Climate change risks on food shortage, floods and tropical cyclones

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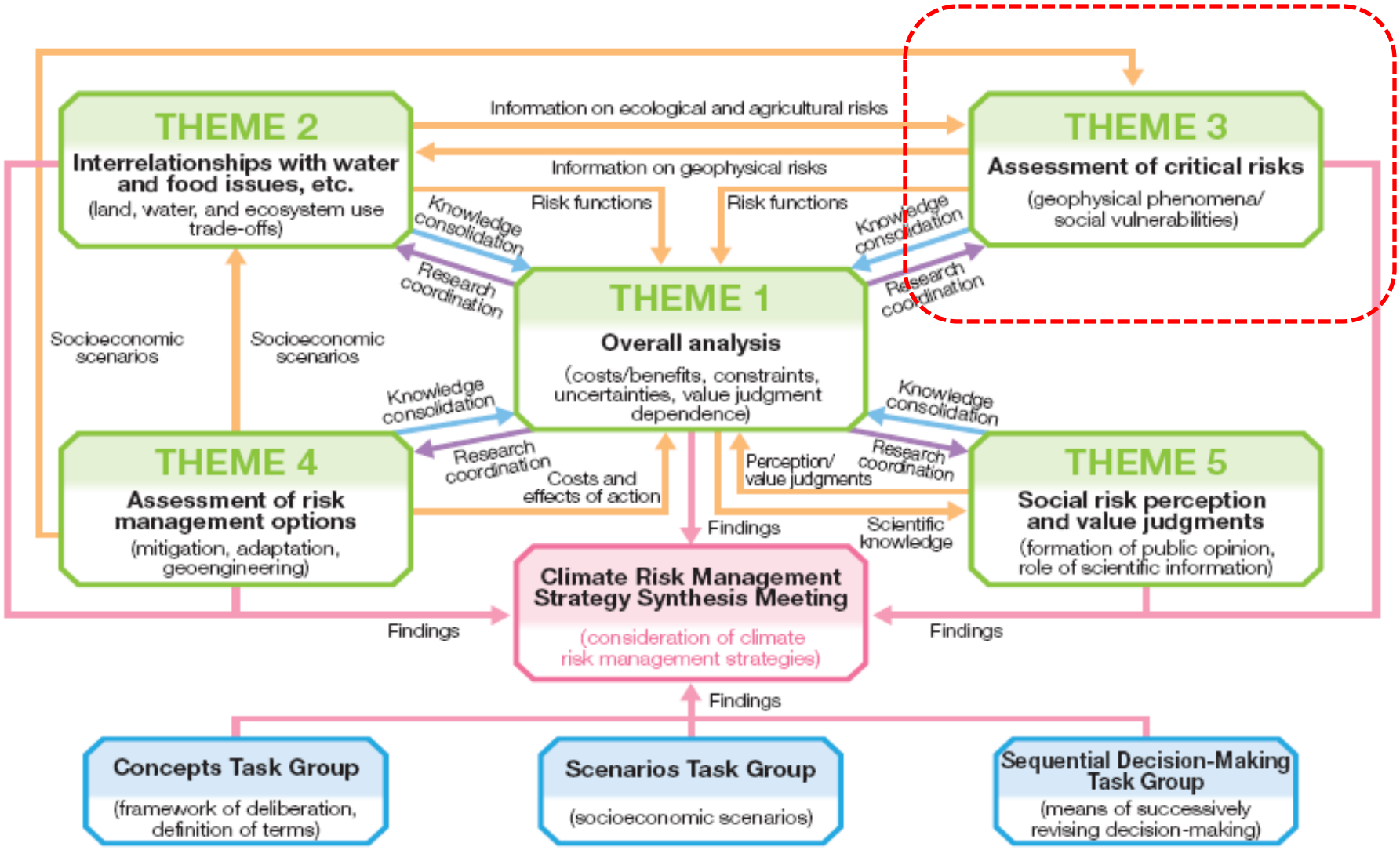

THEME 2
Interrelationships with water and food issues, etc.
(land, water, and ecosystem use trade-offs)
Information on ecological and agricultural risks
Information on geophysical risks
THEME 3
Assessment of critical risks
(geophysical phenomena/ social vulnerabilities)
Knowledge consolidation
Research coordination
Risk functions
Risk functions
Knowledge consolidation
Research coordination
THEME 1
Overall analysis
(costs/benefits, constraints, uncertainties, value judgment dependence)
Socioeconomic scenarios
Socioeconomic scenarios
Knowledge consolidation
Research coordination
Knowledge consolidation
Research coordination
THEME 4
Assessment of risk management options
(mitigation, adaptation, geoengineering)
Costs and effects of action
Perception/ value judgments
THEME 5
Social risk perception and value judgments
(formation of public opinion, role of scientific information)
Findings
Scientific knowledge
Climate Risk Management Strategy Synthesis Meeting
(consideration of climate risk management strategies)
Findings
Findings
Findings
Concepts Task Group
(framework of deliberation, definition of terms)
Scenarios Task Group
(socioeconomic scenarios)
Sequential Decision-Making Task Group
(means of successively revising decision-making)

S10-3 (2):
Climate change risk analysis in water, energy and food sectors

- Aims:
  - ❖ Contribute towards development of global climate risk management strategies
  - ❖ Provide quantitative information about climate change risk

- We focus on critical risks covering following topics:
  - ❖ Water
    - Tropical cyclones
    - Floods
  - ❖ Food
    - Food shortage (undernourishment)
  - ❖ Energy
    - Renewable energy

Today's talks are …

- Towards quantifying flood risks due to climate change at global scale

- Global climate risks on food shortage evaluated from Disability Adjusted-Life years

- Global climate risks on tropical cyclone economical damages

Towards quantifying flood risks due to climate change at global scale

Contents:

- Materials
- Flow diagram
- Results
- Summary

Materials

- Retrospective land surface model runoff outputs (Koirala et al., 2013)
- Catchment-Based Macro-scale Floodplain (CaMa-Flood) model (Yamazaki et al., 2011)
- Population data (source: United Nations)
- GDP per capita (source: United Nations)
- Country boundary (source: ESRI 2005)

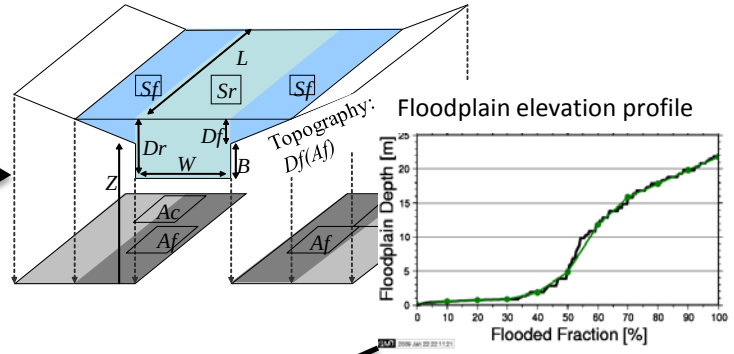
Flow diagram

Population exposure, GDP exposure and damages

Runoff of Land-Surface Model (MATSIRO), 1979-2010

Flood plain model **CaMa-Flood**

discharge | **water level** | **…**



Annual maxium discharge

Gumbel

T(2~1000)-yr flood (15 min)

H-Q (Height-Discharge) Relationship in 15 min

Flood fraction of T-yr flood (2.5 min)

Flood depth of T-yr flood (2.5 min)

Global map

Population data (2.5 min)

GDP pcap data (2.5 min)

Depth-damage function

Look-up table of GDP damage for T-yr flood

Global map

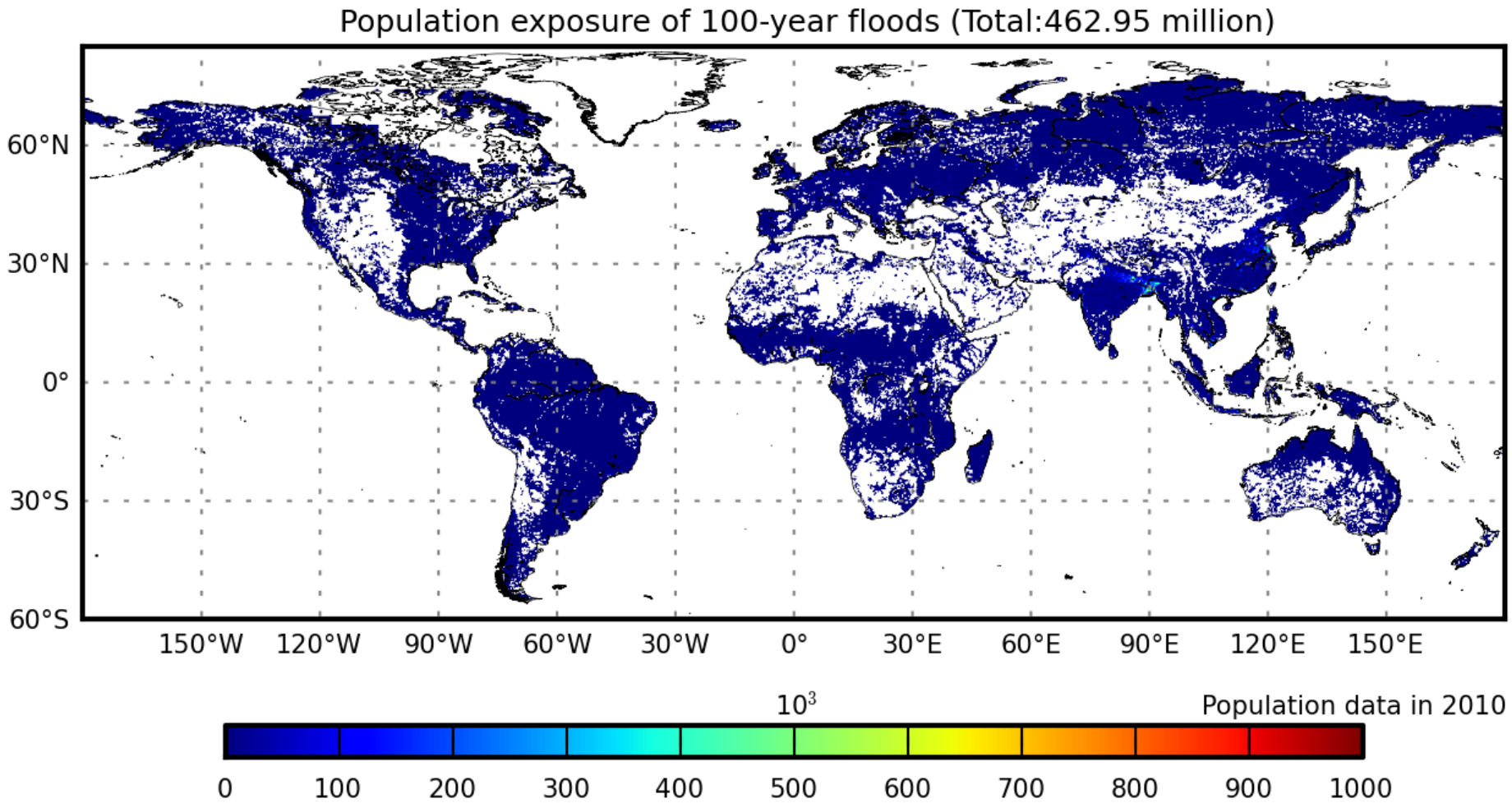
Return Period

Flood of each year

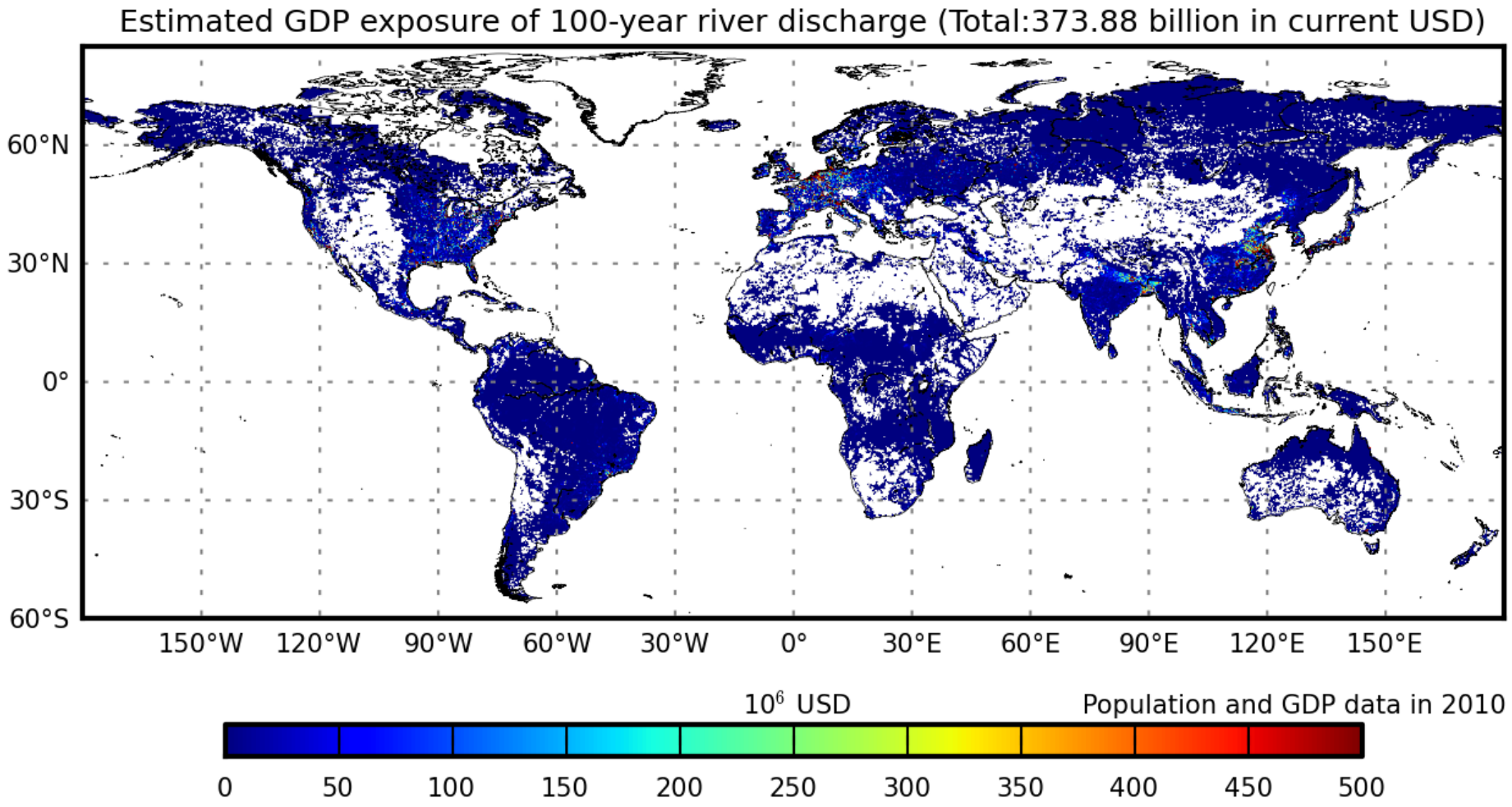
Annual GDP damage

To be calculated using GCM outputs

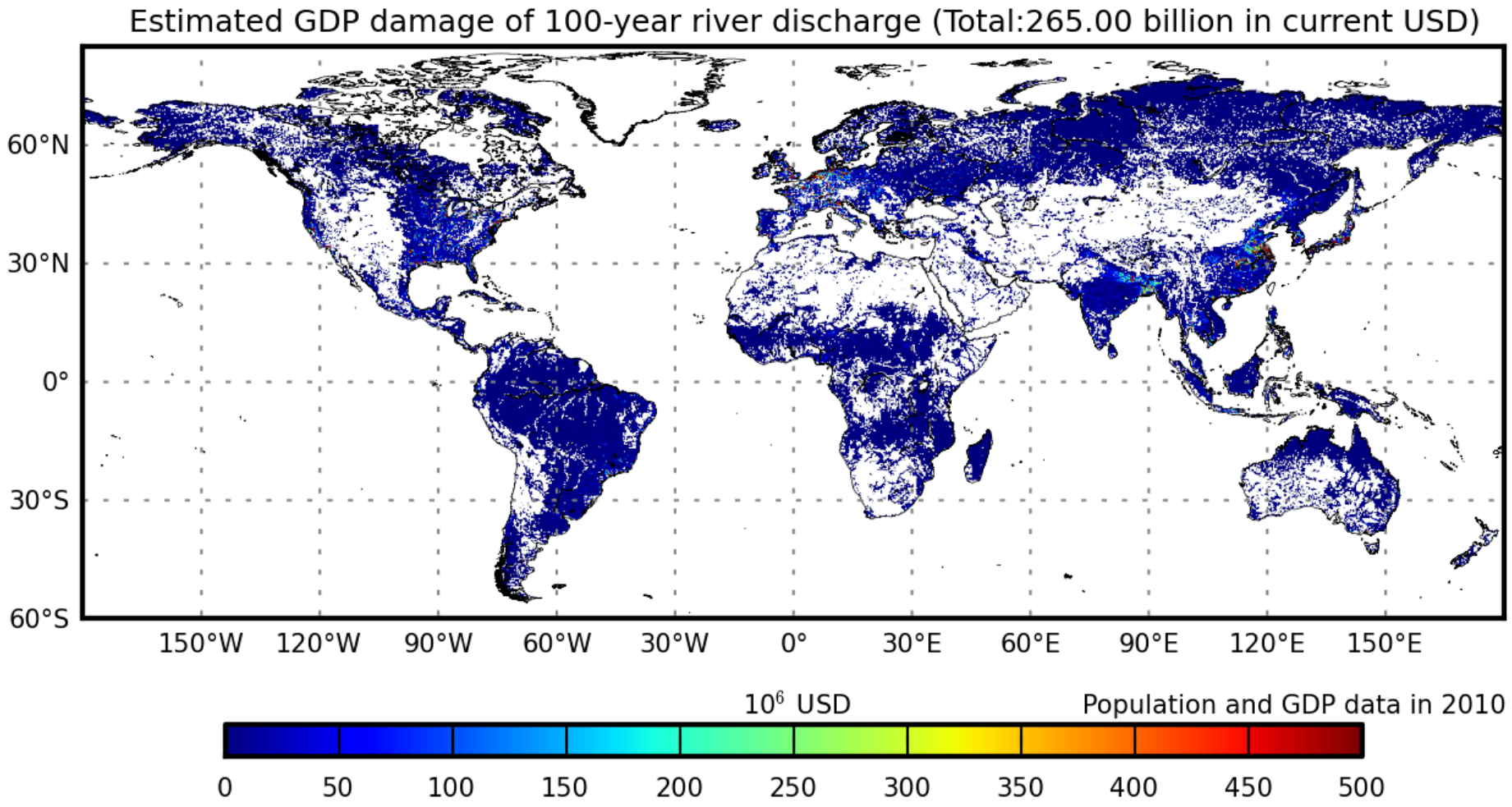
Results: Population exposure



Results: GDP exposure



Results: GDP damage



Summary

- Demonstrated calculation of:
  - Population exposure
  - GDP exposure
  - GDP damage
- What to refine/consider next?
  - Assets of different land-use (e.g., urban, agriculture)
  - Depth-damage relationships (for different assets)
  - Calculations using GCM runoff outputs

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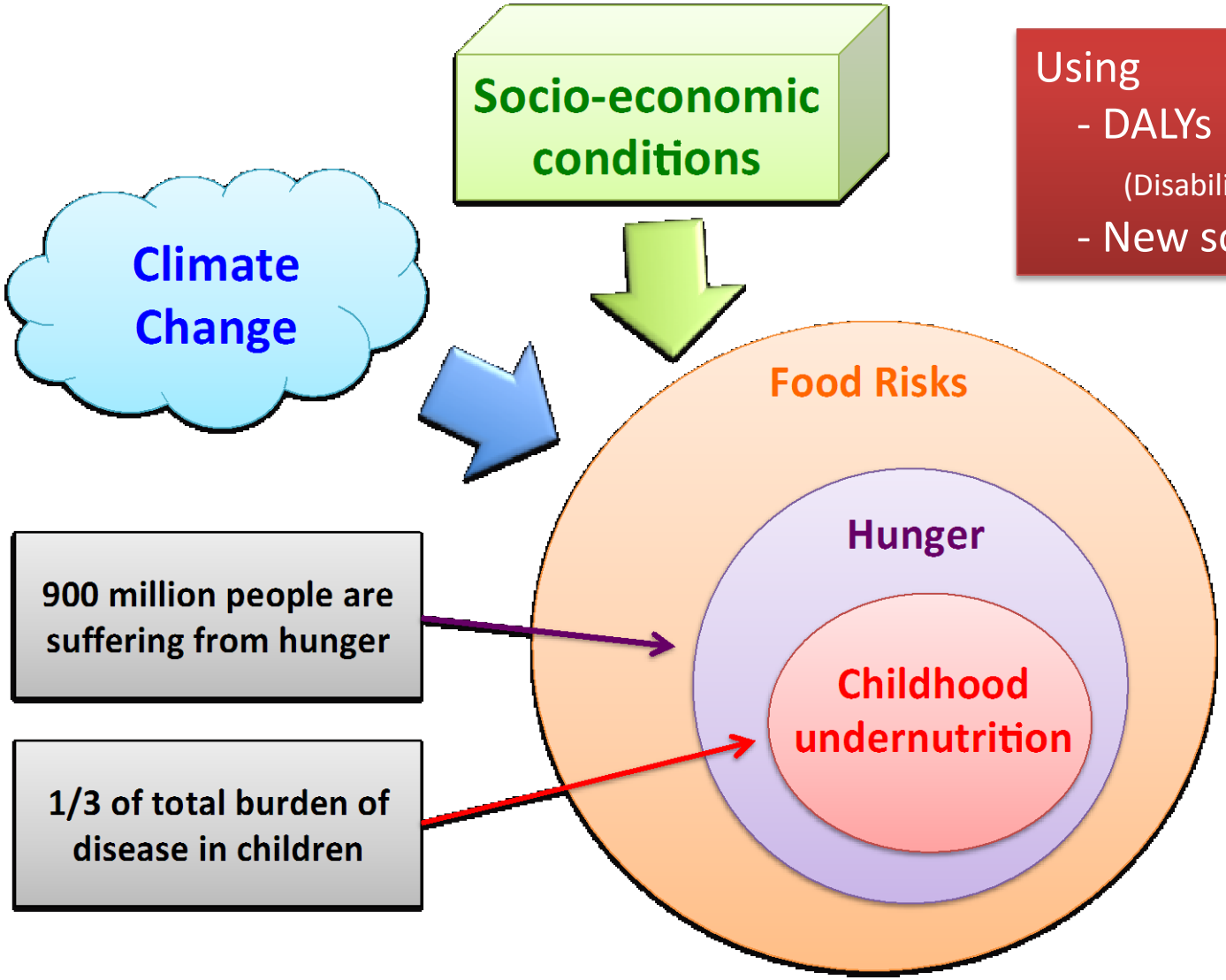
1. Introduction



Using
- DALYs
  (Disability Adjusted Life Years)
- New scenario framework

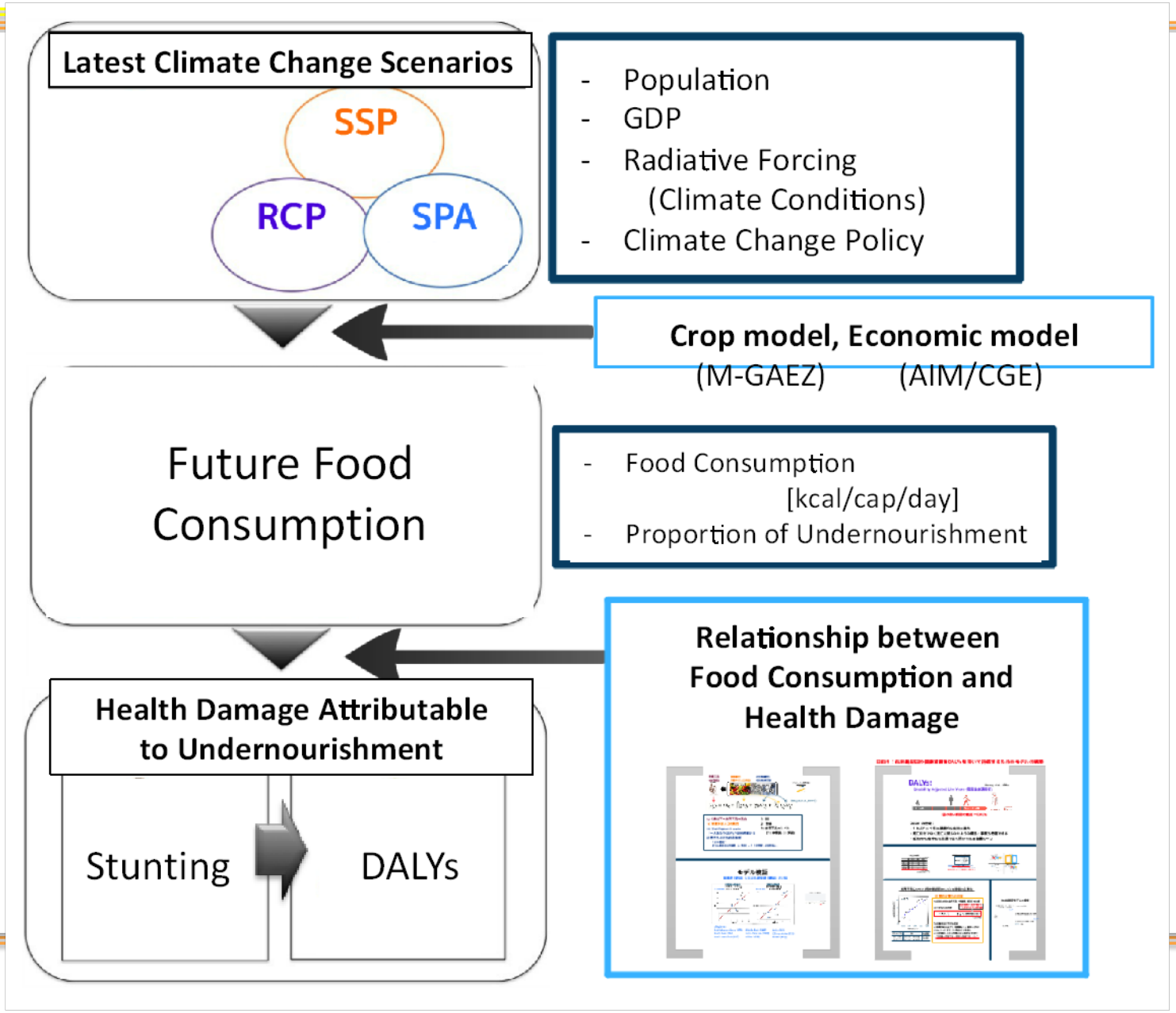
DALYs:
Disability Adjusted Life Years (Murray et al. 1996)

- 1 DALY = 1 lost year of “healthy” life
- Not only death but poor health or disability
- Becoming increasingly common in health impact assessment

Future projection of DALYs Attributable to Childhood Underweight (DAtU)

2. Method

Framework



RCPs & SSPs as future scenarios

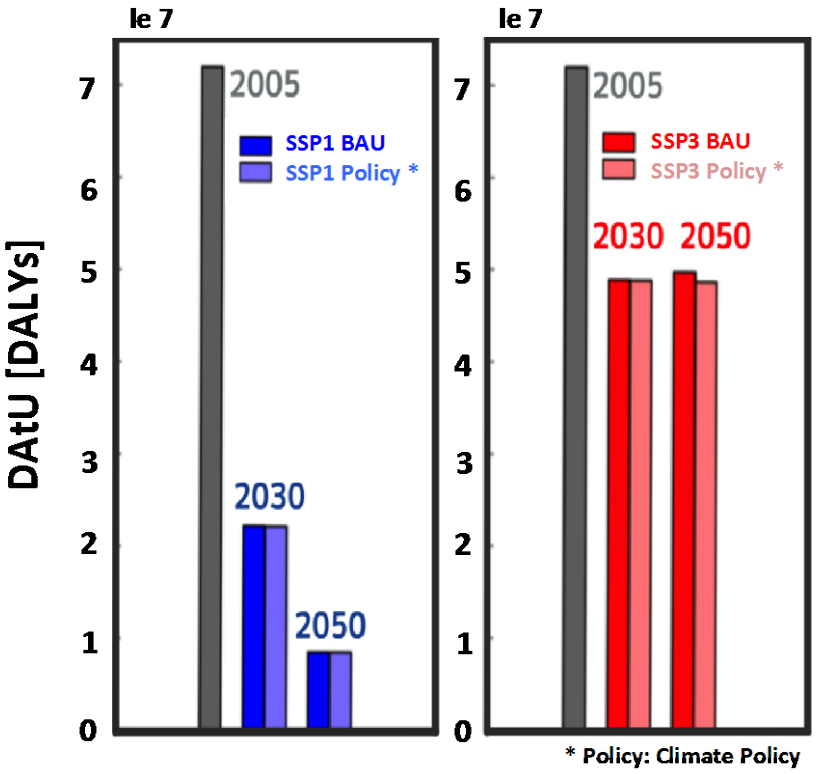
	RCP2.6	RCP4.5	RCP8.5
SSP1	SSP1 Policy	SSP1 BAU	
SSP2		SSP2 Policy	SSP2 BAU
SSP3		SSP3 Policy	SSP3 BAU

SSP: Shared Socio-economic Pathways
RCP: Representative Concentration Pathways
BAU: Business As Usual

3. Results&Discussion

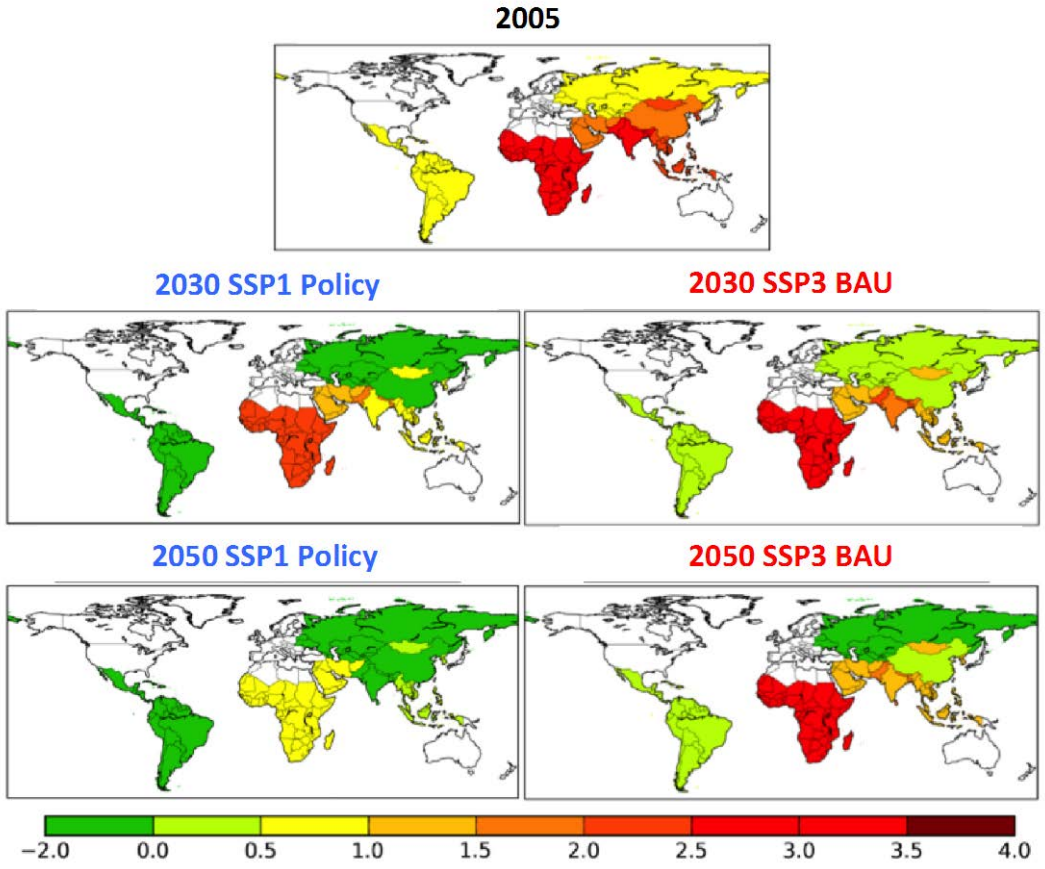
World & Region-level DAtU

World total DAtU



Little impact of Climate Change (Differences between BAU and Policy)

Region-level DAtU [per 1000 persons]



log(DAtU) [DALYs per 1000 persons]

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Tropical cyclones (TCs) cause severe damage on human lives triggering floods, landslides, storm surges and so on.

Furthermore,
TCs activity has increased since 1970s. (AR5)
TCs max. wind speed and rain rates are likely to increase.(IPCC AR5, 2013)

To predict future TCs loss is important for decision making.

Target risk: **Economic Loss** caused by TC (Data source for economic loss: EM-DAT)

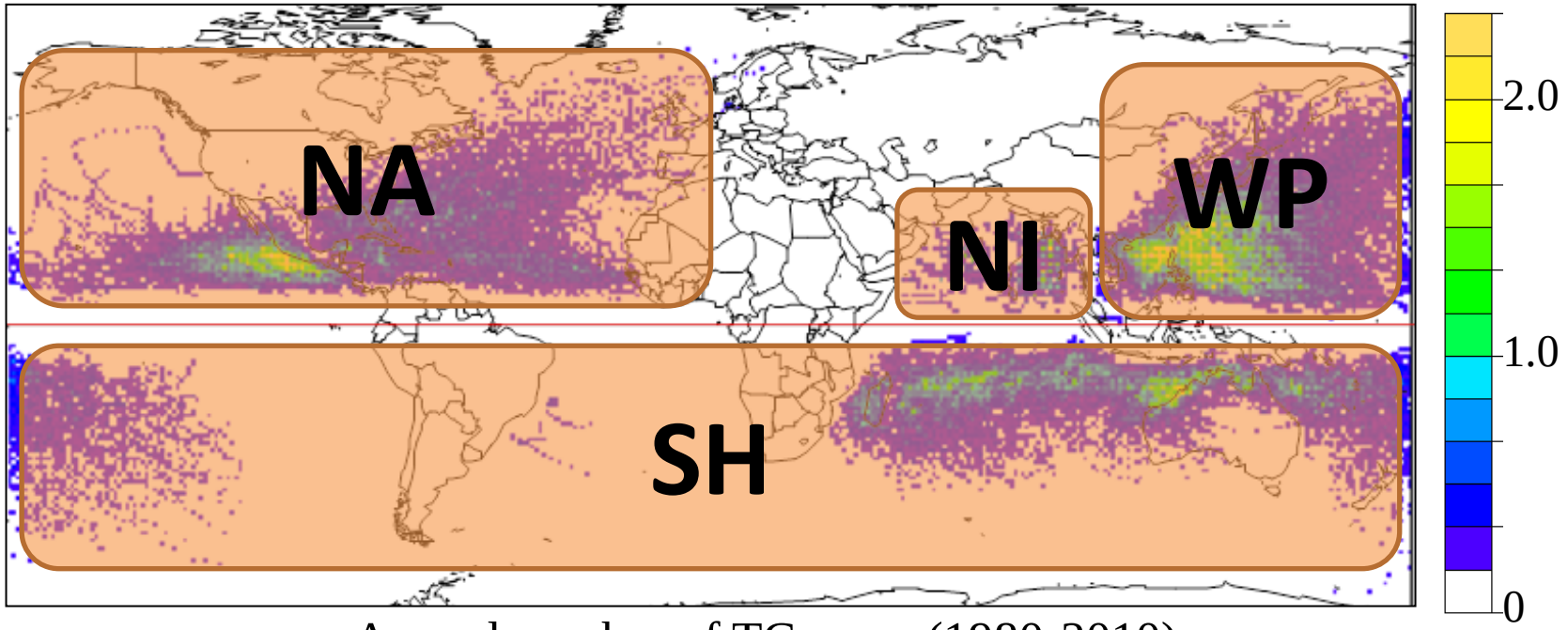
Target period: Present period: **1986 to 2010**

Future projection year: **2100**

Target countries: the member of United Nations

* countries without TC loss, population or GDP were excluded.

* all countries are categorized into 4 regions.



Annual number of TCs pass (1980-2010)

TCs loss models were developed by using regression analysis.
Loss models were parameterized by **each geographical regions**.

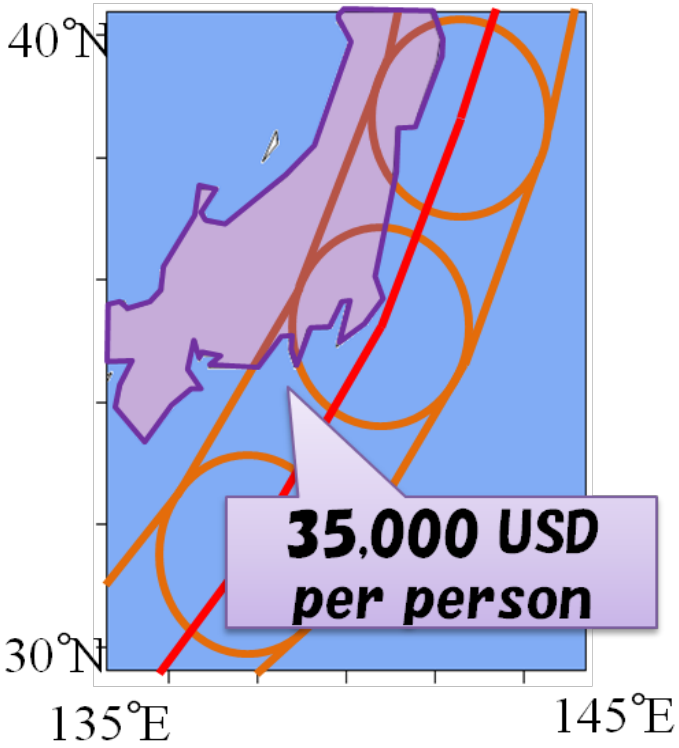
$$R = \exp(\alpha + \beta_1\sqrt{Hazard} + \beta_2\sqrt{Exposure} + \beta_3\sqrt{Vulnerability}$$

R: Economic loss
[1990USD million]

Maximum pressure drop [hPa]
* **Pressure drop;** difference between environmental pressure and central pressure of TCs.

Populations in TC affected area [persons].
*TC affected area; The area where maximum wind speed is greater than 17.5 [m/s]

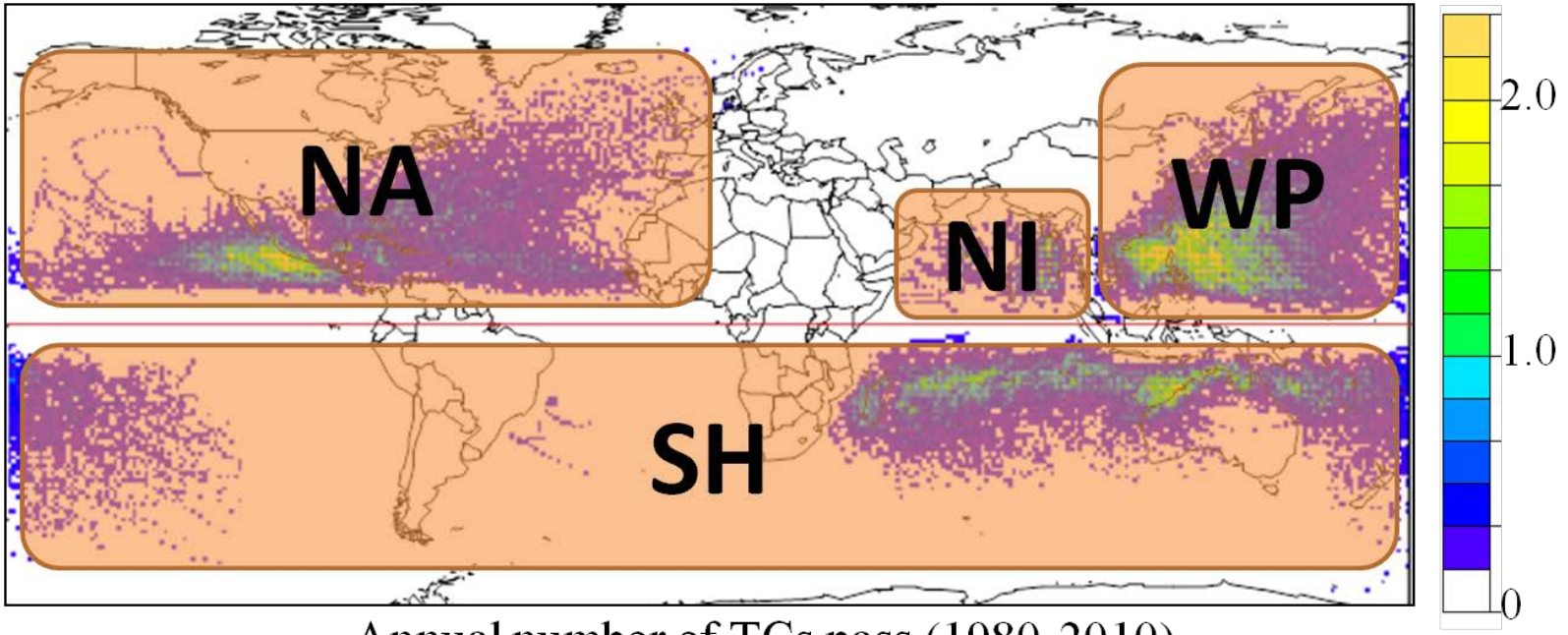
GDP per capita
[1990USD/person]



Developed model for TC economic loss calculation

$$R = \exp(\alpha + \beta_1\sqrt{Hazard} + \beta_2\sqrt{Exposure} + \beta_3\sqrt{Vulnerability}$$

Region	α	β_1(H)	β_2(E)	β_3(V)	Samples
NI	6.48	0.10	0.62	0.78	21
WP	5.55	0.17	0.73	0.62	218
NA	6.77	0.65	0.82	0.58	105
SH	3.96	0.19	0.92	1.17	36



Annual number of TCs pass (1980-2010)

$$R = \exp(\alpha + \beta_1\sqrt{Hazard} + \beta_2\sqrt{Exposure} + \beta_3\sqrt{Vulnerability}$$

With developed model, **future TCs loss** at 2100 was projected **with socioeconomic change and/or climate change**.

Climate change: (Knutson, 2010)
Pressure drop increase by 21%
Number of TCs decrease by 6% at global scale

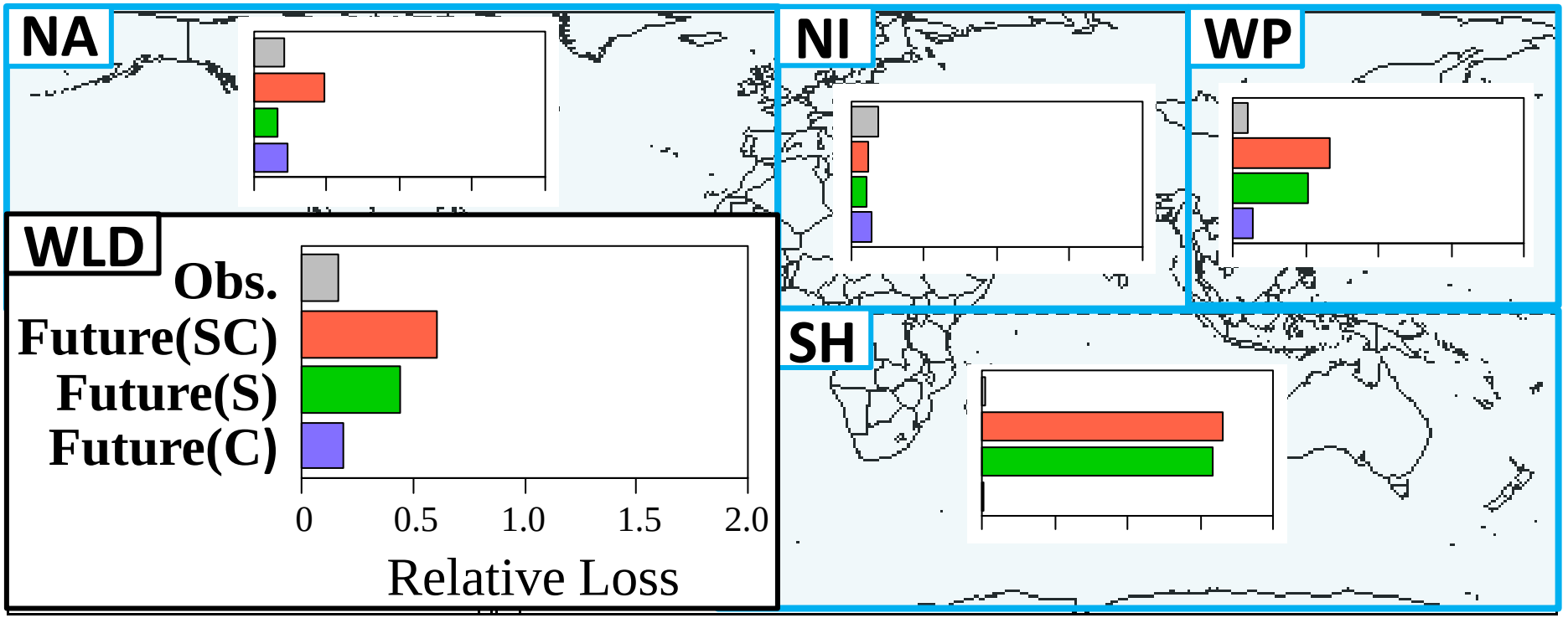
Hazard | Exposure | Vulnerability

Socio-economic change: (CIESIN, 2004)
Population and GDP change based on A1B scenarios. (A1B)

3 scenarios for future projection

SC scenario: Both of socioeconomic and climate change
S scenario: Only socioeconomic change
C scenario: Only climate change

Relative Loss : The ratio of absolute loss to GDP [%]



- Global **relative losses** increase with all scenarios.
  - For SC and S scenarios, relative loss of SH are quite increase.
  - For C scenario, relative losses of WP and SH regions increase.
- **The increasing of relative losses** is owe to **socioeconomic change** rather than **climate change**.