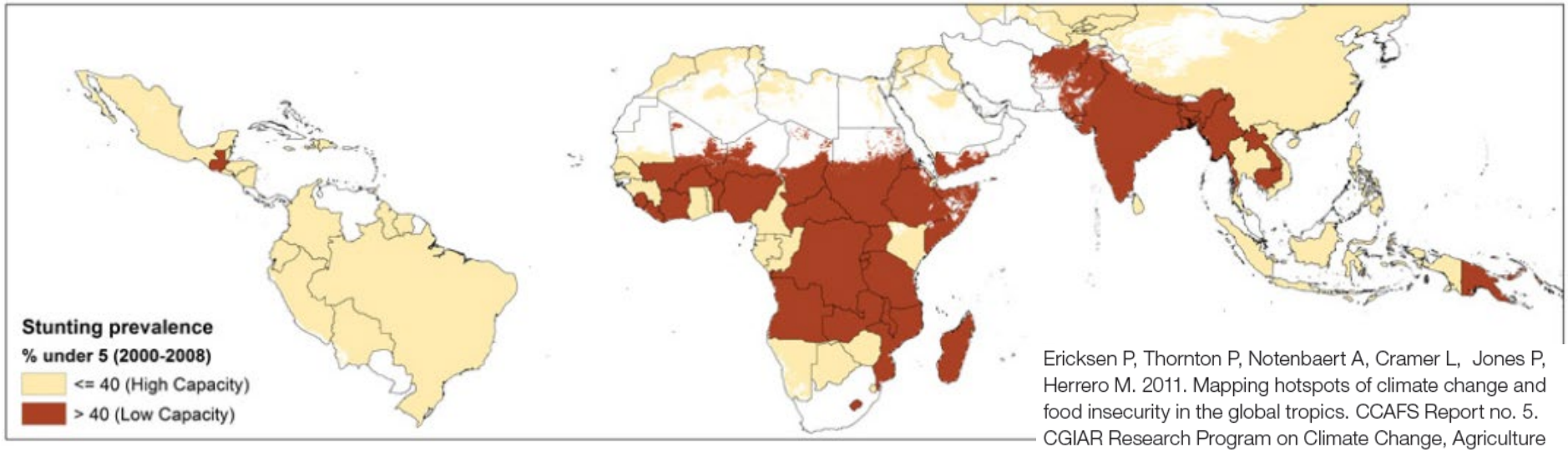




Ericksen P, Thornton P, Notenbaert A, Cramer L, Jones P, Herrero M. 2011. Mapping hotspots of climate change and food insecurity in the global tropics. CCAFS Report no. 5. CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). Copenhagen, Denmark. Available online at: www.ccafs.cgiar.org.

Sensitivity & Coping Capacity





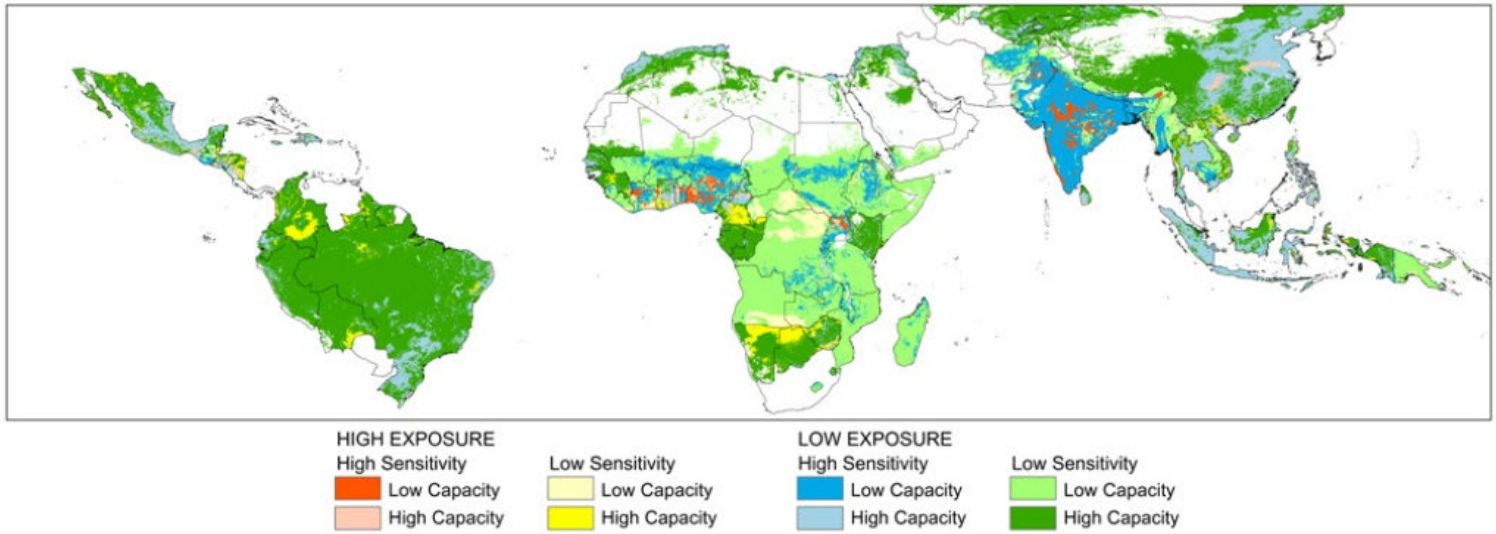
Ericksen P, Thornton P, Notenbaert A, Cramer L, Jones P, Herrero M. 2011. Mapping hotspots of climate change and food insecurity in the global tropics. CCAFS Report no. 5. CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). Copenhagen, Denmark. Available online at: www.ccafs.cgiar.org.

Vulnerability Domains

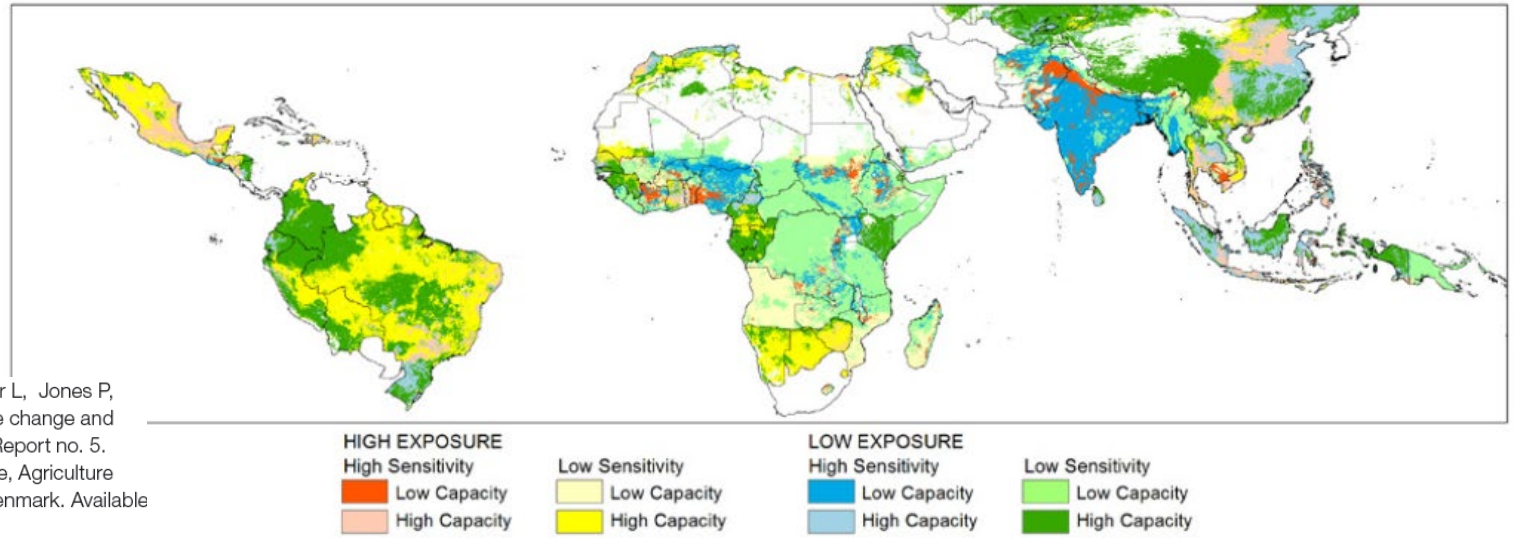
Domain	Exposure	Sensitivity	Coping capacity
HHL	High	High	Low
HHH			High
HLL		Low	Low
HLH			High
LHL	Low	High	Low
LHH			High
LLL		Low	Low
LLH			High

Ericksen P, Thornton P, Notenbaert A, Cramer L, Jones P, Herrero M. 2011. Mapping hotspots of climate change and food insecurity in the global tropics. CCAFS Report no. 5. CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). Copenhagen, Denmark. Available online at: www.ccafs.cgiar.org.

Vulnerability to Food Insecurity



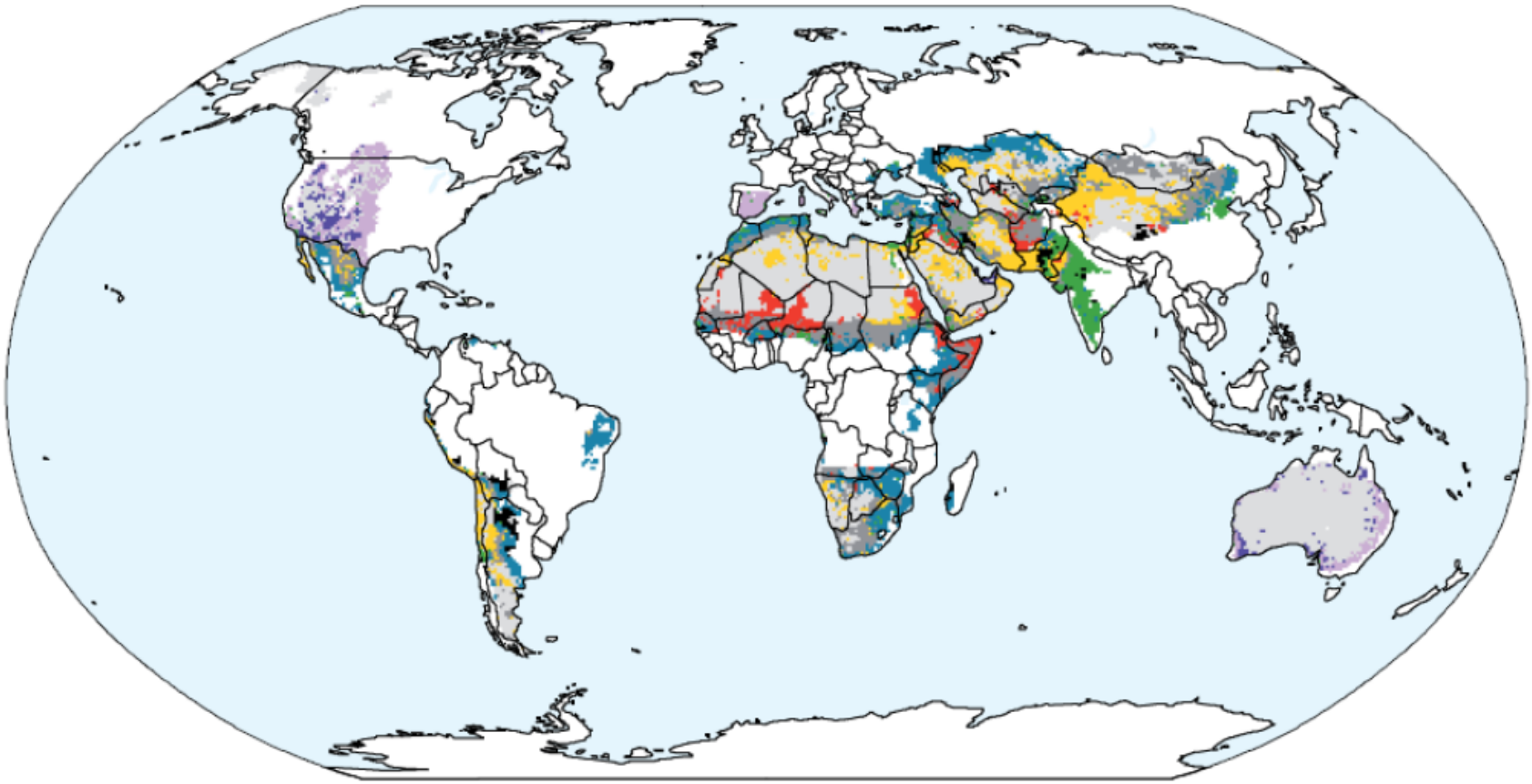
Map 4.8. *Exposure 5: Maximum daily temperature during the growing season flips from < 30°C to > 30°C (threshold 5).*



Ericksen P, Thornton P, Notenbaert A, Cramer L, Jones P, Herrero M. 2011. Mapping hotspots of climate change and food insecurity in the global tropics. CCAFS Report no. 5. CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). Copenhagen, Denmark. Available online at: www.ccafs.cgiar.org.

Map 4.4. *Exposure 1: Areas where there is greater than 5% change in LGP.*

Geographic Distribution of Vulnerability Profiles

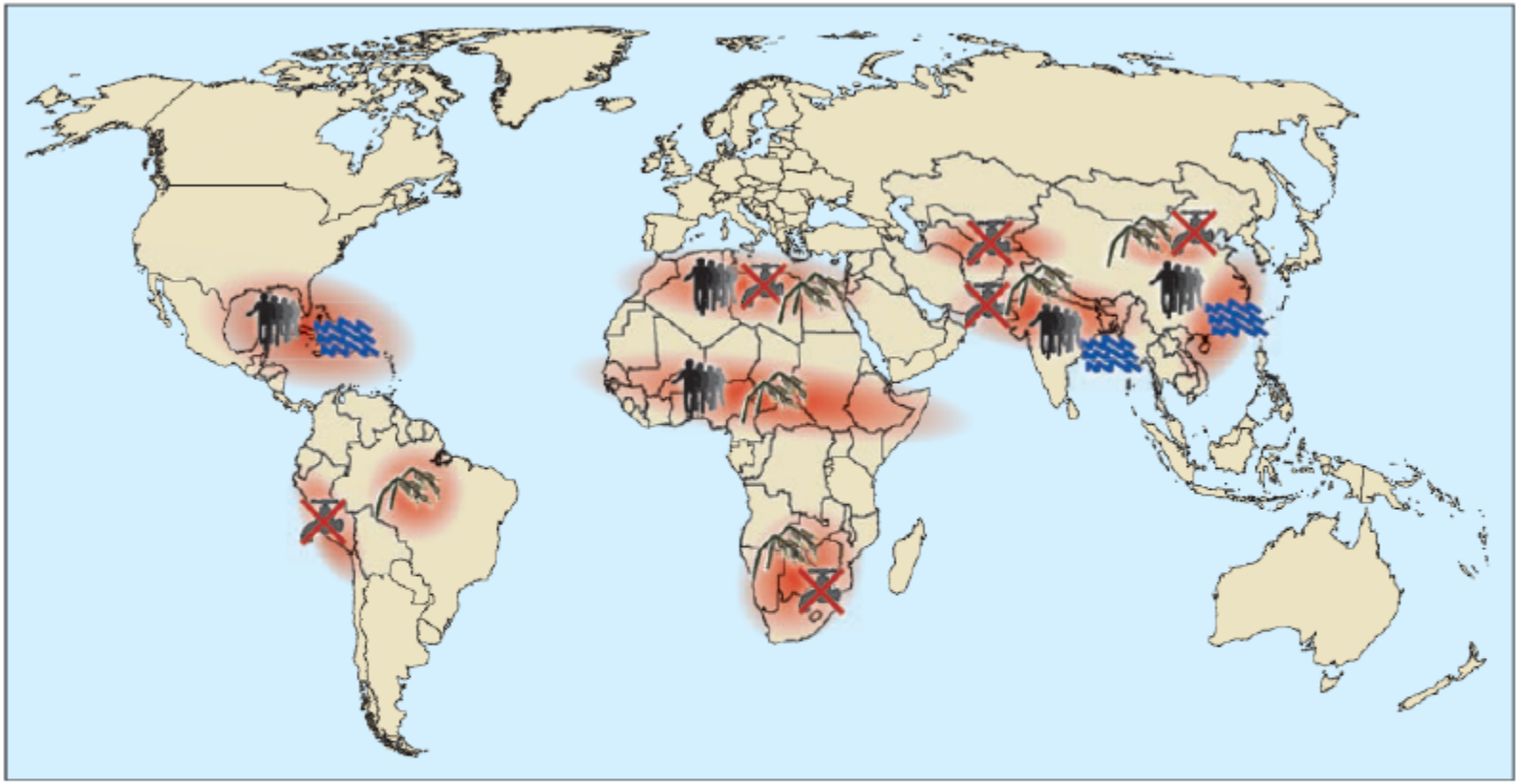


Source: Kok et al. 2010, Figure 2.9.

De Sherbinin. *Climatic Change* (2014) 123:23–37

Security Hotspots

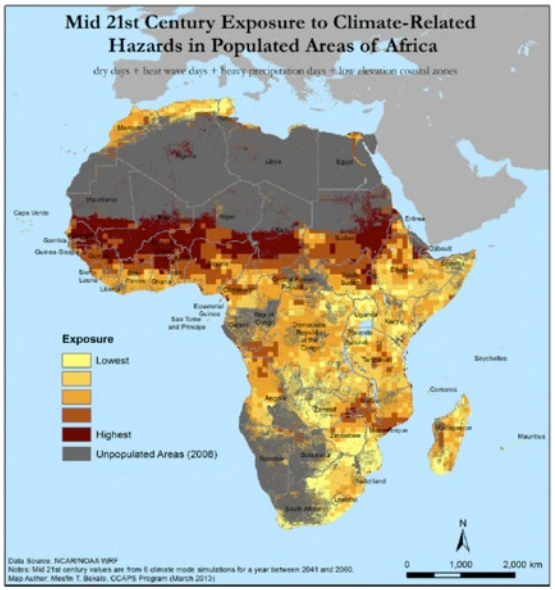
Figure S23. Security risks associated with climate change: Selected hotspots



Source: Schubert et al. 2007, Figure 8.1-3

De Sherbinin. *Climatic Change* (2014) 123:23–37

Africa



Busby et al. 2014

Composite Vulnerability in Africa

Mid 21st Century Climate-Related Hazard Exposure + Population Density + Household & Community Resilience + Governance & Violence

Vulnerability (Quintiles)

Lowest

Highest

Unpopulated area (2008)

Data Sources: World Bank Governance Indicators; Polity IV Project: Political Regime Characteristics and Transitions; KOF Index of Globalization; Armed Conflict Location and Event Data (ACLED); World Health Organization; World Development Indicators; Food and Agriculture Organization of the United Nations Food Security Statistics; UNICEF Multiple Indicator Cluster Survey (MICS); Demographic and Health Surveys; LandScan; CIESIN; NCAR/NOAA WRF
Map Author: Kaiba White, CCAPS Program (January, 2012)

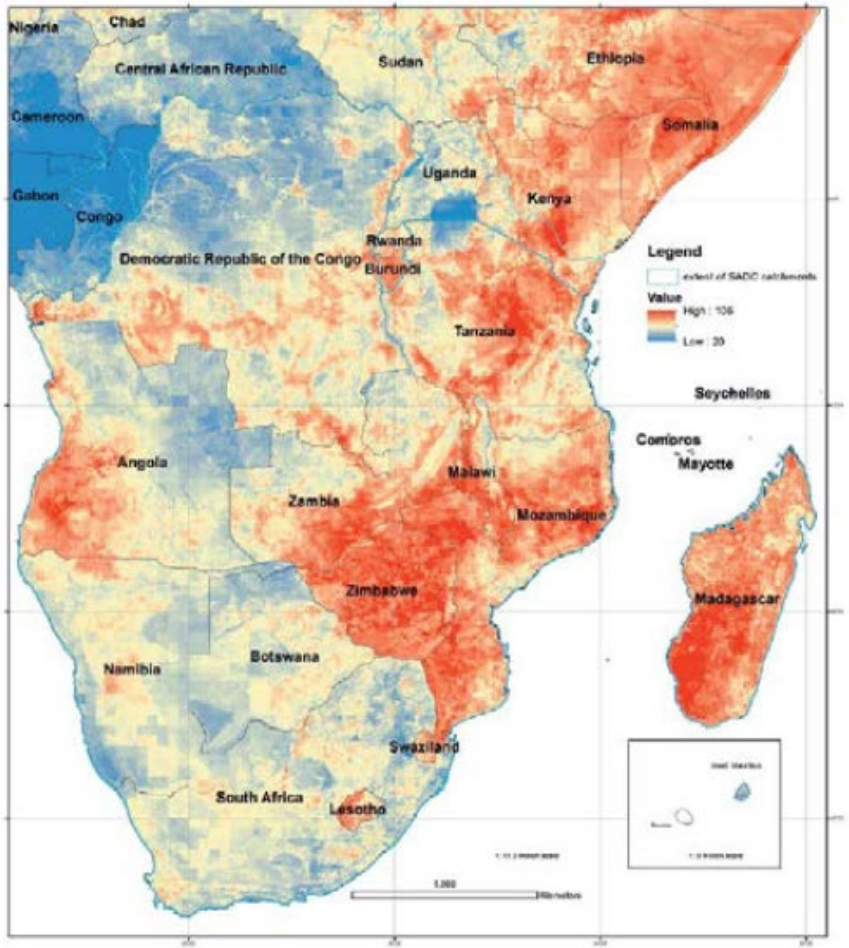
N

0 1,000 2,000 km

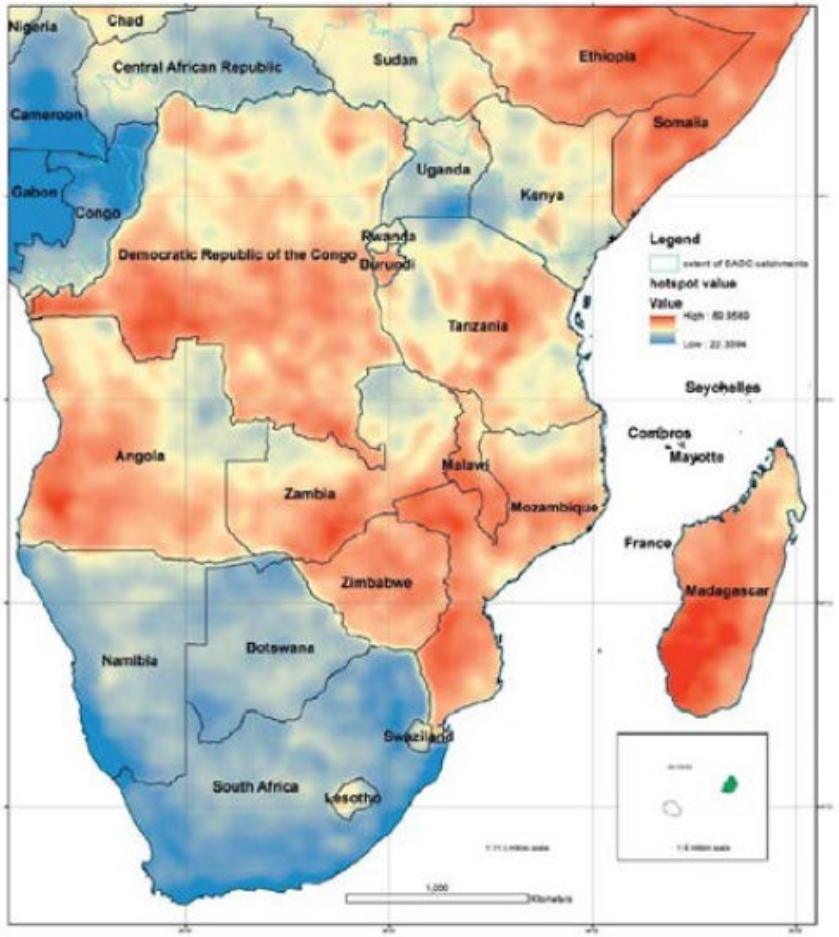
Regional Hotspots

Figure S15. Vulnerability hotspots (a. 2008 and b. 2050). (Red values indicate hotspots where people are most likely to be most in need of help adapting to climate stressors, while the blue areas indicate areas of resilience.)

a.



b.

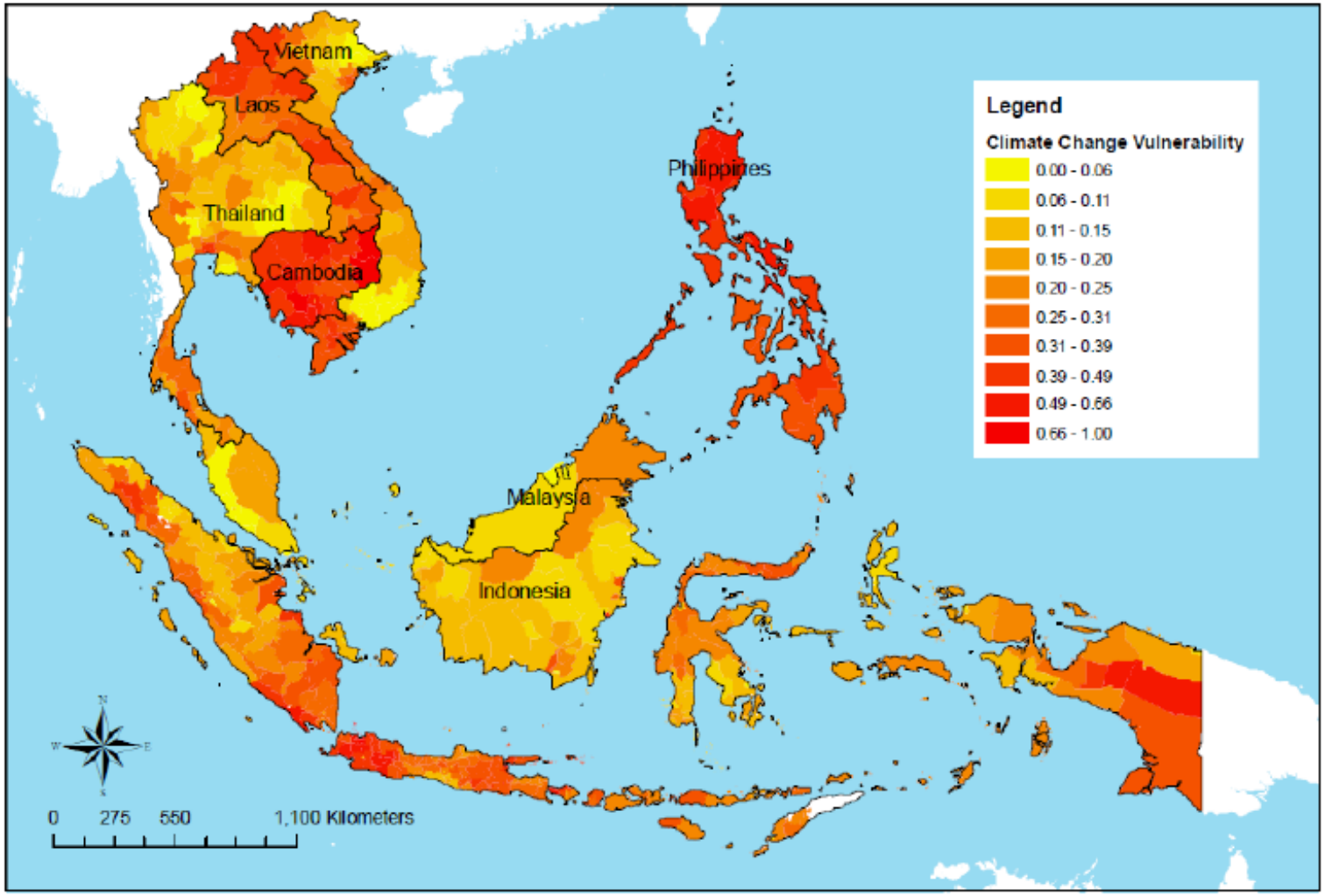


Source: Midgley et al. 2011, Figures 6 and 11.

De Sherbinin. *Climatic Change* (2014) 123:23–37

More Regional Vulnerability

Figure S19. Climate Change Vulnerability for Southeast Asia



Source: Yusuf and Francisco 2009.

5 hazards:

- Cyclones
- Drought
- Floods
- Landslides
- Coastal indundation (sea level change)

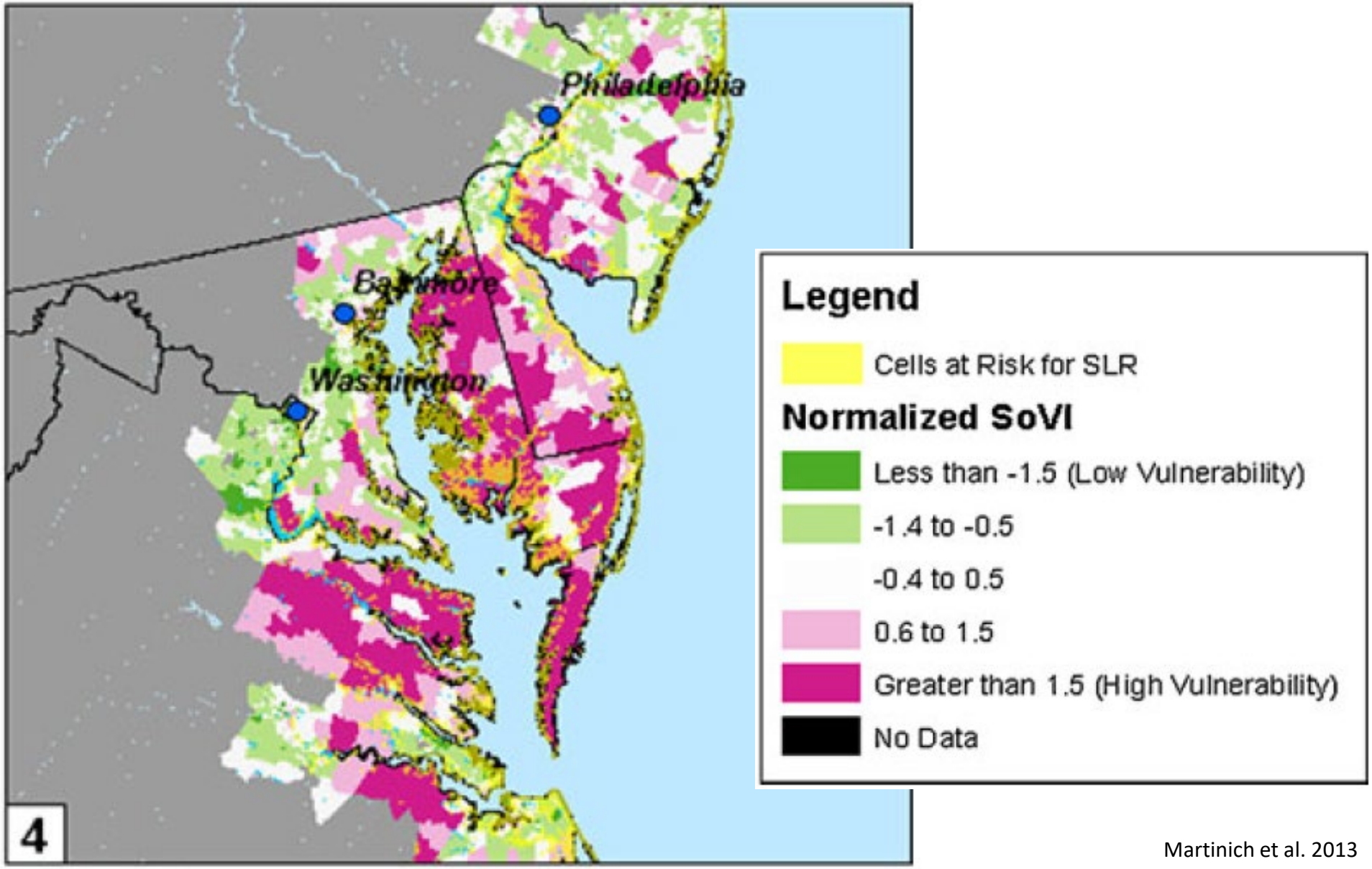
Population density

Adaptive capability

⇨average

De Sherbinin. *Climatic Change* (2014) 123:23–37

Social Vulnerability Index (USA)



Martinich et al. 2013

Components for Regional Analysis

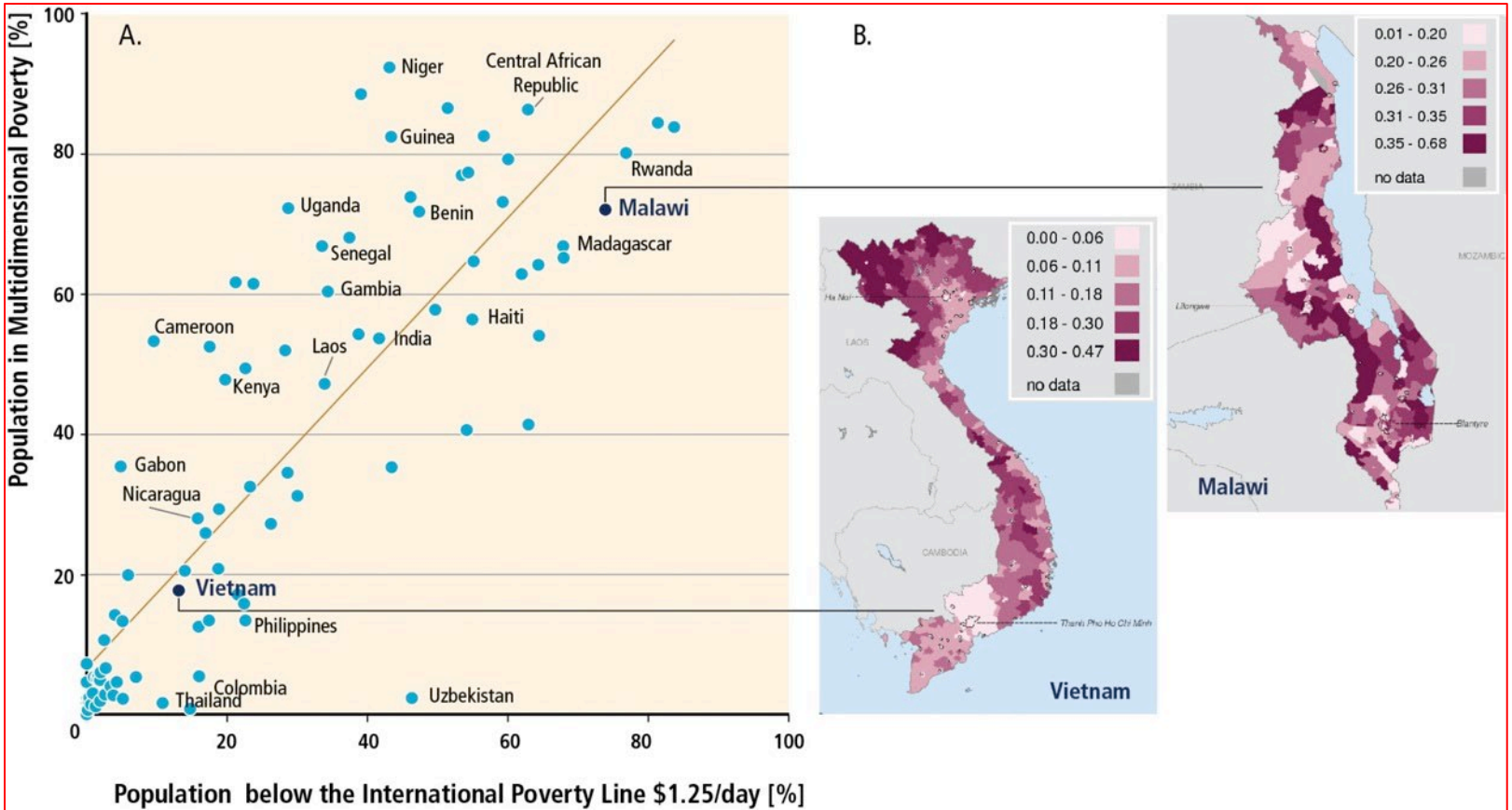
Table 1 Components for each regional analysis in the contiguous United States. The table displays the Social Vulnerability Index components, including the dominant variables and their associated variance explained for each regional principle components analysis

North Atlantic		South Atlantic		Gulf		Pacific	
Component	Percent Variance Explained	Component	Percent Variance Explained	Component	Percent Variance Explained	Component	Percent Variance Explained
Poverty	22.5	Poverty	20.3	Poverty	22.4	Poverty	21.6
Rural/ Urban	11.4	Family structure	17.5	Labor force participation	16.6	Age (children)	13.1
Age (elderly)	10.5	Rural/Urban	11.4	Foreign-born	12.3	Rural/Urban	11.7
Foreign-born	8.8	Foreign-born	10.0	Wealth	8.2	Labor force participation	8.7
Age (children)	7.4	Native American/ Female	6.6	Rural/Urban	5.6	Female	7.5
Occupation	5.4	Occupation	4.8	Occupation	4.4	Occupation	5.6
Female	5.0			Female	4.0		

Martinich et al. 2013

Challenges

- How to measure (and map) social vulnerability?
- Can poverty be used as a proxy for adaptive capacity?
- What poverty metrics to use?



Multidimensional Poverty Index

Destitute in Delhi – Bibi Ayesha's story

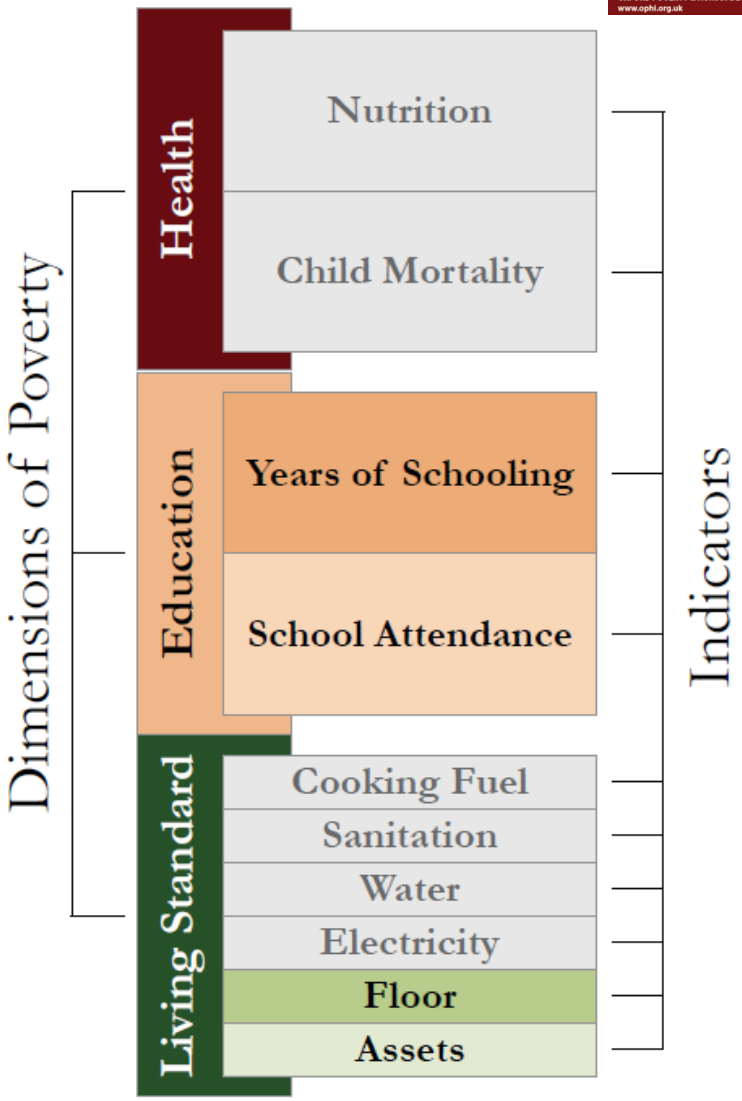
Photo by Vanita Leah Falcao/OPHI

Bibi Ayesha lives in a box-like structure on stilts near a temple in Delhi, India. Injured in an accident years ago, she is unable to walk and gets around on a hand-pedalled tricycle. For sanitation she relies on government restrooms near her makeshift home, which has no electricity or water. Her flooring is not dirt or sand – although it could hardly be called proper flooring!

She earns a little money by cleaning a nearby homeless shelter and collecting alms in front of the temple, but most of the money is spent on medication for her chronic respiratory condition. What little food she can afford, she cooks over wood on a little mud stove and shares with her mentally ill son.

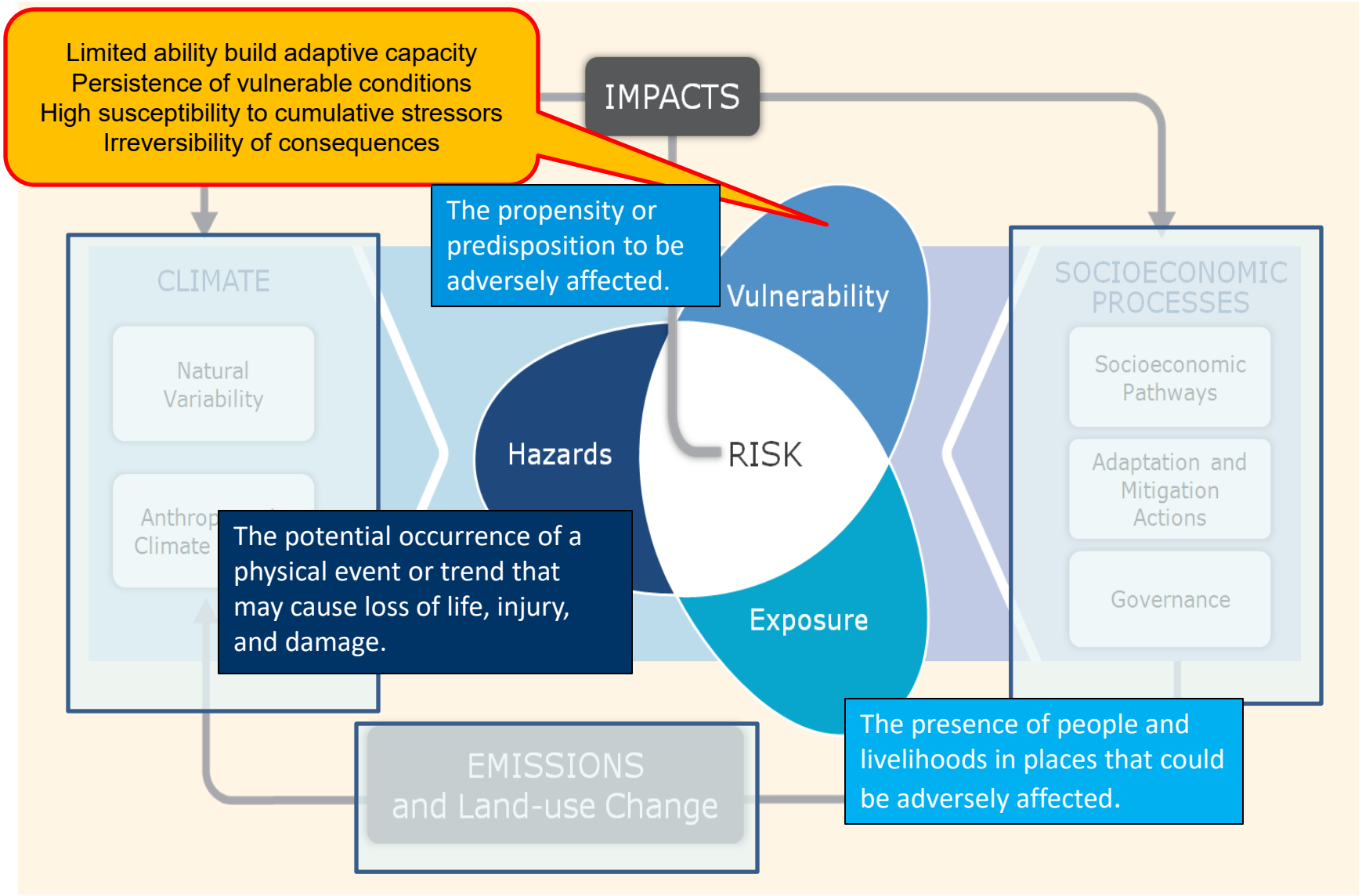
Bibi is deprived in the shaded indicators shown in her poverty profile, and as such is multidimensionally poor. She is also deprived in 7/18 of the more extreme indicators shown in the table, and is therefore identified as destitute.

OPHI
OXFORD POVERTY & HUMAN DEVELOPMENT INITIATIVE
www.ophi.org.uk



Alkire et al. 2014. Destitution.

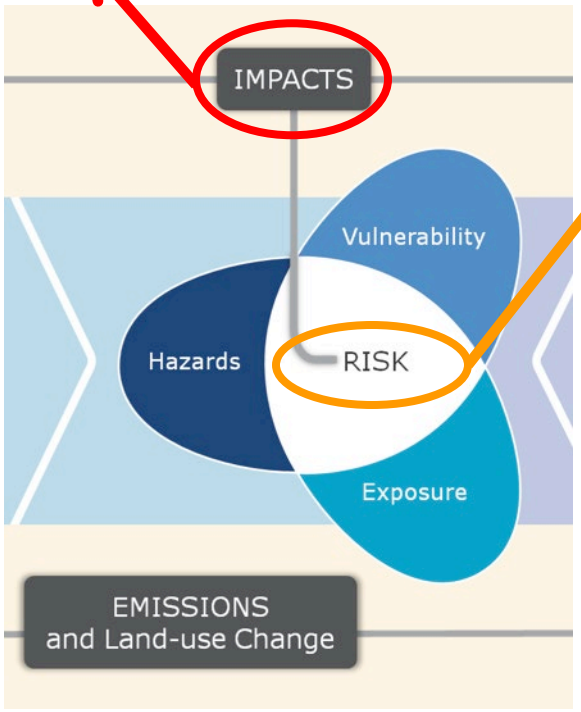
Highlighting Risk in the AR5 (WGII)



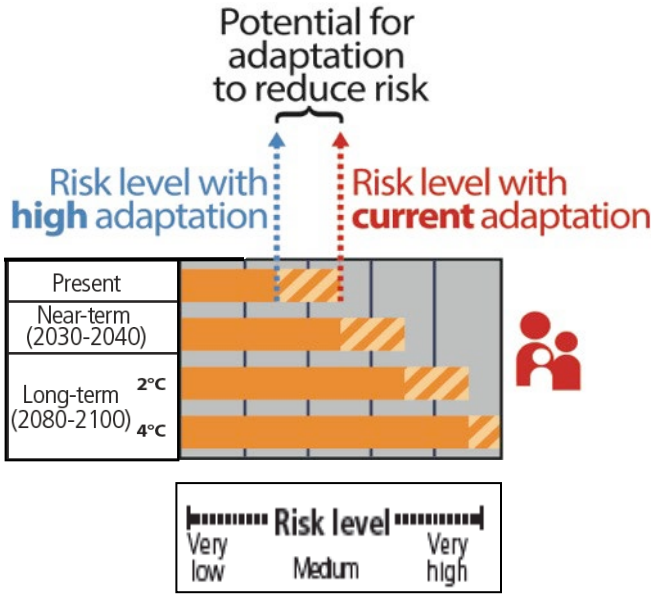
SPM, WGII AR5, 2014

Examples of Impacts and Risks for People

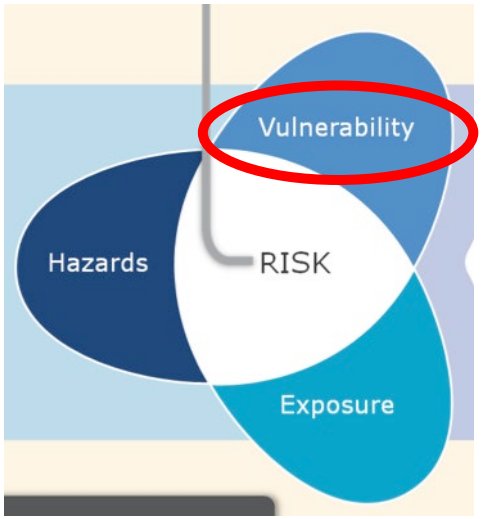
Example: **Additional duties for woman** as laborers and caregivers, reduced food intake, more distress, adverse mental health, and in some cases increasing incidences of domestic violence.



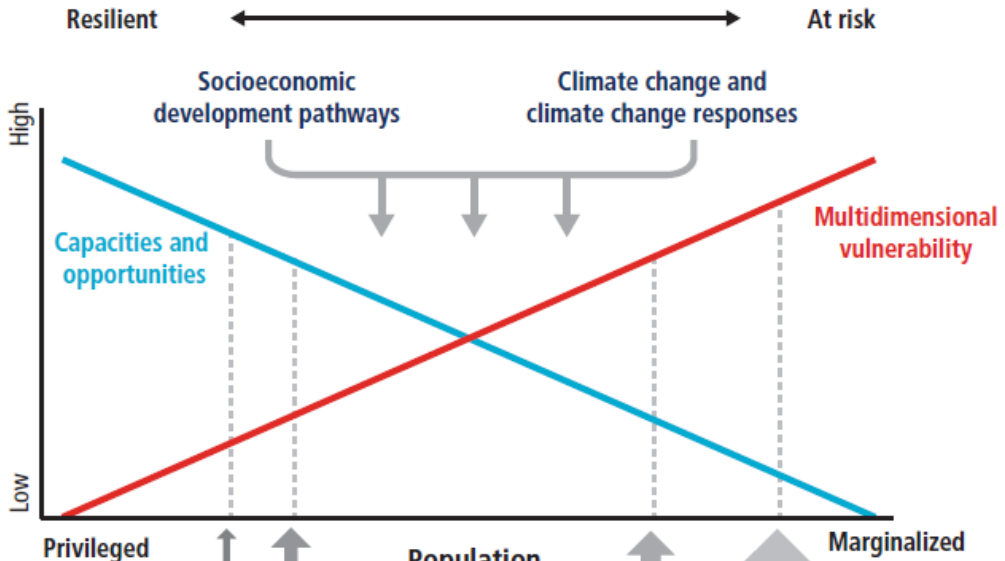
Example: **Heat waves**: declining work productivity, dehydration, heat stroke, and death



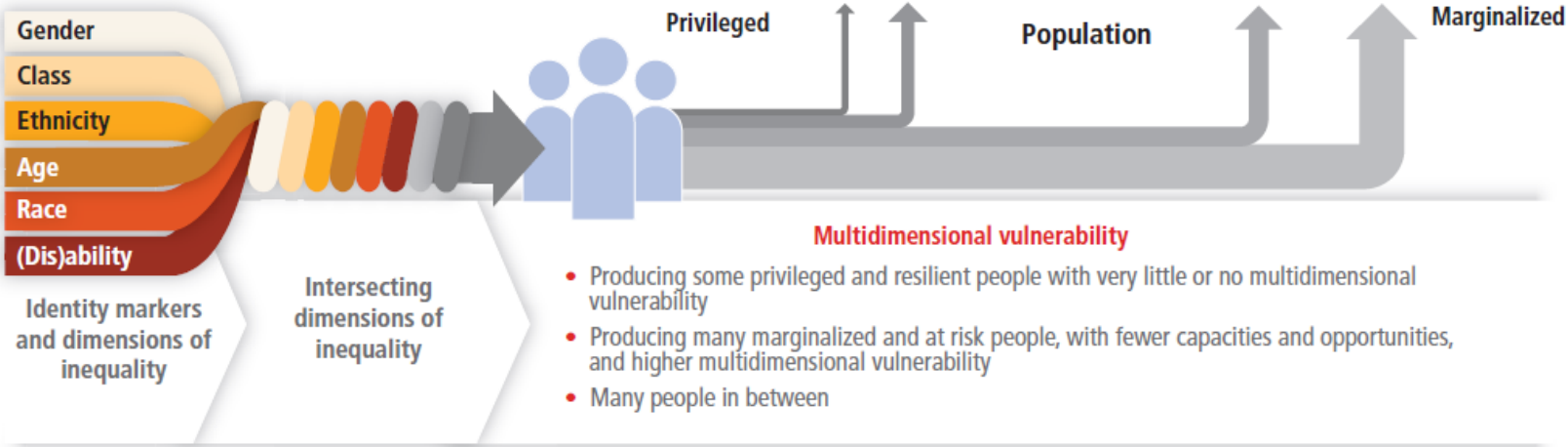
Multidimensional Vulnerability



Inequalities



Olsson et al., Ch 12, and TS, WGII, AR5, 2014

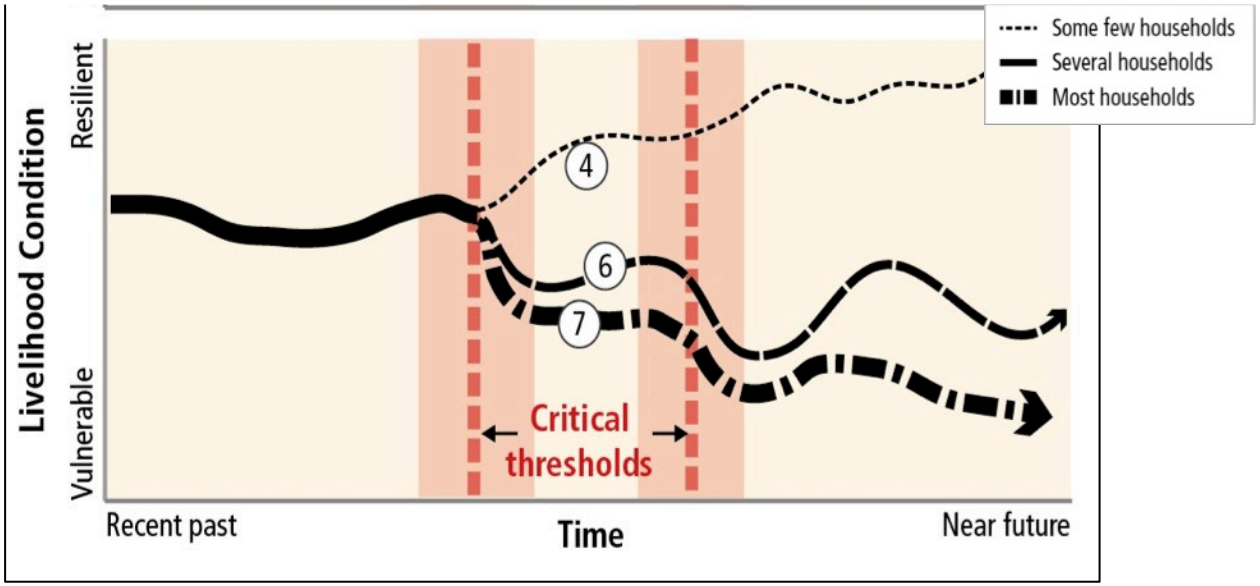


AR5, WGII, March 2014

ES, Ch13: Observed evidence suggests that climate change and climate variability **worsen existing poverty, exacerbate inequalities, and trigger both new vulnerabilities and some opportunities** for individuals and communities. Climate change interacts with non-climatic stressors and **entrenched structural inequalities to shape vulnerabilities** (*high confidence, based on medium evidence, high agreement*).

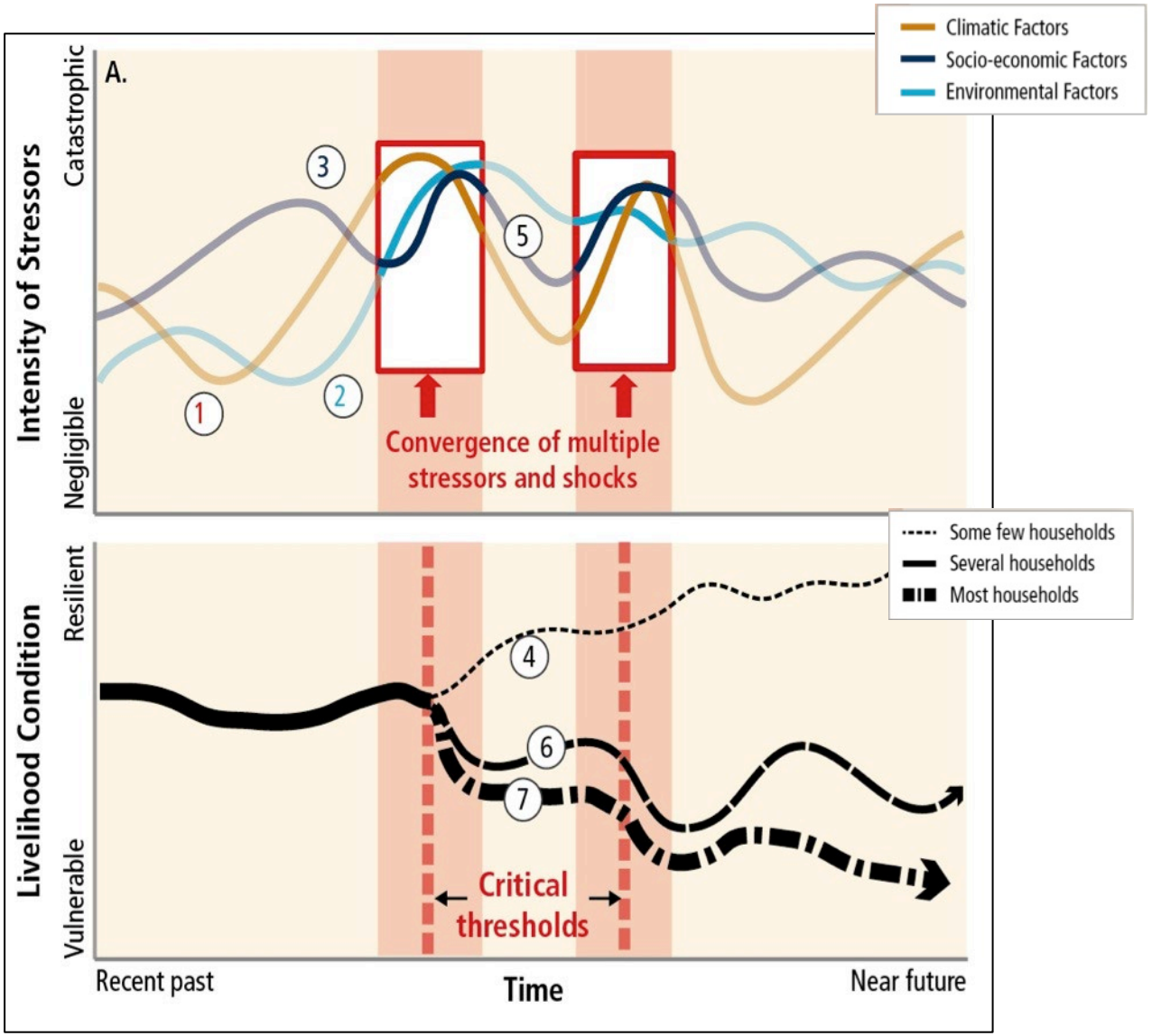
SPM: Differences in vulnerability and exposure arise from non-climatic factors and from multidimensional inequalities often produced by uneven development processes (*very high confidence*). People who are socially, economically, culturally, politically, institutionally, or otherwise **marginalized are especially vulnerable** to climate change and also to some adaptation and mitigation responses (*medium evidence, high agree*ement).

Livelihoods (and Vulnerability) are Dynamic



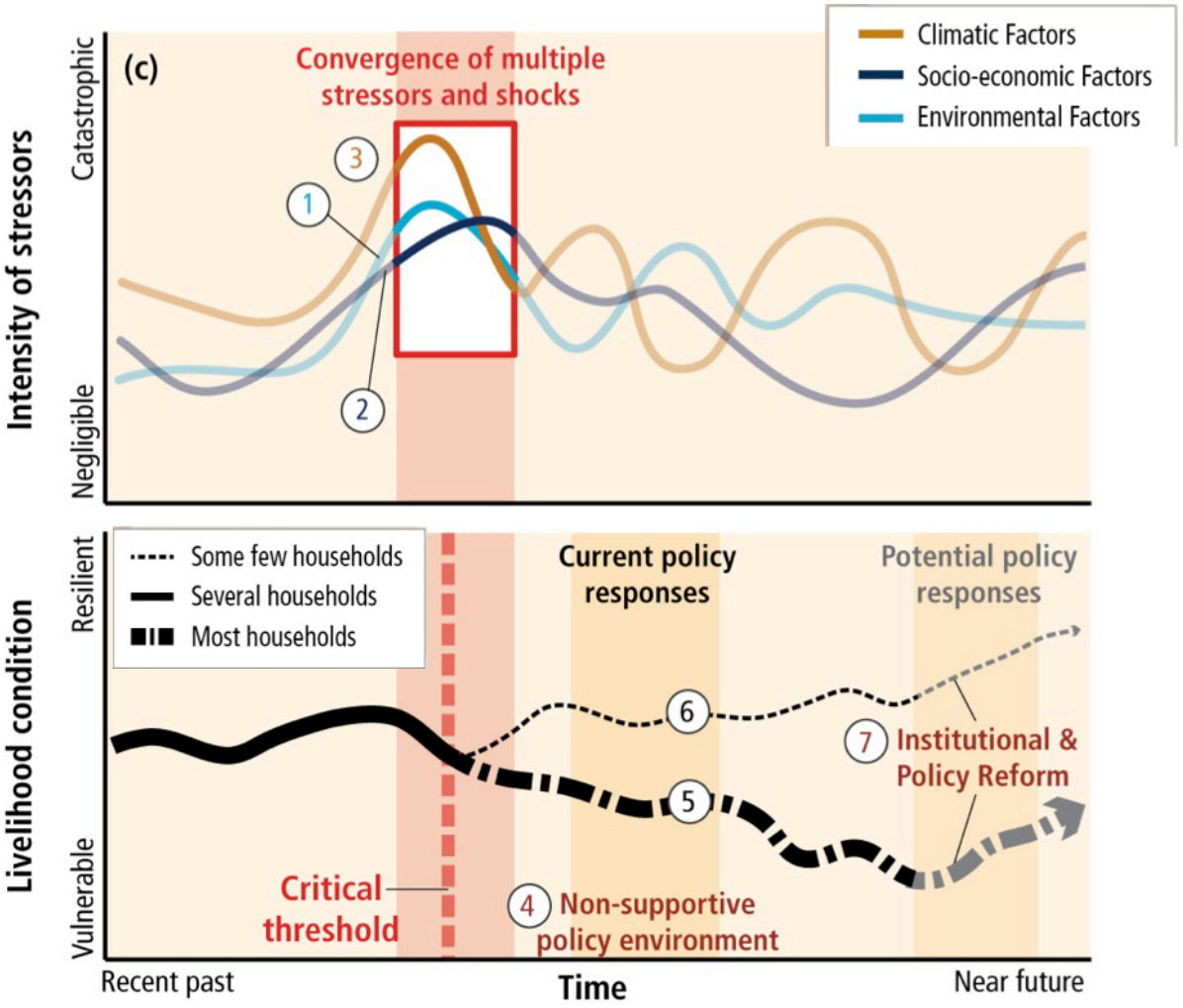
Olsson et al. 2014, Ch13, AR5, WGII

Livelihoods (and Vulnerability) are Dynamic



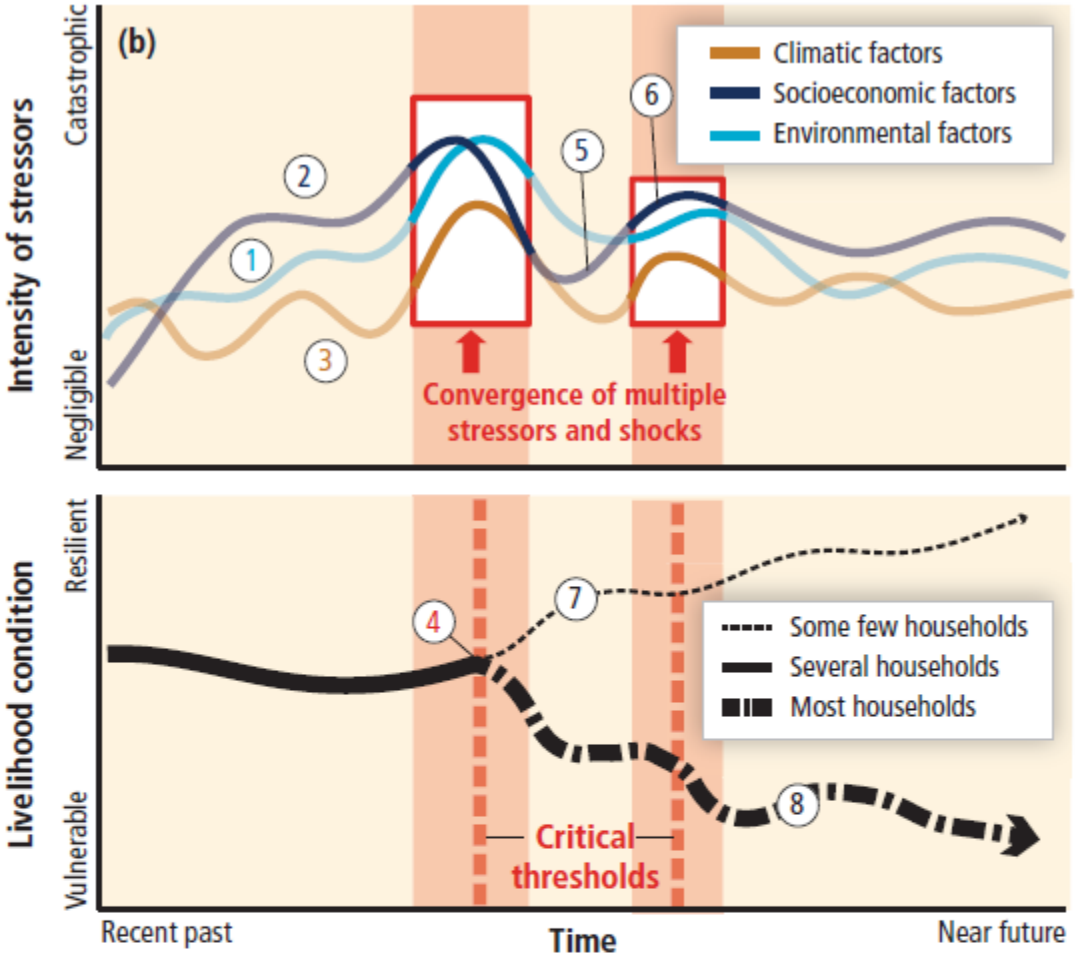
Olsson et al. 2014, Ch13, AR5, WGII

Indigenous Populations, Bolivian Andes



(c) Mountain environments (McDowell and Hess, 2012). Indigenous Aymara farmers in highland Bolivia face land scarcity, pervasive poverty, climate change, and lack of infrastructure due in part to racism and institutional marginalization. The retreat of the Mururata glacier causes water shortages (1), compounded by the increased water requirements of cash crops on smaller and smaller "minifundios" and market uncertainties (2). High temperatures amplify evaporation, and flash floods coupled with delayed rainfall cause irrigation canals to collapse (3). The current policy environment makes it difficult to access loans and obtain land titles (4), pushing many farmers onto downward livelihood trajectories (5) while those who can afford it invest in fruit and vegetable trees at higher altitudes (6). Sustained access to land, technical assistance, and irrigation infrastructure would be effective policy responses to enhance well-being (7).

Olsson et al. 2014, Ch13, AR5, WGII

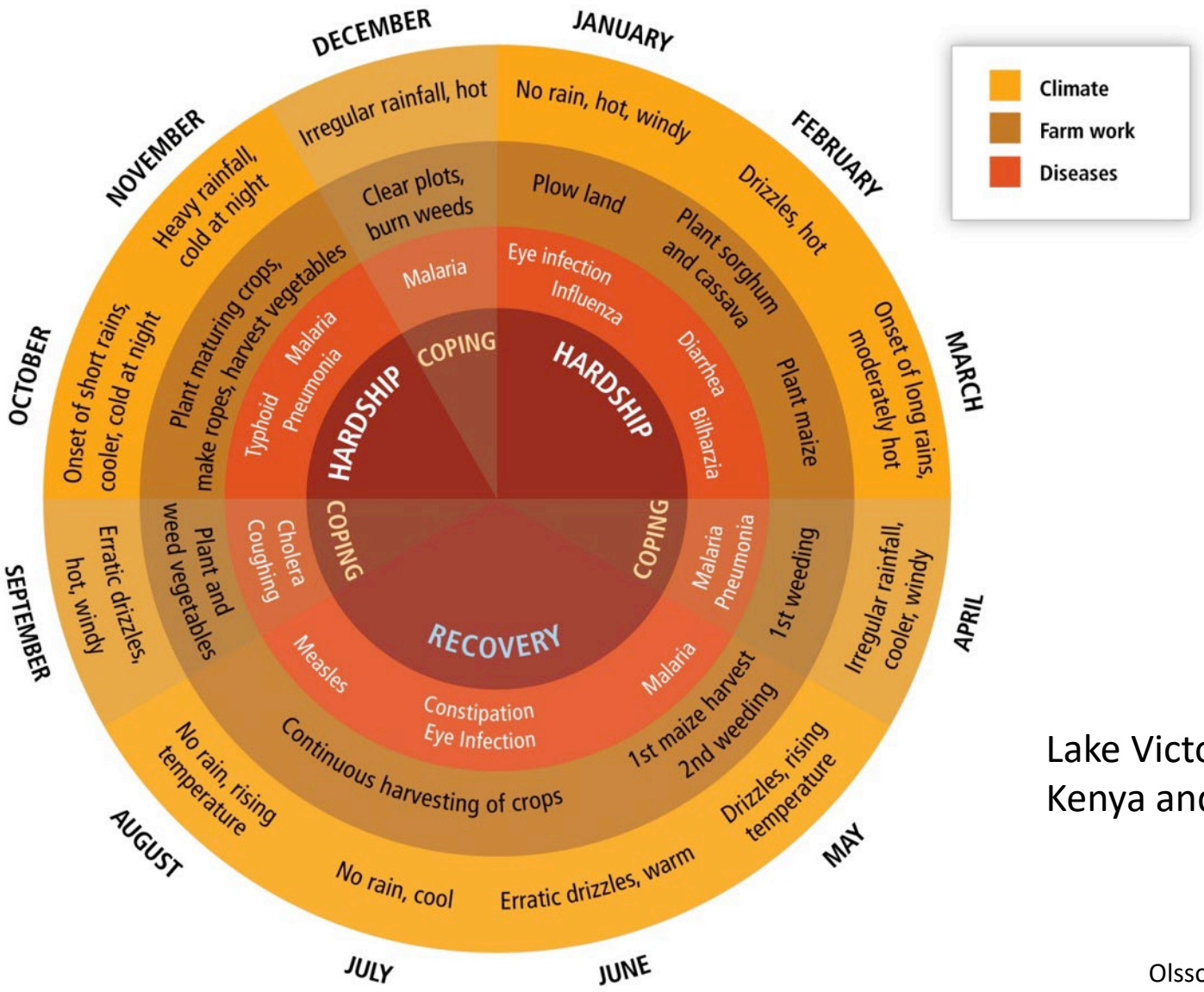


(b) Coastal Bangladesh (Pouliotte et al., 2010). In the Sunderbans, a combination of environmental and socioeconomic factors, out of which climatic stressors appear to play only a minor role, have changed livelihoods: saltwater intrusion (1) due to the construction and poor management of the Bangladeshi Coastal Embankment Project, the construction of a dam in India, local water diversions (2), and sea level rise and storm surges (3). The convergence of these stressors caused households to cross a critical threshold from rice and vegetable cultivation to saltwater shrimp farming (4). A strong export market and international donor and national government support facilitated this shift (5). However, increasing density of shrimp farming then triggered rising disease levels (6). Wealth and power started to become more concentrated among a few affluent families (7) while livelihood options for the poorer households further diminished due to lacking resources to grow crops in salinated water, the loss of grazing areas and dung from formerly accessible rice fields (8), and rising disease levels (6).

Coastal Bangladesh

Olsson et al. 2014, Ch13, AR5, WGII

Seasonal Vulnerability

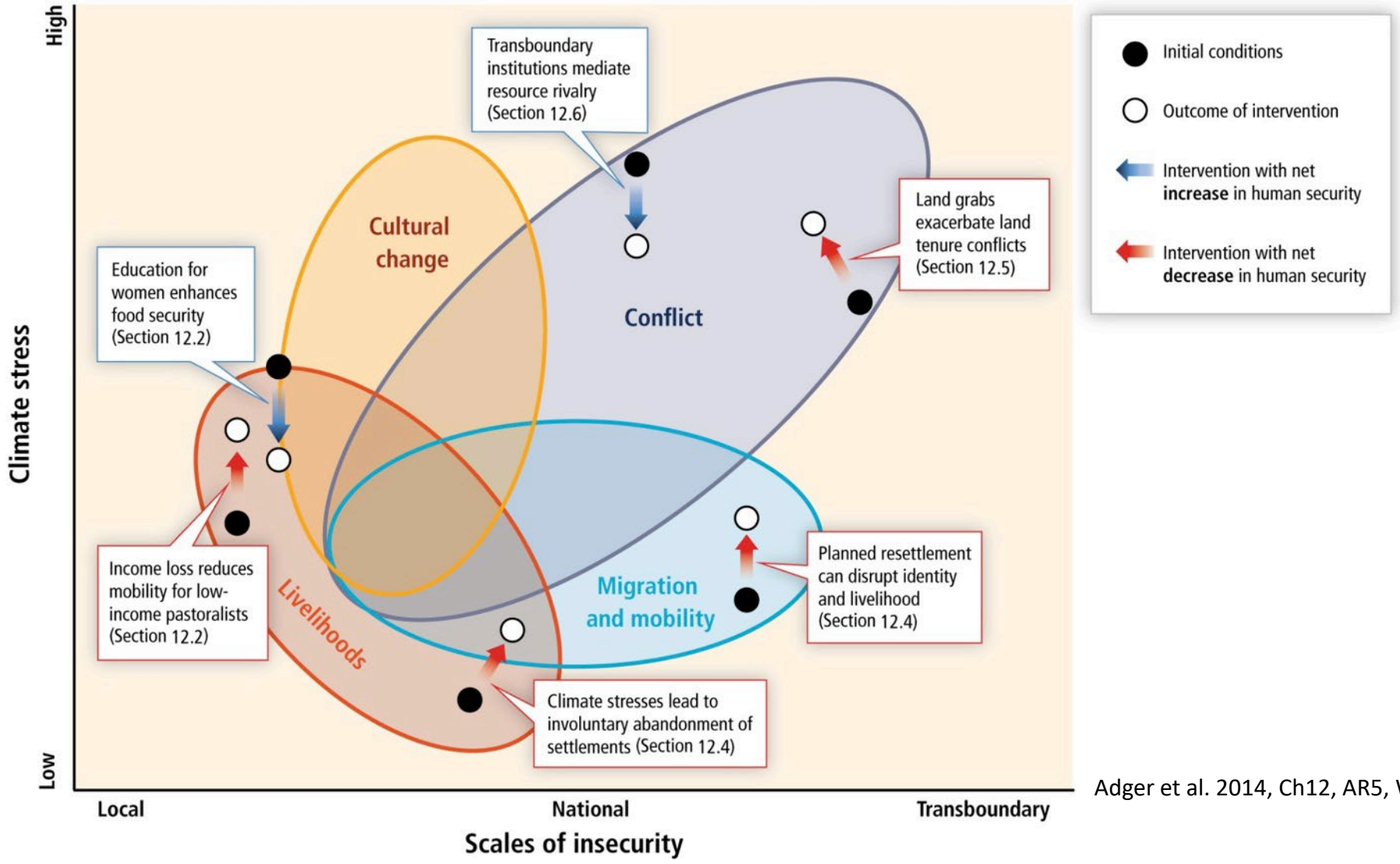


Lake Victoria Basin,
Kenya and Tanzania

Olsson et al. 2014, Ch13, AR5, WGII

After Gabrielsson et al. 2012

Ch 12 Human Security

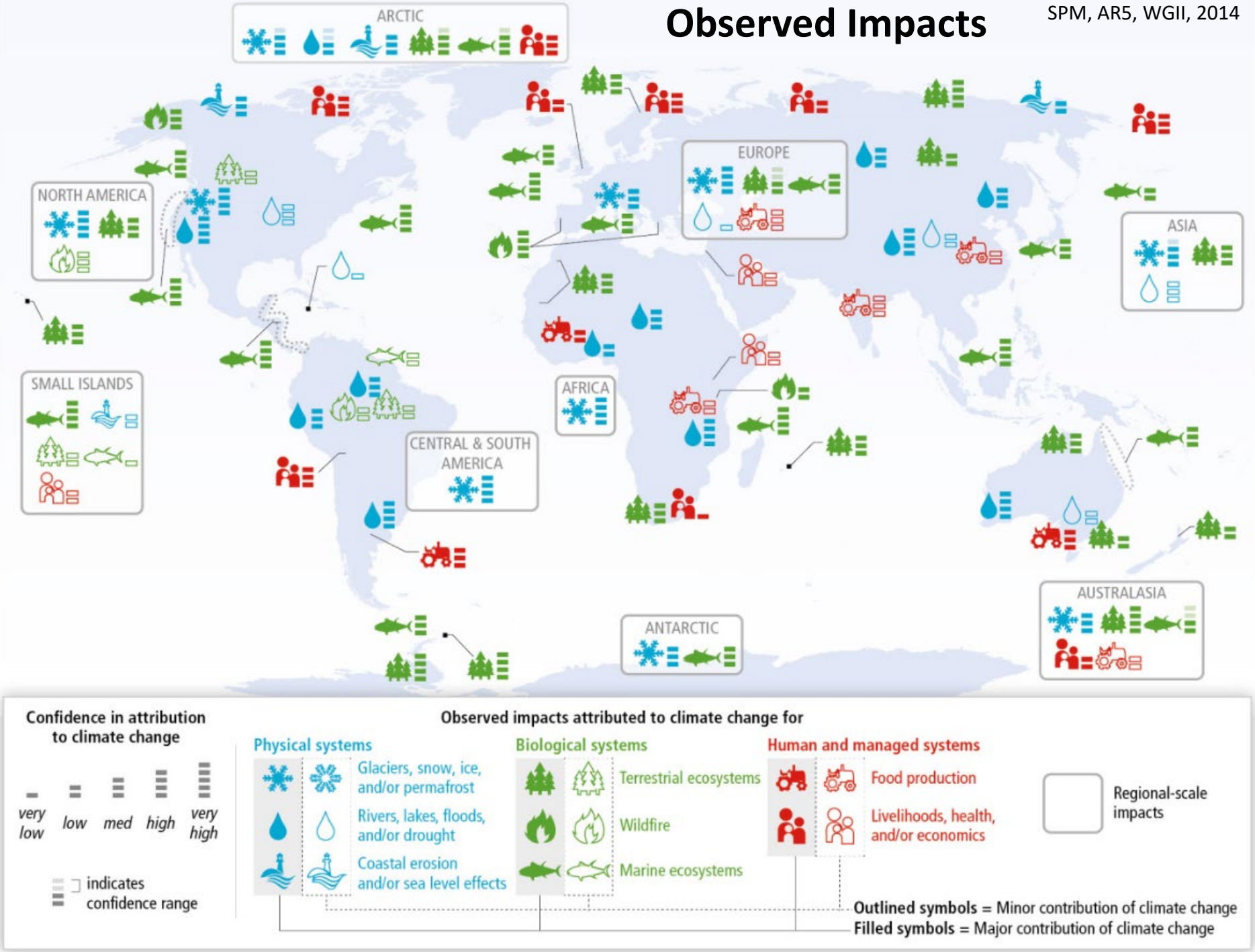


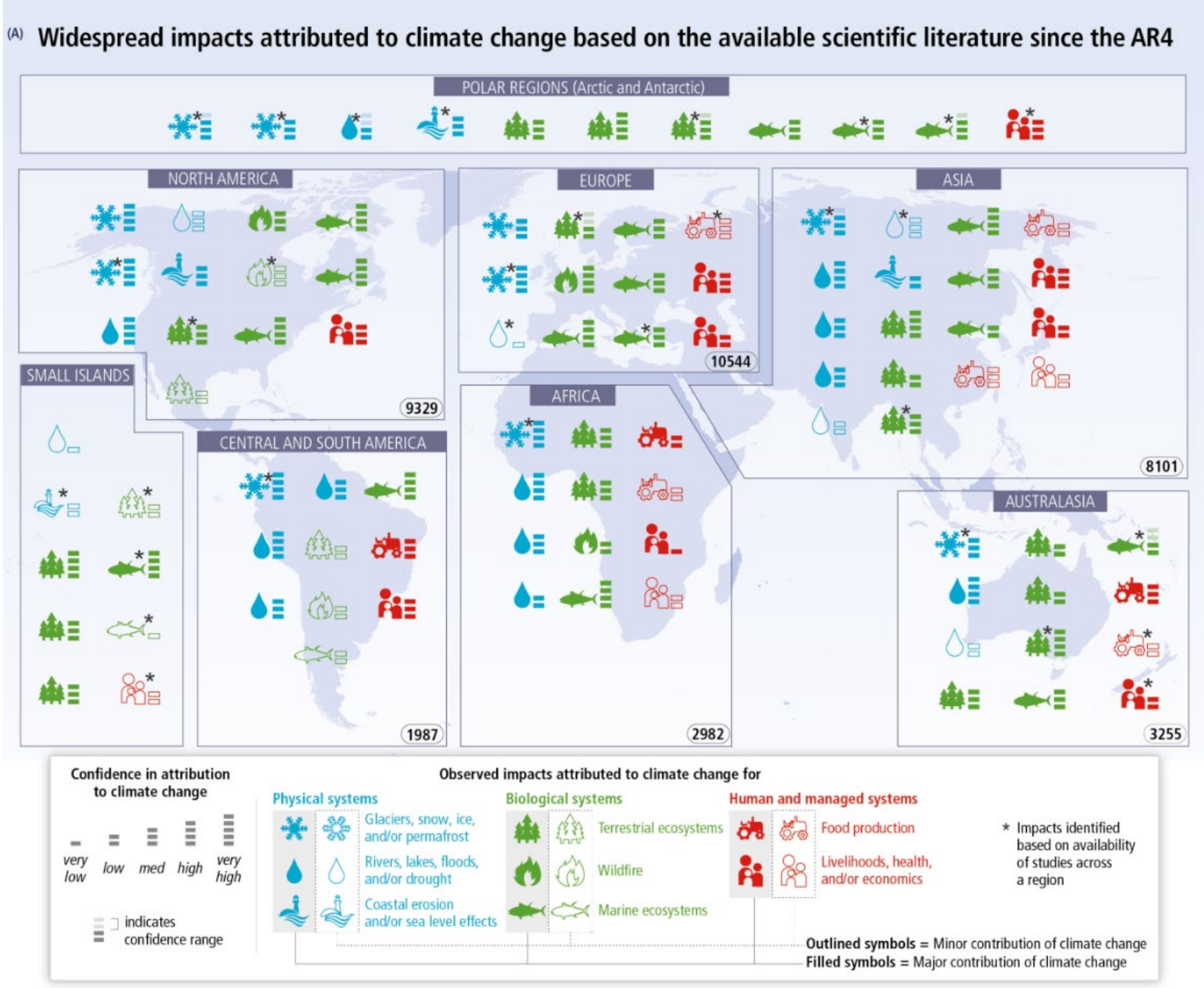
Adger et al. 2014, Ch12, AR5, WGII

Figure 12-3 | Synthesis of evidence on the impacts of climate change on elements of human security and the interactions between livelihoods, conflict, culture, and migration. Interventions and policies indicated by difference between initial conditions (solid black) and outcome of intervention (white circles). Some interventions (blue arrows) show net increase human security while others (red arrows) lead to net decrease in human security.

Observed Impacts

SPM, AR5, WGII, 2014





SPM, Synthesis Report, AR5, 2014

Observed + Projected Future Changes (2071-2100)

Region/ region code	Trends in daytime temperature extremes (frequency of hot and cool days)		Trends in heavy precipitation (rain, snow)		Trends in dryness and drought	
	Observed	Projected	Observed	Projected	Observed	Projected
West Africa WAF, 15	Significant increase in temperature of hottest day and coolest day in some parts[a] Insufficient evidence in other parts[a]	*Likely* increase in hot days (decrease in cool days)[b]	Rainfall intensity increased[a]	Slight or no change in heavy precipitation indicators in most areas[b] Low model agreement in northern areas[b]	*Likely* increase but 1970s Sahel drought dominates the trend; greater inter-annual variation in recent years[a, c]	Inconsistent signal[b]
Central America and Mexico CAM, 6	Increases in the number of hot days, decreases in the number of cool days[a]	*Likely* increase in hot days (decrease in cool days)[b]	Spatially varying trends. Increase in many areas, decrease in a few others[a]	Inconsistent trends[b]	Varying and inconsistent trends[a]	Increase in dryness in Central America and Mexico, with less confidence in trend in extreme south of region[b]
Amazon AMZ, 7	Insufficient evidence to identify trends[a]	Hot days *likely* to increase (cool days *likely* to decrease)[b]	Increase in many areas, decrease in a few[a]	Tendency for increases in heavy precipitation events in some metrics[b]	Decrease in dryness for much of the region. Some opposite trends and inconsistencies[a]	Inconsistent signals[b]
Northeastern Brazil NEB, 8	Increases in the number of hot days[a]	Hot days *likely* to increase (cool days *likely* to decrease)[b]	Increase in many areas, decrease in a few[a]	Slight or no change[b]	Varying and inconsistent trends[a]	Increase in dryness[b]
Southeast Asia SEA, 24	Increases in hot days (decreases in cool days) for northern areas[a] Insufficient evidence for Malay Archipelago[a]	*Likely* increase in hot days (decrease in cool days)[b]	Spatially varying trends, partial lack of evidence[a]	Increases in most metrics over most (especially non-continental) regions. One metric shows inconsistent signals of change.[b]	Spatially varying trends[a]	Inconsistent signal of change[b]

Symbols

Increasing trend or signal | Decreasing trend or signal | Both increasing and decreasing trend or signal | Inconsistent trend or signal or insufficient evidence | No change or only slight change

Level of confidence in findings

Low confidence | *Medium confidence* | *High confidence*

TS, AR5, WGII, 2014

Future Risks and Impacts

Climate change will **amplify existing risks** and **create new risks** for natural and human systems.

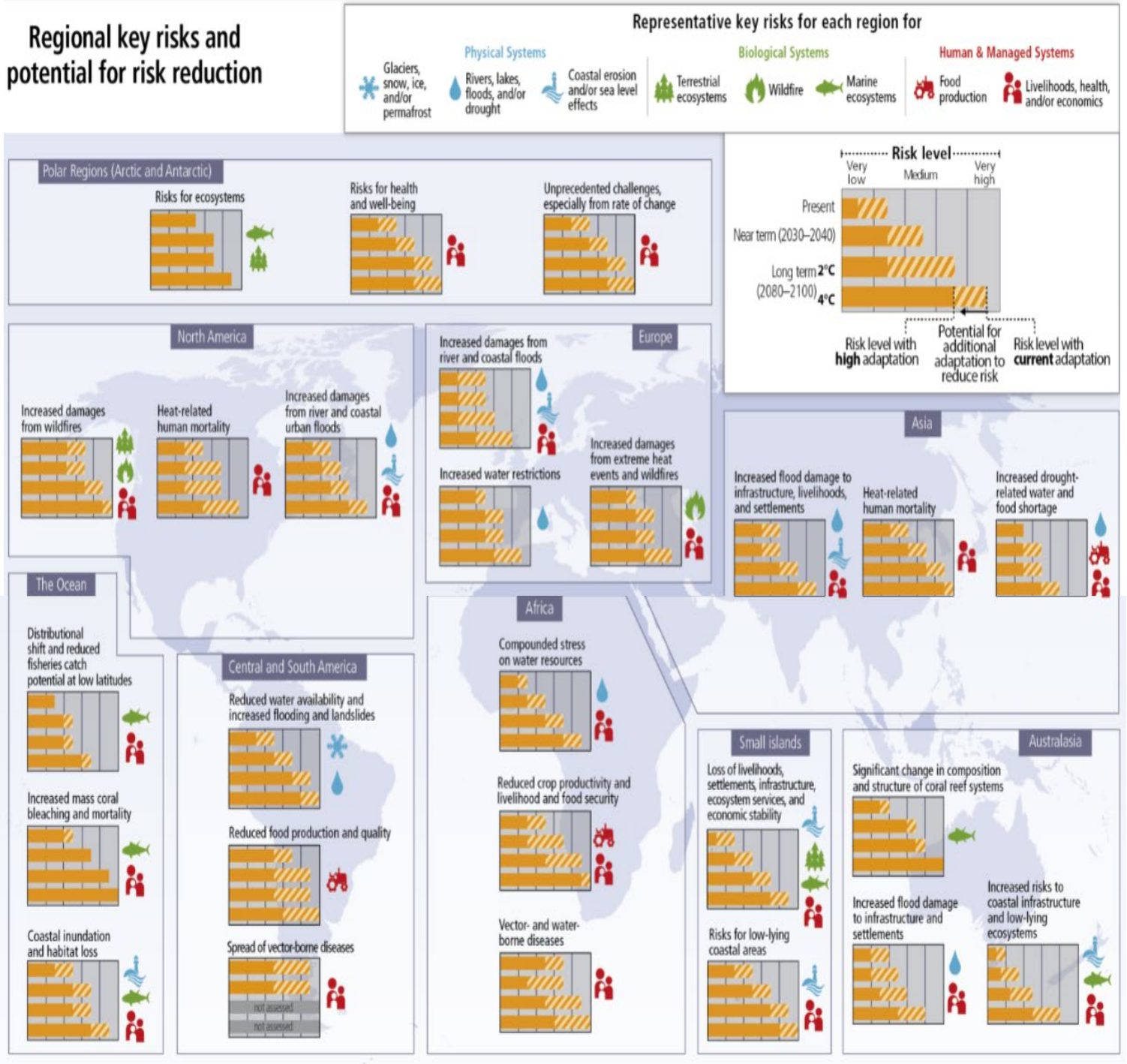
Risks are unevenly distributed and are generally greater for disadvantaged people and communities in countries at all levels of development.

Examples of Key Vulnerabilities and Risks

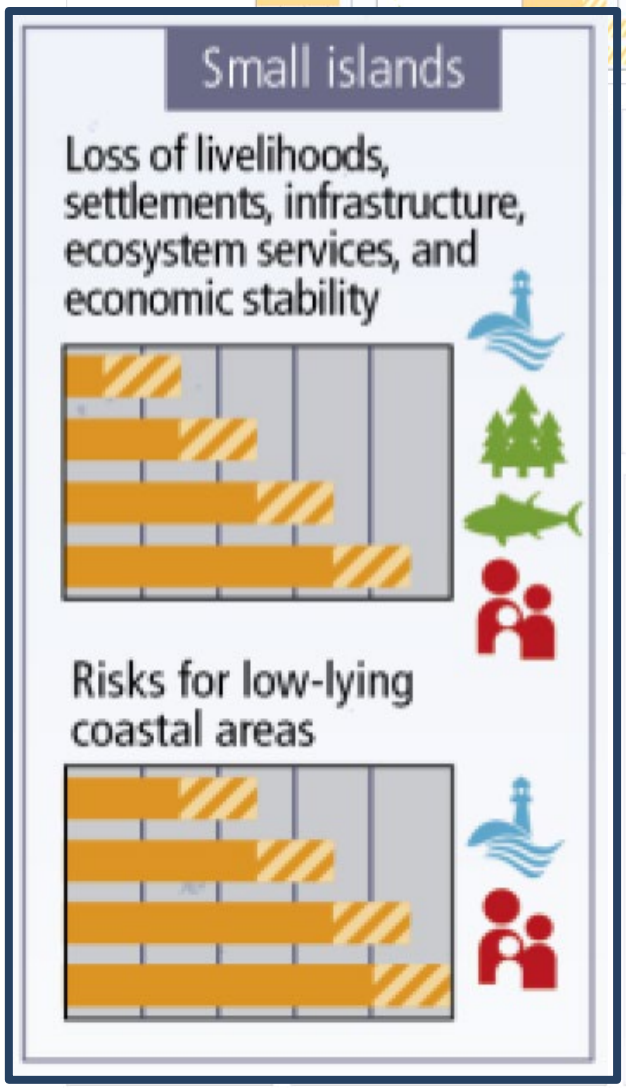
Table TS.3 | A selection of the hazards, key vulnerabilities, key risks, and emergent risks identified in chapters of this report. The examples underscore the complexity of risks determined by various interacting climate-related hazards, non-climatic stressors, and multifaceted vulnerabilities (see also Figure TS.1). Vulnerabilities identified as key arise when exposure to hazards combines with social, institutional, economic, or environmental vulnerability, as indicated by icons in the table. Emergent risks arise from complex system interactions. Roman numerals correspond with key risks listed in Section B-1. [19.6, Table 19-4]

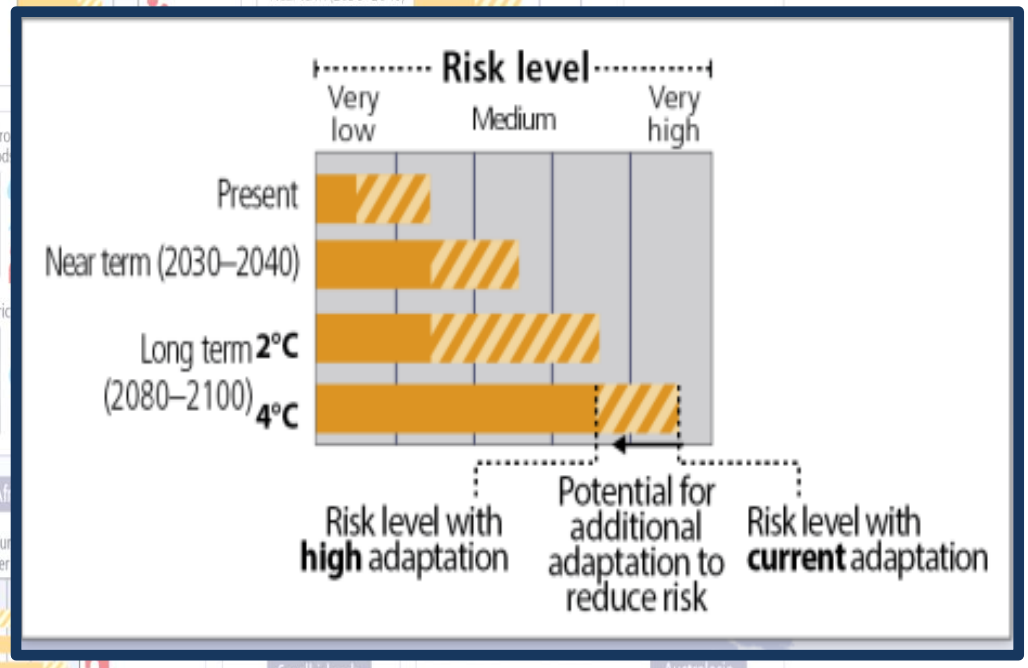
No.	Hazard	Key vulnerabilities	Key risks	Emergent risks
i	Sea level rise and coastal flooding including storm surges [5.4.3, 8.1.4, 8.2.3, 8.2.4, 13.1.4, 13.2.2, 24.4, 24.5, 26.7, 26.8, 29.3, 30.3.1, Boxes 25-1 and 25-7; WGI AR5 3.7, 13.5, Table 13-5]	High exposure of people, economic activity, and infrastructure in low-lying coastal zones and Small Island Developing States (SIDS) and other small islands Urban population unprotected due to substandard housing and inadequate insurance. Marginalized rural population with multidimensional poverty and limited alternative livelihoods Insufficient local governmental attention to disaster risk reduction	Death, injury, and disruption to livelihoods, food supplies, and drinking water Loss of common-pool resources, sense of place, and identity, especially among indigenous populations in rural coastal zones	Interaction of rapid urbanization, sea level rise, increasing economic activity, disappearance of natural resources, and limits of insurance; burden of risk management shifted from the state to those at risk leading to greater inequality
v	Warming, drought, and precipitation variability [7.3 to 7.5, 11.3, 11.6.1, 13.2, 19.3.2, 19.4.1, 22.3.4, 24.4, 26.8, 27.3.4; WGI AR5 11.3.2]	Poorer populations in urban and rural settings are susceptible to resulting food insecurity; includes particularly farmers who are net food buyers and people in low-income, agriculturally dependent economies that are net food importers. Limited ability to cope among the elderly and female-headed households	Risk of harm and loss of life due to reversal of progress in reducing malnutrition	Interactions of climate changes, population growth, reduced productivity, biofuel crop cultivation, and food prices with persistent inequality, and ongoing food insecurity for the poor increase malnutrition, giving rise to larger burden of disease. Exhaustion of social networks reduces coping capacity.
vii	Rising ocean temperature, ocean acidification, and loss of Arctic sea ice [5.4.2, 6.3.1, 6.3.2, 7.4.2, 9.3.5, 22.3.2, 24.4, 25.6, 27.3.3, 28.2, 28.3, 29.3.1, 30.5, 30.6, Boxes CC-OA and CC-CR; WGI AR5 11.3.3]	High susceptibility of warm-water coral reefs and respective ecosystem services for coastal communities; high susceptibility of polar systems, e.g., to invasive species Susceptibility of coastal and SIDS fishing communities depending on these ecosystem services; and of Arctic settlements and culture	Loss of coral cover, Arctic species, and associated ecosystems with reduction of biodiversity and potential losses of important ecosystem services. Risk of loss of endemic species, mixing of ecosystem types, and increased dominance of invasive organisms	Interactions of stressors such as acidification and warming on calcareous organisms enhancing risk

TS, AR5, WGII, 2014



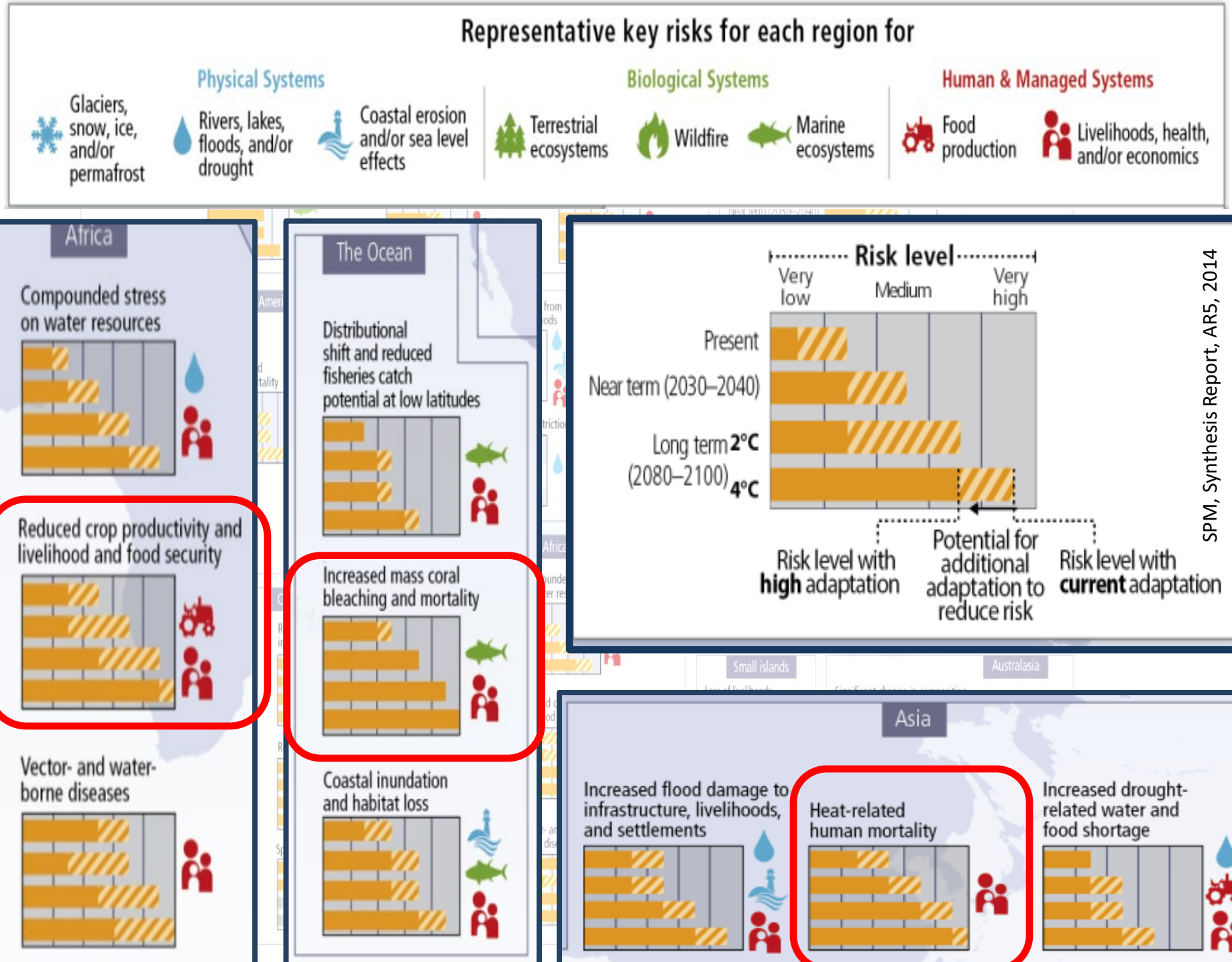
SPM, Synthesis Report, AR5, 2014

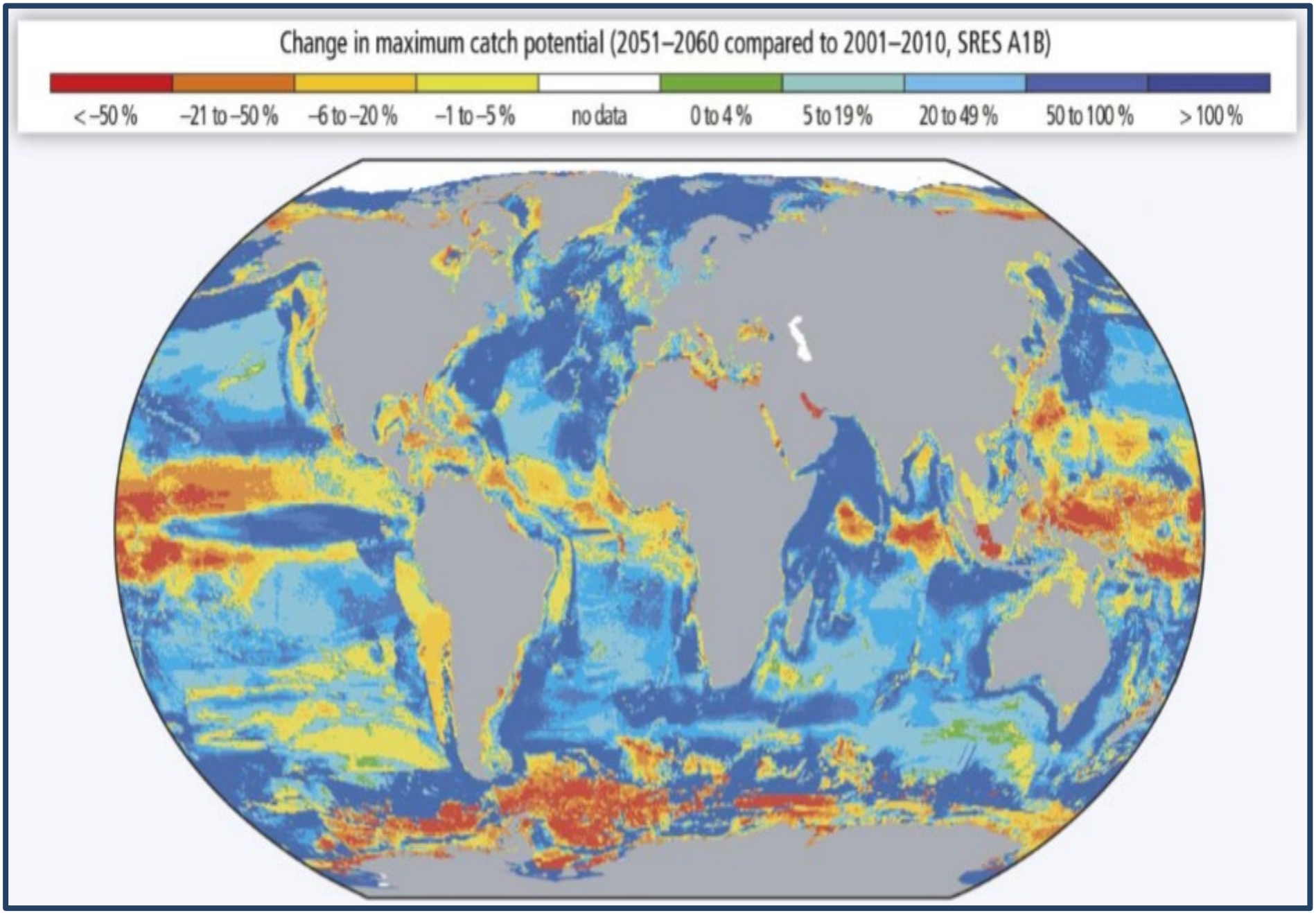




Regional key risks and potential for risk reduction

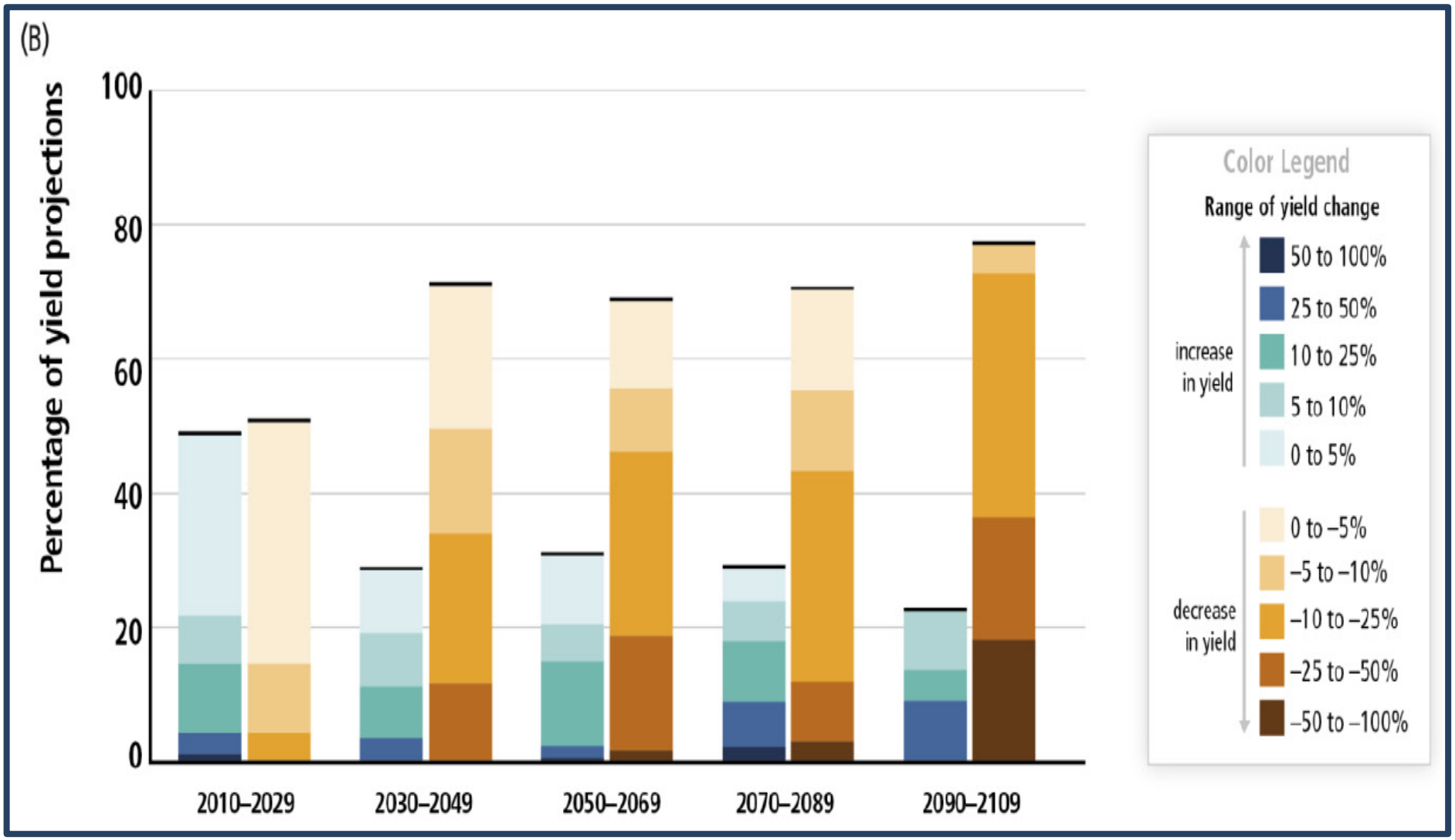
SPM, Synthesis Report, AR5, 2014


Representative key risks for each region for
Physical Systems
Glaciers, snow, ice, and/or permafrost
Rivers, lakes, floods, and/or drought
Coastal erosion and/or sea level effects
Biological Systems
Terrestrial ecosystems
Wildfire
Marine ecosystems
Human & Managed Systems
Food production
Livelihoods, health, and/or economics
Africa
Compounded stress on water resources
Reduced crop productivity and livelihood and food security
Vector- and water-borne diseases
The Ocean
Distributional shift and reduced fisheries catch potential at low latitudes
Increased mass coral bleaching and mortality
Coastal inundation and habitat loss
Risk level
Very low
Medium
Very high
Present
Near term (2030–2040)
Long term (2080–2100)
2°C
4°C
Risk level with high adaptation
Potential for additional adaptation to reduce risk
Risk level with current adaptation
SPM, Synthesis Report, AR5, 2014
Small islands
Australasia
Asia
Increased flood damage to infrastructure, livelihoods, and settlements
Heat-related human mortality
Increased drought-related water and food shortage



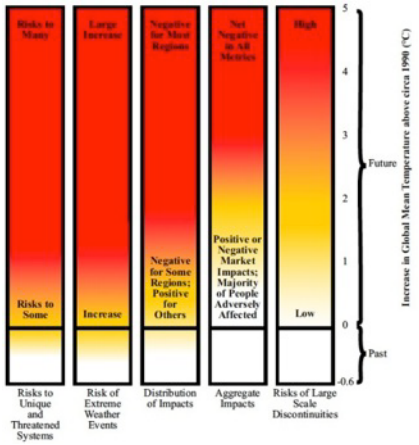
SPM, Synthesis Report, AR5, 2014

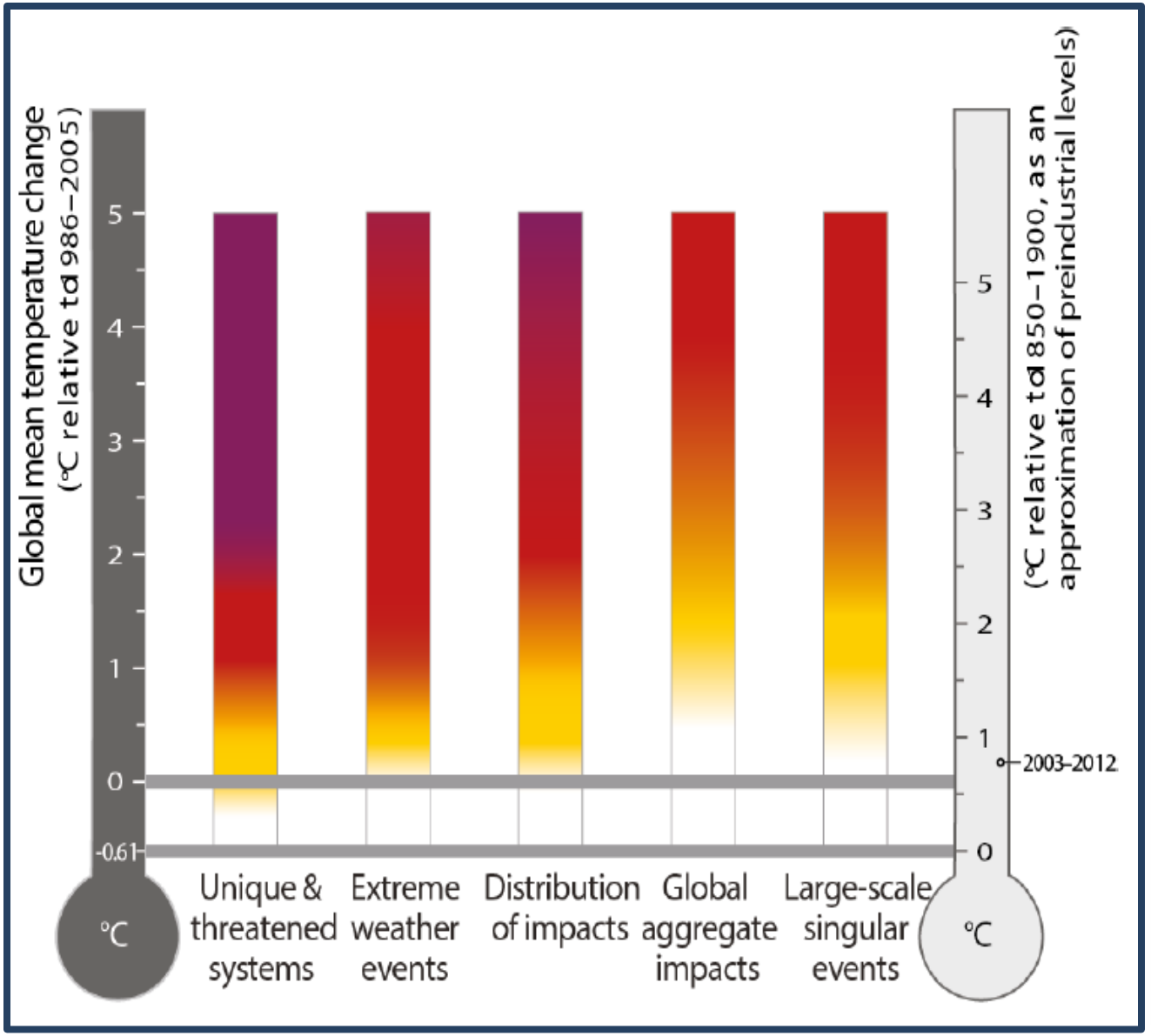
Impacts for Food Security



SPM, Synthesis Report, AR5, 2014

Reasons for Concern





SPM, Synthesis Report, AR5, 2014

Vulnerability a Function of Power

Gemenne et al. 2014 (*Climatic Change*)

- "the power of political processes and markets to deny some groups the freedoms and opportunities that they need to make choices in their interests and to act on those decisions, and the power of institutions to appropriate and divert processes that aim to overcome vulnerability"

- Measurable metrics of vulnerability and exposure (economic and geographic marginality), but also resistance of power and interventions

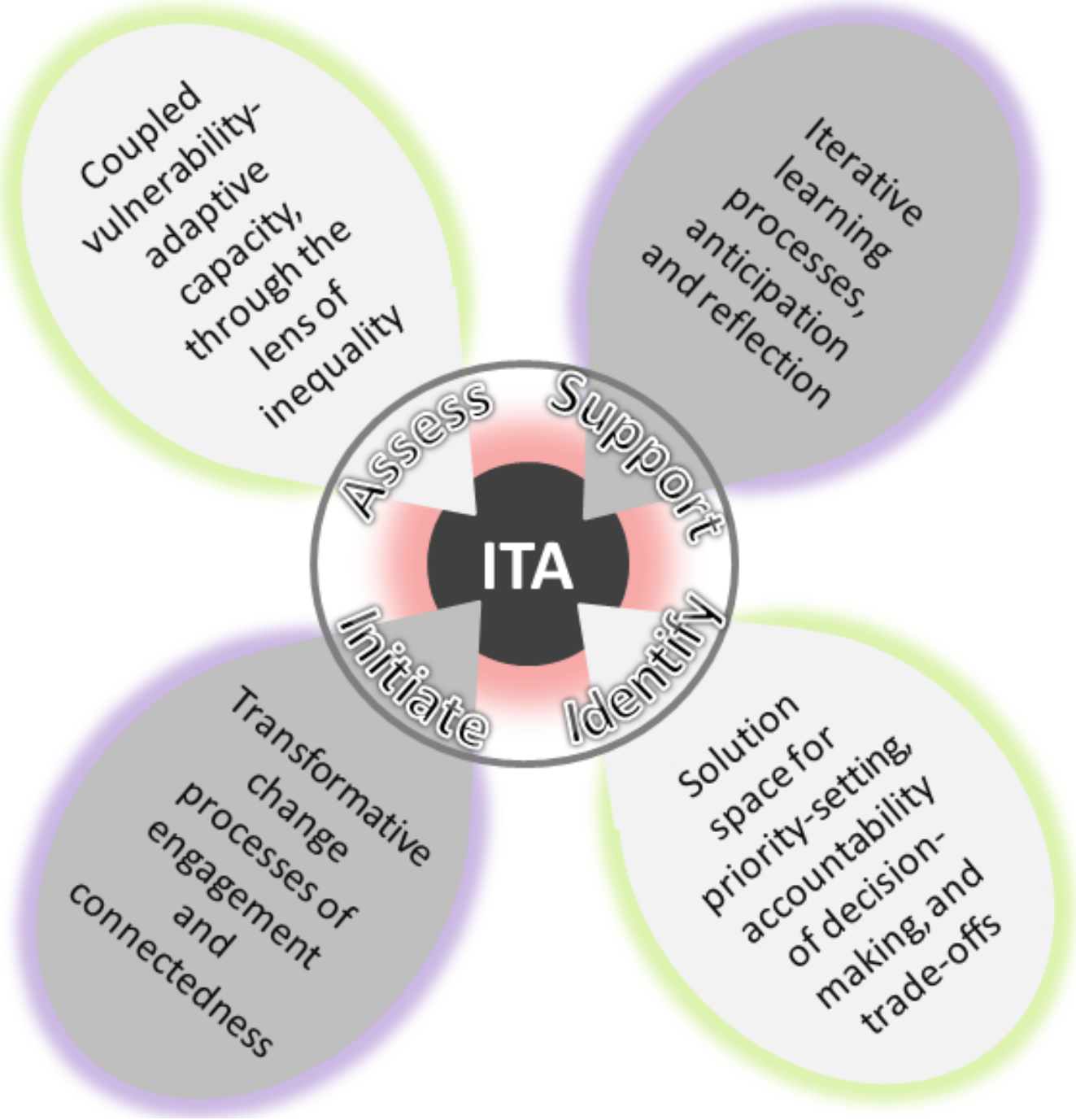
Relational Vulnerability

Tschakert et al. Sept 2013 (*Climate & Development*)

- Imbalance between harm and flourishing as a relational dysfunction
- Preoccupation with local manifestations of CC impacts obscures unequal geographies of power and political and institutional drivers
- Flourishing of privileged at the expense of those disadvantaged
- Inequality and Transformation Analyses (ITAs)

Taylor Sept 2013 (*Climate & Development*)

- Relative security of some - production of insecurity among others
- Subordinate groups need access to assets controlled by dominant Gs
- Adverse inclusion through profoundly unequal power relations
- Processes of vulnerabilization and impoverishment
- Example: Andhra Pradesh: agrarian change, debt, suicide, MGNREGA



Tschakert et al. 2013

Conclusion

- Vulnerability not useful concept in regional context
- Solidifies rather than unpacks existing narratives
- Multidimensional, dynamic, and relational Vs are pervasive across all societies and income levels
- Reducing Vs is a prerequisite for CC adaptation
- Persistent Vs and inequalities – limits to adaptation

Recent Debate in Geography

Tom Bassett and Charles Fogelman, *Geoforum* 2013: Déjà vu or something new?

- Extraordinary comeback of the concept of adaptation in recent CC literature
- Despite social theoretical critique (PE) of hazards literature in the 1970s and 1980s
- The IPCC's (1-4) framing of vulnerability and adaptation (lack of causal structures)
- Review of 558 articles in 4 selected journals (GEC, CC, C&D, MASGC)
- 70% adjustment adaptation, climate impacts as main source of vulnerability
- 27% risk located in society and biophysical hazards
- 3% social roots of vulnerability, political-economic change to achieve transformative A

Susanne Lorenz et al., *Geoforum*, 2014: A response

- Critique of narrow sample used in journal analysis
- 42 journals (WoK) – additional sources reveal many omissions in original review
- Several pieces by females researchers (Moser & Ekstrom, Osbahr, Silva, Berrang-Ford)
- Livelihood changes, political changes, economic pressures, coping capacity, risks
- More of 'something new'