Climate Change 2014 Impacts, Adaptation, and Vulnerability

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IPCC; Thomson Reuter
18th of June

http://www.afes-press.de/html/download_oswald.html

Working Group 2

The Report

- **1** scoping meeting to outline 30 chapters
- 1217 author nominations representing 92 nationalities
- 242 lead authors and 66 review editors from 70 countries
- 436 contributing authors from 54 countries
- over 12,000 scientific references cited

Total Reviews

- 50,492 comments
- 1729 expert reviewers from 84 countries
- 49 governments

The First Order Draft Expert Review

- 1774 individuals registered as expert reviewers
- 19,598 comments
- 2631 individuals registered as expert reviewers
- 28,544 comments
- 1271 expert reviewers* from 67 countries
- 33 governments

The Second Order Draft Expert and Government Review

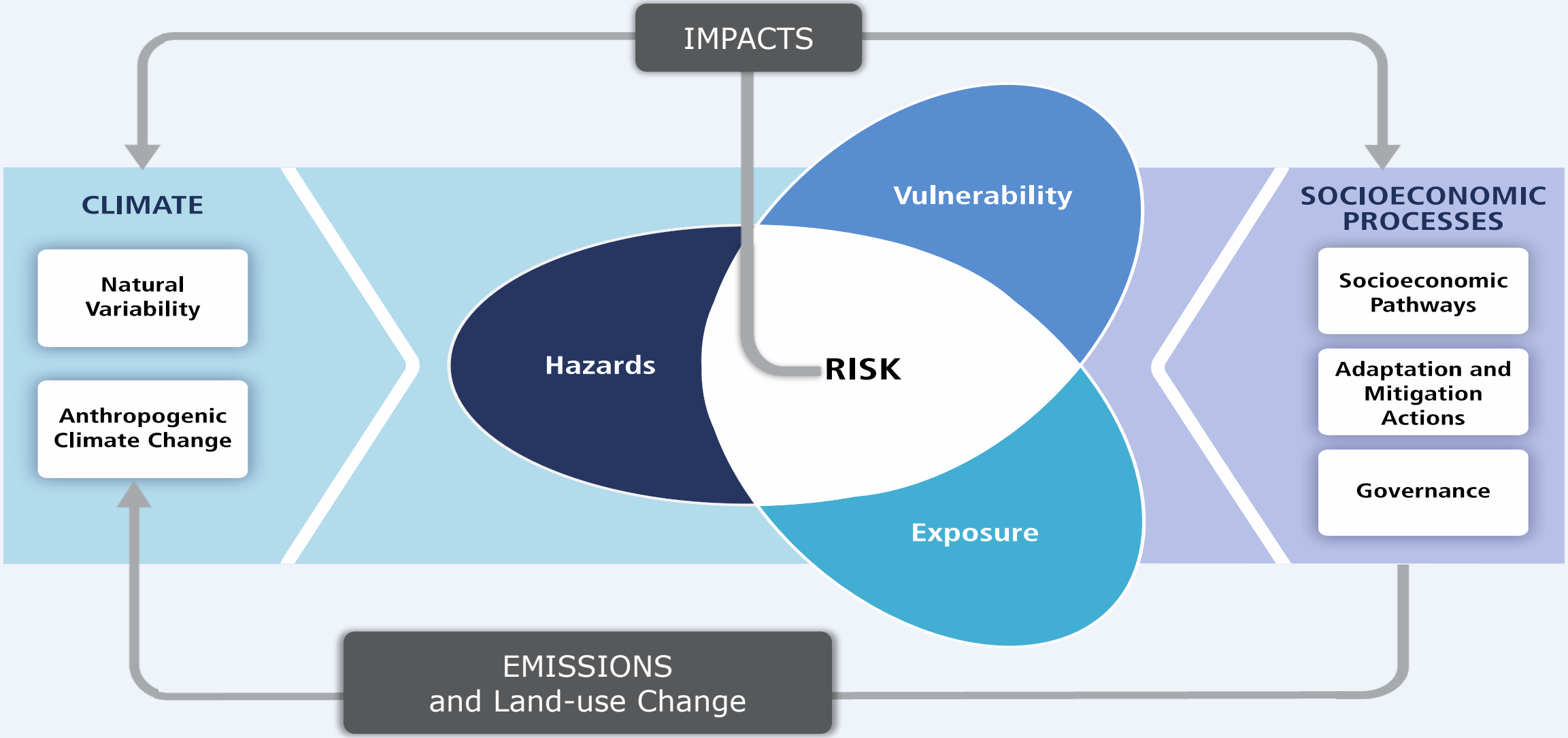
The Final Government Distribution

- 2350 comments on the Final Draft of the Summary for Policymakers
- 241 reviewers from 45 governments

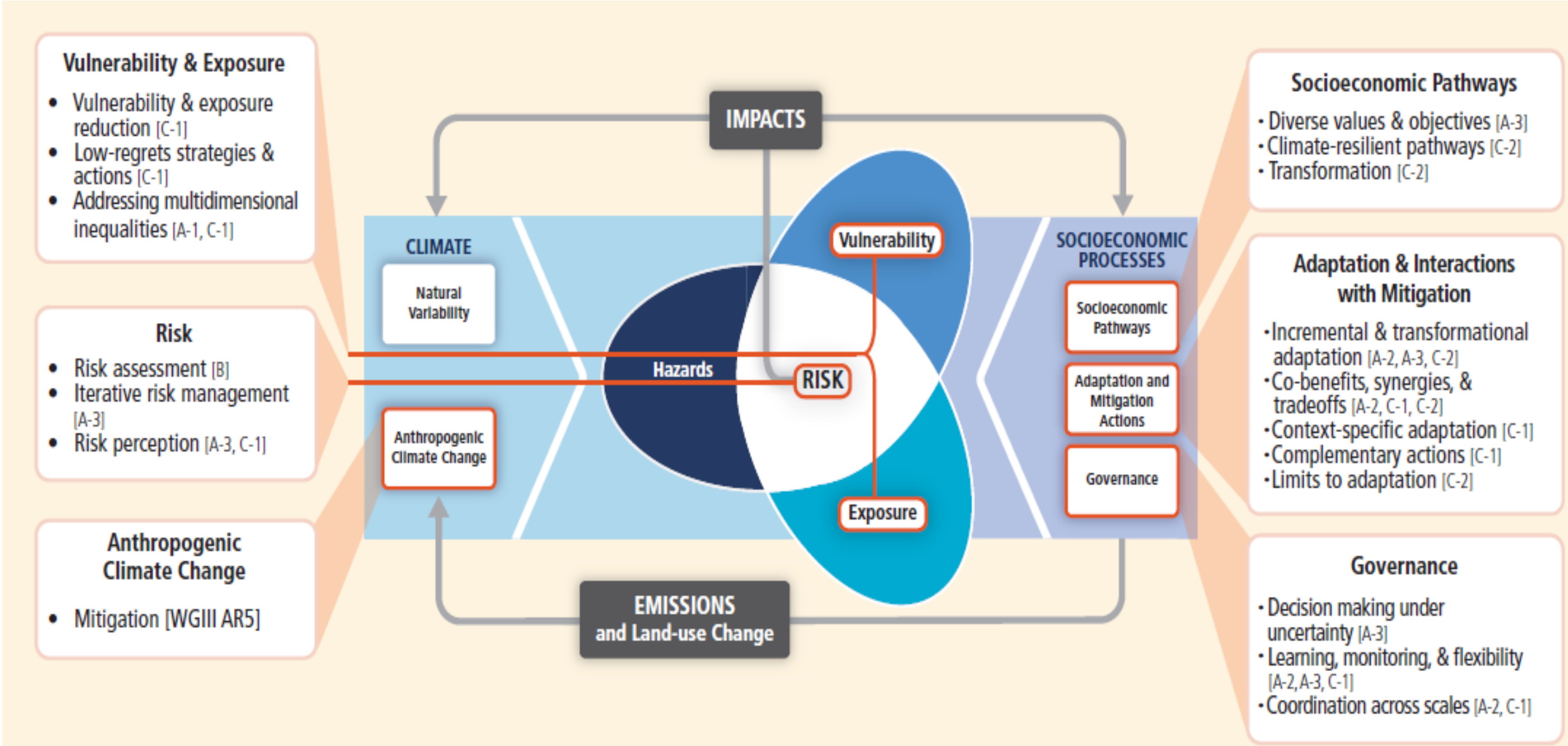
Climate change, adaptation, mitigation and sustainable development

- **Climate change is a threat to equitable and sustainable development. Adaptation, mitigation and sustainable development are closely related, with potential for synergies and trade-offs.**
- **Climate change poses an increasing threat to equitable and sustainable development (*high confidence*)**. Some climate-related impacts on development are already being observed. Climate change is a threat multiplier. It exacerbates other threats to social and natural systems, placing additional burdens particularly on the poor and constraining possible development paths for all. Development along current global pathways can contribute to climate risk and vulnerability, further eroding the basis for sustainable development.
- **Aligning climate policy with sustainable development requires attention to both adaptation and mitigation (*high confidence*)**. Interaction among adaptation, mitigation and sustainable development occurs both within and across regions and scales, often in the context of multiple stressors. Some options for responding to climate change could impose risks of other environmental and social costs, have adverse distributional effects and draw resources away from other development priorities, including poverty eradication.
- **Co-benefits:** (i) improved air quality; (ii) enhanced energy security, (iii) reduced energy and water consumption in urban areas through greening cities and recycling water; (iv) sustainable agriculture and forestry; and (v) protection of ecosystems for carbon storage and other ecosystem services.

Impacts, risks, prevention and development

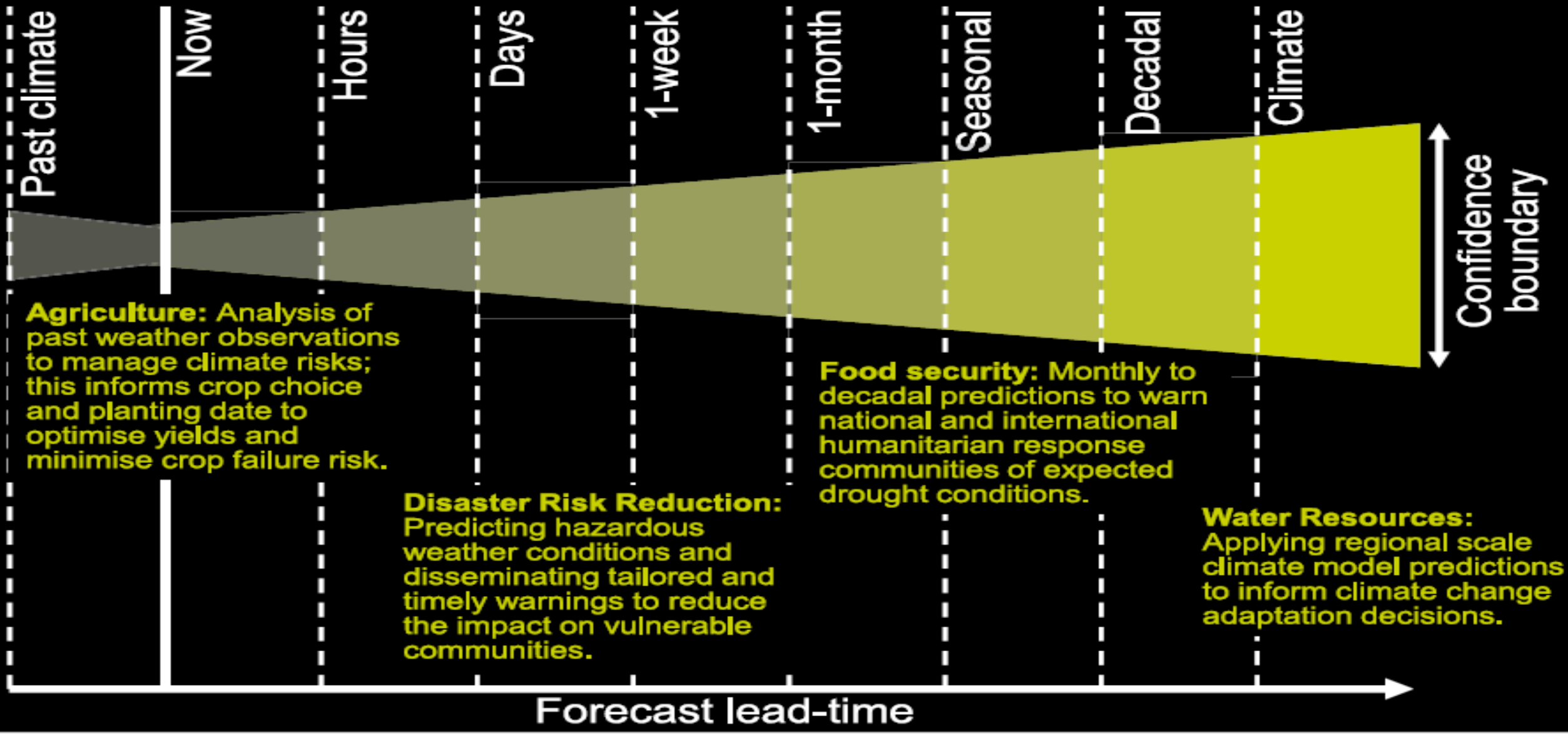

IMPACTS
CLIMATE
Natural Variability
Anthropogenic Climate Change
Hazards
Vulnerability
RISK
Exposure
SOCIOECONOMIC PROCESSES
Socioeconomic Pathways
Adaptation and Mitigation Actions
Governance
EMISSIONS and Land-use Change

Risk, Impacts, Vulnerability, Development



Prediction on all timescales

Supporting decision making for international development



Climate change, hazard, exposure

- **Climate change:** Climate change refers to a change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcings such as modulations of the solar cycles, volcanic eruptions, and persistent anthropogenic changes in the composition of the atmosphere or in land use. Note that the Framework Convention on Climate Change (UNFCCC), in its Article 1, defines climate change as: “a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods.” The UNFCCC thus makes a distinction between climate change attributable to human activities altering the atmospheric composition, and climate variability attributable to natural causes.
- **Hazard:** The potential occurrence of a natural or human-induced physical event or trend or physical impact that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, ecosystems, and environmental resources. In this report, the term hazard usually refers to climate-related physical events or trends or their physical impacts.
- **Exposure:** The presence of people, livelihoods, species or ecosystems, environmental functions, services, and resources, infrastructure, or economic, social, or cultural assets in places and settings that could be adversely affected.

WIDESPREAD OBSERVED IMPACTS

A CHANGING WORLD

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INTERGOVERNMENTAL PANEL ON Climate change

Key risks

1) Unique and threatened systems: Some unique and threatened systems, including ecosystems and cultures, are already at risk from climate change (*high confidence*). The number of such systems at risk of severe consequences is higher with additional warming of around 1°C. Many species and systems with limited adaptive capacity are subject to very high risks with additional warming of 2°C, particularly Arctic-sea-ice and coral-reef systems.

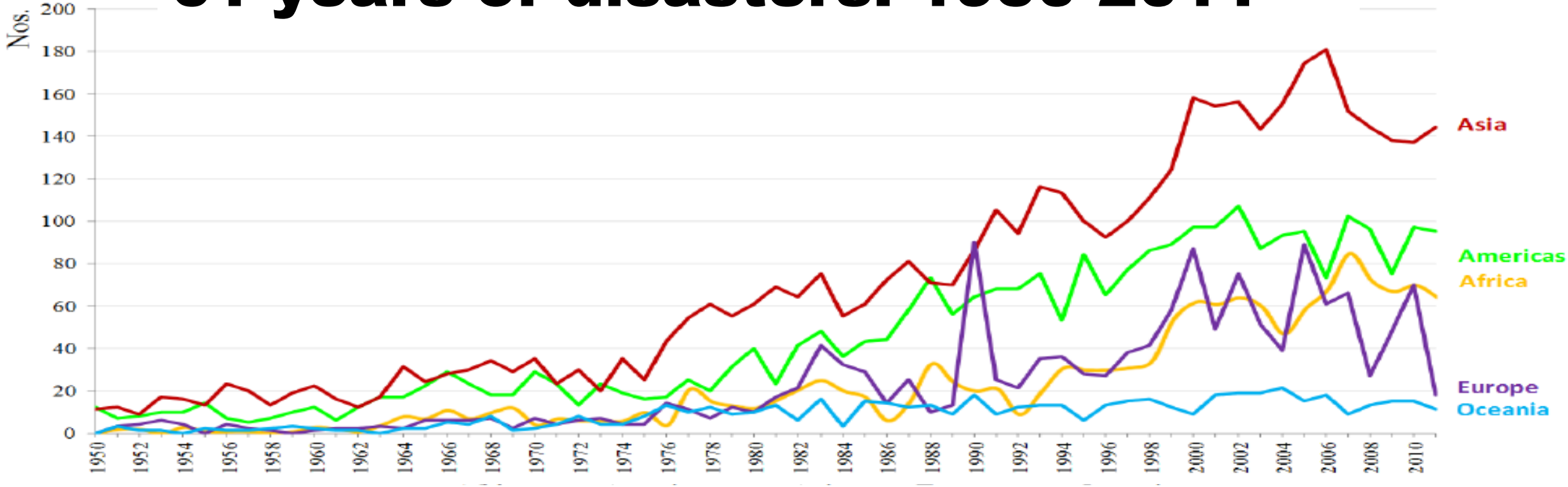
2) Extreme weather events: Climate-change-related risks from extreme events, such as heat waves, extreme precipitation, and coastal flooding, are already moderate (*high confidence*) and high with 1°C additional warming (*medium confidence*). Risks associated with some types of extreme events (e.g., extreme heat) increase further at higher temperatures (*high confidence*).

3) Distribution of impacts: Risks are unevenly distributed and are generally greater for disadvantaged people and communities in countries at all levels of development. Risks are already moderate because of regionally differentiated climate-change impacts on crop production in particular (*medium* to *high confidence*). Based on projected decreases in regional crop yields and water availability, risks of unevenly distributed impacts are high for additional warming above 2°C (*medium confidence*).

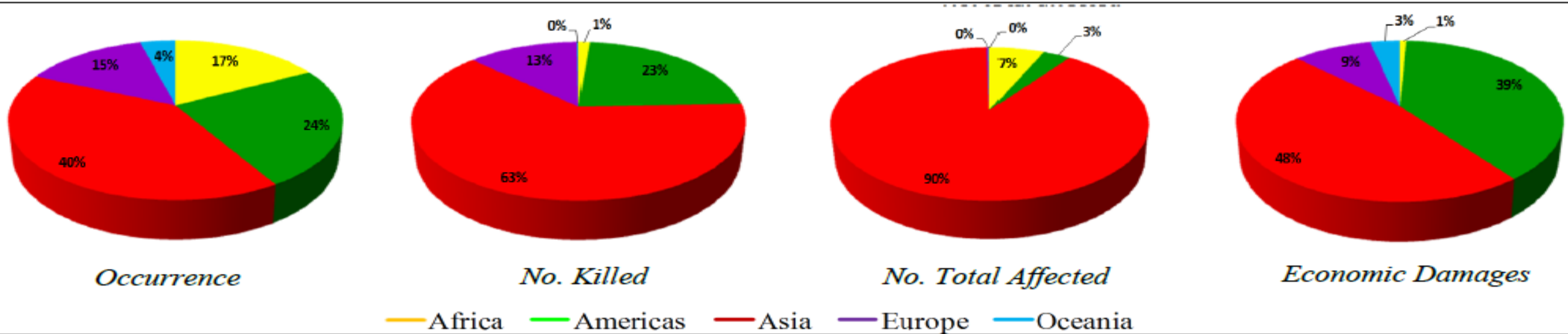
4) Global aggregate impacts: Risks of global aggregate impacts are moderate for additional warming between 1–2°C, reflecting impacts to both Earth's biodiversity and the overall global economy (*medium confidence*). Extensive biodiversity loss with associated loss of ecosystem goods and services results in high risks around 3°C additional warming (*high confidence*). Aggregate economic damages accelerate with increasing temperature (*limited evidence*, *high agreement*), but few quantitative estimates have been completed for additional warming around 3°C or above.

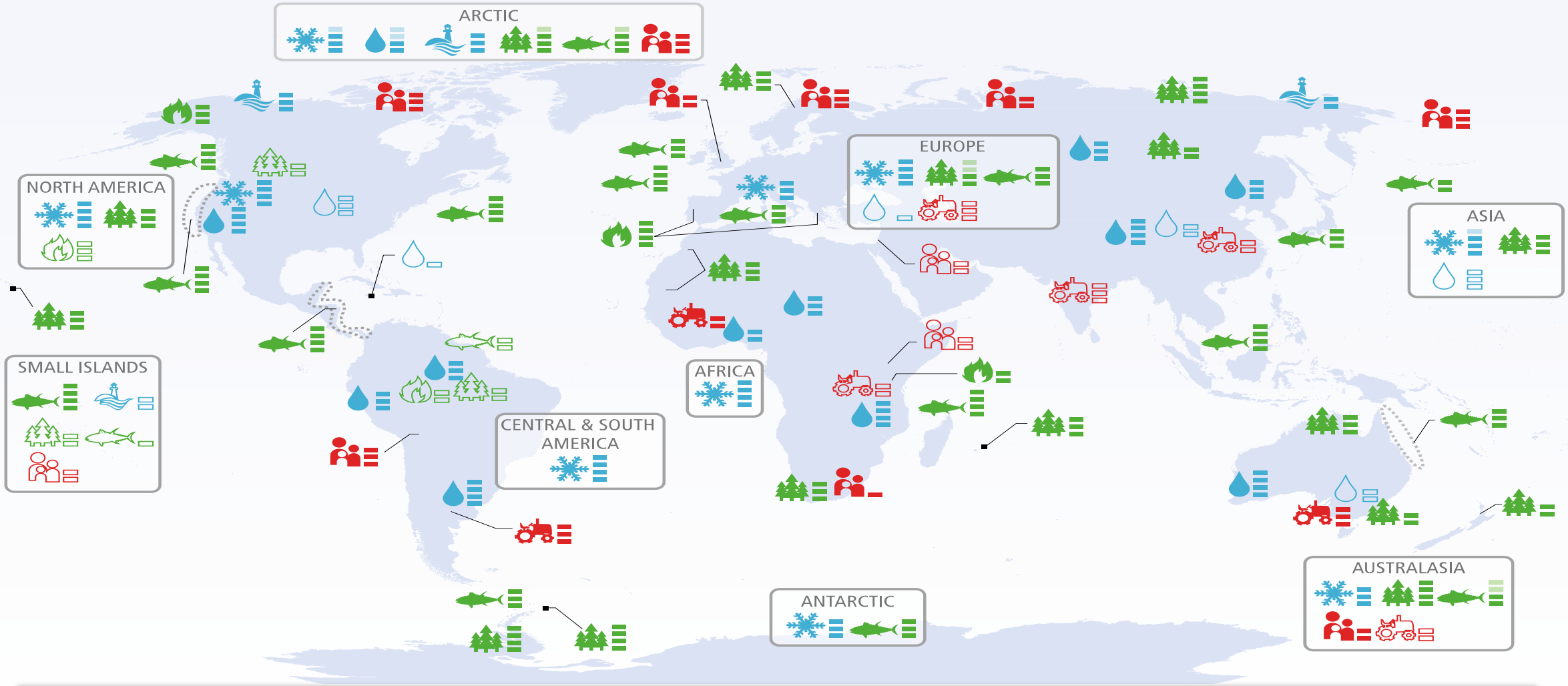
5) Large-scale singular events: With increasing warming, some physical systems or ecosystems may be at risk of abrupt and irreversible changes. Risks associated with such tipping points become moderate between 0–1°C additional warming, due to early warning signs that both warm-water coral reef and Arctic ecosystems are already experiencing irreversible regime shifts (*medium confidence*). Risks increase disproportionately as temperature increases between 1–2°C additional warming and become high above 3°C, due to the potential for a large and irreversible sea level rise from ice sheet loss. For sustained warming greater than some threshold,35 near-complete loss of the Greenland ice sheet would occur over a millennium or more, contributing up to 7 m of global mean sea level rise.

61 years of disasters: 1950-2011

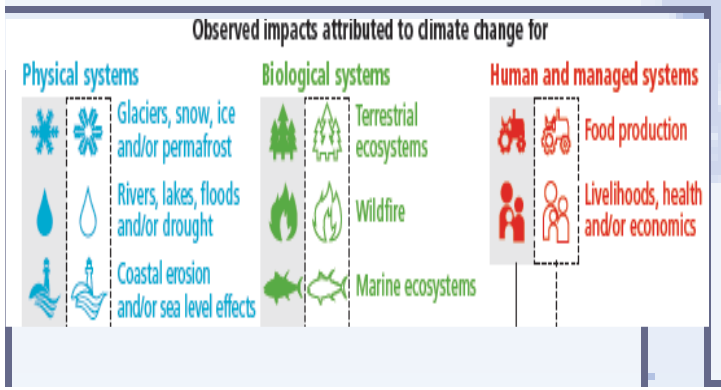


Asia's share: 2002-2011




ARCTIC
NORTH AMERICA
EUROPE
ASIA
SMALL ISLANDS
AFRICA
CENTRAL & SOUTH AMERICA
ANTARCTIC
AUSTRALASIA
Confidence in attribution to climate change
very low
low
med
high
very high
indicates confidence range
Observed impacts attributed to climate change 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 and managed systems
Food production
Livelihoods, health, and/or economics
Regional-scale impacts
Outlined symbols = Minor contribution of climate change
Filled symbols = Major contribution of climate change

NORTH AMERICA



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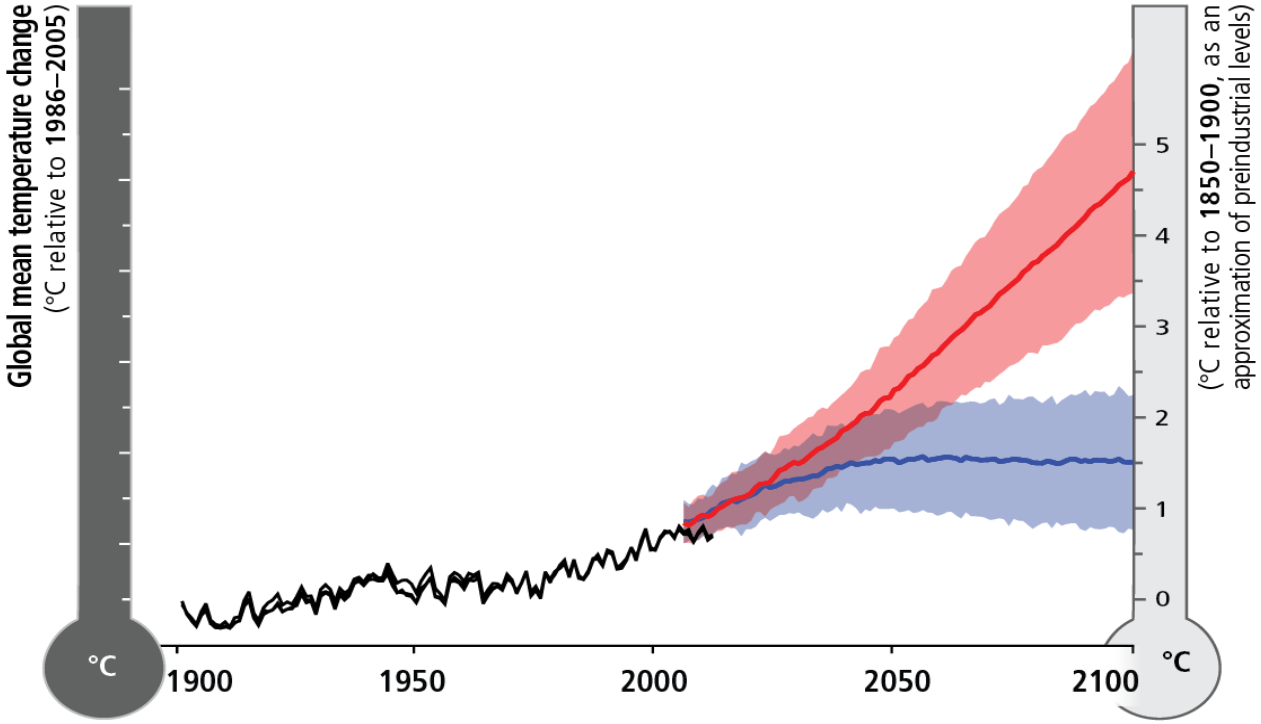
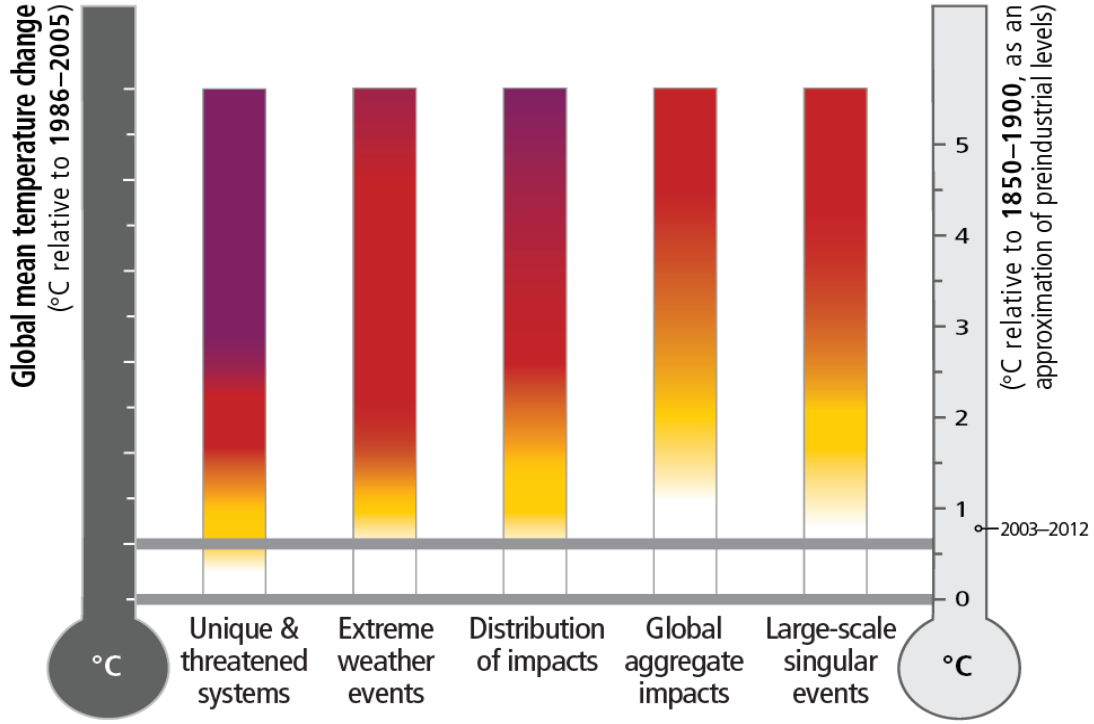
Key risks





Observed
RCP8.5 (a high-emission scenario)
Overlap
RCP2.6 (a low-emission mitigation scenario)

Level of additional risk due to climate change

Undetectable | Moderate | High | Very high

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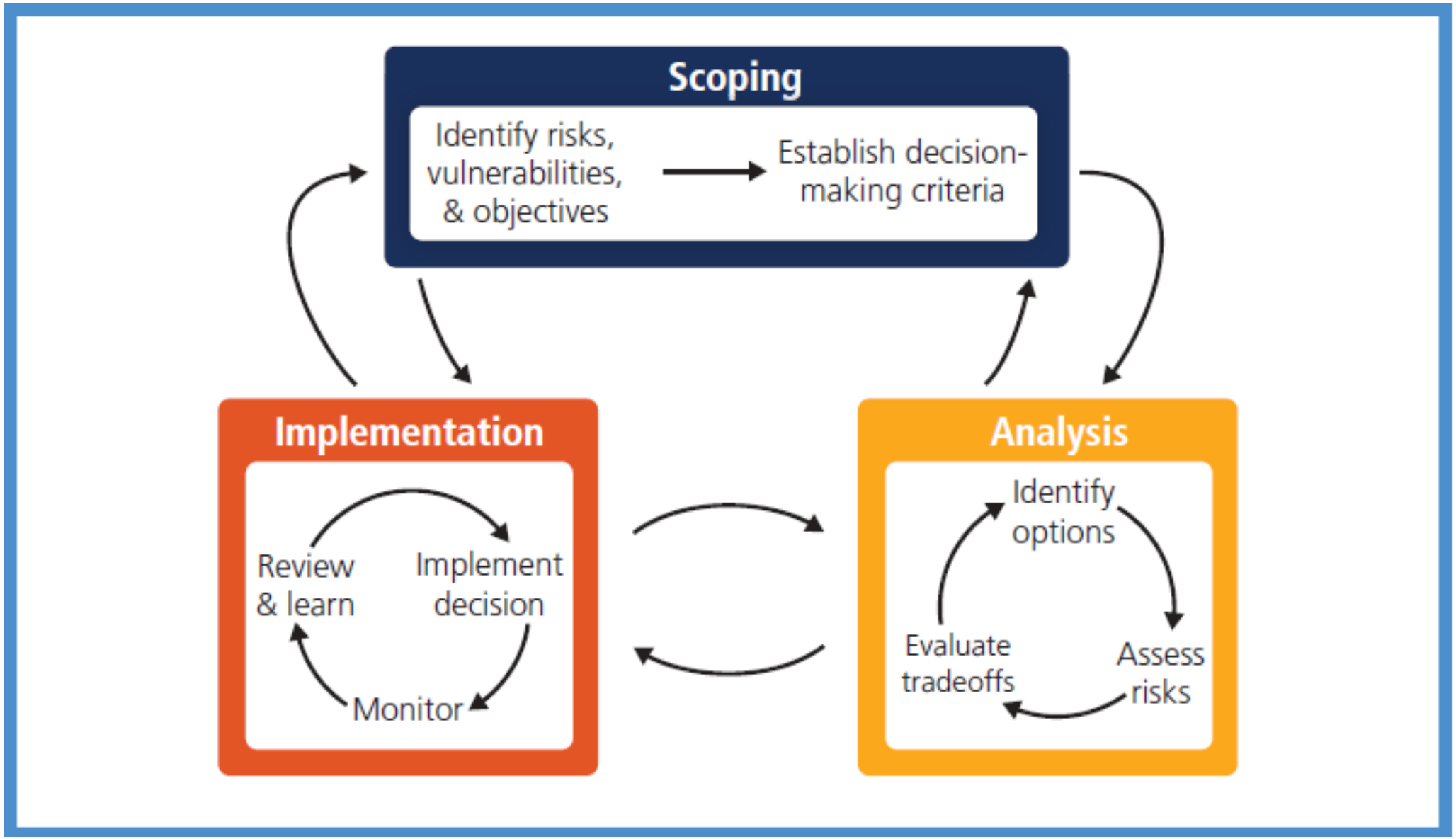
INTERGOVERNMENTAL PANEL ON climate change

Risk, analysis and implementation



VULNERABILITY AND EXPOSURE

AROUND THE WORLD

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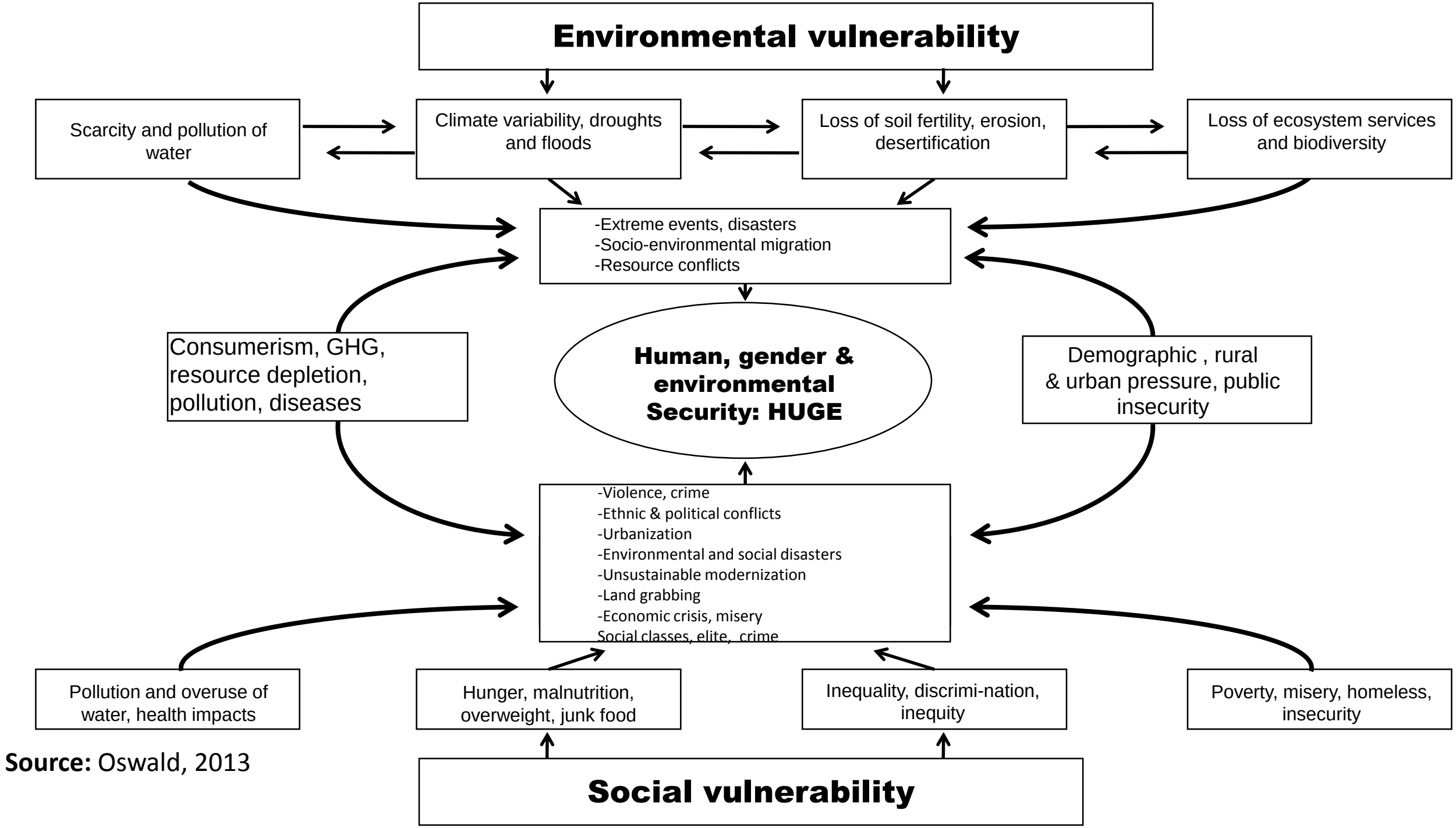
INTERGOVERNMENTAL PANEL ON Climate change

Vulnerability, impacts and risks

- **Vulnerability:** The propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt.
- **Impacts:** Effects on natural and human systems. In this report, the term impacts is used primarily to refer to the effects on natural and human systems of extreme weather and climate events and of climate change. Impacts generally refer to effects on lives, livelihoods, health, ecosystems, economies, societies, cultures, services, and infrastructure due to the interaction of climate changes or hazardous climate events occurring within a specific time period and the vulnerability of an exposed society or system. Impacts are also referred to as consequences and outcomes. The impacts of climate change on geophysical systems, including floods, droughts, and sea level rise, are a subset of impacts called physical impacts. Risk: The potential for consequences where something of value is at stake and where the outcome is uncertain, recognizing the diversity of values. Risk is often represented as probability of occurrence of hazardous events or trends multiplied by the impacts if these events or trends occur.
- **Risk** results from the interaction of vulnerability, exposure, and hazard. In this report, the term risk is used primarily to refer to the risks of climate-change impacts.



Source: Oswald, 2013

Category	Vulnerability & Exposure Reduction
Human development	Improved access to education, nutrition, health facilities, energy, safe housing & settlement structures, & social support structures; Reduced gender inequality & marginalization in other forms.
Poverty alleviation	Improved access to & control of local resources; Land tenure; Disaster risk reduction; Social safety nets & social protection; Insurance schemes.
Livelihood security	Income, asset & livelihood diversification; Improved infrastructure; Access to technology & decision-making fora; Increased decision-making power; Changed cropping, livestock & aquaculture practices; Reliance on social networks.
Disaster risk management	Early warning systems; Hazard & vulnerability mapping; Diversifying water resources; Improved drainage; Flood & cyclone shelters; Building codes & practices; Storm & wastewater management; Transport & road infrastructure improvements.
Ecosystem management	Maintaining wetlands & urban green spaces; Coastal afforestation; Watershed & reservoir management; Reduction of other stressors on ecosystems & of habitat fragmentation; Maintenance of genetic diversity; Manipulation of disturbance regimes; Community-based natural resource management.
Spatial or land-use planning	Provisioning of adequate housing, infrastructure & services; Managing development in flood prone & other high risk areas; Urban planning & upgrading programs; Land zoning laws; Easements; Protected areas.

Adaptation
including incremental & transformational adjustments

tructural/physical	***Engineered & built-environment options***: Sea walls & coastal protection structures; Flood levees; Water storage; Improved drainage; Flood & cyclone shelters; Building codes & practices; Storm & wastewater management; Transport & road infrastructure improvements; Floating houses; Power plant & electricity grid adjustments.
	Technological options: New crop & animal varieties; Indigenous, traditional & local knowledge, technologies & methods; Efficient irrigation; Water-saving technologies; Desalinisation; Conservation agriculture; Food storage & preservation facilities; Hazard & vulnerability mapping & monitoring; Early warning systems; Building insulation; Mechanical & passive cooling; Technology development, transfer & diffusion.
	Ecosystem-based options: Ecological restoration; Soil conservation; Afforestation & reforestation; Mangrove conservation & replanting; Green infrastructure (e.g., shade trees, green roofs); Controlling overfishing; Fisheries co-management; Assisted species migration & dispersal; Ecological corridors; Seed banks, gene banks & other *ex situ* conservation; Community-based natural resource management.
	Services: Social safety nets & social protection; Food banks & distribution of food surplus; Municipal services including water & sanitation; Vaccination programs; Essential public health services; Enhanced emergency medical services.

Category	Examples
Institutional	***Economic options***: Financial incentives; Insurance; Catastrophe bonds; Payments for ecosystem services; Pricing water to encourage universal provision and careful use; Microfinance; Disaster contingency funds; Cash transfers; Public-private partnerships.
	Laws & regulations: Land zoning laws; Building standards & practices; Easements; Water regulations & agreements; Laws to support disaster risk reduction; Laws to encourage insurance purchasing; Defined property rights & land tenure security; Protected areas; Fishing quotas; Patent pools & technology transfer.
	National & government policies & programs: National & regional adaptation plans including mainstreaming; Sub-national & local adaptation plans; Economic diversification; Urban upgrading programs; Municipal water management programs; Disaster planning & preparedness; Integrated water resource management; Integrated coastal zone management; Ecosystem-based management; Community-based adaptation.

Transformation

Social	***Educational options***: Awareness raising & integrating into education; Gender equity in education; Extension services; Sharing indigenous, traditional & local knowledge; Participatory action research & social learning; Knowledge-sharing & learning platforms.
	Informational options: Hazard & vulnerability mapping; Early warning & response systems; Systematic monitoring & remote sensing; Climate services; Use of indigenous climate observations; Participatory scenario development; Integrated assessments.
	Behavioural options: Household preparation & evacuation planning; Migration; Soil & water conservation; Storm drain clearance; Livelihood diversification; Changed cropping, livestock & aquaculture practices; Reliance on social networks.
Spheres of change	***Practical***: Social & technical innovations, behavioural shifts, or institutional & managerial changes that produce substantial shifts in outcomes.
	Political: Political, social, cultural & ecological decisions & actions consistent with reducing vulnerability & risk & supporting adaptation, mitigation & sustainable development.
	Personal: Individual & collective assumptions, beliefs, values & worldviews influencing climate-change responses.

Adaptation and resilience

Adaptation and resilience

- **Adaptation:** The process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities. In some natural systems, human intervention may facilitate adjustment to expected climate and its effects. Transformation: A change in the fundamental attributes of natural and human systems.Within this summary, transformation could reflect strengthened, altered, or aligned paradigms, goals, or values towards promoting adaptation for sustainable development, including poverty reduction.
- **Resilience:** The capacity of social, economic, and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity, and structure, while also maintaining the capacity for adaptation, learning, and transformation.

Adaptation

- **Many adaptation and mitigation options can help address climate change, but no single option is sufficient by itself. Effective implementation depends on policies and cooperation at all scales and can be enhanced through integrated responses that link mitigation and adaptation with other societal objectives.**
- **Adaptation and mitigation responses are underpinned by common enabling factors. These include effective institutions and governance, innovation and investments in environmentally sound technologies and infrastructure, sustainable livelihoods and behavioural and lifestyle choices.**
- **For many regions and sectors, enhanced capacities to mitigate and adapt are part of the foundation essential for managing climate change risks (*high confidence*).** Such capacities are place- and context-specific and therefore there is no single approach for reducing risk that is appropriate across all settings. For example, developing nations with low income levels have the lowest financial, technological and institutional capacities to pursue low-carbon, climate-resilient development pathways.
- **Improving institutions as well as enhancing coordination and cooperation in governance can help overcome regional constraints associated with mitigation, adaptation and disaster risk reduction (*very high confidence*).** Despite the presence of a wide array of multilateral, national and sub-national institutions focused on adaptation and mitigation, global GHG emissions continue to increase and identified adaptation needs have not been adequately addressed.

Adaptation experiences

- Adaptation is becoming embedded in **planning processes**, with more limited implementation of responses (high confidence). Engineered and technological options are commonly implemented adaptive responses, often integrated within existing programs such **as disaster risk management and water management**. There is increasing recognition of the value of social, institutional, and ecosystem-based measures and of the extent of constraints to adaptation. Adaptation options adopted to date continue to emphasize incremental **adjustments and co-benefits** and are starting to emphasize flexibility and learning (medium evidence, medium agreement). Most assessments of adaptation have been restricted to **impacts, vulnerability, and adaptation planning**, with very few assessing the **processes of implementation** or the effects of adaptation actions (medium evidence, high agreement).

Effective adaptation

Effective adaptation and mitigation responses will depend on policies and measures across multiple scales: international, regional, national and sub-national. Policies across all scales supporting technology development, diffusion and transfer, as well as finance for responses to climate change, can complement and enhance the effectiveness of policies that directly promote adaptation and mitigation.

Trade-offs, synergies and interactions

- **Climate change is a threat to sustainable development. Nonetheless, there are many opportunities to link mitigation, adaptation and the pursuit of other societal objectives through integrated responses (high confidence). Successful implementation relies on relevant tools, suitable governance structures and enhanced capacity to respond (medium confidence).**
- **Climate change exacerbates other threats to social and natural systems, placing additional burdens particularly on the poor (high confidence).** Aligning climate policy with sustainable development requires attention to both adaptation and mitigation (high confidence). Delaying global mitigation actions may reduce options for climate-resilient pathways and adaptation in the future. Opportunities to take advantage of positive synergies between adaptation and mitigation may decrease with time, particularly if limits to adaptation are exceeded. Increasing efforts to mitigate and adapt to climate change imply an increasing complexity of interactions, encompassing connections among human health, water, energy, land use and biodiversity (medium evidence, high agreement).
- **Strategies and actions can be pursued now which will move towards climate-resilient pathways for sustainable development, while at the same time helping to improve livelihoods, social and economic well-being and effective environmental management.** In some cases, economic diversification can be an important element of such strategies. The effectiveness of integrated responses can be enhanced by relevant tools, suitable governance structures and adequate institutional and human capacity (medium confidence). Integrated responses are especially relevant to energy planning and implementation; interactions among water, food, energy and biological carbon sequestration; and urban planning, which provides substantial opportunities for enhanced resilience, reduced emissions and more sustainable development (medium confidence).

CLIMATE CHANGE

REDUCING AND MANAGING RISKS

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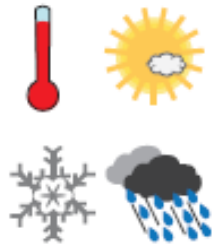
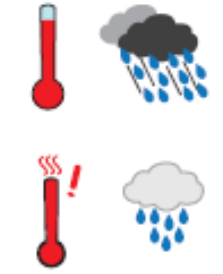
Regional analysis

Central and South America

Key risk	Adaptation issues & prospects	Climatic drivers	Timeframe	Risk & potential for adaptation
Water availability in semi-arid and glacier-melt-dependent regions and Central America; flooding and landslides in urban and rural areas due to extreme precipitation (*high confidence*) [27.3]	• Integrated water resource management • Urban and rural flood management (including infrastructure), early warning systems, better weather and runoff forecasts, and infectious disease control		Present Near term (2030–2040) Long term (2080–2100) 2°C 4°C	Very low – Medium – Very high
Decreased food production and food quality (*medium confidence*) [27.3]	• Development of new crop varieties more adapted to climate change (temperature and drought) • Offsetting of human and animal health impacts of reduced food quality • Offsetting of economic impacts of land-use change • Strengthening traditional indigenous knowledge systems and practices		Present Near term (2030–2040) Long term (2080–2100) 2°C 4°C	Very low – Medium – Very high
Spread of vector-borne diseases in altitude and latitude (*high confidence*) [27.3]	• Development of early warning systems for disease control and mitigation based on climatic and other relevant inputs. Many factors augment vulnerability. • Establishing programs to extend basic public health services		Present Near term (2030–2040) Long term (2080–2100) 2°C 4°C	Very low – Medium – Very high not available not available

North America

Key risk	Adaptation issues & prospects	Climatic drivers	Timeframe	Risk & potential for adaptation
Wildfire-induced loss of ecosystem integrity, property loss, human morbidity, and mortality as a result of increased drying trend and temperature trend (*high confidence*) [26.4, 26.8, Box 26-2]	• Some ecosystems are more fire-adapted than others. Forest managers and municipal planners are increasingly incorporating fire protection measures (e.g., prescribed burning, introduction of resilient vegetation). Institutional capacity to support ecosystem adaptation is limited. • Adaptation of human settlements is constrained by rapid private property development in high-risk areas and by limited household-level adaptive capacity. • Agroforestry can be an effective strategy for reduction of slash and burn practices in Mexico.		Present Near term (2030–2040) Long term (2080–2100) 2°C 4°C	Very low · Medium · Very high
Heat-related human mortality (*high confidence*) [26.6, 26.8]	• Residential air conditioning (A/C) can effectively reduce risk. However, availability and usage of A/C is highly variable and is subject to complete loss during power failures. Vulnerable populations include athletes and outdoor workers for whom A/C is not available. • Community- and household-scale adaptations have the potential to reduce exposure to heat extremes via family support, early heat warning systems, cooling centers, greening, and high-albedo surfaces.		Present Near term (2030–2040) Long term (2080–2100) 2°C 4°C	Very low · Medium · Very high
Urban floods in riverine and coastal areas, inducing property and infrastructure damage; supply chain, ecosystem, and social system disruption; public health impacts; and water quality impairment, due to sea level rise, extreme precipitation, and cyclones (*high confidence*) [26.2-4, 26.8]	• Implementing management of urban drainage is expensive and disruptive to urban areas. • Low-regret strategies with co-benefits include less impervious surfaces leading to more groundwater recharge, green infrastructure, and rooftop gardens. • Sea level rise increases water elevations in coastal outfalls, which impedes drainage. In many cases, older rainfall design standards are being used that need to be updated to reflect current climate conditions. • Conservation of wetlands, including mangroves, and land-use planning strategies can reduce the intensity of flood events.		Present Near term (2030–2040) Long term (2080–2100) 2°C 4°C	Very low · Medium · Very high

EFFECTIVE CLIMATE CHANGE ADAPTATION

A MORE VIBRANT WORLD

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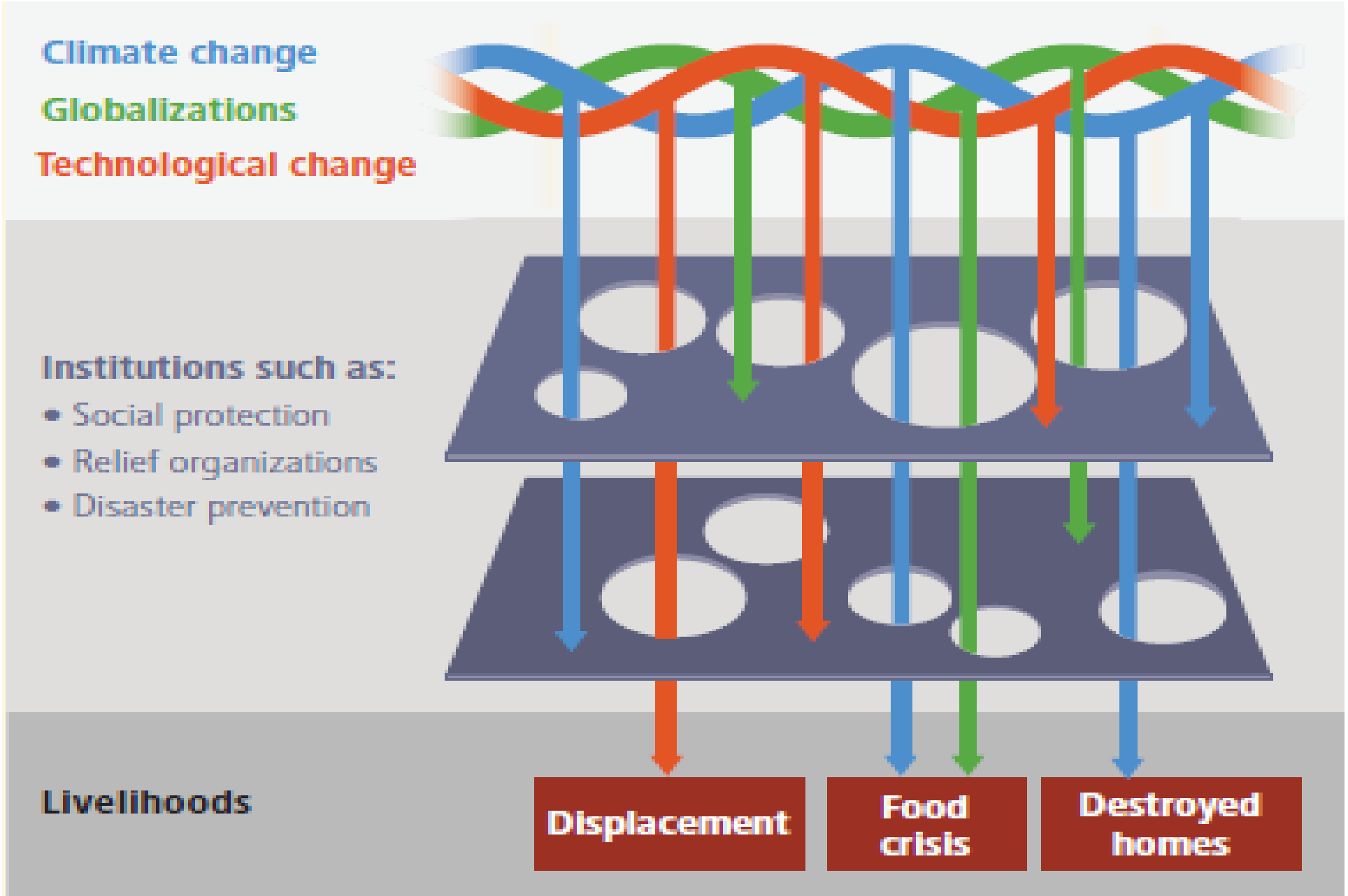
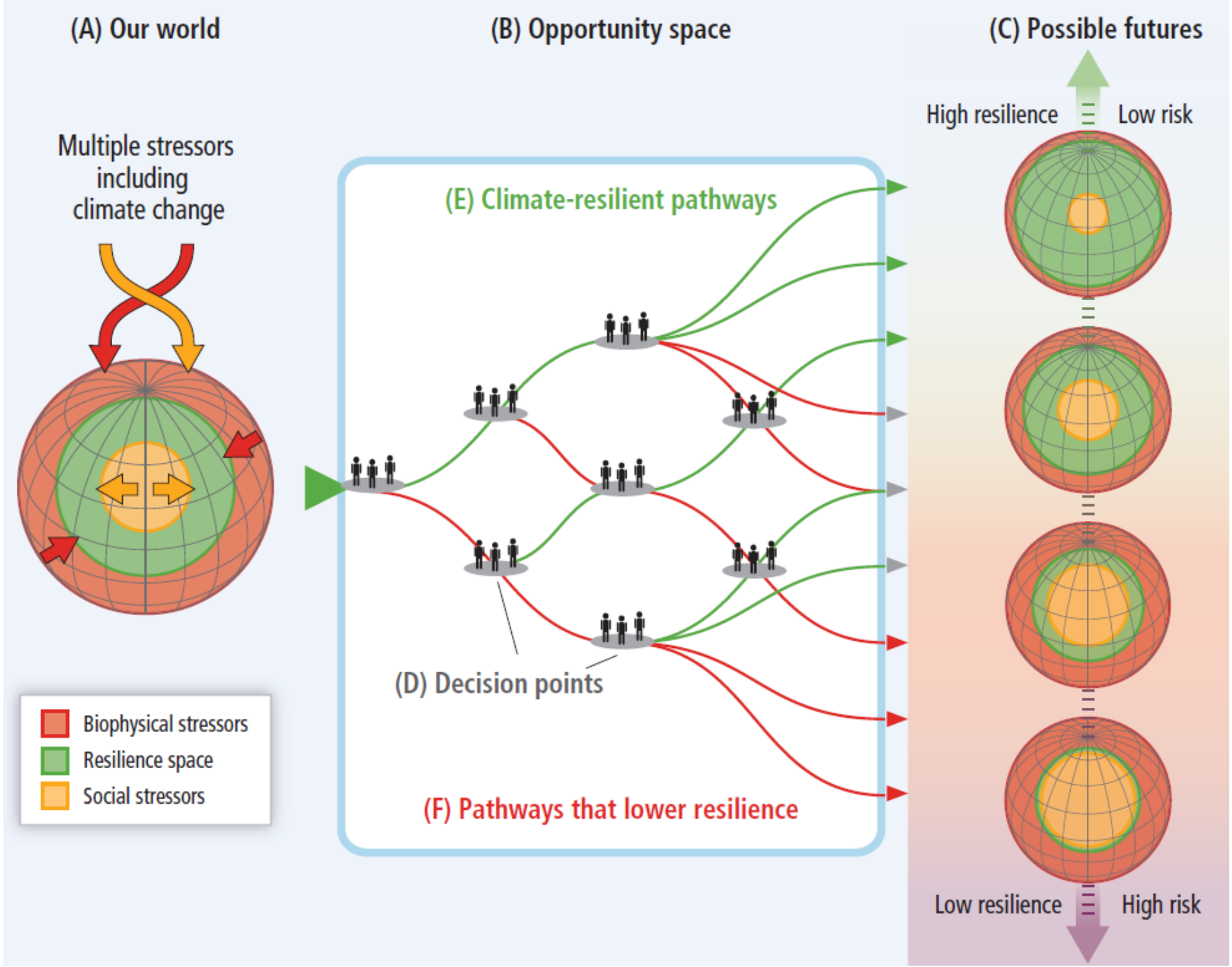
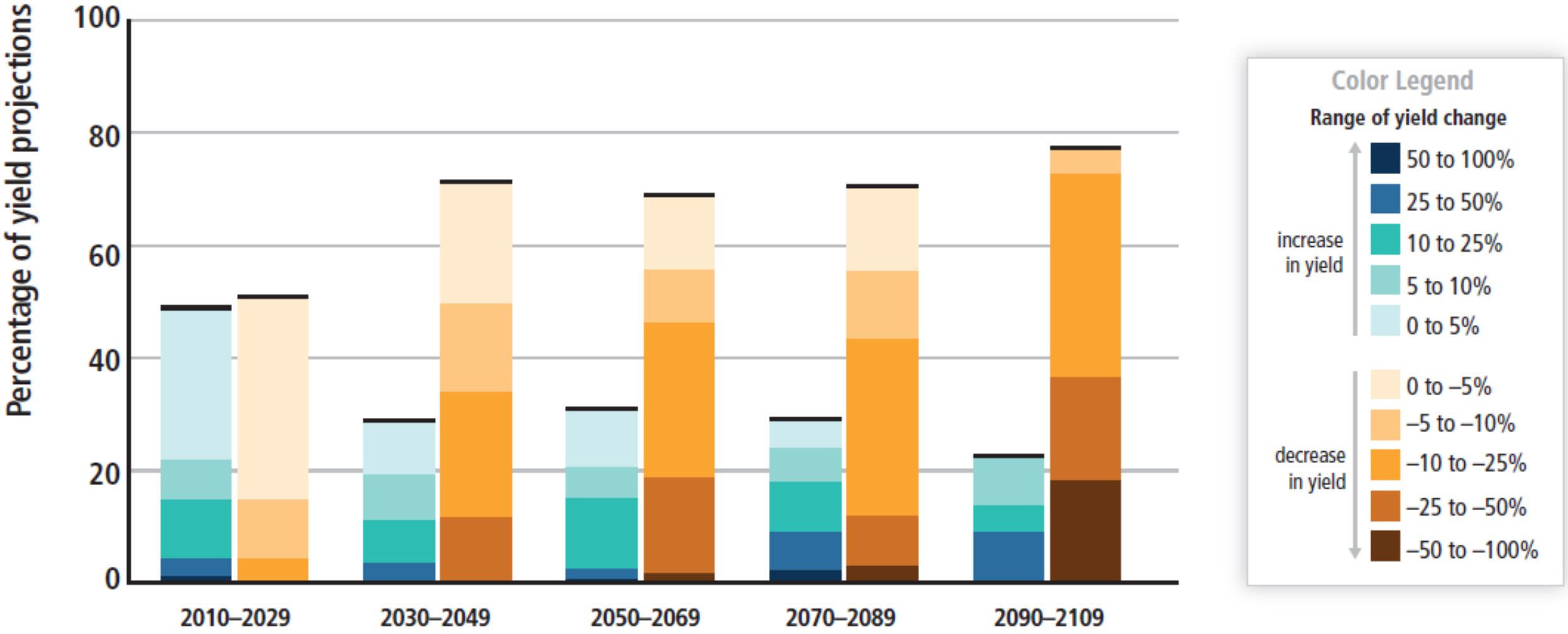
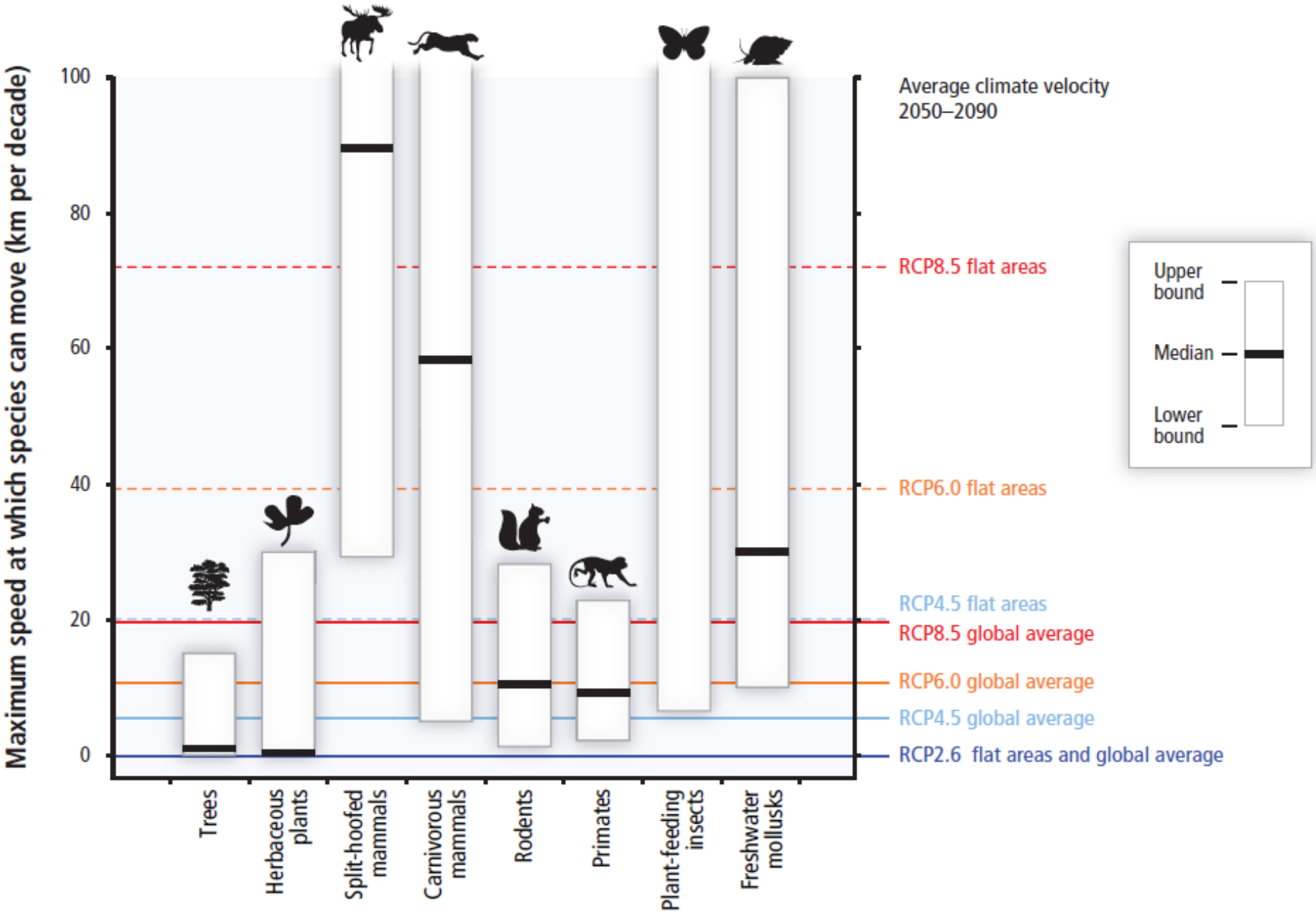
Multiple stressors




(A) Our world
(B) Opportunity space
(C) Possible futures
Multiple stressors including climate change
(E) Climate-resilient pathways
(D) Decision points
(F) Pathways that lower resilience
High resilience
Low risk
Low resilience
High risk
Biophysical stressors
Resilience space
Social stressors

Food security and projected changes in crop yields



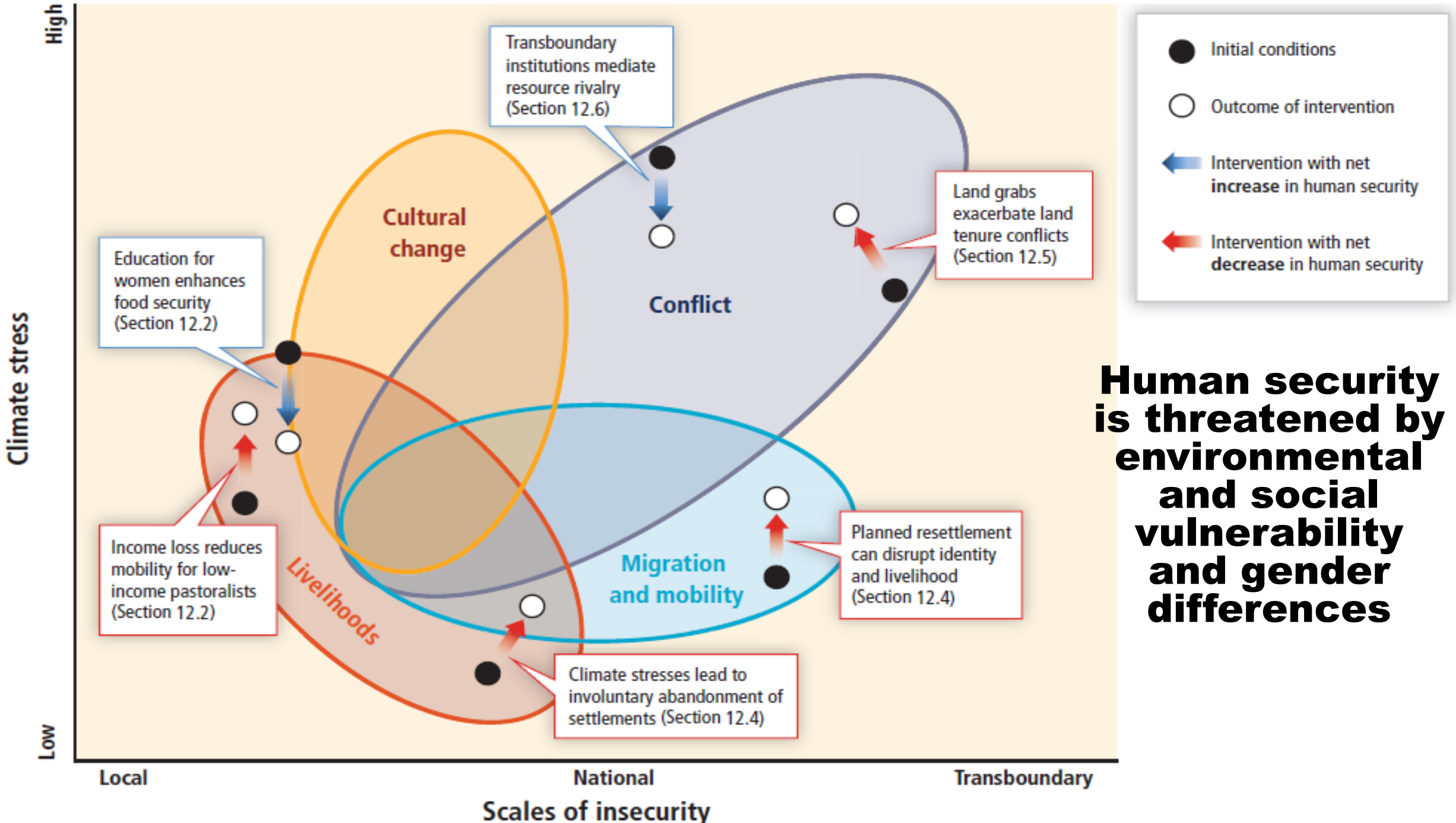


Adaptation and movement of different species

Human health

Until mid-century, projected climate change will impact human health mainly by exacerbating health problems that already exist (*very high confidence*). Throughout the 21st century, climate change is expected to lead to increases in ill-health in many regions and especially in developing countries with low income, as compared to a baseline without climate change (*high confidence*). Examples include greater likelihood of **injury, disease, and death** due to more intense **heat waves and fires** (*very high confidence*); increased likelihood of **under-nutrition** resulting from diminished food production in poor regions (*high confidence*); risks from lost work capacity and **reduced labor productivity** in vulnerable populations; and increased risks from **food- and water-borne diseases** (*very high confidence*) and **vector-borne diseases** (*medium confidence*). Positive effects are expected to include modest reductions in **cold-related mortality and morbidity** in some areas due to fewer cold extremes (*low confidence*), geographical shifts in food production (*medium confidence*), and reduced capacity of vectors to transmit some diseases.

But globally over the 21st century, the magnitude and **severity of negative impacts** are projected to increasingly outweigh positive impacts (*high confidence*). The most effective vulnerability reduction measures for health in the near term are programs that implement and improve basic public health measures such as provision of **clean water and sanitation**, secure essential health care including vaccination and child health services, increase capacity for disaster preparedness and response, and alleviate poverty (*very high confidence*). By 2100 for the high-emission scenario RCP8.5, the combination of high temperature and humidity in some areas for parts of the year is **projected to compromise normal human activitie**s, including **growing food or working outdoors** (*high confidence*).



Human security is threatened by environmental and social vulnerability and gender differences

Human security

Climate change over the 21st century is projected to increase displacement of people (*medium evidence*, *high agreement*). Displacement risk increases when populations that lack the resources for planned migration experience higher exposure to extreme weather events, in both rural and urban areas, particularly in developing countries with low income. Expanding opportunities for mobility can reduce vulnerability for such populations. Changes in migration patterns can be responses to both extreme weather events and longer-term climate variability and change, and migration can also be an effective adaptation strategy. There is *low confidence* in quantitative projections of changes in mobility, due to its complex, multi-causal nature.63

Climate change can indirectly increase risks of violent conflicts in the form of civil war and inter-group violence by amplifying well-documented drivers of these conflicts such as poverty and economic shocks (*medium confidence*). Multiple lines of evidence relate climate variability to these forms of conflict.

The impacts of climate change on the critical infrastructure and territorial integrity of many states are expected to influence national security policies (*medium evidence*, *medium agreement*). For example, land inundation due to sea level rise poses risks to the territorial integrity of small island states and states with extensive coastlines. Some transboundary impacts of climate change, such as changes in sea ice, shared water resources, and pelagic fish stocks, have the potential to increase rivalry among states, but robust national and intergovernmental institutions can enhance cooperation and manage many of these rivalries.

Urban Areas

Many global risks of climate change are concentrated in urban areas (*medium confidence*). Steps that build resilience and enable sustainable development can accelerate successful climate-change adaptation globally. Heat stress, extreme precipitation, inland and coastal flooding, landslides, air pollution, drought, and water scarcity pose risks in urban areas for people, assets, economies, and ecosystems (*very high confidence*). Risks are amplified for those lacking essential infrastructure and services or living in poor-quality housing and exposed areas. Reducing basic service deficits, improving housing, and building resilient infrastructure systems could significantly reduce vulnerability and exposure in urban areas. Urban adaptation benefits from effective multi-level urban risk governance, alignment of policies and incentives, strengthened local government and community adaptation capacity, synergies with the private sector, and appropriate financing and institutional development (*medium confidence*). Increased capacity, voice, and influence of low-income groups and vulnerable communities and their partnerships with local governments also benefit adaptation.

Rural areas

Major future rural impacts are expected in the near term and beyond through impacts on water availability and supply, food security, and agricultural incomes, including shifts in production areas of food and non-food crops across the world (*high confidence*). These impacts are expected to disproportionately affect the welfare of the poor in rural areas, such as female-headed households and those with limited access to land, modern agricultural inputs, infrastructure, and education. Further adaptations for agriculture, water, forestry, and biodiversity can occur through policies taking account of rural decision-making contexts. Trade reform and investment can improve market access for small-scale farms (*medium confidence*).

Thank you for your attention

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