Adaptation to Climate Change

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Training Programme on Climate Change for Bhutanese Policymakers

5-9 February 2018, NIES, Tsukuba

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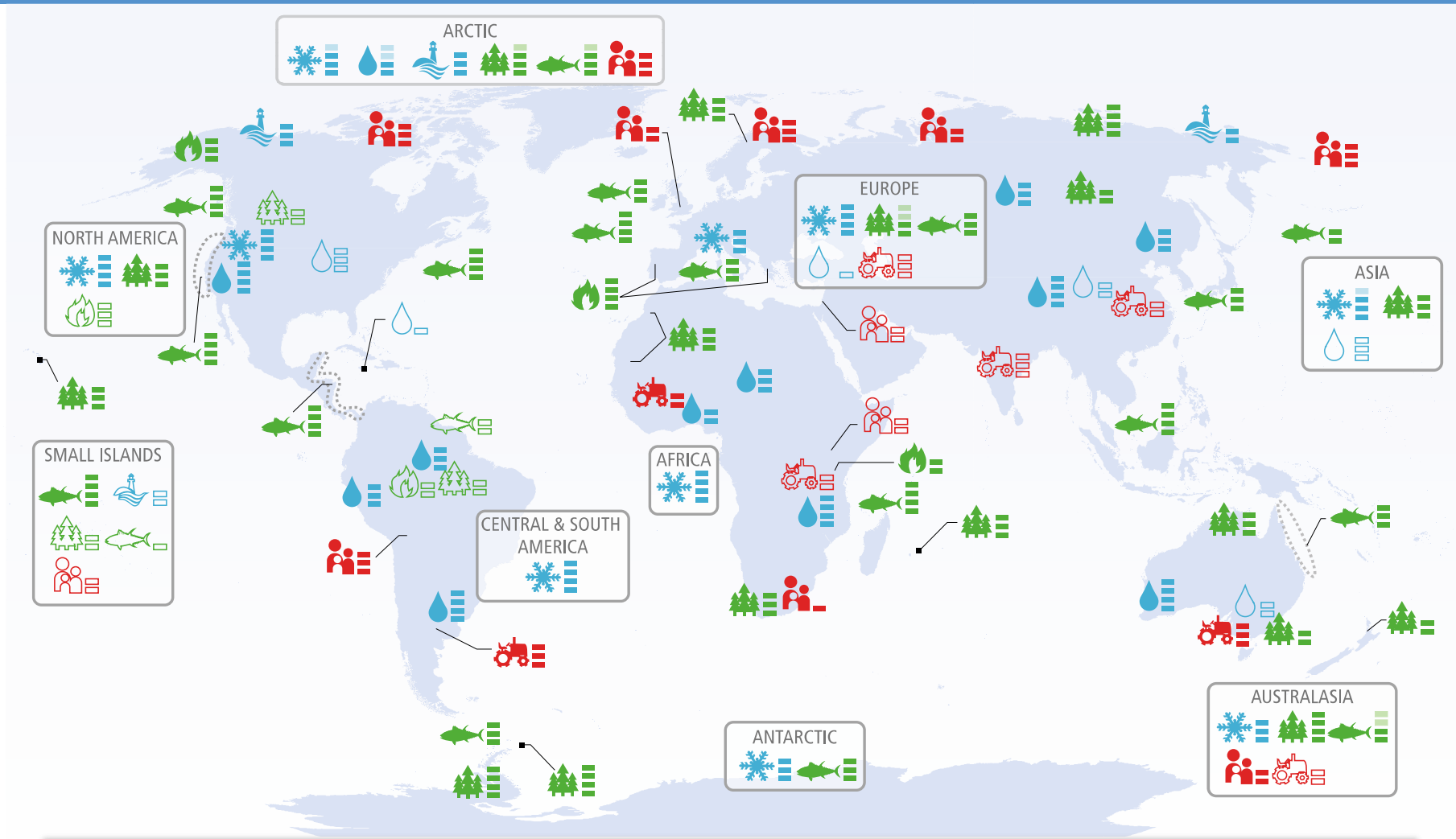
Climate Change Impacts

- **Effects on natural and human systems**.
- In IPCC WGII AR5, 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**.

Observed Climate Change Impacts

- In recent decades, changes in climate **have caused impacts** on natural and human systems on all continents and across the oceans.

- Impacts are due to observed climate change, irrespective of its cause, **indicating the sensitivity of natural and human systems** to changing climate.

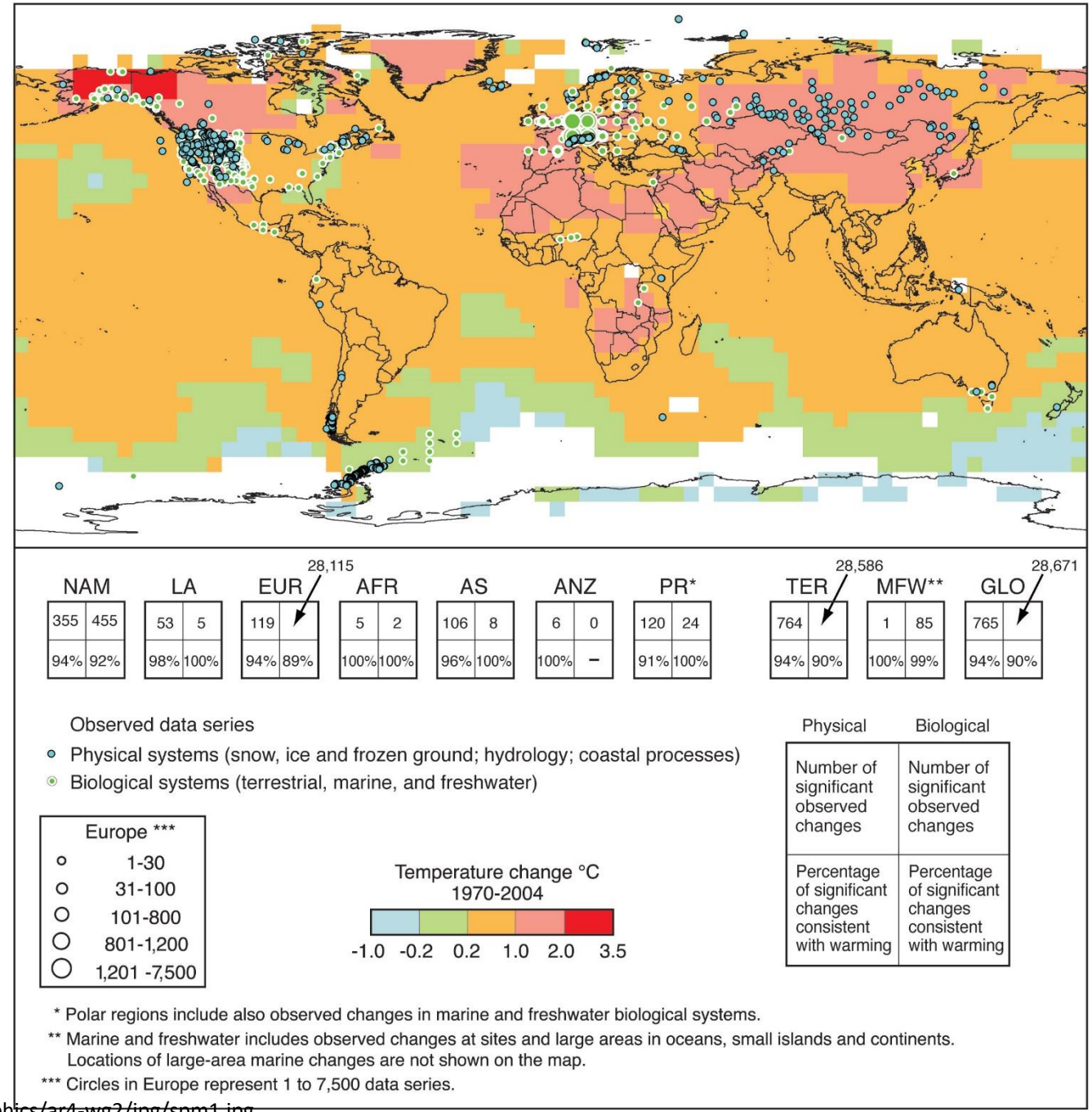


https://ipcc-wg2.gov/AR5/images/uploads/WG2AR5_SPM_FINAL.pdf

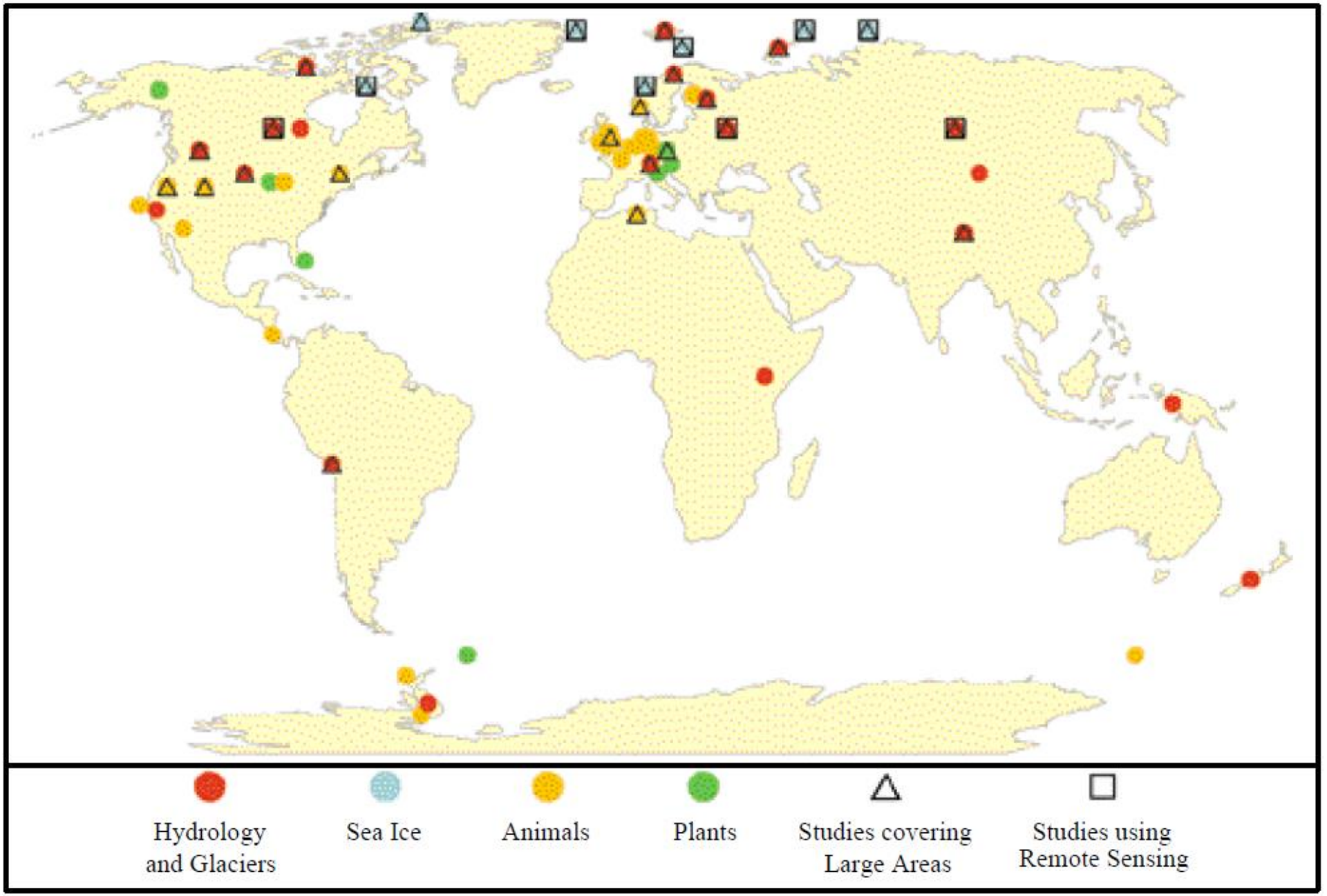
Table SPM.A1 (Asia)

Observed impacts attributed to climate change reported in the scientific literature since the AR4

Snow & Ice, Rivers & Lakes, Floods & Drought	● Permafrost degradation in Siberia, Central Asia, and Tibetan Plateau (***HC***, Major C from CC) ● Shrinking mountain glaciers across most of Asia (***MC***, Major C from CC) ● Changed water availability in many Chinese rivers, beyond changes due to land use (***LC***, Minor C from CC) ● Increased flow in several rivers due to shrinking glaciers (***HC***, Major C from CC) ● Earlier timing of maximum spring flood in Russian rivers (***MC***, Major C from CC) ● Reduced soil moisture in north-central and northeast China (1950 – 2006) (***MC***, Major C from CC) ● Surface water degradation in parts of Asia, beyond changes due to land use (***MC***, Minor C from CC)
Terrestrial Ecosystems	● Changes in plant phenology and growth in many parts of Asia (earlier greening), particularly in the north and east (***MC***, Major C from CC) ● Distribution shifts of many plant and animal species upwards in elevation or polewards, particularly in the north of Asia (***MC***, Major C from CC) ● Invasion of Siberian larch forests by pine and spruce during recent decades (***LC***, Major C from CC) ● Advance of shrubs into the Siberian tundra (***HC***, Major C from CC)
Coastal Erosion & Marine Ecosystems	● Decline in coral reefs in tropical Asian waters, beyond decline due to human impacts (***HC***, Major C from CC) ● Northward range extension of corals in the East China Sea and western Pacific, and of a predatory fish in the Sea of Japan (***MC***, Major C from CC) ● Shift from sardines to anchovies in the western North Pacific, beyond fluctuations due to fisheries (***LC***, Major C from CC) ● Increased coastal erosion in Arctic Asia (***LC***, Major C from CC)
Food Production & Livelihoods	● Impacts on livelihoods of indigenous groups in Arctic Russia, beyond economic and sociopolitical changes (***LC***, Major C from CC) ● Negative impacts on aggregate wheat yields in South Asia, beyond increase due to improved technology (***MC***, Minor C from CC) ● Negative impacts on aggregate wheat and maize yields in China, beyond increase due to improved technology (***LC***, Minor C from CC) ● Increases in a water-borne disease in Israel (***LC***, Minor C from CC)



http://www.ipcc.ch/graphics/ar4-wg2/jpg/spm1.jpg

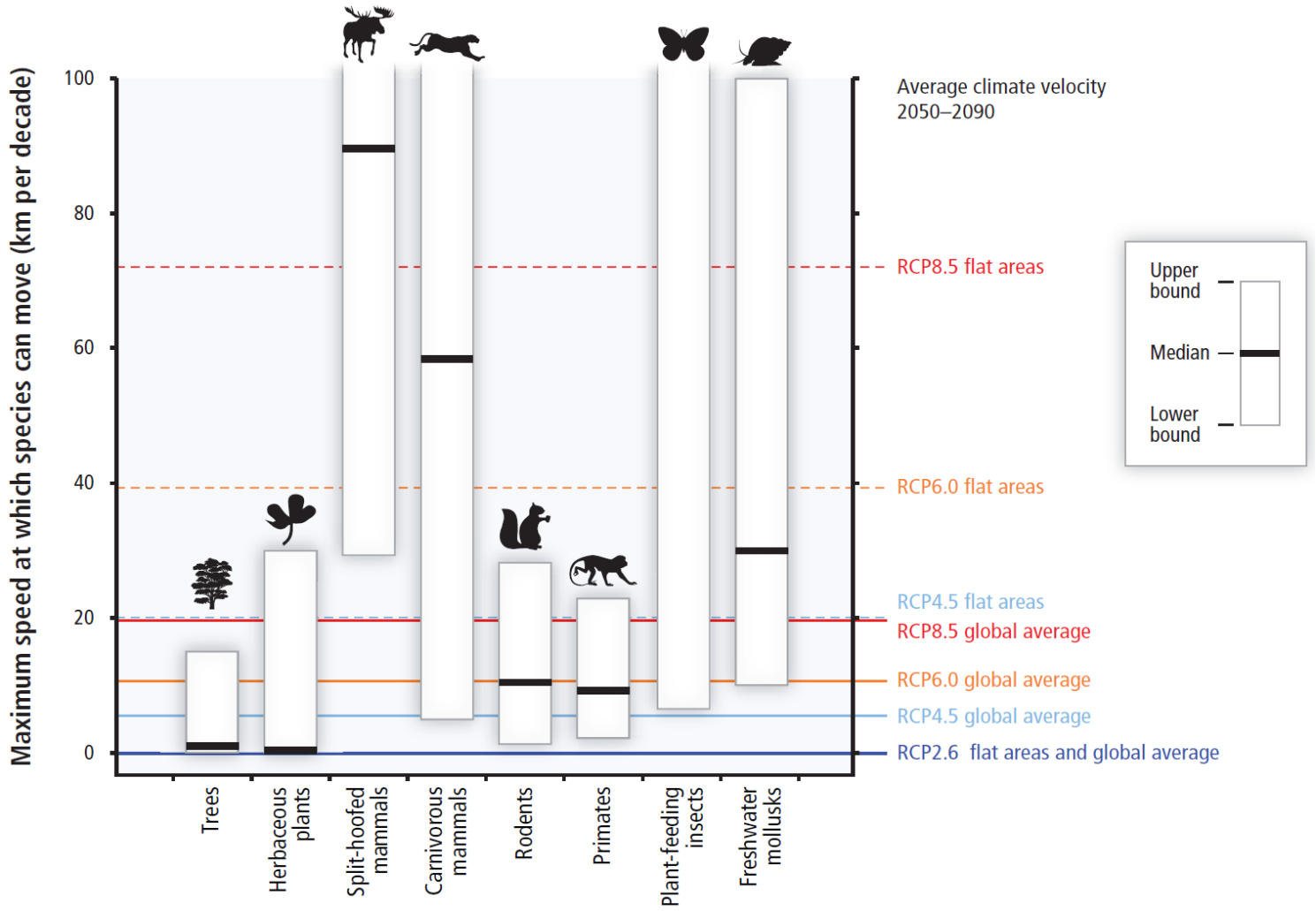


http://www.grida.no/climate/ipcc_tar/vol4/english/pdf/wg2spm.pdf

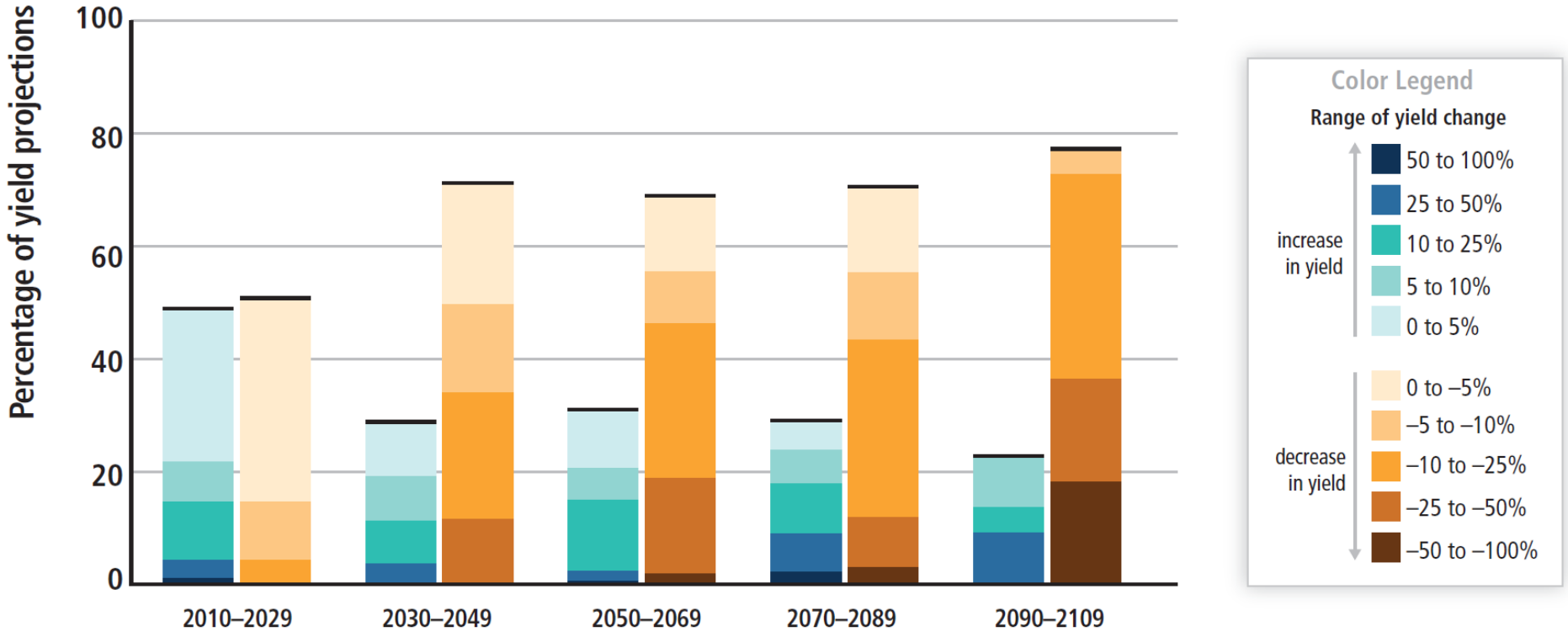
Future Climate Change Impacts

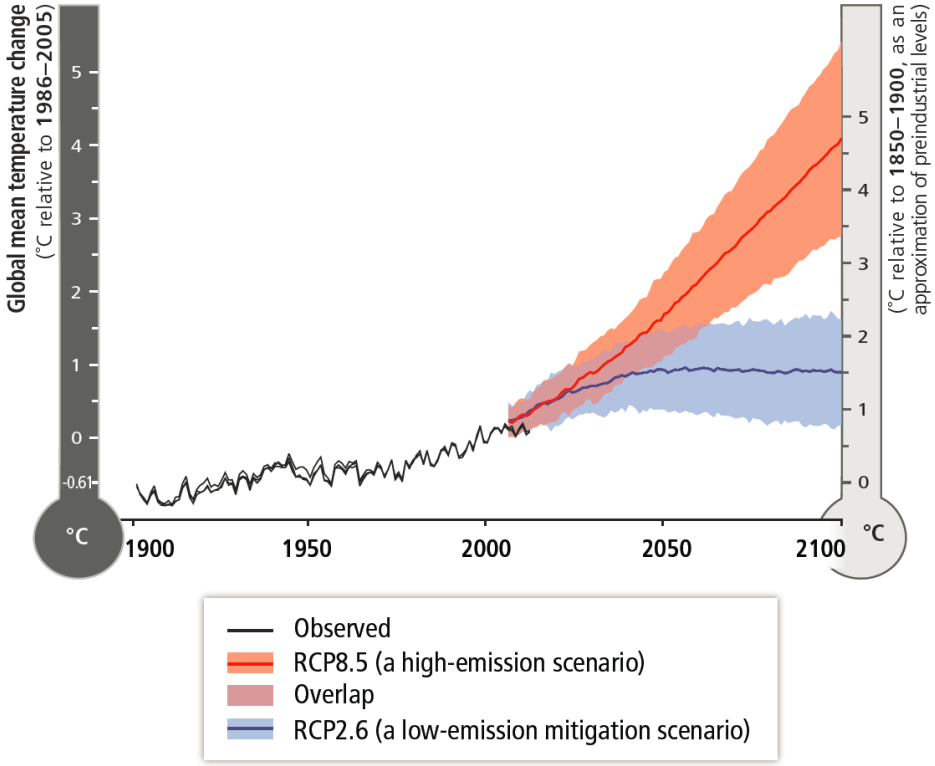
- Climate change **will amplify** existing risks and create new risks for natural and human systems. Risks are **unevenly distributed** and are generally greater for disadvantaged people and communities in countries at all levels of development.

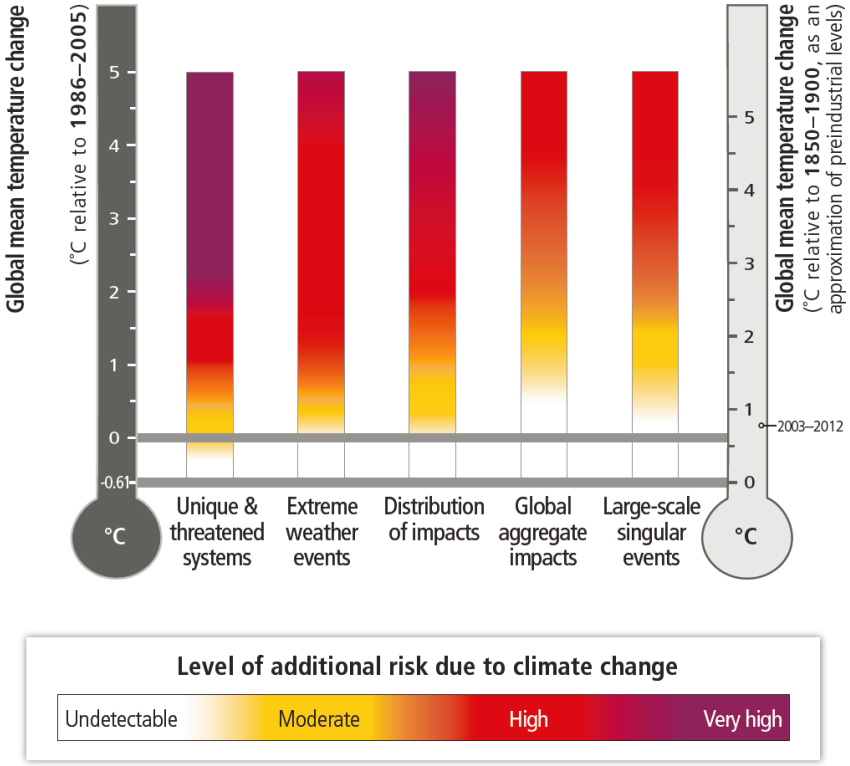
Maximum speeds at which species can move across landscapes (based on observations and models; vertical axis on left), compared with speeds at which temperatures are projected to move across landscapes (climate velocities for temperature; vertical axis on right). Human interventions, such as transport or habitat fragmentation, can greatly increase or decrease speeds of movement. White boxes with black bars indicate ranges and medians of maximum movement speeds for trees, plants, mammals, plant-feeding insects (median not estimated), and freshwater mollusks. For RCP2.6, 4.5, 6.0, and 8.5 for 2050–2090, horizontal lines show climate velocity for the global-land-area average and for large flat regions. Species with maximum speeds below each line are expected to be unable to track warming in the absence of human intervention.



Summary of projected changes in crop yields, due to climate change over the 21st century. The figure includes projections for different emission scenarios, for tropical and temperate regions, and for adaptation and no-adaptation cases combined. Relatively few studies have considered impacts on cropping systems for scenarios where global mean temperatures increase by 4°C or more. For five timeframes in the near term and long term, data (n=1090) are plotted in the 20-year period on the horizontal axis that includes the midpoint of each future projection period. Changes in crop yields are relative to late-20th-century levels. Data for each timeframe sum to 100%.







http://ipcc-wg2.gov/AR5/images/uploads/WG2AR5_SPM_FINAL.pdf

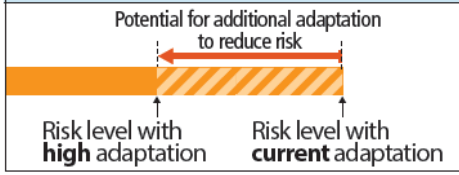
http://ipcc-wg2.gov/AR5/press-events/press-kit/

Assessment Box SPM.2 Table 1 (Asia)

Key regional risks from climate change and the potential for reducing risks through adaptation and mitigation

Climate-related drivers of impacts						
Warming trend	Extreme temperature	Extreme precipitation	Drying trend	Damaging cyclone	Sea level	Ocean acidification

Level of risk & potential for adaptation



Asia

Key risk	Adaptation issues & prospects	Climatic drivers	Timeframe	Risk & potential for adaptation (Very low / Medium / Very high)
Increased riverine, coastal, and urban flooding leading to widespread damage to infrastructure, livelihoods, and settlements in Asia (*medium confidence*) [24.4]	• Exposure reduction via structural and non-structural measures, effective land-use planning, and selective relocation • Reduction in the vulnerability of lifeline infrastructure and services (e.g., water, energy, waste management, food, biomass, mobility, local ecosystems, telecommunications) • Construction of monitoring and early warning systems; Measures to identify exposed areas, assist vulnerable areas and households, and diversify livelihoods • Economic diversification		Present Near term (2030–2040) Long term (2080–2100) 2°C / 4°C	
Increased risk of heat-related mortality (*high confidence*) [24.4]	• Heat health warning systems • Urban planning to reduce heat islands; Improvement of the built environment; Development of sustainable cities • New work practices to avoid heat stress among outdoor workers		Present Near term (2030–2040) Long term (2080–2100) 2°C / 4°C	
Increased risk of drought-related water and food shortage causing malnutrition (*high confidence*) [24.4]	• Disaster preparedness including early-warning systems and local coping strategies • Adaptive/integrated water resource management • Water infrastructure and reservoir development • Diversification of water sources including water re-use • More efficient use of water (e.g., improved agricultural practices, irrigation management, and resilient agriculture)		Present Near term (2030–2040) Long term (2080–2100) 2°C / 4°C	

Climate Change Impact Assessment in Asia
-Executive Summary (1)-

- Warming trends and increasing temperature extremes have been observed across most of the Asian region over the past century (*high confidence*).
- Water scarcity is expected to be a major challenge for most of the region as a result of increased water demand and lack of good management (*medium confidence*)
- The impacts of climate change on food production and food security in Asia will vary by region, with many regions to experience a decline in productivity (*medium confidence*).

Climate Change Impact Assessment in Asia
-Executive Summary (2)-

- Terrestrial systems in many parts of Asia have responded to recent climate change with shifts in the phenologies, growth rates, and the distributions of plant species, and with permafrost degradation, and the projected changes in climate during the 21st century will increase these impacts (*high confidence*).
- Coastal and marine systems in Asia are under increasing stress from both climatic and non-climatic drivers (*high confidence*)

Climate Change Impact Assessment in Asia
-Executive Summary (3)-

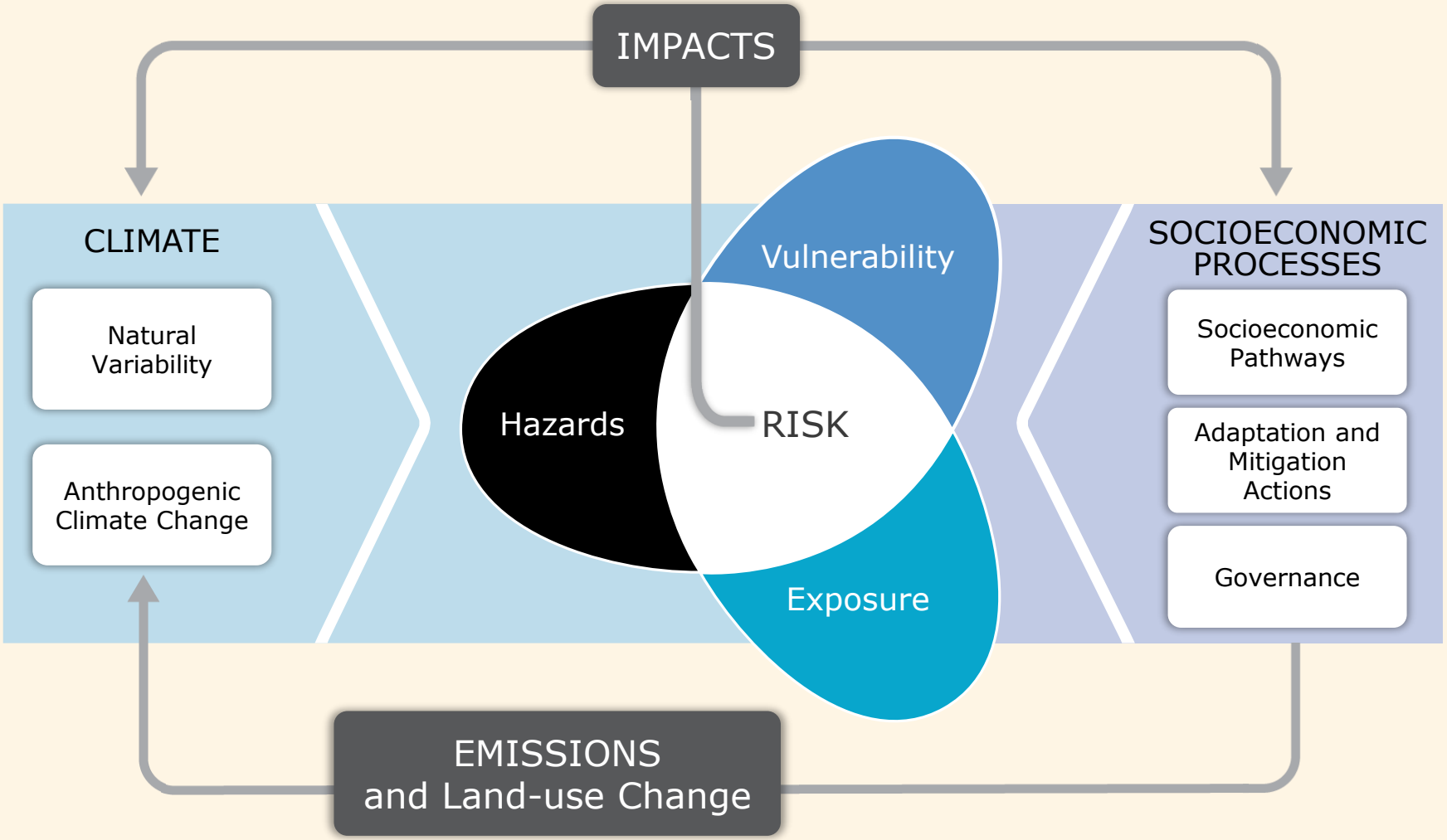
- Multiple stresses caused by rapid urbanization, industrialization, and economic development will be compounded by climate change (*high confidence*).
- Extreme climate events will have an increasing impact on human health, security, livelihoods, and poverty, with the type and magnitude of impact varying across Asia (*high confidence*).
- Studies of observed climate changes and their impacts are still inadequate for many areas, particularly in North, Central, and West Asia (*high confidence*).

Mitigation and Adaptation (1)

- **Without additional mitigation** efforts beyond those in place today, and even with adaptation, warming by the end of the 21st century will lead to **high to very high risk** of severe, widespread and irreversible impacts globally.

Mitigation and Adaptation (2)

1. Implementing GHG reductions poses substantial technological, economic, social and institutional challenges, **which increase with delays in additional mitigation and if key technologies are not available**.
2. **Adaptation** and **mitigation** are **complementary strategies** for reducing and managing the risks of climate change.
3. **Inertia** in many aspects of the socio-economic system **constrains** adaptation and mitigation options


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

Hazards, Vulnerability, Exposure and Risk

- **Hazards**: 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 the IPCC WGII AR5, the term hazard usually refers to **climate-related physical events or trends or their physical impacts**.
- **Vulnerability:** Adaptation that does not constitute a conscious response to climatic stimuli but is **triggered by ecological** changes in natural systems and **by market** or **welfare** changes in human systems. Also referred to as spontaneous adaptation.
- **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**.
- **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. In the IPCC WGII AR5, the term risk is used primarily to refer to the **risks of climate-change impacts**.

IPCC WGII AR5 Video

Climate Change 2014: Impacts, Adaptation, and Vulnerability

https://youtu.be/jMIFBJYpSgM

12’ 04’’

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Adaptation definition

Adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities. Various types of adaptation can be distinguished, including anticipatory, autonomous and planned adaptation:

- **Anticipatory adaptation**: Adaptation that takes place before impacts of climate change are observed. Also referred to as proactive adaptation.
- **Autonomous adaptation:** Adaptation that does not constitute a conscious response to climatic stimuli but is triggered by ecological changes in natural systems and by market or welfare changes in human systems. Also referred to as spontaneous adaptation.
- **Planned adaptation**: Adaptation that is the result of a deliberate policy decision, based on an awareness that conditions have changed or are about to change and that action is required to return to, maintain, or achieve a desired state.

Contents of IPCC WGII AR4 (2007)

1. Assessment of observed changes and responses in natural and managed systems
2. New assessment methods and the characterisation of future conditions
3. Freshwater resources and their management
4. Ecosystem, their properties, goods and services
5. Food, fibre and forest products
6. Coastal systems and low-lying areas
7. Industry, settlement and society
8. Human health
9. Africa
10. Asia
11. Australia and New Zealand
12. Europe
13. Latin America
14. North America
15. Polar Regions (Arctic and Antarctic)
16. Small islands
17. **Assessment of adaptation practices, options, constraints and capacity**
18 .Inter-relationships between adaptation and mitigation
19. Assessing key vulnerabilities and the risk from climate change
20. Perspectives on climate change and sustainability

Contents of IPCC WGII AR5 (2014)

PART A: GLOBAL AND SECTORAL ASPECTS

Context for the AR5

Ch. 1 Point of departure

Ch. 2 Foundations for decisionmaking

Natural and Managed Resources and Systems, and Their Uses

Ch. 3 Freshwater resources

Ch. 4 Terrestrial and inland water systems

Ch. 5 Coastal systems and low-lying areas

Ch. 6 Ocean systems

Ch. 7 Food production systems and food security,

Human Settlements, Industry, and Infrastructure

Ch. 8 Urban Areas

Ch. 9 Rural Areas

Ch. 10 Key economic sectors and services

Human Health, Well-Being, and Security

Ch. 11 — Human health

Ch. 12 — Human security

Ch. 13 — Livelihoods and poverty

Adaptation

Ch. 14 Adaptation needs and options

Ch. 15 Adaptation planning and implementation

Ch. 16 Adaptation opportunities, constraints, and limits

Ch. 17 Economics of adaptation

Multi-Sector Impacts, Risks, Vulnerabilities, and Opportunities

Ch. 18 — Detection and attribution of observed impacts

Ch. 19 — Emergent risks and key vulnerabilities

Ch. 20 — Climate-resilient pathways: adaptation, mitigation, and sustainable development

PART B: REGIONAL ASPECTS

Ch. 21 — Regional context

Regional Chapters

Ch. 22 Africa, Ch. 23 Europe, Ch. 24 Asia, Ch. 25 Australasia, Ch. 26 North America, Ch. 27 Central and South America, Ch. 28 Polar Regions, Ch. 29 Small Islands, Ch. 30 Open Oceans

Adaptation Videos

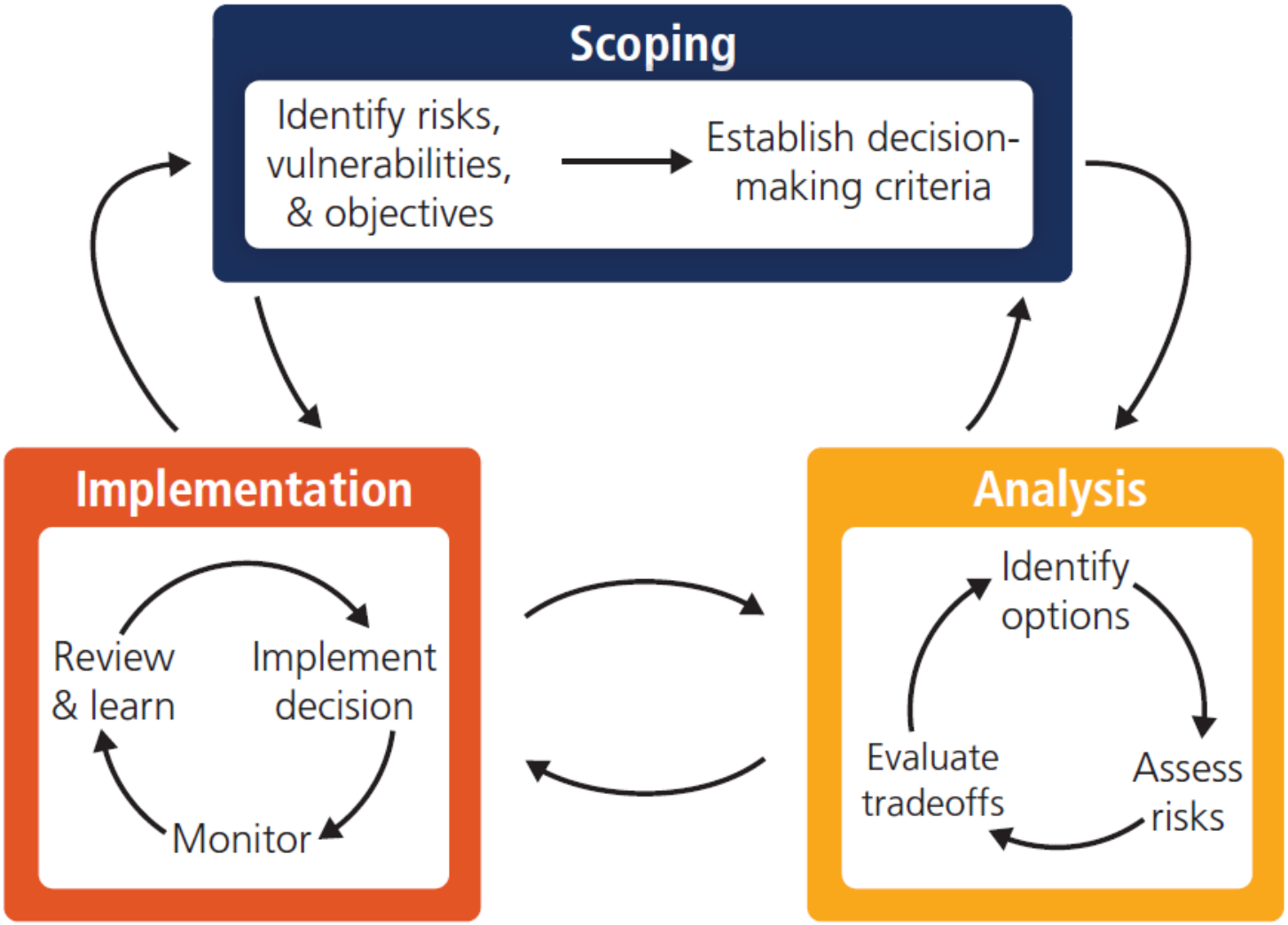
Adapting to a changing climate (UNFCCC, 19’33”)

https://www.youtube.com/watch?v=lGMx2xP3dcM

Climate Change Adaptation: it‘s time for decisions now (GIZ, 5’41”)

https://www.youtube.com/watch?v=FO46sPwm4xk

Climate-change adaptation as an iterative risk management process with multiple feedbacks. People and knowledge shape the process and its outcomes.



Toward New Paradigm of Adaptation (1)

- Adaptation is **place- and context-specific**, with no single approach for reducing risks appropriate across all settings.
- Adaptation planning and implementation can be enhanced through **complementary actions** across levels, from individuals to governments.
- A **first step** towards adaptation to future climate change is **reducing vulnerability and exposure to present climate variability**. Strategies include actions with co-benefits for other objectives.
- Adaptation planning and implementation at all levels of governance are **contingent on societal values, objectives, and risk perceptions**. **Recognition** of diverse interests, circumstances, social-cultural contexts, and expectations can benefit decision-making processes.

Toward New Paradigm of Adaptation (2)

- **Decision support** is most effective when it is sensitive to context and the diversity of decision types, decision processes, and constituencies.
- Existing and emerging **economic instruments** can foster adaptation by providing incentives for anticipating and reducing impacts.
- **Constraints** can interact to impede adaptation planning and implementation.
- Poor planning, overemphasizing short-term outcomes, or failing to sufficiently anticipate consequences can result in **maladaptation**.
- **Limited evidence** indicates a **gap** between global adaptation **needs** and the **funds** available for adaptation.

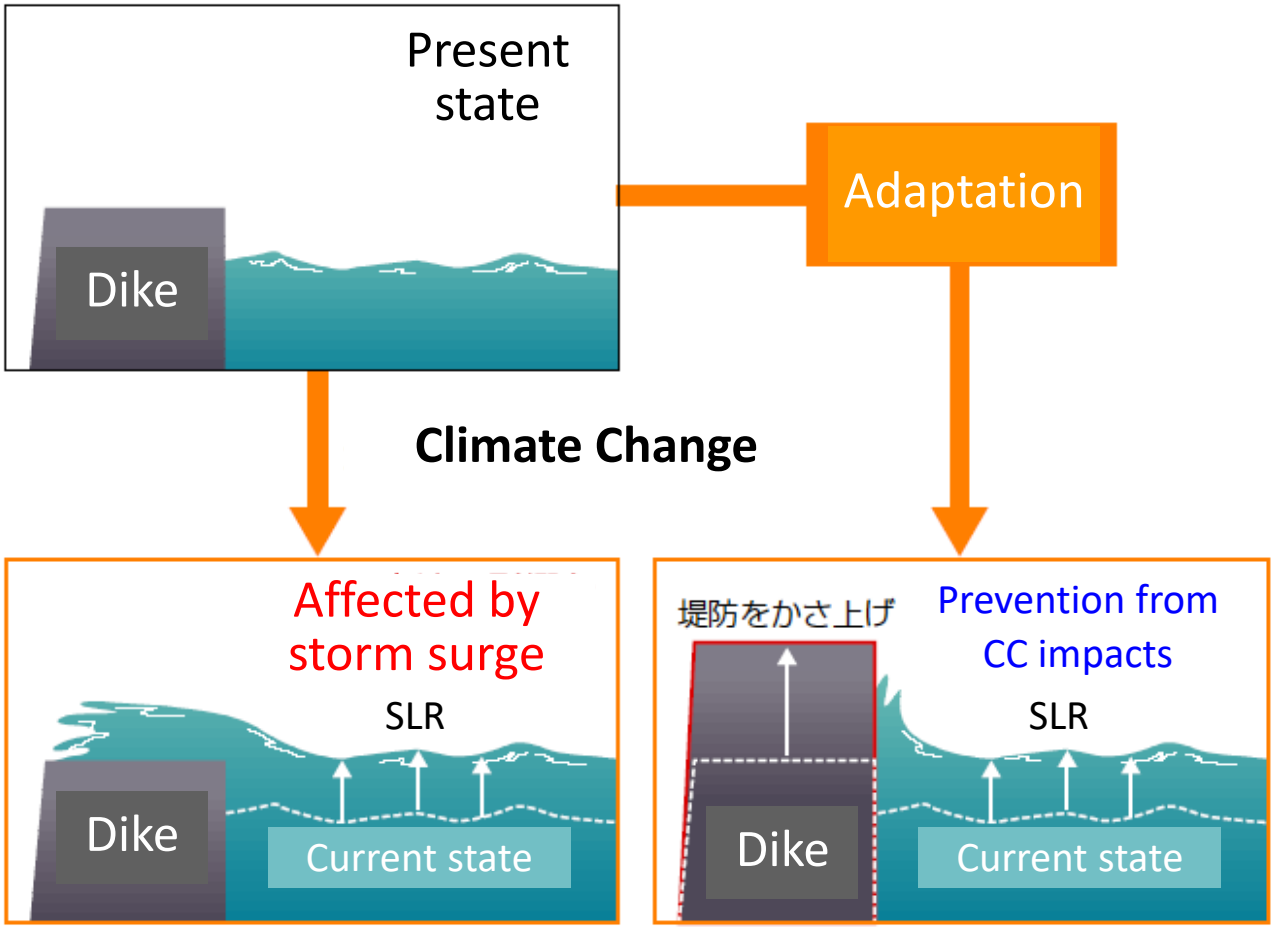
Toward New Paradigm of Adaptation (3)

- **Significant co-benefits**, **synergies**, and **trade-offs** exist between mitigation and adaptation and among different adaptation responses; interactions occur both within and across regions.
- Prospects for **climate-resilient pathways** for sustainable development are related fundamentally to what the world accomplishes with **climate-change mitigation**.
- **Greater rates and magnitude of climate change** increase the likelihood of **exceeding adaptation limits**.
- **Transformations** in economic, social, technological, and political decisions and actions can enable climate-resilient pathways.

Adaptation Experience in Asia

- In Asia, adaptation is being facilitated in some areas through mainstreaming climate adaptation action into **subnational development planning**, **early warning systems**, **integrated water resources management**, **agroforestry**, and **coastal reforestation of mangroves**.

Example of adaptation (1)



Adaptation option for Sea Level Rise

出典： STOP THE 温暖化 2005

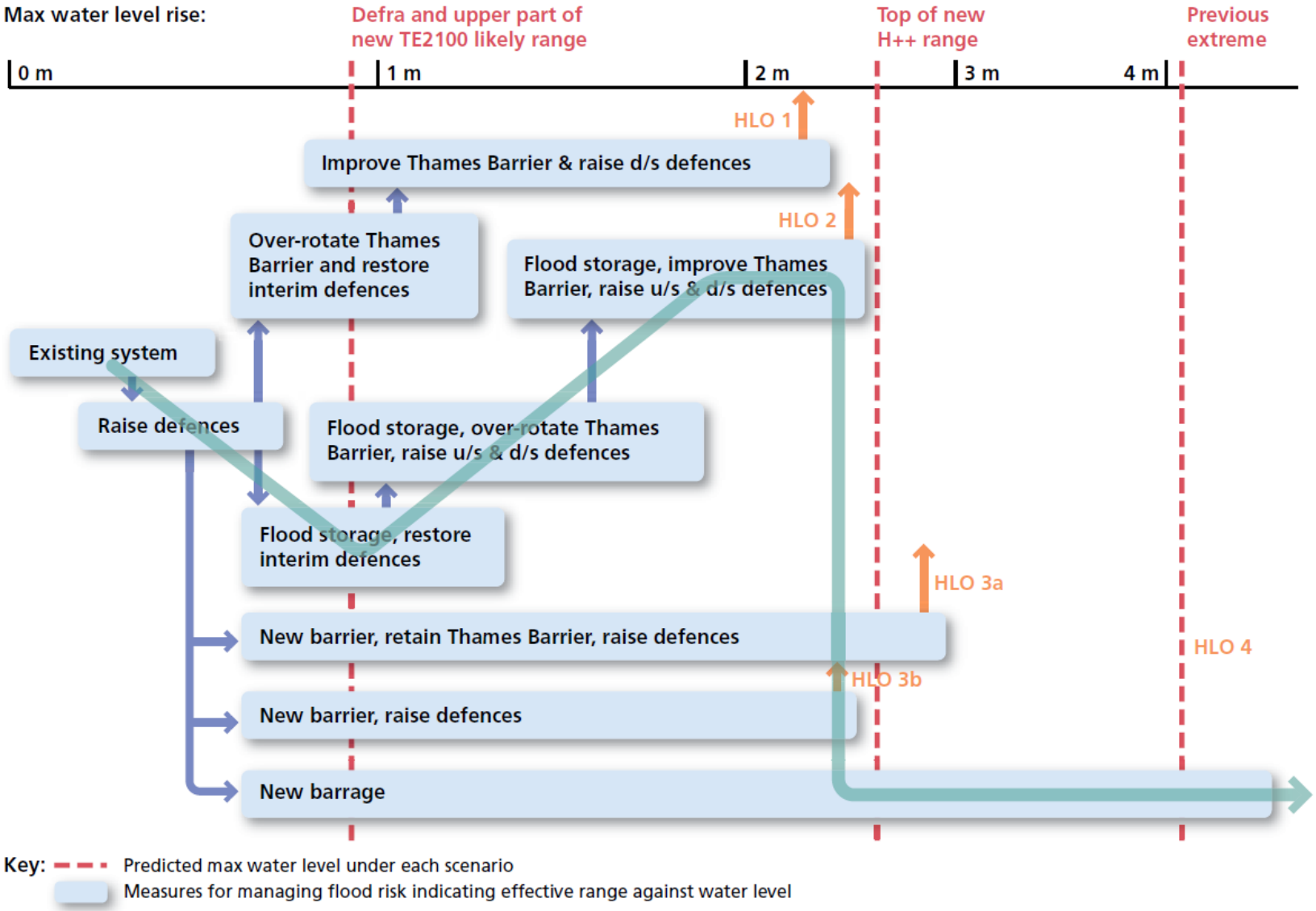
Example of adaptation (2)

- Thames Barrier -

Example of adaptation (2)

- Thames Barrier -

http://ukclimateprojections.metoffice.gov.uk/media.jsp?mediaid=87898&filetype=pdf



Example of adaptation (2)

- Thames Barrier -

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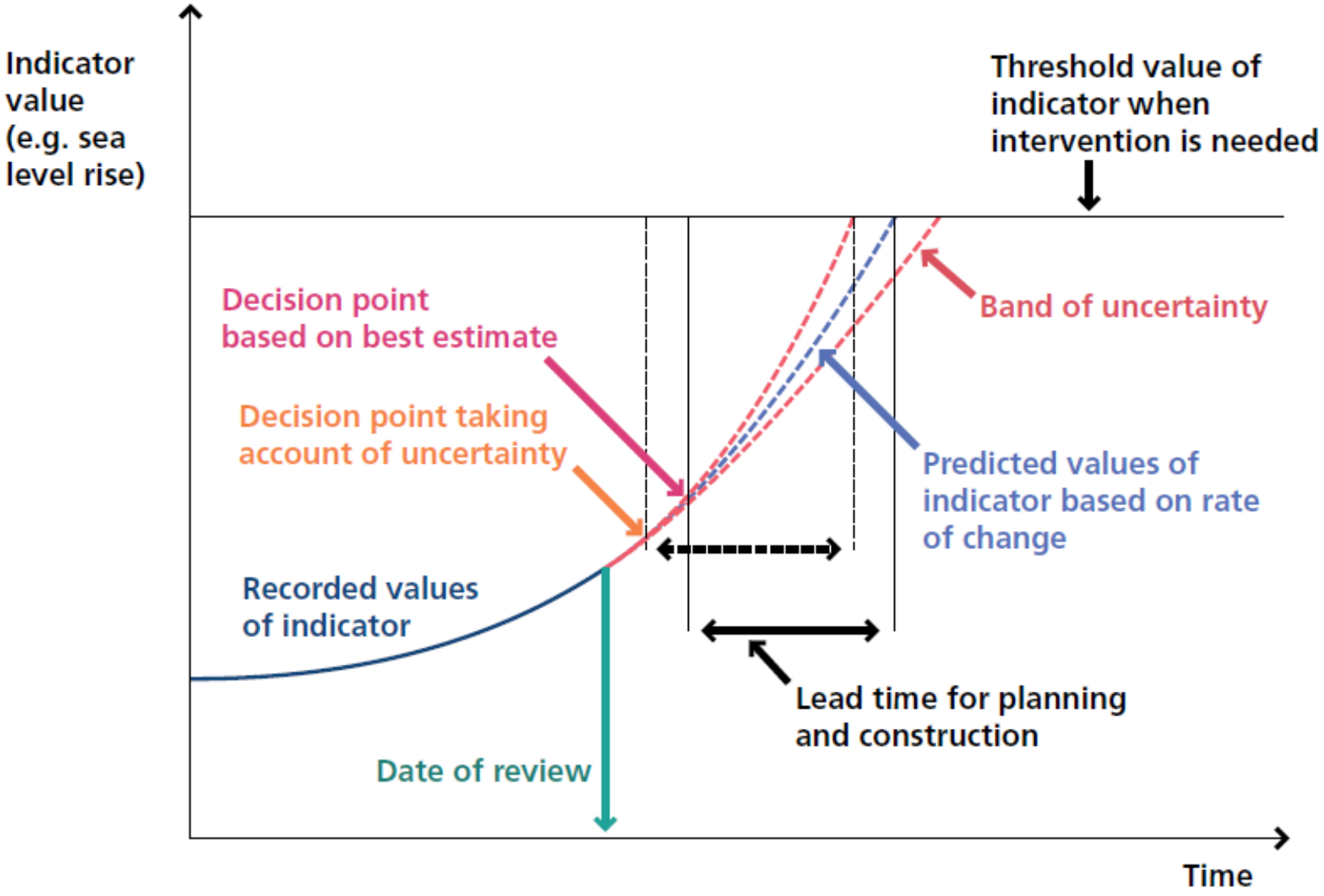

Example of adaptation (3)

- The Netherlands: movable storm surge barrier-

Flood risks from the Rhine river is projected to increase due to intense rains and to have a 10% or more increased flow in 2050 than today. National Flood Risk Management Plan in Netherlands was established to improve the safety level of flood control by securing an approximately 7,000 hectare flood control basin. In Rotterdam, the Maeslantkering (movable storm surge barrier) was built to protect the city from storm surges from the North Sea.

https://www.env.go.jp/en/focus/docs/files/20150331-83.pdf p20

Example of adaptation (4)

- Tuvalu: mangrove forest-

Mangroves grow in the brackish environment where the sea and river meet, and function as a levee to protect coastal areas from storm surges.
In the mangrove forest, both fresh and salt water creatures as well as aquatic and land creatures are creating a rich biodiversity.
Tuvalu is now facing problems of flooding caused by sea level rise, and planting mangroves is underway on Funafala Island.

https://www.env.go.jp/en/focus/docs/files/20150331-83.pdf p20

Adaptation efforts in Japan (1)

- Wakayama: “Heat-resistant” chickens-

Birds do not have sweat glands and have a very low tolerance for summer heat. Poultry Research Center has experimented by feeding chickens special feeds that contain antioxidants such as Japanese pepper seed, and found that the feeds improve egg production while keeping the decrease in the egg laying rate, daily egg production and egg quality
to a minimum under the stress of summer heat.

https://www.env.go.jp/en/focus/docs/files/20150331-83.pdf p20

Adaptation efforts in Japan(2)

- Tohoku region: Growing temperate citrus in cold area-

In Yamagata's cool weather, fruit trees such as apple are grown, but it is projected that Yamagata can grow citrus trees, which are usually grown in warmer places. Researches found that citrus can overwinter fairly well if they were covered with non-woven fabrics during the winter.

Since the temperature in winter drops to around -7ºC, the whole tree is covered by a non-woven fabric to overwinter.

https://www.env.go.jp/en/focus/docs/files/20150331-83.pdf p20

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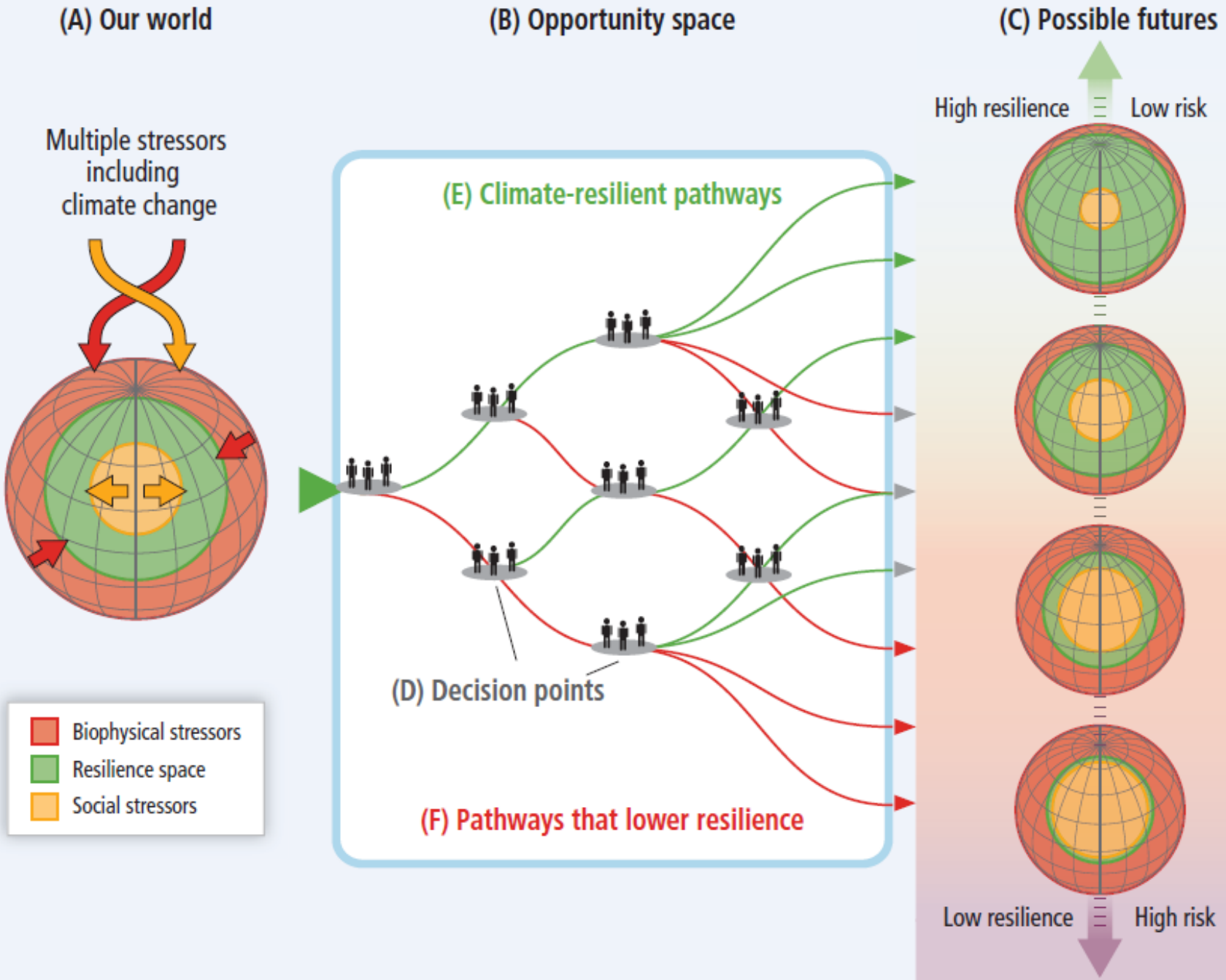
Conclusion

Climate-resilient pathways are sustainable-development trajectories that combine adaptation and mitigation to reduce climate change and its impacts.

They include iterative processes to ensure that effective risk management can be implemented and sustained



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Thank you for your kind attention!!

Adaptation Videos

9.1 Introduction to Climate Change Adaptation (Standard YouTube License, 8’51”)

https://www.youtube.com/watch?v=9Oq_Z7YoMfc

9.2 Adaptation Strategies (Standard YouTube License, 10’42”)

https://www.youtube.com/watch?v=wTC11TeW4bU