Assessing flood risk globally using an improved country-based risk index

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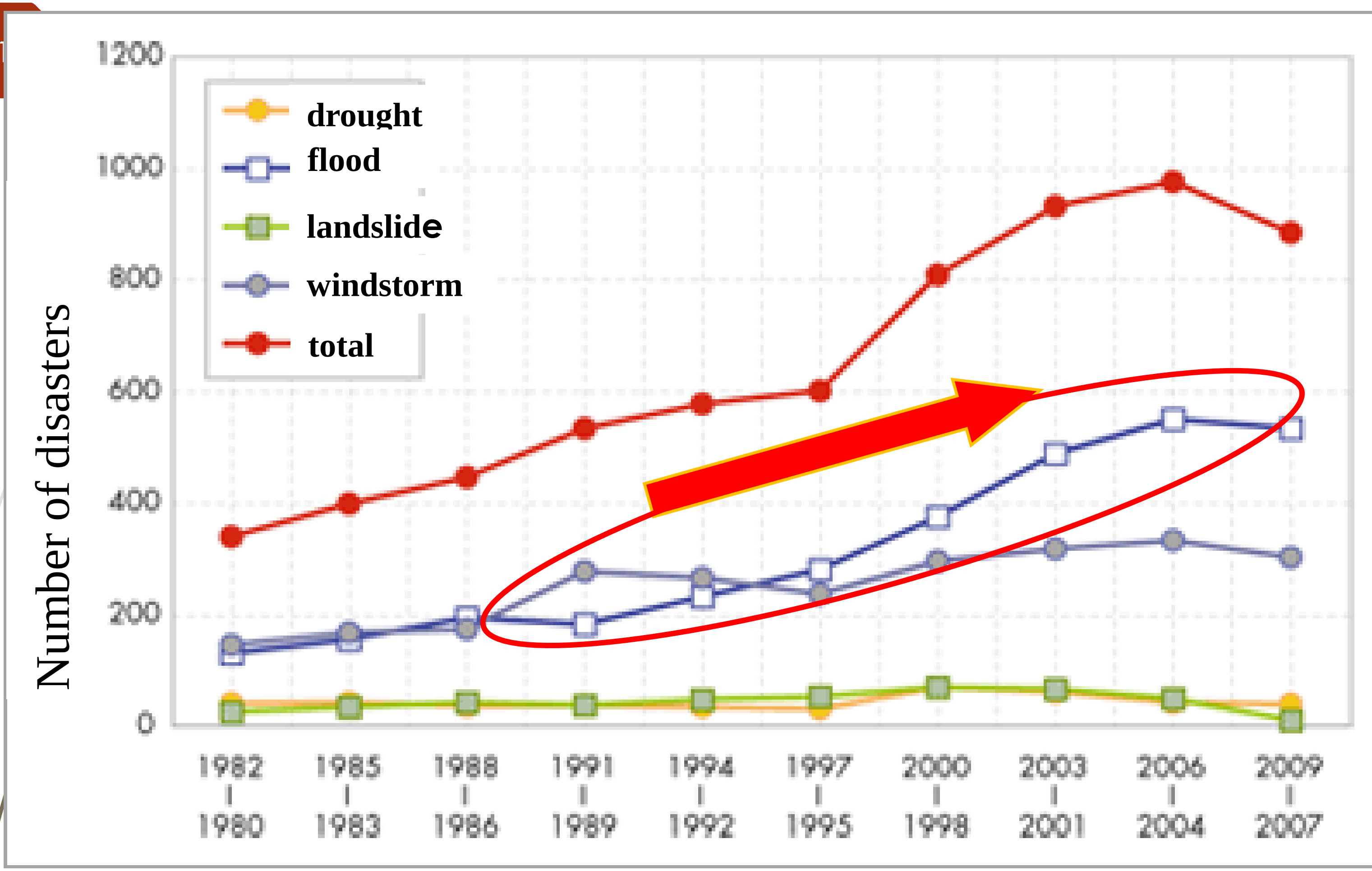
Introduction

Increasing water disasters



Number of water-related disasters（1980-2009）

Water-related disasters are increasing.
Especially damage in Asia is serious.

出典）ICHARM HP（http://kankyorenrakukai.org/symposium_12/pdf/koen_7.pdf）（Made by ICHARM database from EM-DAT)

Why do we need to assess flood risk?

Increasing flood damage

ICHARM developed water-related risk assessment indicators (Asian Water Development Outlook(AWDO) issued by Asian Development Bank (ADB))

Assessing and quantifying flood risk of countries ・・・ Easy to understand by policy makers and general public

Guiding policy makers and planners for reducing flood damage and sustainable development

AWDO（Asian Water Development Outlook）

・・・Five key dimensions on water security

KD5: Resilience to water-related disasters

（Resilience）

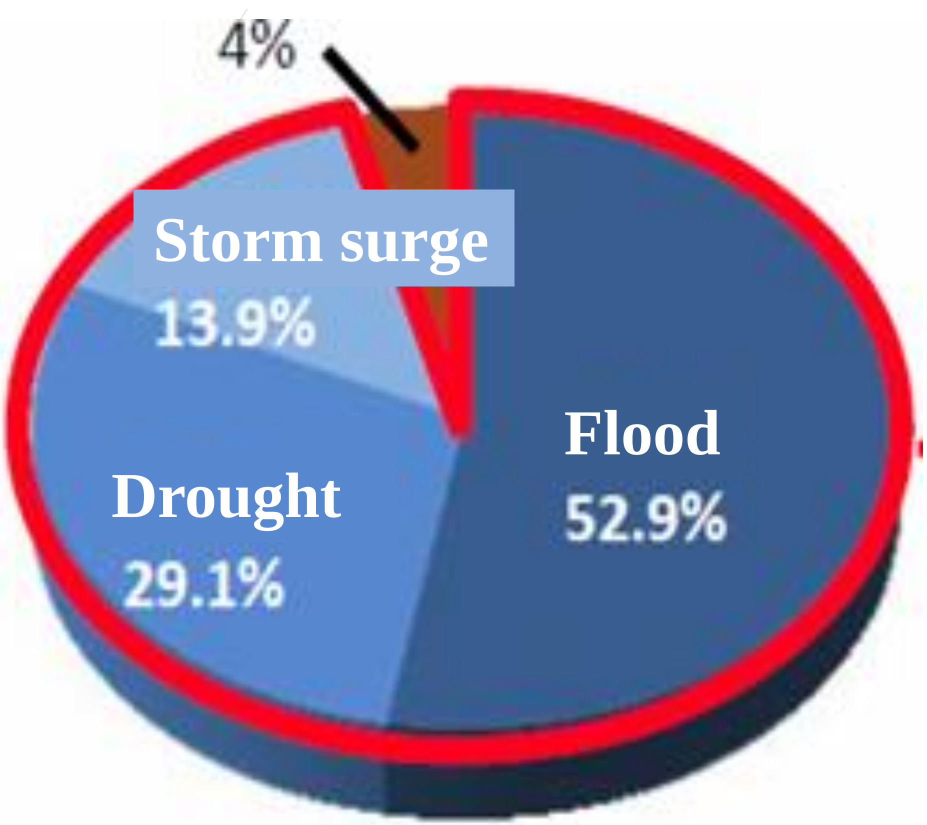
Reducing water-related risks and minimizing impacts of disasters

Countries with larger GDP per capita have more resilience to water-related disasters.

Economic development increases resilience to water-related disasters, which supports sustainable development.

Focusing on floods

※AWDO：evaluated water-related disasters (Flood, Drought, Storm surge).



Affected population
(1980-2013)

More than half damage is cuased by floods
(affected population)

Focusing on floods

Ref) ICHARM HP (http://kankyorenrakukai.org/symposium_12/pdf/koen_7.pdf)

Objectives

AWDO

- Limitation on global datasets.
- Only in the Asia-Pacific countries.

Objectives

① Improving flood risk index

・・・Updating data

＋Factoring in more factors

②Applying from Asia-Pacific countries to the world

・・・Flood damage is increasing in other than regions as well.

Methodology

How the Flood Risk Index is computed

Indicator and Subindicator

- Indicators

  The Flood Risk Index is computed by five indicators.

Flood Risk Index
- Hazard
- Exposure
- Vulnerability
- Hard Coping Capacity
- Soft Coping Capacity

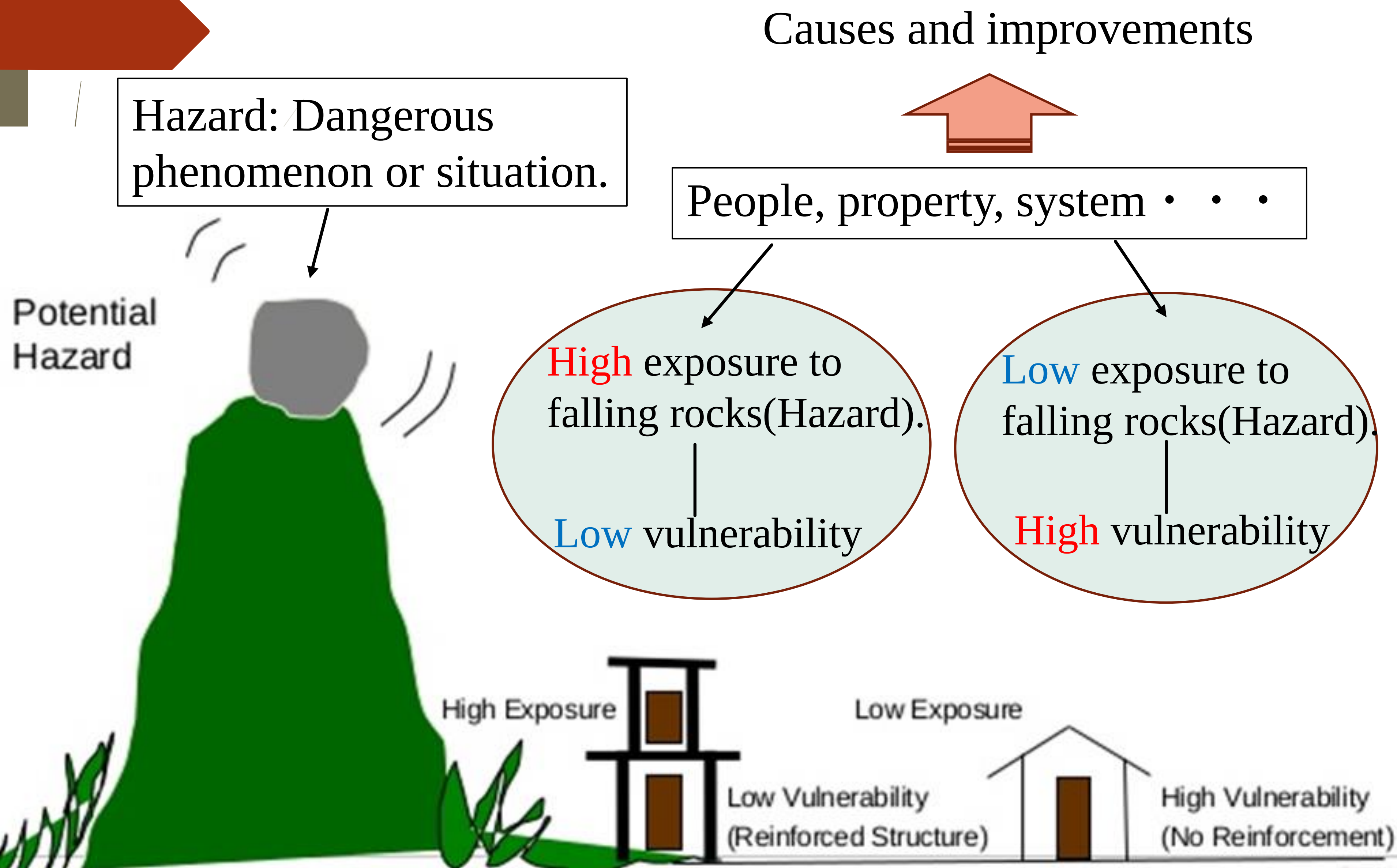
- Subindicators

  An indicator is calculated by subindicators.

E.g.
Hazard
- Maximum precipitation (weekly average)
- Cyclone proneness
- Monthly precipitation etc.

:

Concept



Ref) N. Waidyanatha (https://www.slideshare.net/waidyanatha/overview-em-commnuwandayone)

How to compute the Flood Risk Index

① Selecting subindicators

AWDO's factors

New factors

More holistic aspects

② Calculating a subindicator from factors
（Normalization）

③ Calculating an indictor by adding subindicators.

④ Computing the index from five indictors

How to compute the flood risk index from five indicators

$$\text{Flood Risk Index} = \frac{\text{Hazard} \times \text{Exposure} \times \text{Vulnerability}}{\text{Soft Coping Capacity} \times \text{Hard Coping Capacity}}$$

Indicators to increase risk

- Hazard : Magnitude of natural phenomena that cause floods
- Exposure : Scale of people or areas exposed
- Vulnerability : Susceptibility to the damaging effects of floods

Indicators to reduce risk

- Hard Coping Capacity :Ability to manage flood disasters by structural measures
- Soft Coping Capacity :Ability to manage flood disasters by non-structural measures

How to calculate a subindicator

e.g. Maximum precipitation (weekly average)

$$(\text{Subindicator}) = \frac{\textit{subject country} - \textit{minimum country}}{\textit{maximum country} - \textit{minimum country}}$$

$$= \frac{246\text{mm} - 40\text{mm}}{889\text{mm} - 40\text{mm}} = 0.24$$

e.g.

Subject country: Japan, 246mm,

Maximum country: Papua New Guinea 889m,

Minimum country: Mongolia, 40mm,

The subindicator is calculated as 0.24.

※An indicator is summing up of subindicators

Indicators and Subindicators

Indicator	Subindicator
Hazard	Maximum precipitation (weekly average)
	Cyclone proneness
	Frequency of heavey rainfall (more than 100mm/day)
	Maximum precipitation (monthly average)
	Ratio of the maximum precipitation of monthly average to the minimum
	Maximum precipitation of monthly average/Annual average precipitation
Exposure	Population density
	Urban population growth rate
	Population growth rate
	Inland water area
	Waterway length
Vulnerability	Corruption perception index
	Percentage of daily consumption less than 1$
	Official development assistance ratio
	Deforestation rate
	Infant mortality rate
	Unhealthy life
	Gini coefficient

Indicator	Subindicator
Hard Coping Capacity	GDP per land area
	Total water storage capacity per land area
	Road pavement rate
Soft Coping Capacity	Literacy rate
	Enrollment rate
	Number of television receivers
	Number of mobile phone owners
	Percentage of GDS in GDP
	Internet users
	Public medical expenditure

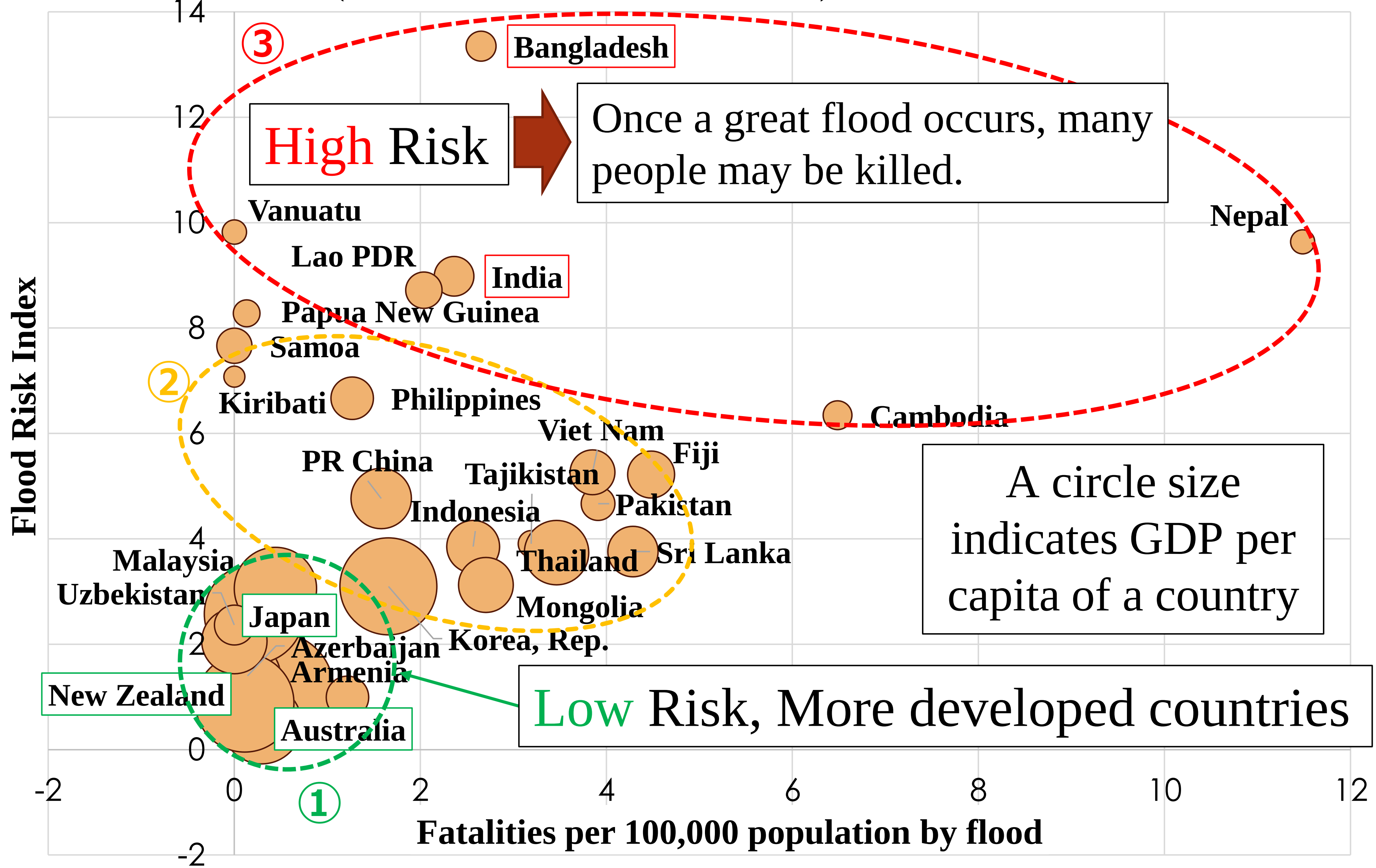
Black: Subindicators used in AWDO

Red: New subindicators

Results
(Asia-Pacific countries)

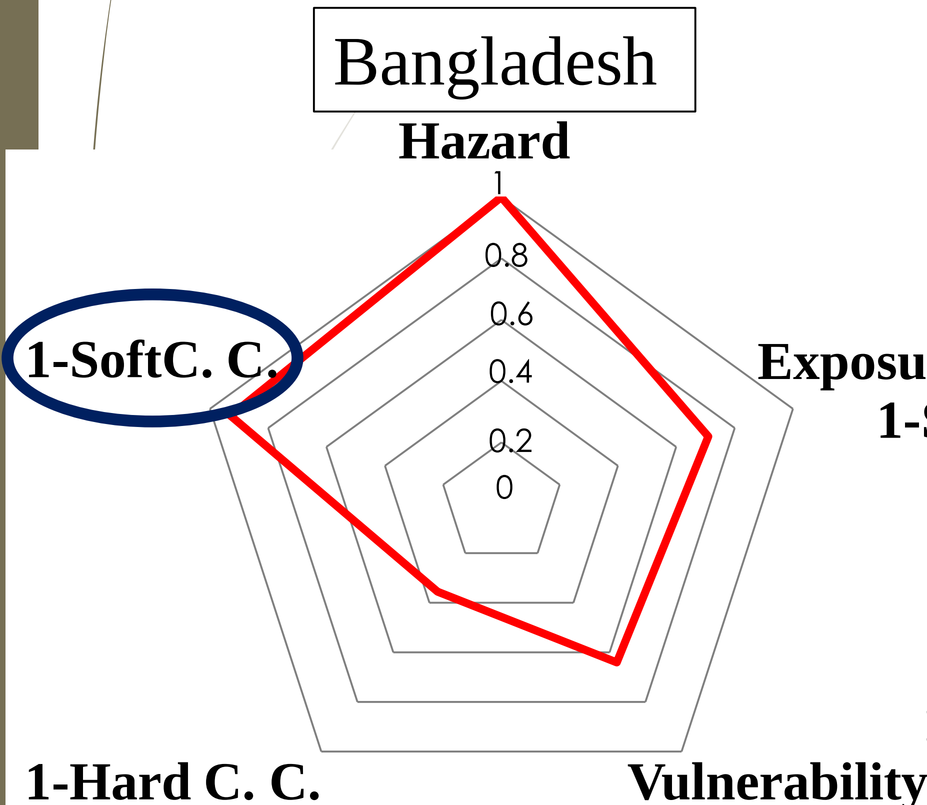
Result 1

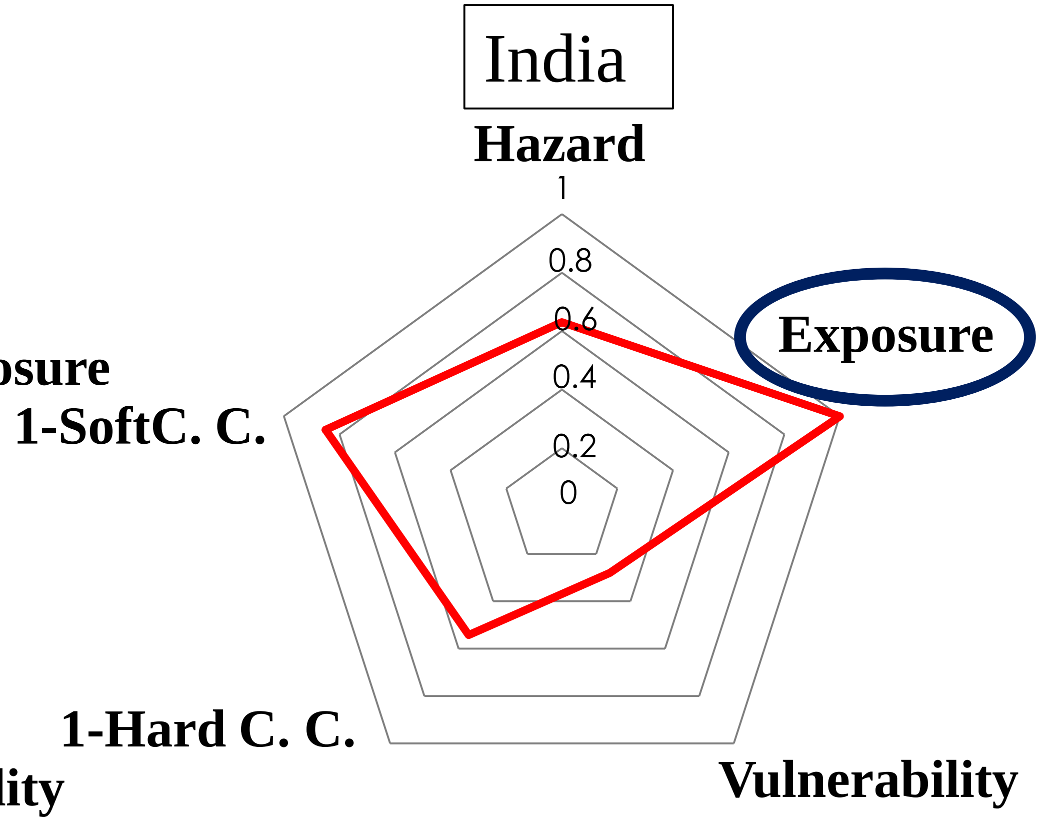
Number of fatalities per 100,000 people and flood risk index (33 Asia-Pacific countries)



Result 2

High risk countries and causes



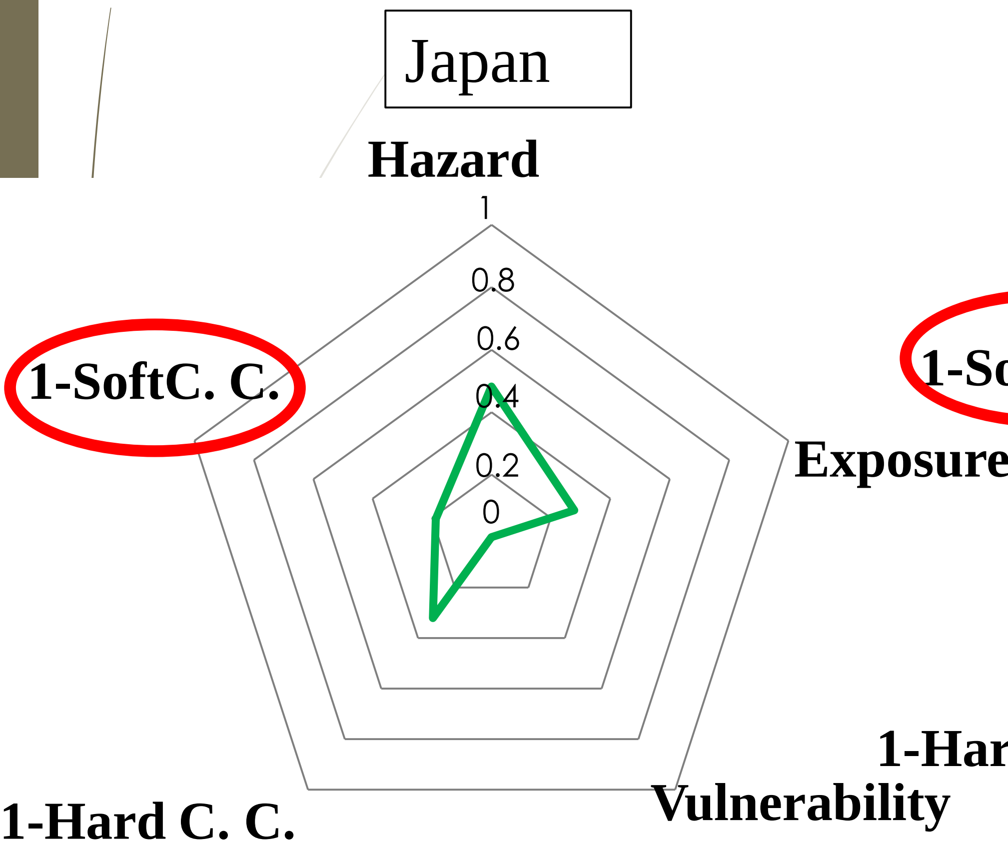


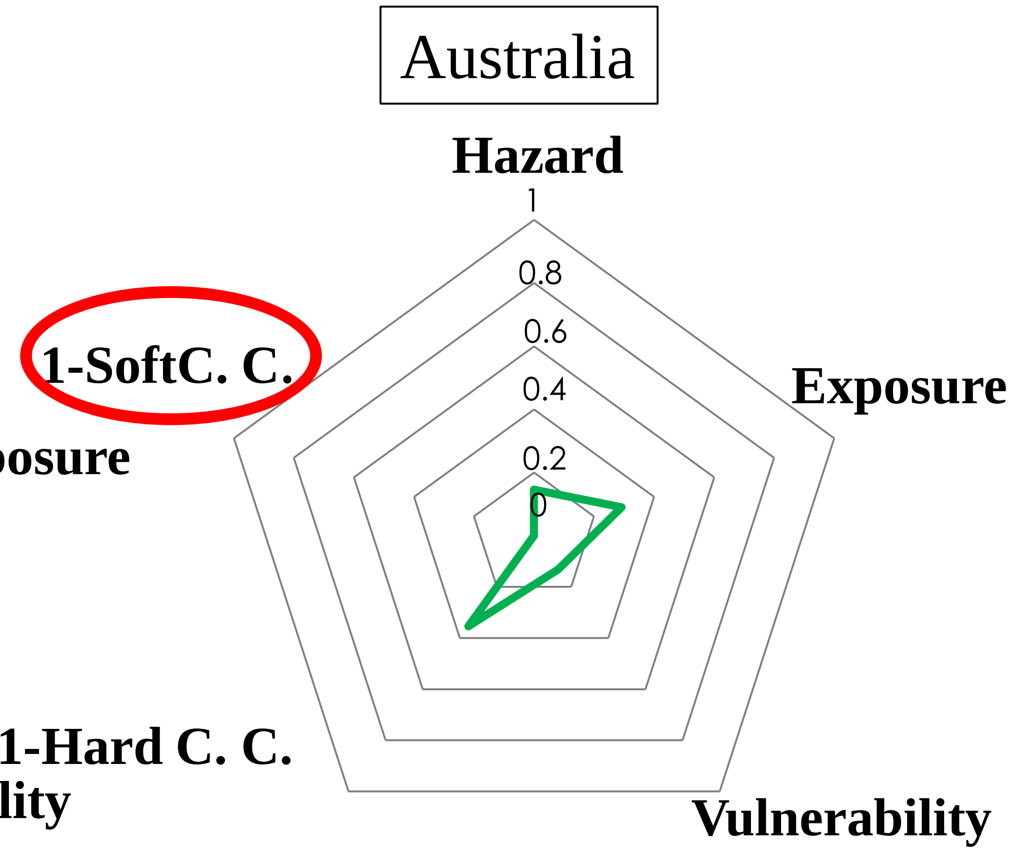
Low literacy rate, enrollment rate

Rapid Urban population growth

Result 3

Low risk countries and reasons





Result 4

Flood Risk Index and five indicators

Increase indicators — Reduction indicators

	Hazard	Exposure	Vulnerability	Hard	Soft
Correlation coefficient R	0.88	0.58	0.65	-0.51	-0.75
Coefficient of determination R^2	0.77	0.34	0.42	0.26	0.57

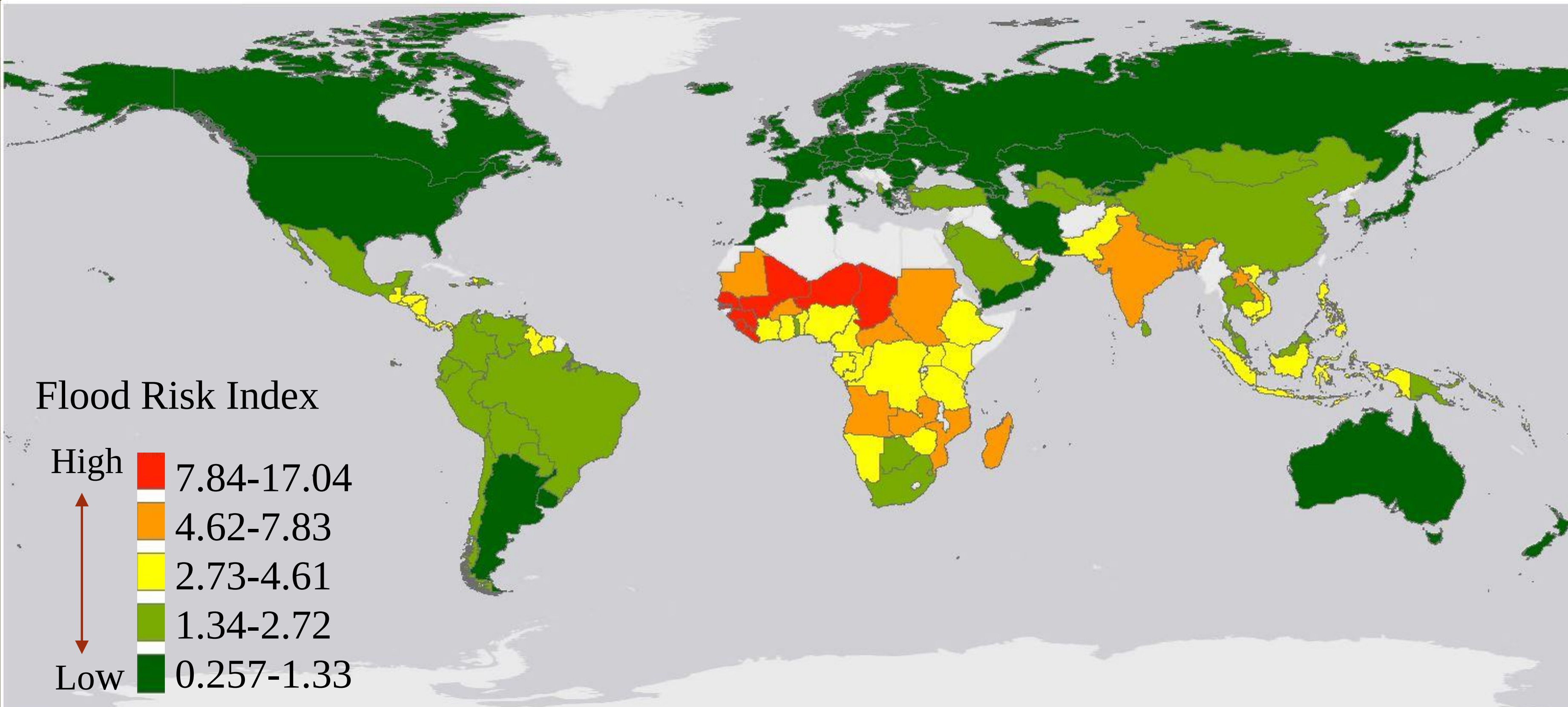
"positive" with increase factor ,"negative" with decrease factor.

→The subindicators used in the study are reasonable.

Results
(Global)

Results 1

Flood Risk Index (146 countries)



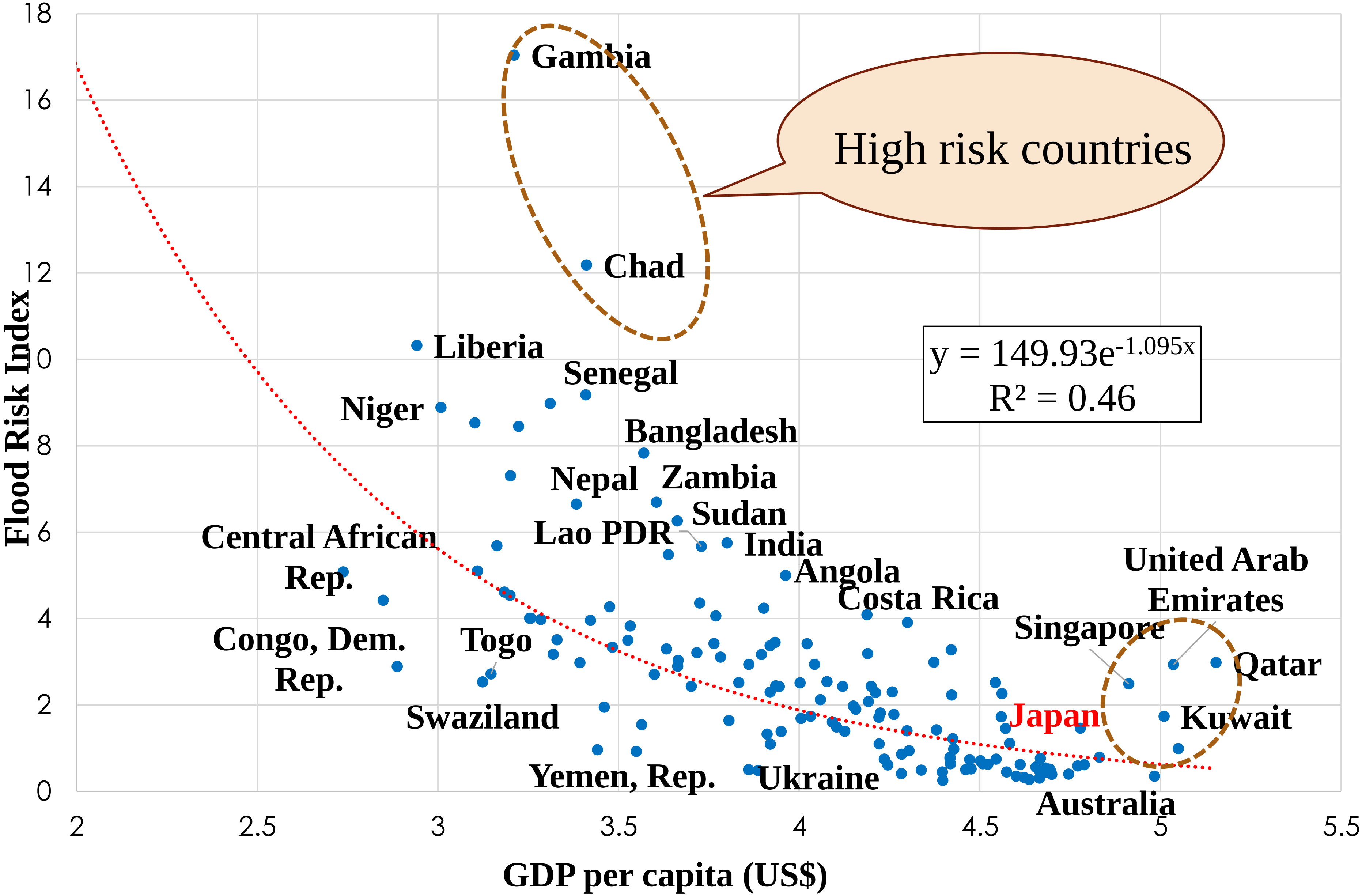
Countries near the equator and in Africa have high Flood Index.

・・・High risk：Central Africa, Pacific countries

・・・Low risk：Developed countries, such as Japan, Australia

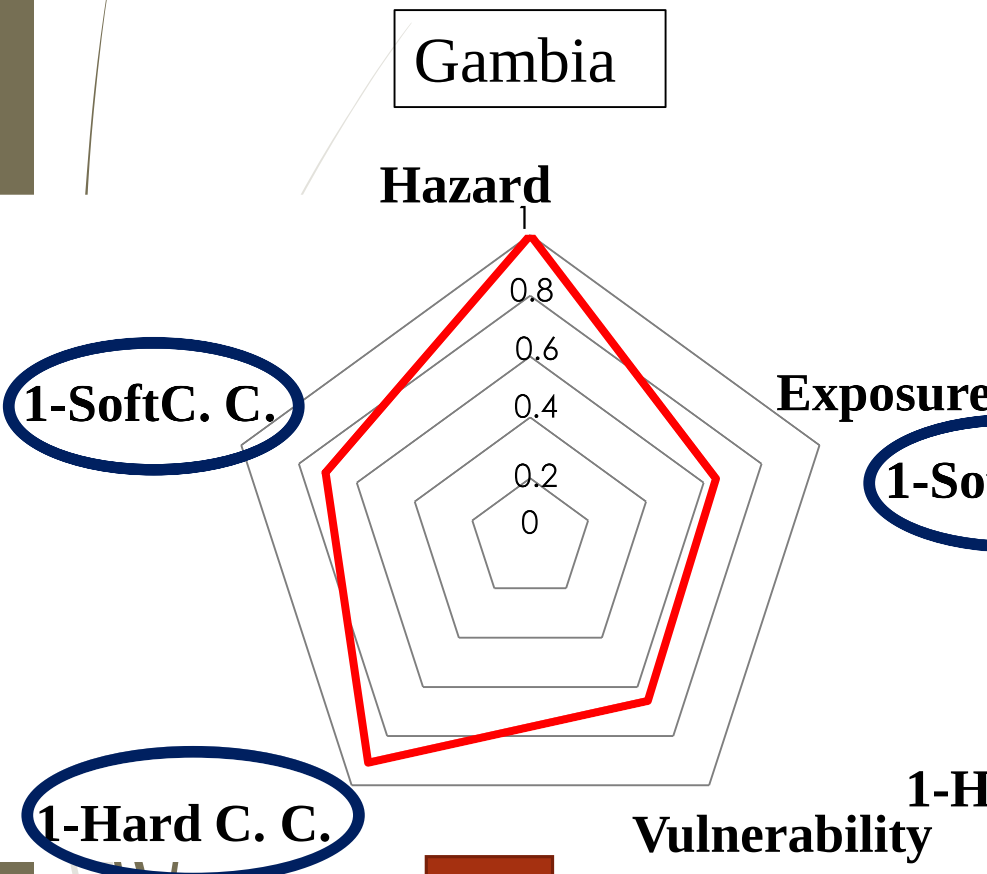
Result 2

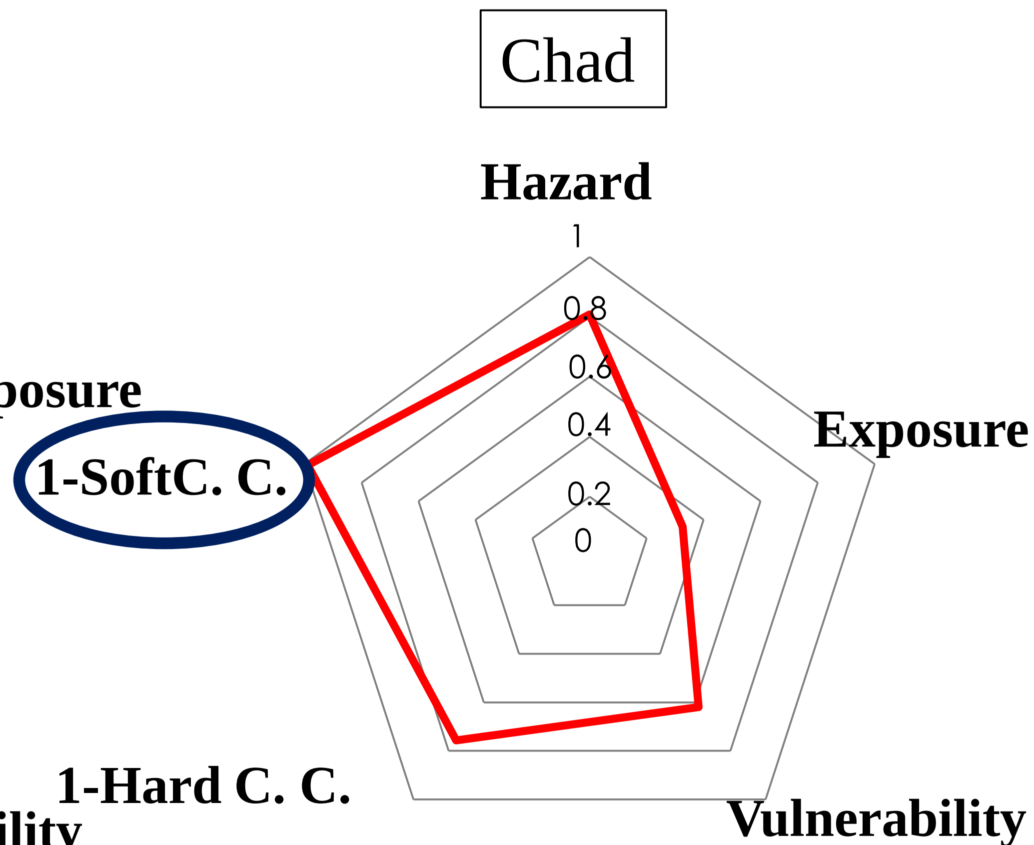
GDP per capita and flood risk index



Results 3

High risk countries and its factors



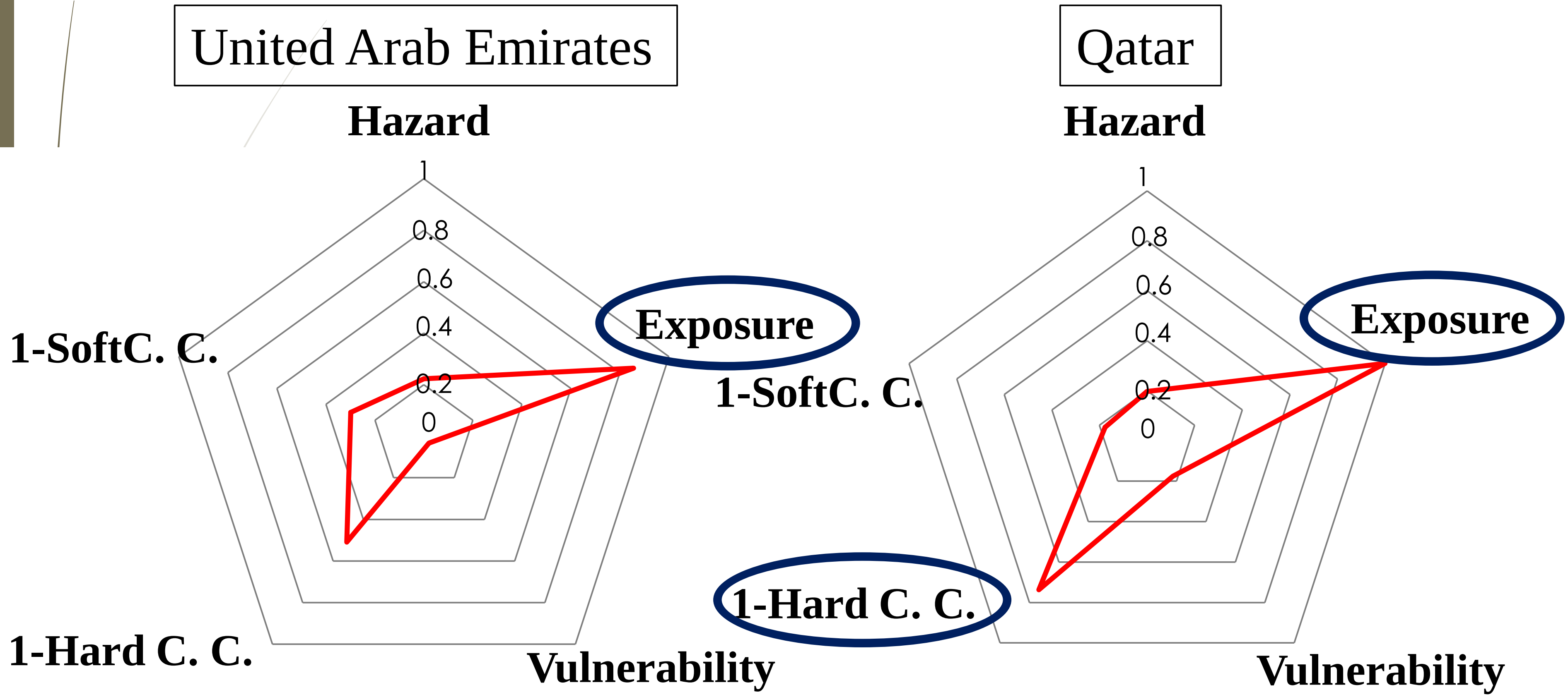


High urban population growth,
Low infrastructure development

Low information system

Result 4

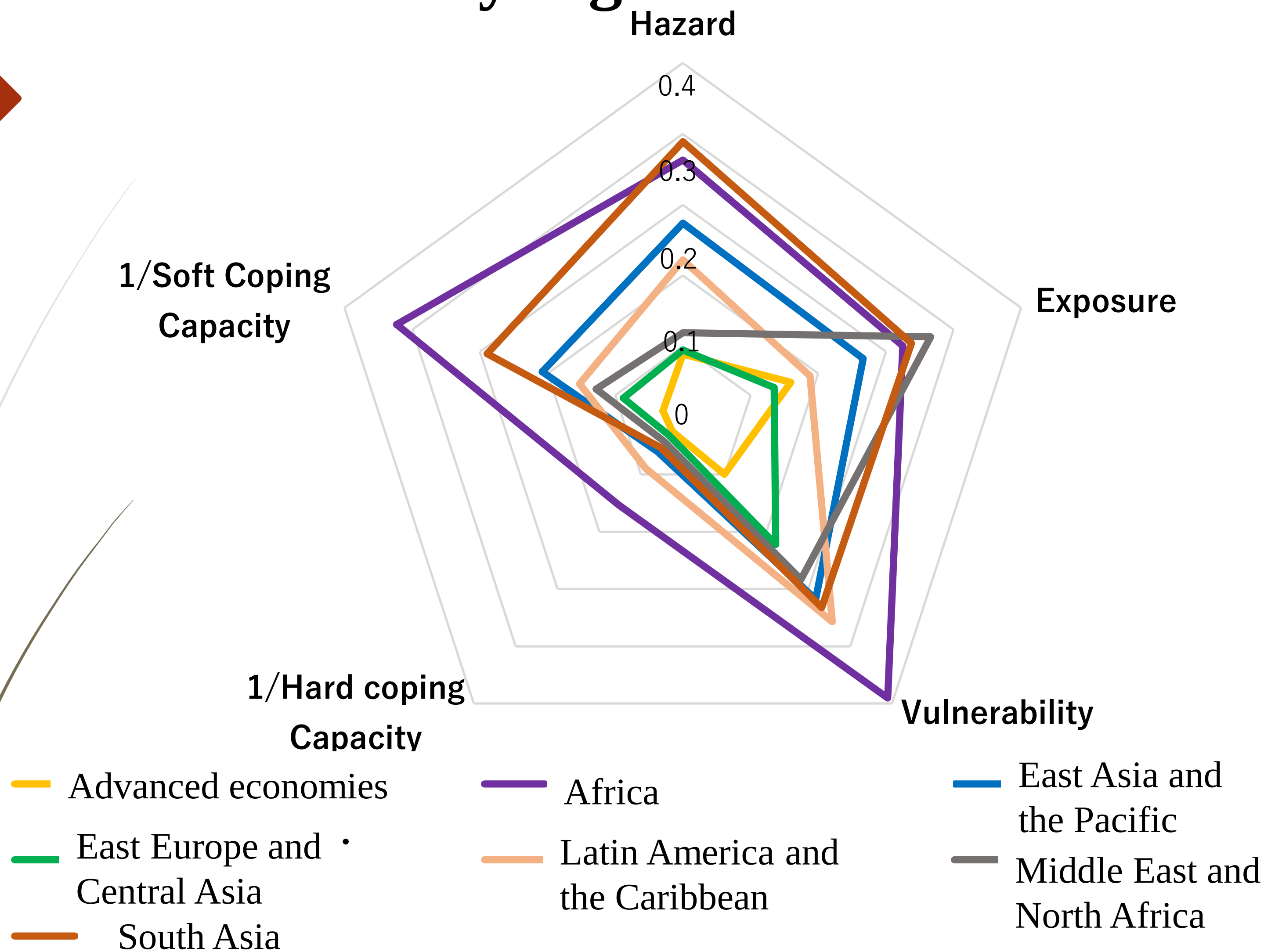
Relative high countries with large GDP per capita



High urban population growth

Rapid deforestation

Result 5: Indicators by region



<u>Africa is the highest flood risk region</u>

⇒ All 5 indicators increase risk highly

Conclusion

・Developed the flood risk index that visualizes causes of risk and contribute to national policy in mitigating damage.

・Applied the developed index to 146 countries globally and illustrated features of countries and regions.

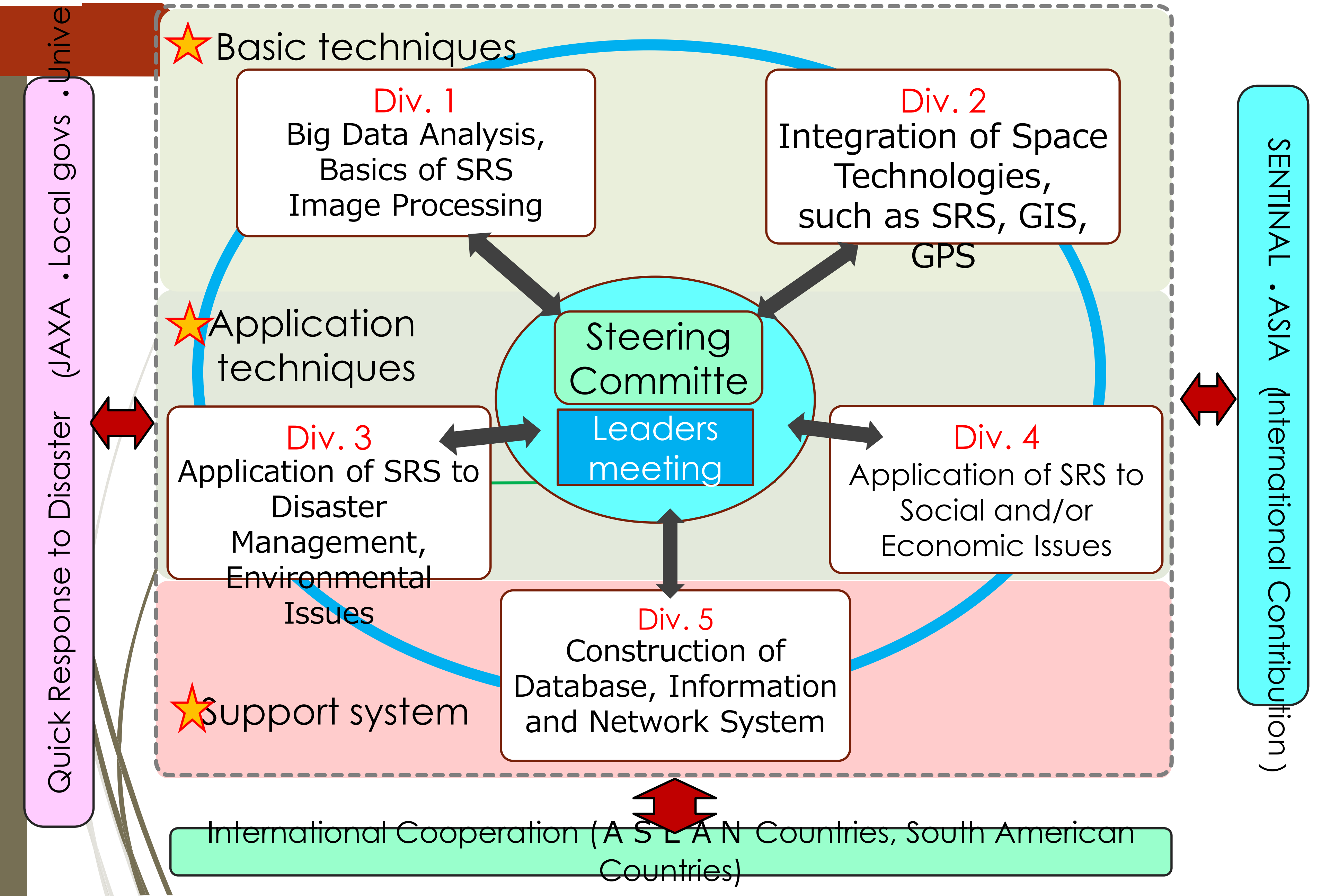
Way forward

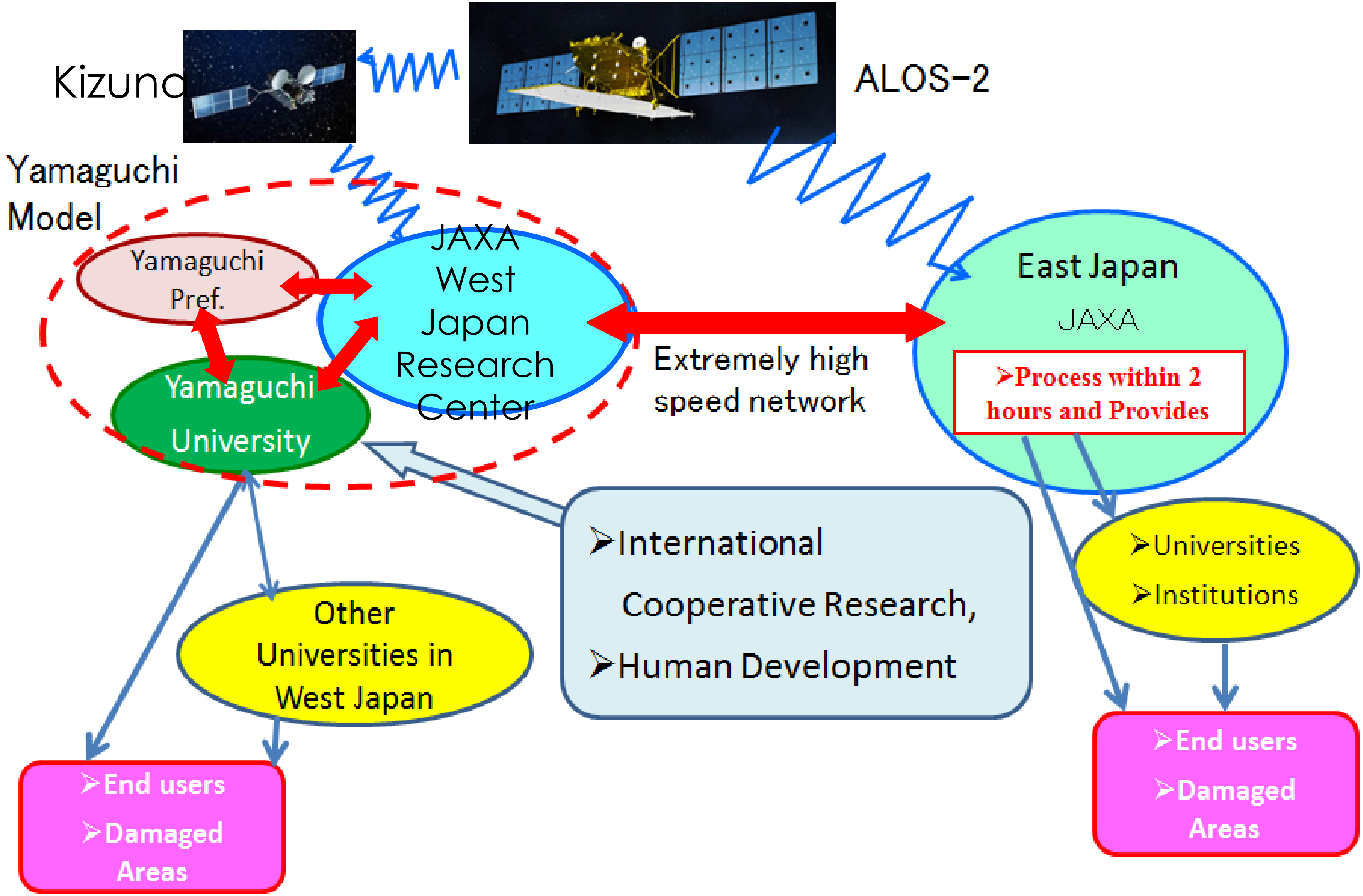
Utilizing remote sensing data to complement global datasets

← global coverage, updating

e.g. GSMaP for precipitation

CRASS: Divisions





The future network regarding the usage of satellite data, i.e., research and human development. YU will cooperate with other universities and research institutions. In addition, we will accelerate and expand international cooperation.

Activities and Network of CRASS