Climate Risk and Vulnerabilities Assessment

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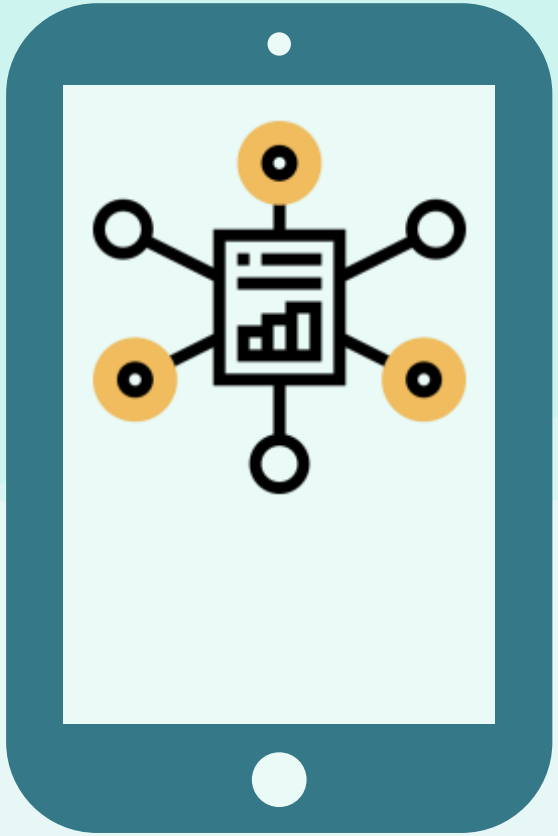
Outline of Presentation

- Climate Risk - Definitions
- Concepts of Climate Risk
- Climate Models and Data Sources
- Climate Modeling and scenario analysis
- Climate Risk Assessment process

Theoretical Background



Definition of Hazard

Hazard is potential occurrence of a natural or human-induced physical event or trend 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.

Cyclone Induced Storm Surge

Flood

Drought

River Erosion

Definition of Exposure

Exposure is the presence of people, livelihoods, species or ecosystems, environmental functions, services, and resources, infrastructure, or economic, social or cultural assets in hazard-prone area and settings that could be adversely affected.

Example:

Average temperature rise

- Regions where average temperatures are high
- Regions where temperature may cross tolerance limit of certain system

Sea level rise, increased storm surge, coastal flood and erosion

- Areas of coastal zone at or below mean sea level
- Coastal zones and island and offshore locations

Definition of Sensitivity

Sensitivity is the degree to which a system or species is affected, either adversely or beneficially, by climate variability or change.

The effect may be direct (e.g. a change in crop yield in response to a change in the mean, range or variability of temperature) or indirect (e.g. damages caused by an increase in the frequency of coastal flooding due to sea level rise).

Factors that influence sensitivity to climate change

- Physical health and age
- Extent to which physical structure and services are affected by climate hazards
- Health, connectivity and robustness of the ecosystems (for ecosystem)

Example:

- Socio-economic: aged or disabled people, children, marginal farmers or people, income etc.
- Bio-physical: phenological change of plant, health etc.

Definition of Adaptive Capacity

The ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantages of opportunities, or to cope with the consequences.

Examples:

- Technological advancement in agriculture
- Embankment construction in coastal area
- Greenbelt development
- Awareness raising and capacity development

Factors that influence adaptive capacity

- Access and ability to process information
- Resources to invest in adaptation
- Willingness to change and adapt

Definition of Potential Impact

Impacts of climate change are the effects of climate change on natural (e.g. water resources, biodiversity, soil, etc.) and human systems (e.g. agriculture, health, tourism, etc.).

Potential impacts are all impacts that may occur on sensitive exposed elements given a projected change in climate, with or without considering adaptation.

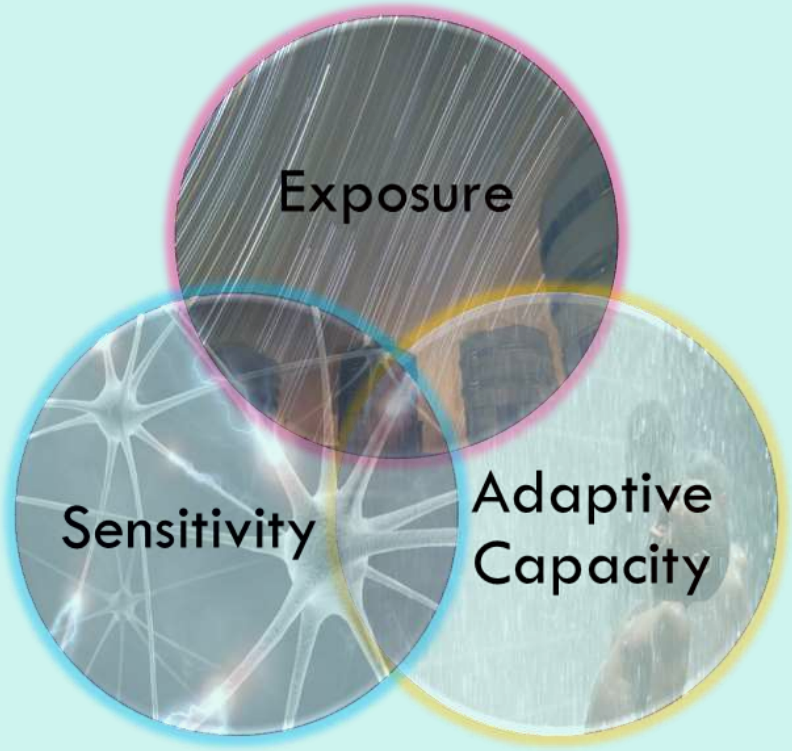
Example :

- Socio-economic: reduced income due to floods, internal displacement, poverty etc.
- Bio-physical: Intrusion of salinity due to sea level rise, increased intensity and frequency of hazards, water shortage or increased cardiovascular disease etc.

Definition of Vulnerability

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

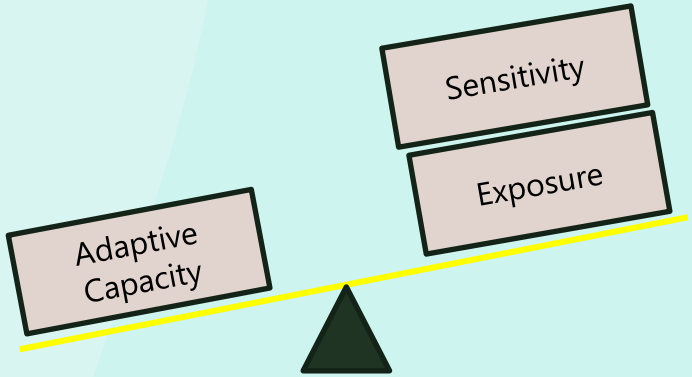
Vulnerability is a function of the character, magnitude and rate of climate change and variation to which a system is **Exposed**, its **Sensitivity,** and its **Adaptive Capacity.**



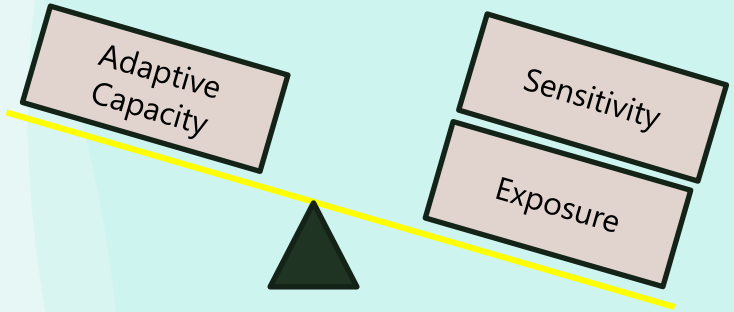
Factors of Vulnerability

Definition of Vulnerability

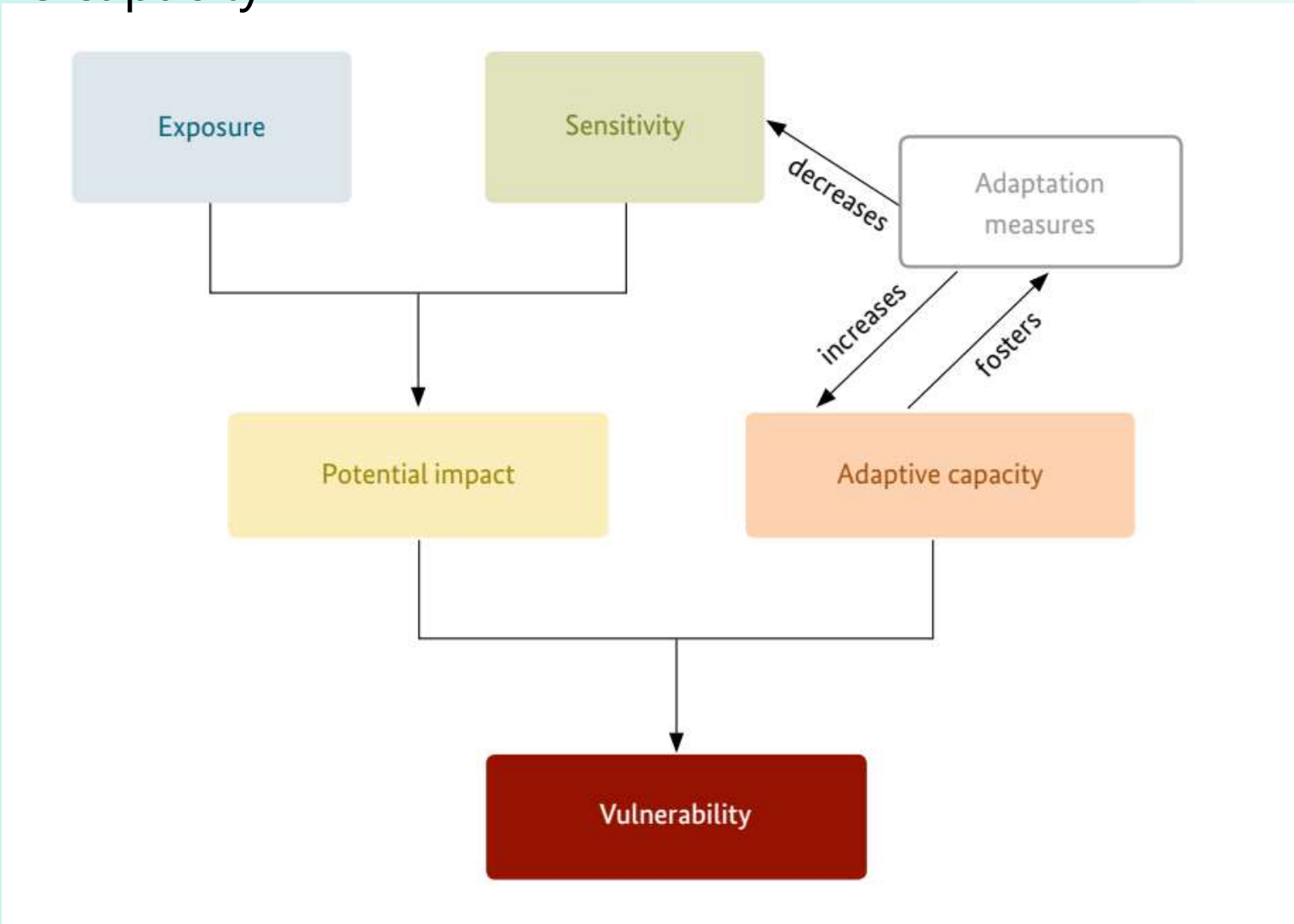
Vulnerable regions or sectors can be therefore identified by linking the potential impacts and adaptive capacity



Low vulnerability

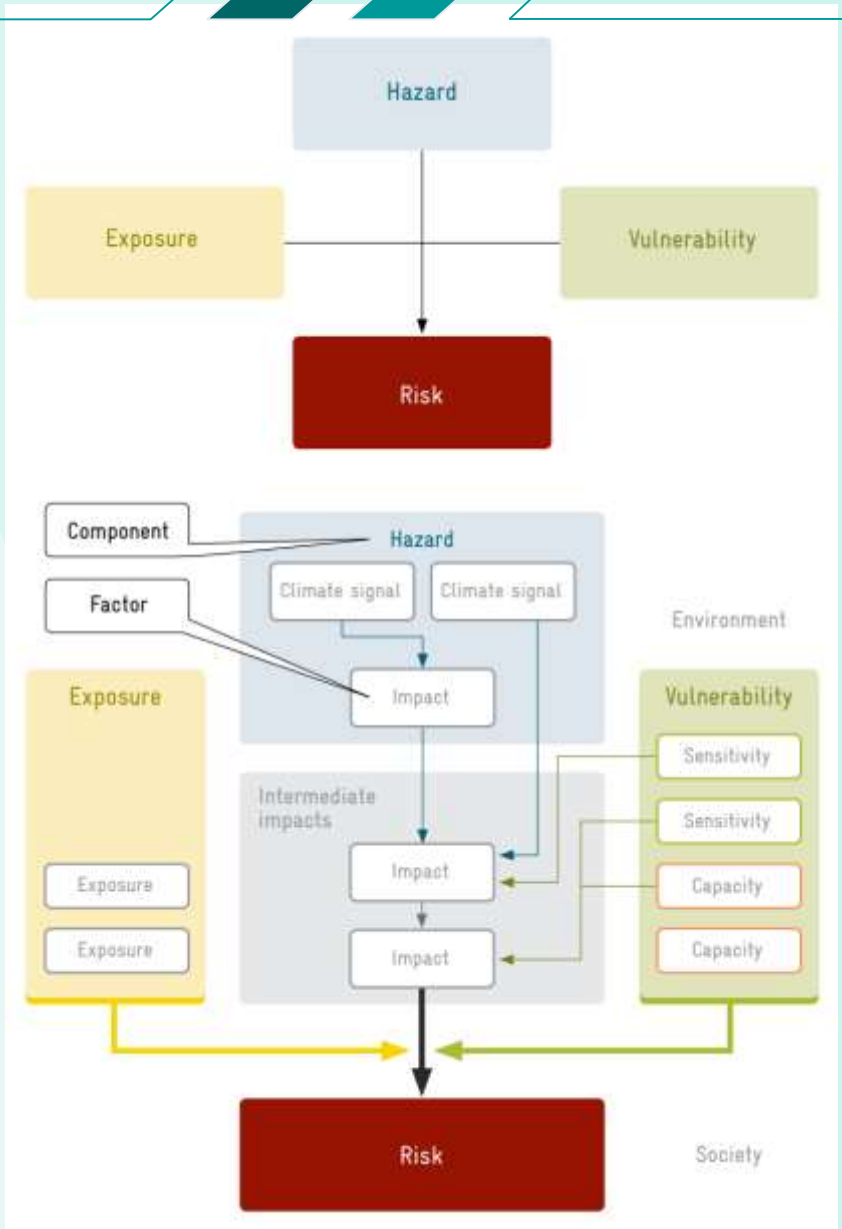


High vulnerability



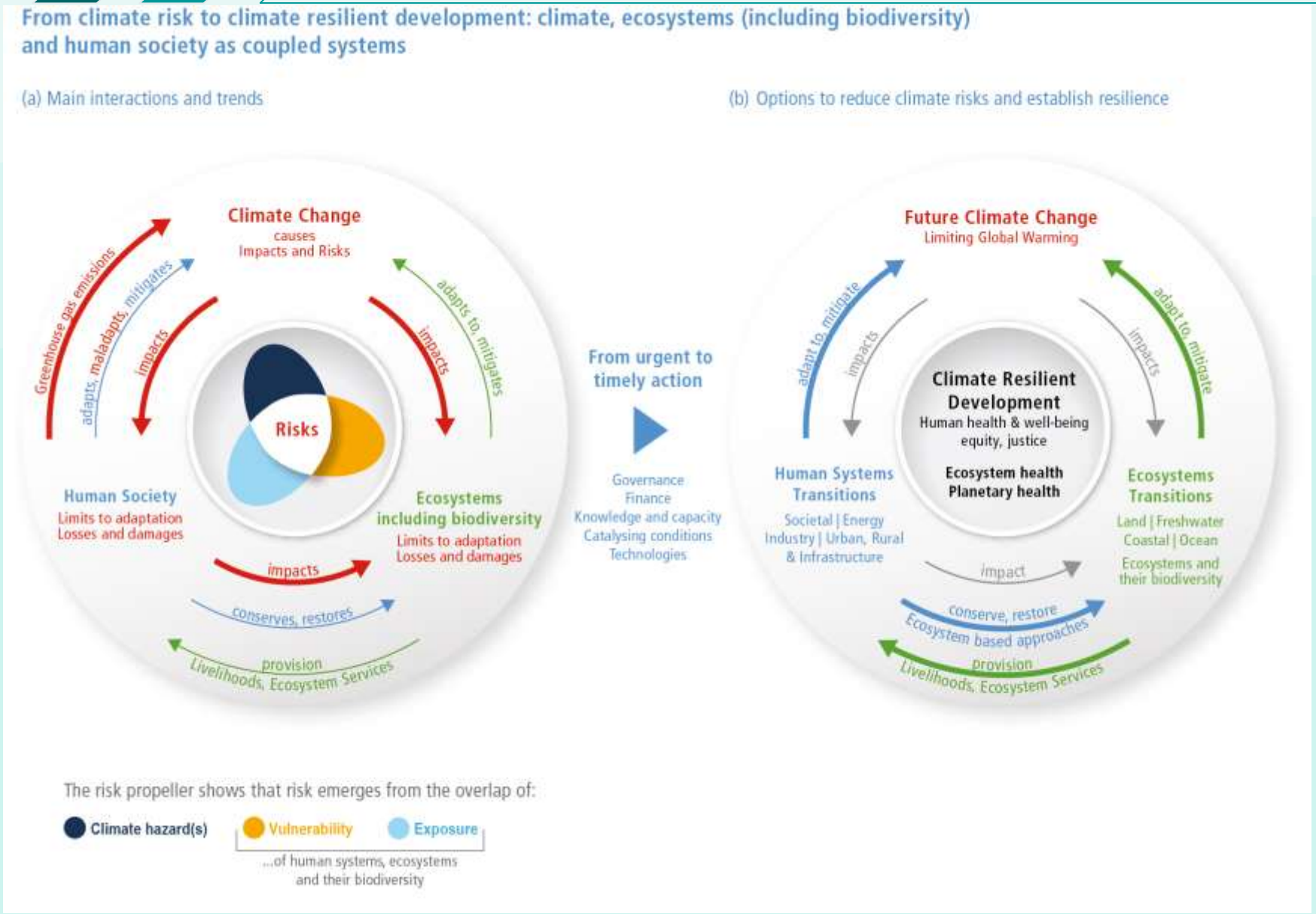
Short Story of Vulnerability

Evolution of Concept of Vulnerability to Risk



Climate Change Risk being assessed, vulnerability is component of Risk

IPCC AR6 Concept of Climate Risk



Other Definition of Risk

Climate Change Risk results from the interaction of Hazard, Exposure and Vulnerability

Disaster Risk is often represented as probability of occurrence of hazardous events or trends multiplied by the impacts if these events or trends occur.

Disaster Risk is often used to refer to the potential for adverse consequences of a climate related hazard

Assessment of absolute probability of Climate induced hazards are complex to understand as climate change impacts are linked with slow onset events or sudden extreme events with large range of uncertainties, while disaster is a sudden

Climate Projections and Information

IPCC Working Group I (WGI): Sixth Assessment Report

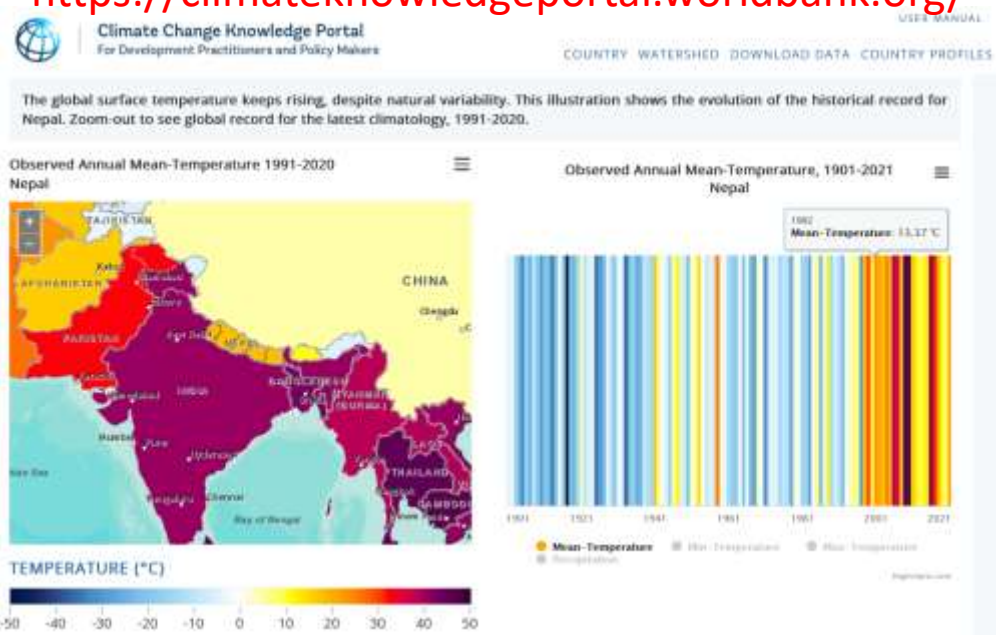
https://interactive-atlas.ipcc.ch/

https://esgf-node.llnl.gov/

https://climateknowledgeportal.worldbank.org/

https://cds.climate.copernicus.eu/

https://atlas.climate.copernicus.eu/atlas

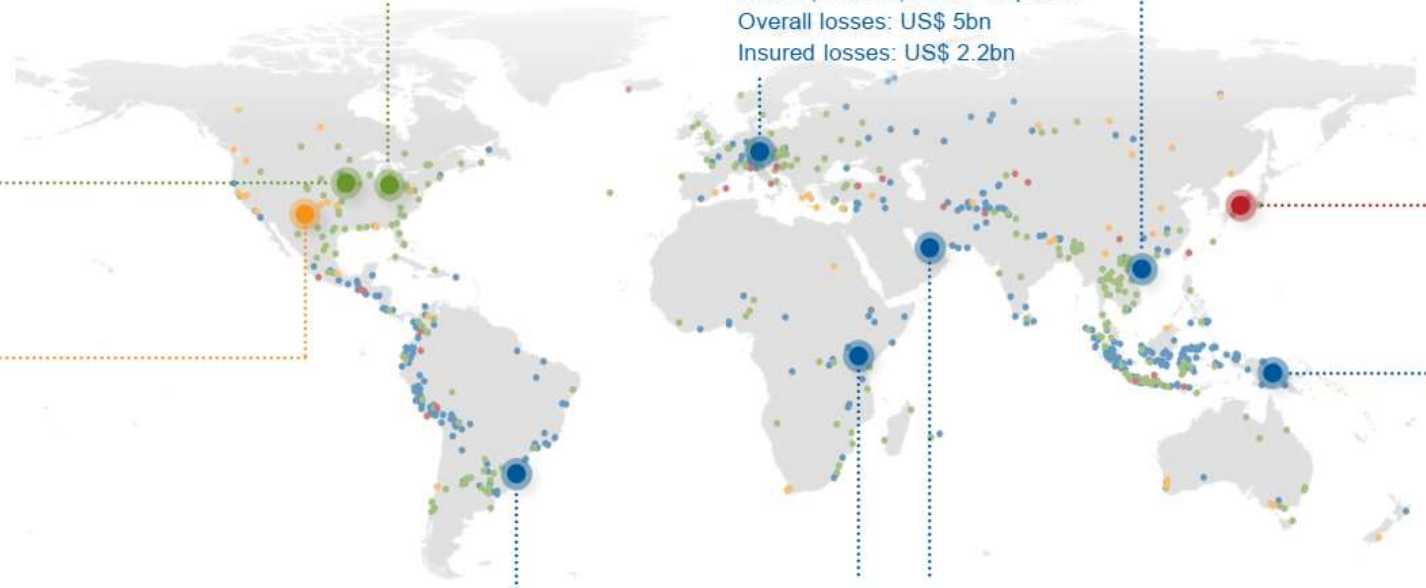


Fast Facts: Risk Trends

Major nat cat loss events January – June 2024

Natural disasters caused overall losses of US$ 120bn

Munich RE



Tornado (series), hailstorm
12–16 Mar, United States
Overall losses: US$ 5.9bn
Insured losses: US$ 4.5bn

Severe storm, tornado
16–22 May, United States
Overall losses: US$ 4.8bn
Insured losses: US$ 3.7bn

Wildfire (South Fork Fire)
17 Jun–15 Jul, United States
Overall losses: US$ 1.2bn
Insured losses: US$ 0.8bn

Flood, flash flood
30 May–5 Jun, Germany, Italy, Austria, Poland, Czech Republic
Overall losses: US$ 5bn
Insured losses: US$ 2.2bn

Flood
Jun–Jul, China
Overall losses: US$ 5bn
Insured losses: US$ 0.3bn
Fatalities: 71

Earthquake, tsunami
1 Jan, Japan
Overall losses: US$ 10bn
Insured losses: US$ 2bn
Fatalities: 245

Landslide
24 May, Papua New Guinea
Fatalities: 670

Flood
29 Apr–17 May, Brazil
Overall losses: US$ 7bn
Insured losses: US$ 2bn
Fatalities: 181

Flood, flash flood, landslide
Mar–Apr, Burundi, Tanzania, Kenya, Somalia
Fatalities: 283

Flood, flash flood
14–22 Apr, Oman, Iran, Bahrain, Yemen, United Arab Emirates
Overall losses: US$ 8.3bn
Insured losses: US$ 2.8bn

Geophysical events
Earthquake, tsunami, volcanic activity

Meteorological events
Tropical storm, extratropical storm, convective storm, local storm

Hydrological events
Flood, mass movement

Climatological events
Extreme temperature, drought, wildfire

Significant catastrophes

Small, medium and large loss events

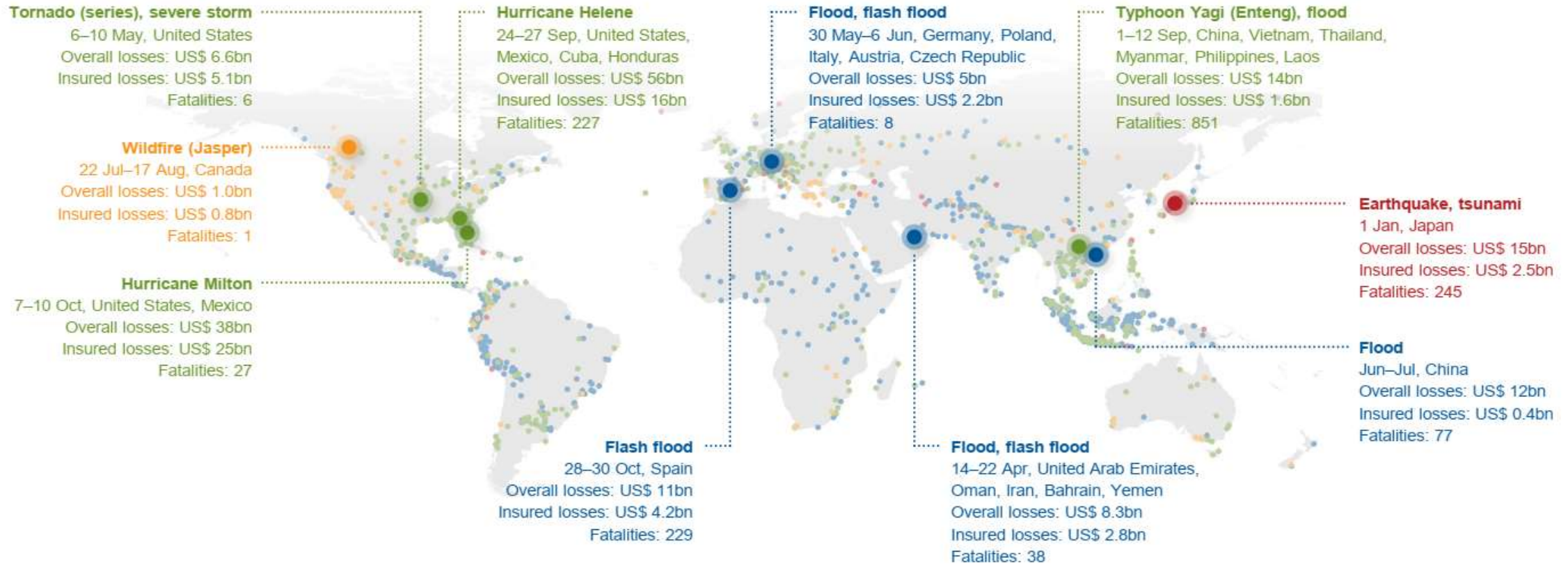
Source: Munich Re, NatCatSERVICE, 2024

Fast Facts: Risk Trends

Nat cat loss events 2024

Natural catastrophes caused overall losses of US$ 320bn worldwide

Munich RE



Source: Munich Re, NatCatSERVICE, 2025

Risk Assessment

Risk results from the **interaction of vulnerability** (of the affected system), its **exposure** over time (to the hazard), as well as the (climate-related) hazard and the **likelihood of its occurrence.**

Qualitative Assessment

Qualitative assessment rely on descriptive information and expert knowledge and evaluation ranking into qualitative classes such as “High”, “Medium”, “ Low”

Quantitative Assessment

Where technical expert and appropriate models are available, quantitative assessment of risk may be performed.

Qualitative Assessment (Descriptive) Stakeholder involvement, meeting, interviews, questionnaire

Quantitative Assessment
Indicators, Indices, Maps

Quantitative Assessment of Disaster Risk

Risk of Climate Change Risk can be assessed through following approach similar to Disaster Risk

Risk = Hazard X Probability
or Risk = Extent of Consequences X Probability of Hazard

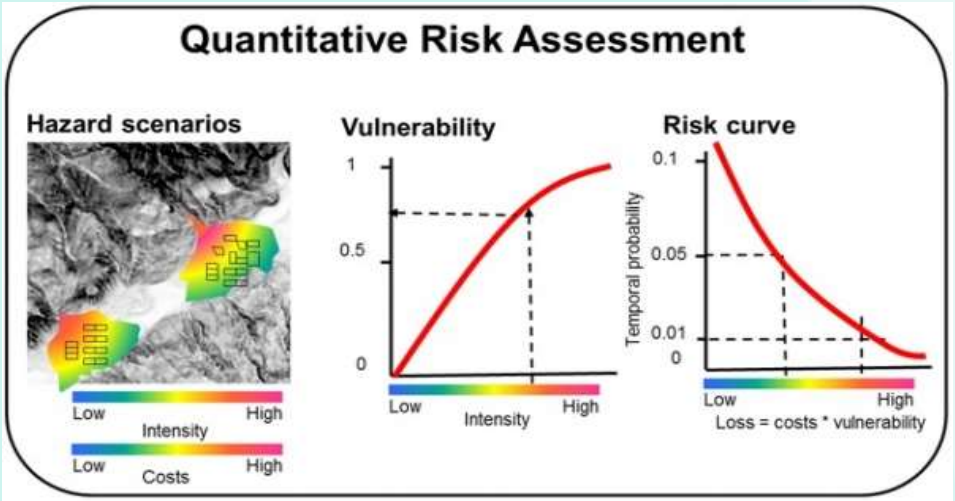
If, The maximum yield decrease is 14.1 metric tons (consequence) due to reduced precipitation (CC impact) and its probability is 56.1%

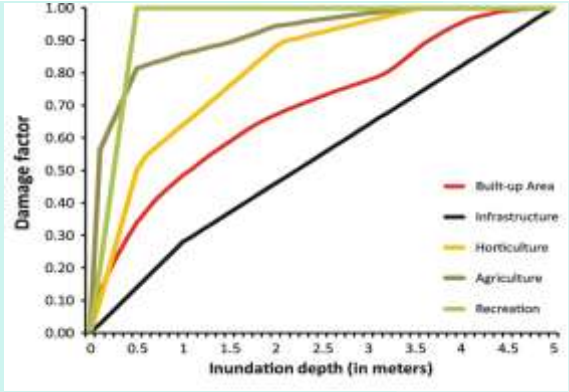
Then its Risk = 14.1X 0.561 = 7.9 (Max Risk Value)

If, The maximum yield decrease is 2.1 metric tons (consequence) due to reduced precipitation (CC impact) and its probability is 80%

Then its Risk = 2.1X 0.8 = 1.7 (Min Risk Value)

Taking ranges of risk value risk level can be fixed like Low, Medium, High





This approach limited to addressing sudden extreme weather events or probabilistic events only

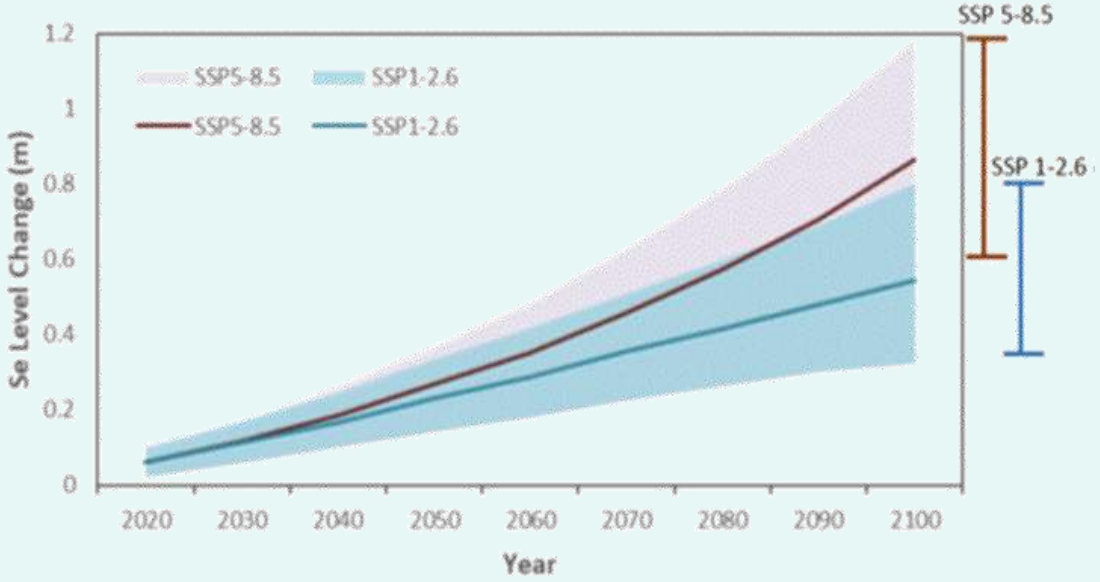
Climate Impacts

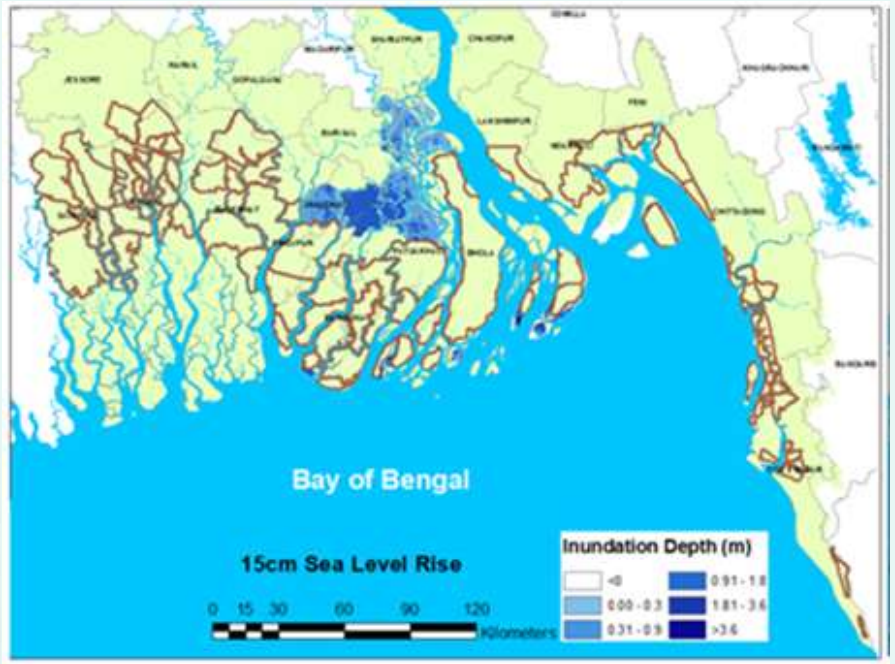
Sea Level Rise

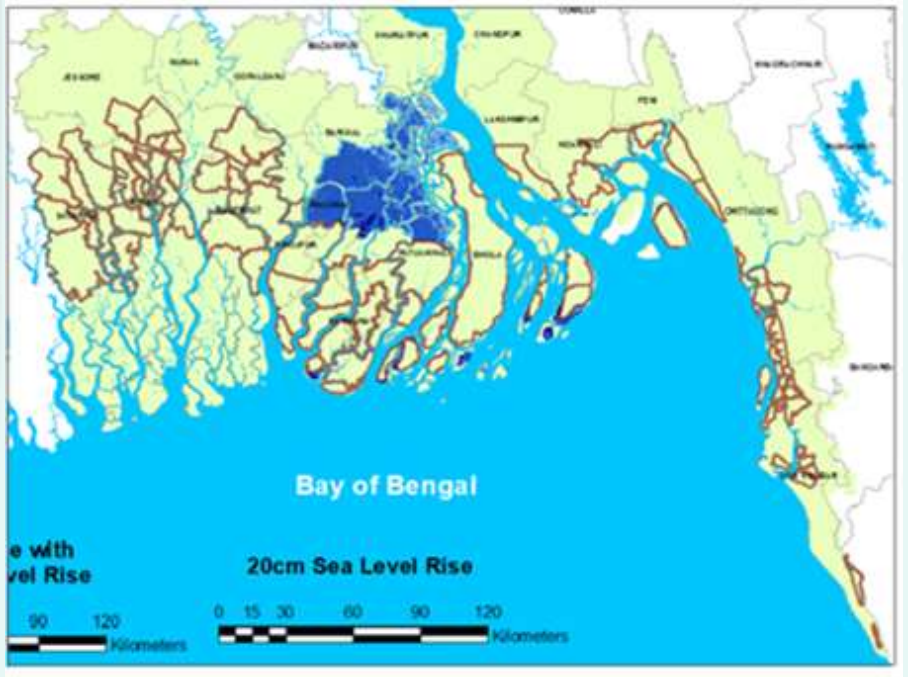
Bangladesh experiencing the **rising trend in sea level** because geographic location and nature of the delta

Between 1901 and 2010 sea level has risen at a rate of **1.7mm/year** & from 1993 to 2010 at **2.8±0.8mm/year**.

SLR will be between **0.11-0.12 m in near-term**, **0.23-0.27 m in mid-term** and **0.54-0.86 m in long-term** (IPCC, 2021)

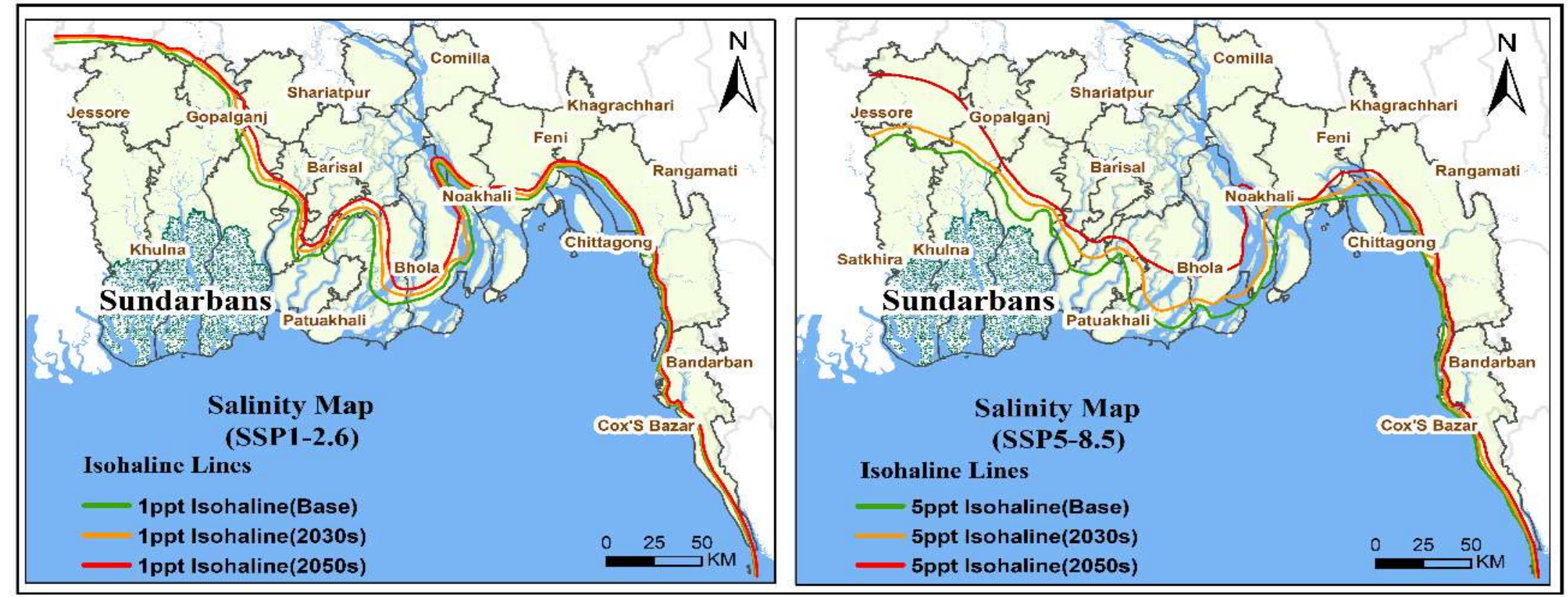






Climate Impacts

Salinity Intrusion



- 1 ppt and 5 ppt salinity front will move 9-13 km inwards SW and SC 25-37 km from its current salinity front by 2085s.
- Around 19.3% of the Ganges coastal area would be exposed to salinity concentration greater than 1ppt by 2050
- Increasing salinity will also jeopardize habitat of important freshwater fisheries.
- New opportunities like mariculture, blue economy, sea food-based food industries will be created due to increased salinity or brackish water habitat.

Qualitative Assessment of Disaster Risk

Qualitative Risk assessment using Risk Matrix following Disaster Risk Concept

Probability of Climate Hazards	Extent of Consequences		
	Low	Medium	High
High	Medium	Medium	High
Medium	Low	Medium	Medium
Low	Low	Low	Medium

Level of Risk

This approach limited to addressing sudden extreme weather events or probabilistic events only

Qualitative Assessment of Risk

Hazard Calendar Matrix

Hazards	Trend in Last 10 Years	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Remarks
Floods	↑					+2								
Flash Floods	↑				+3									
Salinity														Not present
Drought	↓										+3			
Temperature Rise	↑	+2												
Short Duration High Intensity Rain	↑				+3									
Sea Level Rise														Not present
Storm Surge														Not present
.....														
.....														
.....														

Note: ↑= increasing trend, ↓= decreasing trend, ash color=presence of hazard stretching over time, +1=low severity, +2= medium severity, +3= high severity

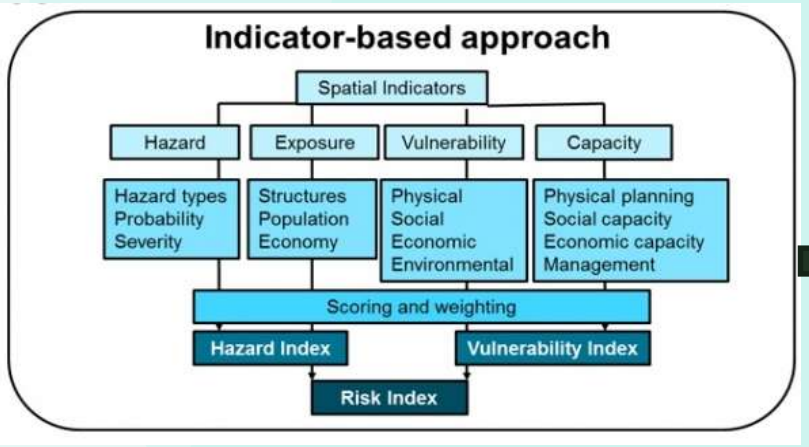
Impact and Vulnerability Matrix

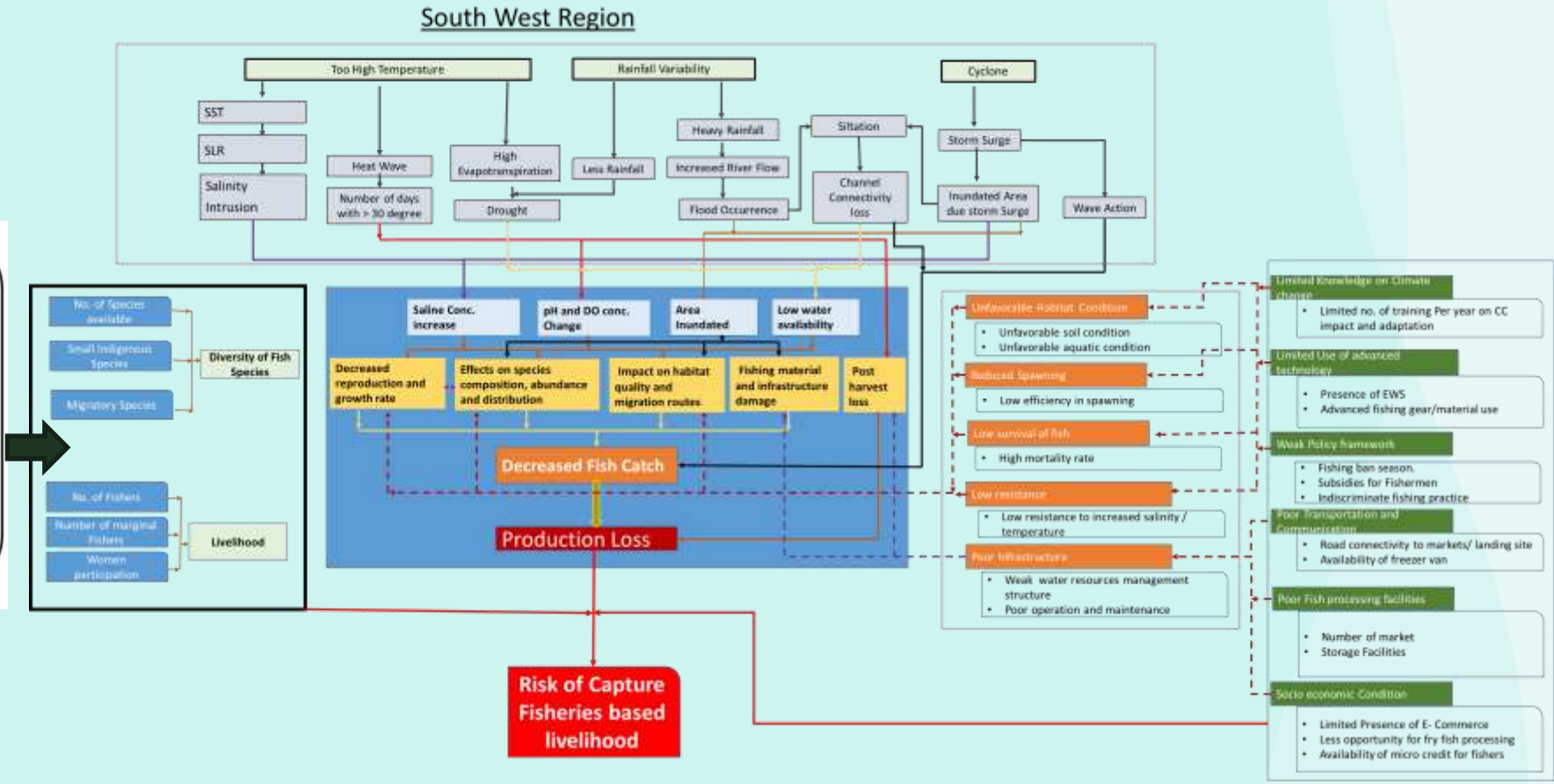
Hazards	Hampered Fish Habitat Condition	Reproductive Changed of Fish Species	Loss of Fish Catch	Loss of Income	Losses and Damage of Fish Farm	Hampered Food Security	Shifting of Occupation	Nutrition Security	...	Remarks
Floods			+3	+3	+1	+1	+2	+1		
Flash Floods			+3	+3	+2	+1	+2	+1		
Salinity	+2	+2						+2		
Drought	+2	+1						+2		
Temperature Rise	+1	+3						+2		
Short Duration High Intensity Rain										
Sea Level Rise					+1	+1				
Storm Surge			+2	+3	+3	+1				
.....										
.....										
.....										

Note: ash color=presence of hazard stretching over time, +1=low severity, +2= medium severity, +3= high severity

Data can be collected in both participatory or scientific approach

IPCC AR5 Preferred Holistic Indicator based Approach

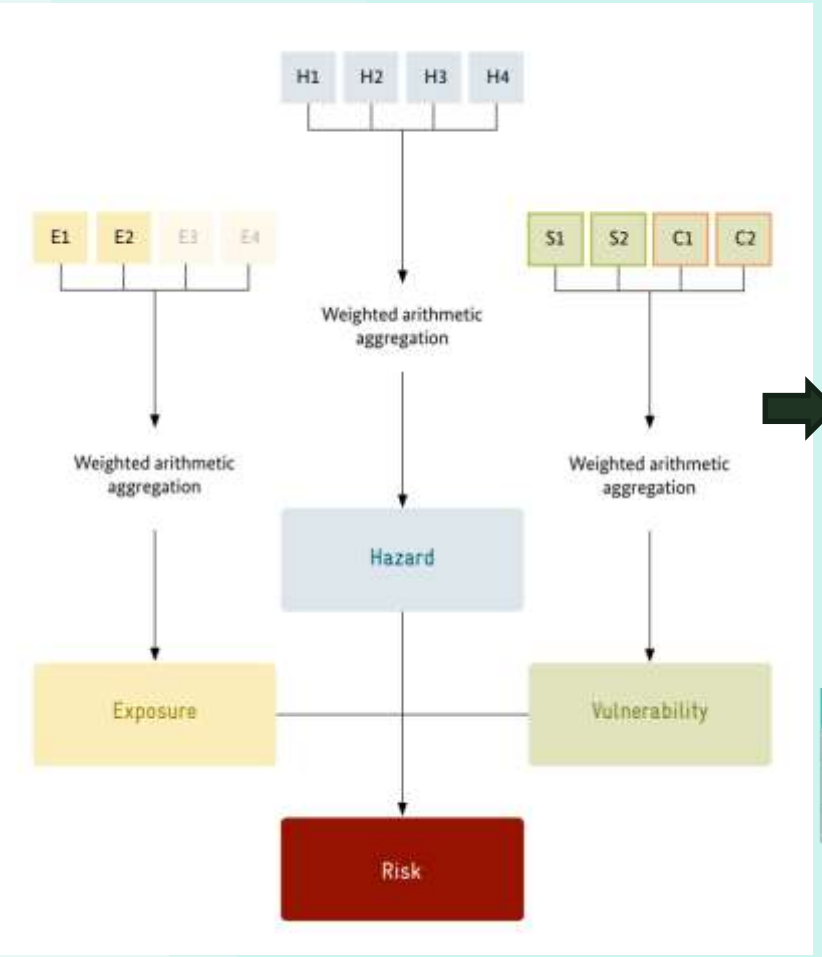


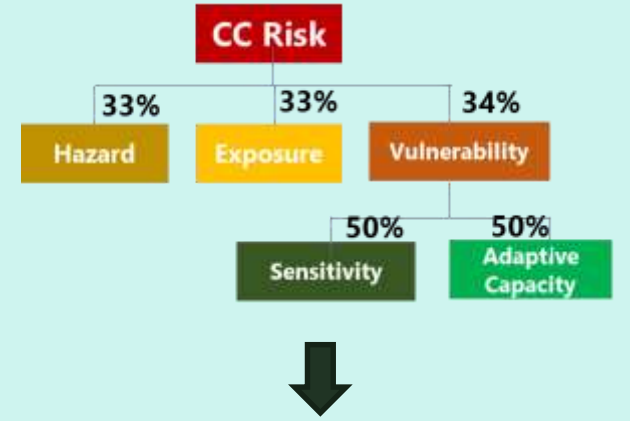


Impact Chain

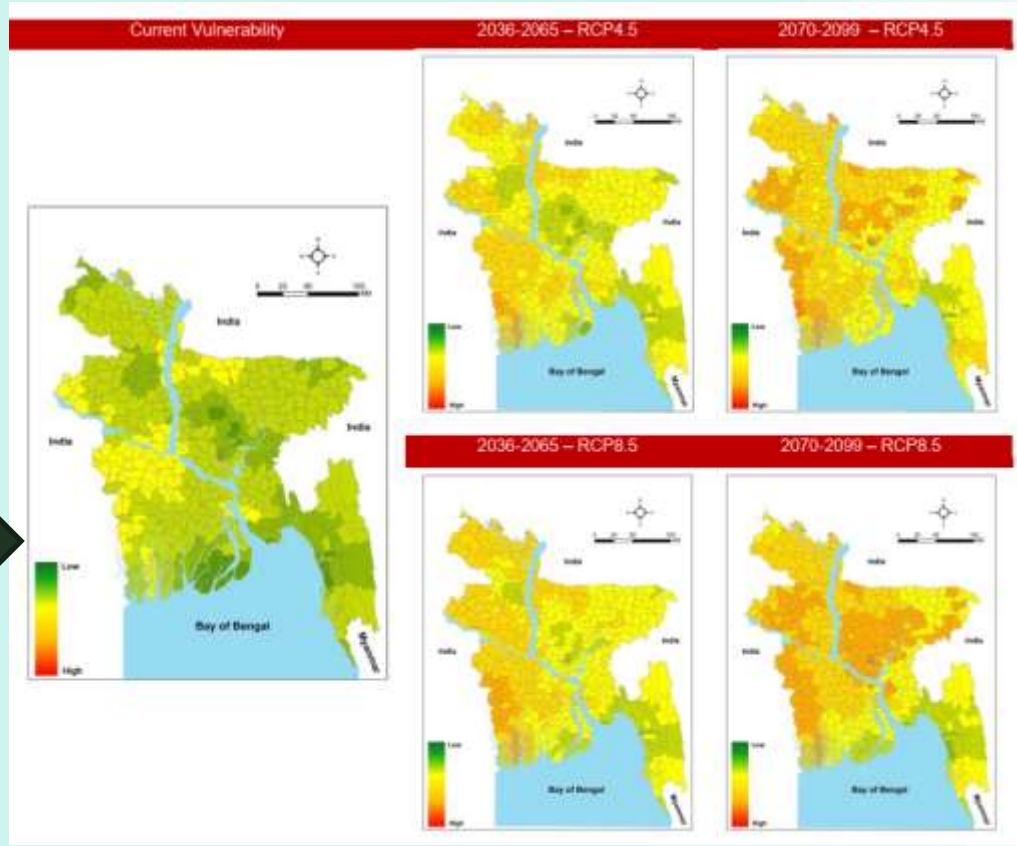
- **This approach allows to address both probabilistic events or slow onset event to assess risk**
- **Risk Assessment outcome may be generated in two ways: Overlay approach or Risk Matrix Approach**

Overlay Approach (IPCC AR5)





Vulnerability/Risk Level	Range of Normalized Score	Risk Level Color
Low	0.00 – 0.40	
Medium	0.41 – 0.70	
High	0.71 – 1.00	



RISK MATRIX Approach (IPCC AR5)