JSPS-ICSSR Seminar

21 November 2022 @Tokyo

Understanding and Addressing Systemic Risks Behind the Socio-economic Impacts of COVID-19 in Japan and India: Developing a Roadmap for a Resilient and Sustainable Future

Assessing the capacity of Japan to address the climate change disasters and its implication to respond to COVID-19 risk

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Outline

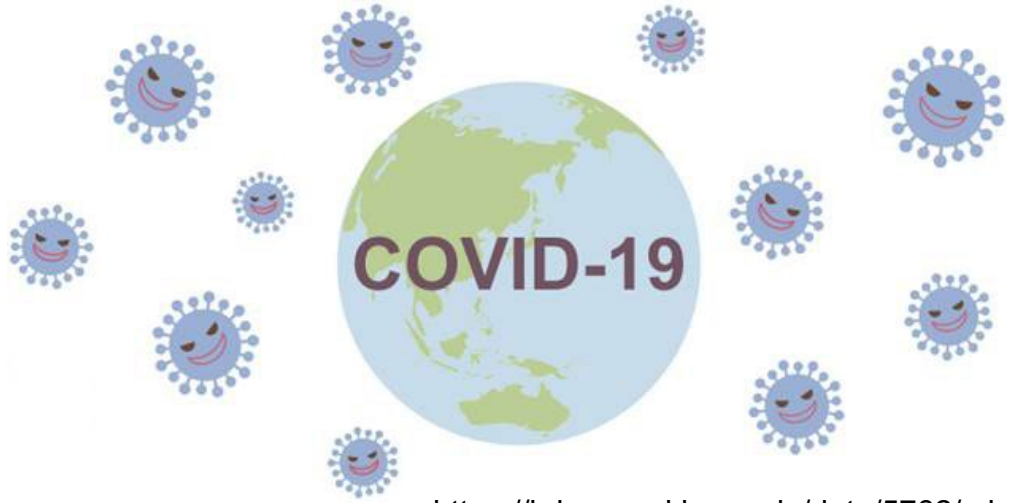
1. Climate disaster analysis

- Background
- Existing literature
- Objective
- Methodology
- Results

2. Implication to respond to COVID-19 risk

3. Discussion & conclusion


Source: Nikkei Business
https://business.nikkei.com/atcl/gen/19/00178/071300001/



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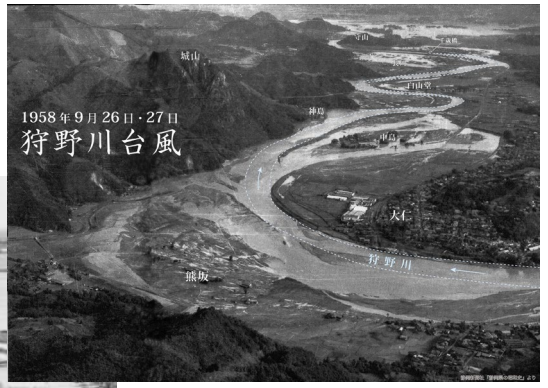
1. Climate disaster analysis

Japan’s history to combat hydrological disasters (1950s-2020s)

- Economic recovery after WWII
- Japan's high economic growth and infrastructure development for disaster prevention
  - Urbanization & population concentration
- **Recent vulnerability**
  - **Aging society and infrastructure**
  - **Isolation of individuals by depopulation and COVID-19**
- **Hazard accelerated by climate change**
  - **Changing precipitation patterns**

1958



1959

The Isewan Typhoon killed more than 5,000 people

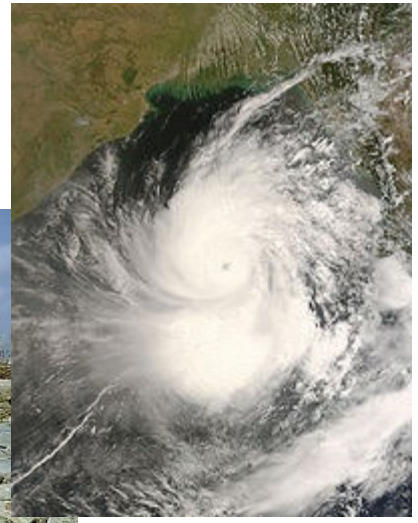
2018

West Japan Heavy Rains

Climate change disasters in Asia

- Intensified climate change on the global scale
- Low development & high vulnerability in many Asian countries
- Adaptive capacity gaps and urgent capacity development needs

2008
Cyclone Nargis in Myanmar



Asia-Pacific Climate Change Adaptation Information Platform (**AP-PLAT**), launched at the G20 Summit in 2019

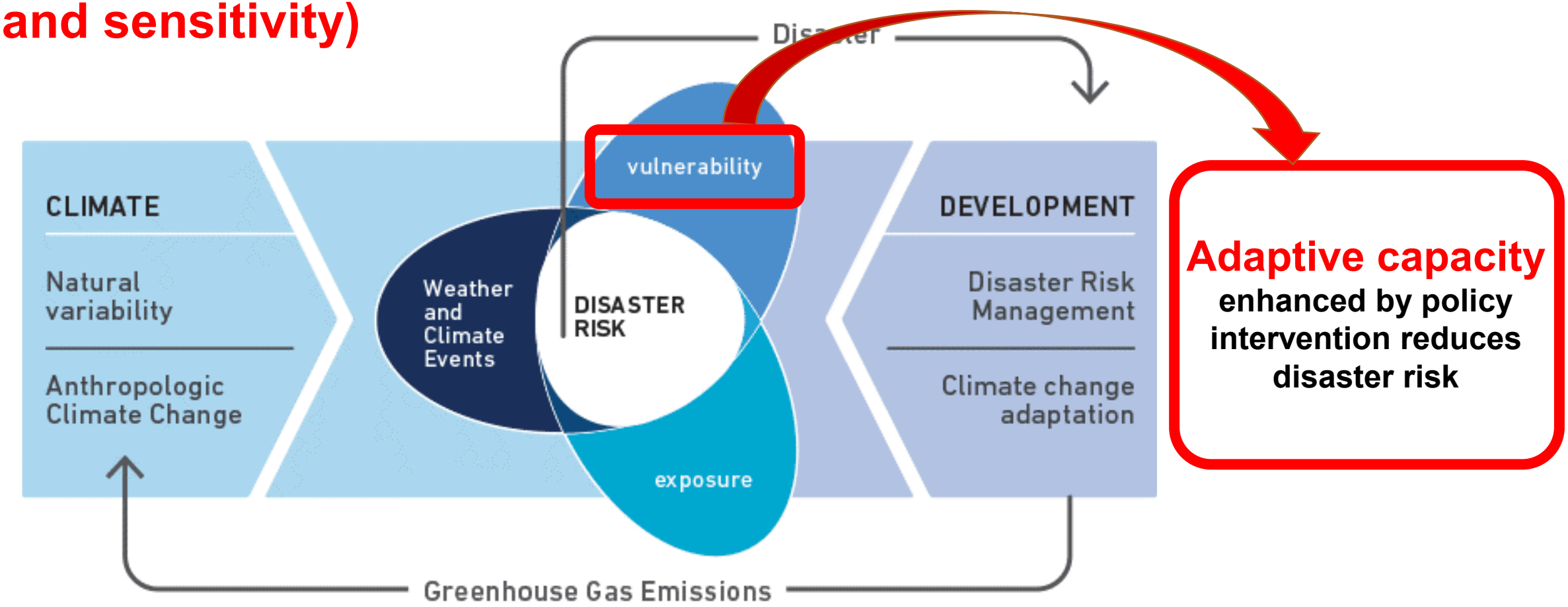
2020
Flood in China

Floods in Cháng Jiāng basis in China

The global goal of the Paris Agreement: "Enhancing **adaptive capacity**, strengthening resilience and reducing vulnerability to climate change" (Article 7.1)."

Conceptual model of disaster risk

- **Risk** (e.g., fatalities, damages) is caused by **hazard (weather and climate events)**, **exposure**, and **vulnerability** **(adaptive capacity and sensitivity)**



IPCC (2012; 2019)

Existing literature on adaptive capacity

- National-level cross-country studies on the determinants of natural disaster impacts since the early 2000s:
  - Factors such as GDP, income inequality, education, quality of institution, democracy, financial system matter for reducing fatalities (Brooks et al., 2005; Kousky, 2014; others).
- Development of subnational adaptive capacity indicators in the 2010s:
  - E.g., Indices at the provincial (Marzi et al., 2017) and city (Tapia et al., 2017) levels

Gaps in scientific knowledge about the **occurrence mechanism of complex climate risks** involving the contribution of **adaptive capacity at subnational or local levels**, primarily due to the lack of dataset and limited coverage in a more downscaled geographical context.

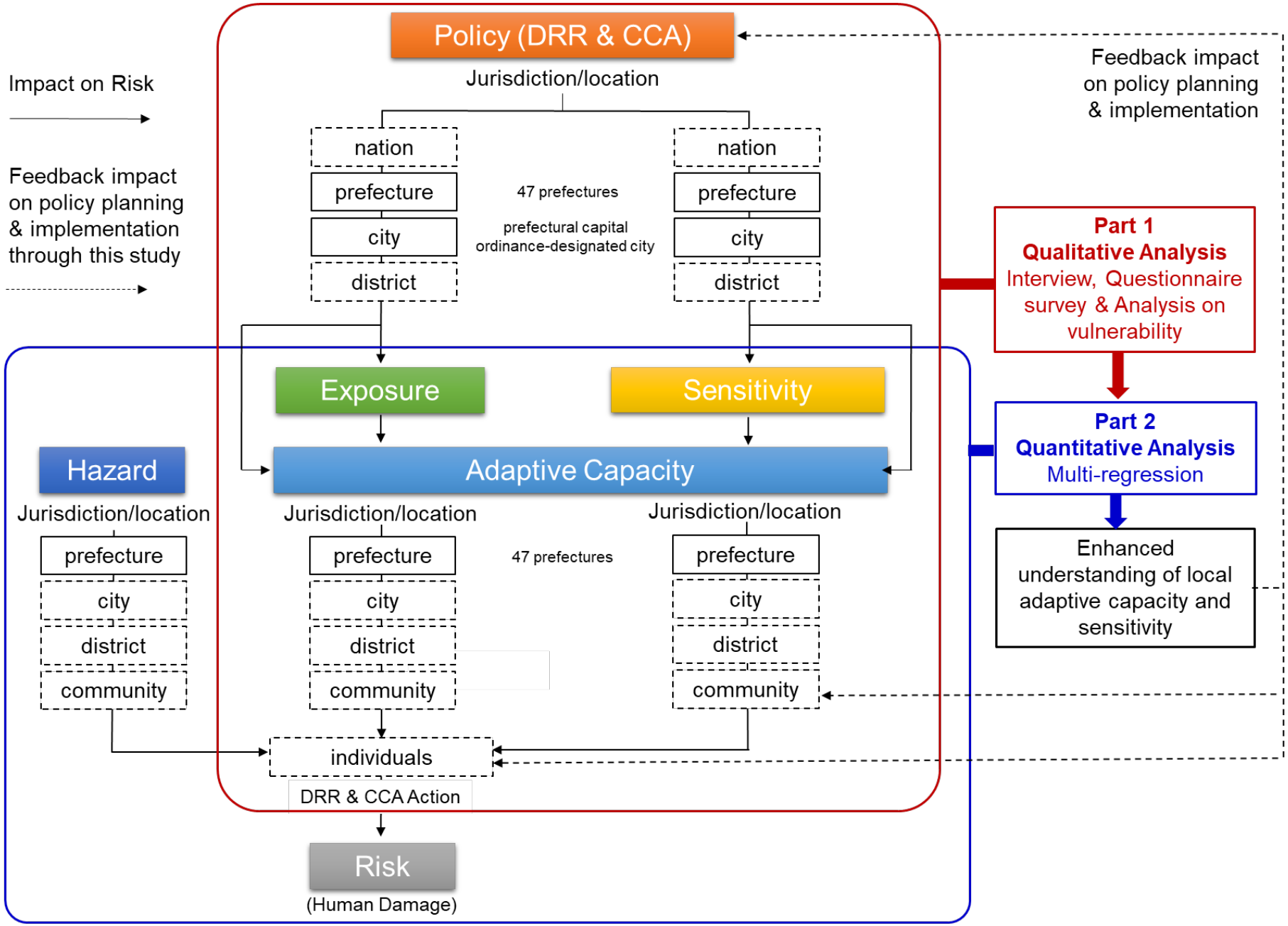
Objective

- To systematically assess the significant factors (determinants) of subnational adaptive capacity (local adaptive capacity) & sensitivity for reducing climate change disasters in Japan

- To present a possible methodology on the identification of determinants of subnational adaptive capacity in Japan's prefectures,

- To contribute to capacity building programs for climate change adaptation (CCA) in Asia

Methodology to assess adaptive capacity & sensitivity



Methodology to assess adaptive capacity & sensitivity

Part 1

Qualitative analysis

- Questionnaire survey (n=38) (Valid response rate: 39%) in Apr-Jun 2020
- Interview survey & Field visit in Feb-Mar 2020 in Chugoku and Kyushu regions

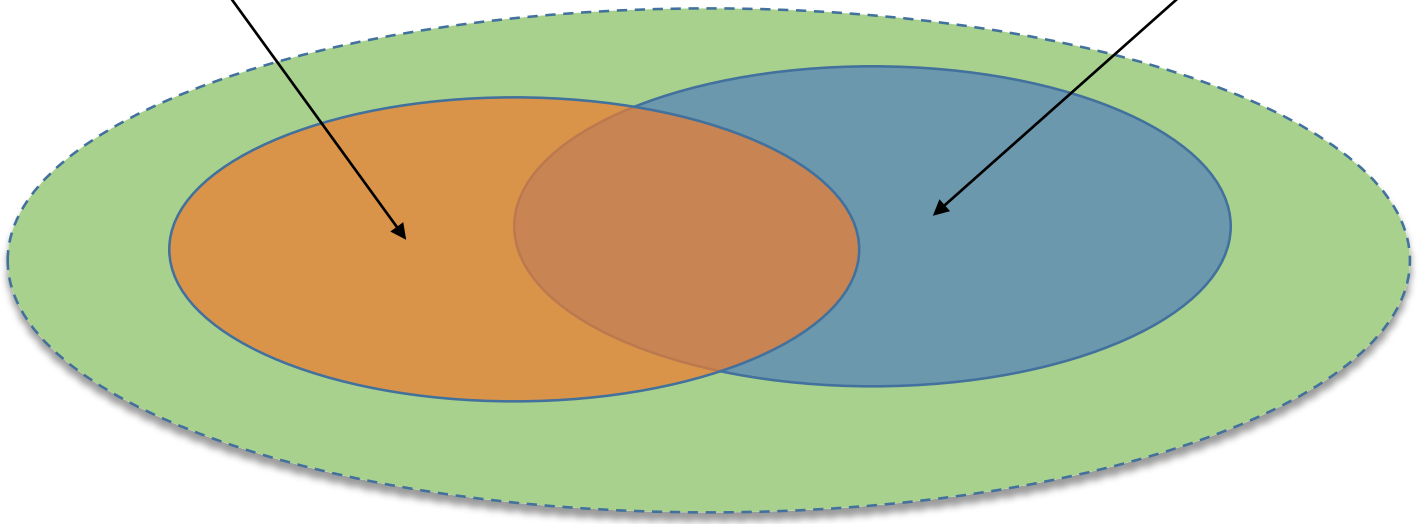
Part 2

Quantitative analysis

- Multi-regression analysis on risk (e.g., fatalities), hazard (precipitation), exposure, and vulnerability (adaptive capacity and sensitivity)
- Prefectual-level; 1976-2014 & 2000-2014

Refining hypothesis
Variable selection

Space for the determinants of vulnerability (adaptive capacity and sensitivity) in Japan

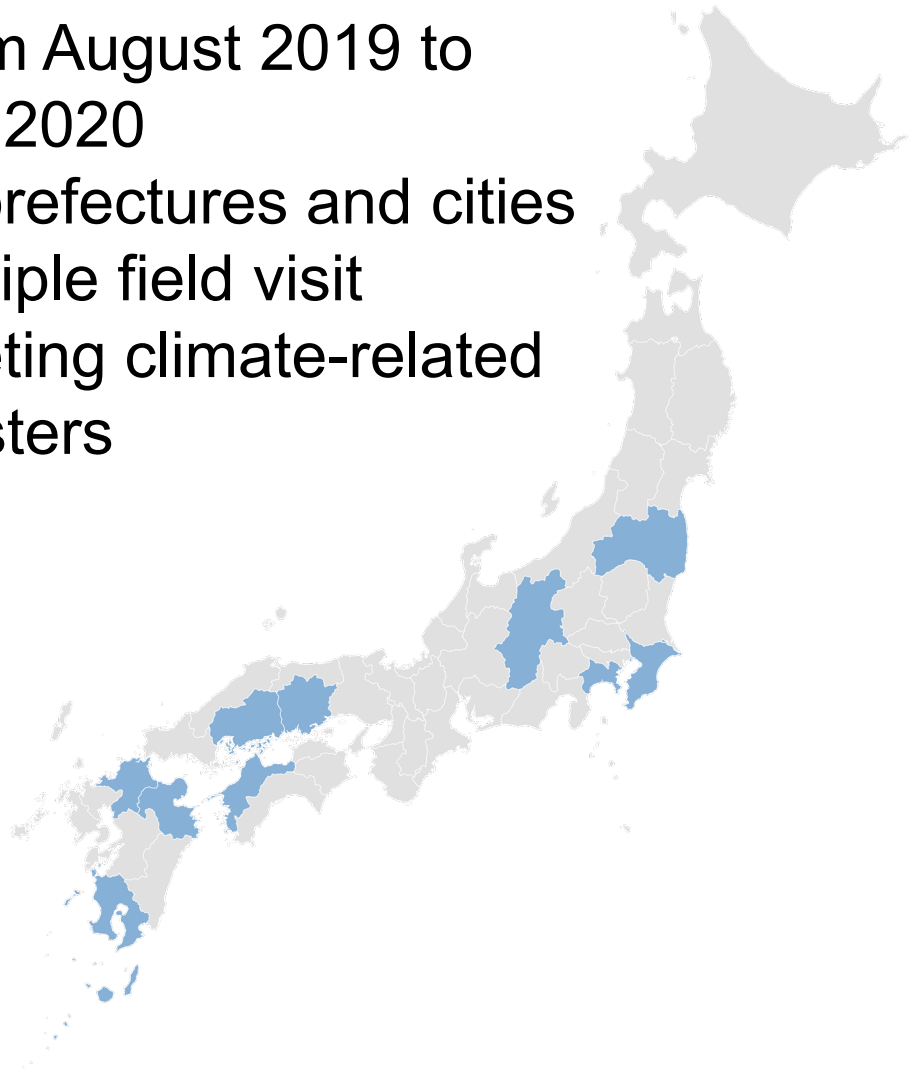


Integration of the results & Discussion

Part 1: Qualitative analysis

Field visit

-From August 2019 to April 2020
-12 prefectures and cities
-Multiple field visit targeting climate-related disasters



Questionnaire survey

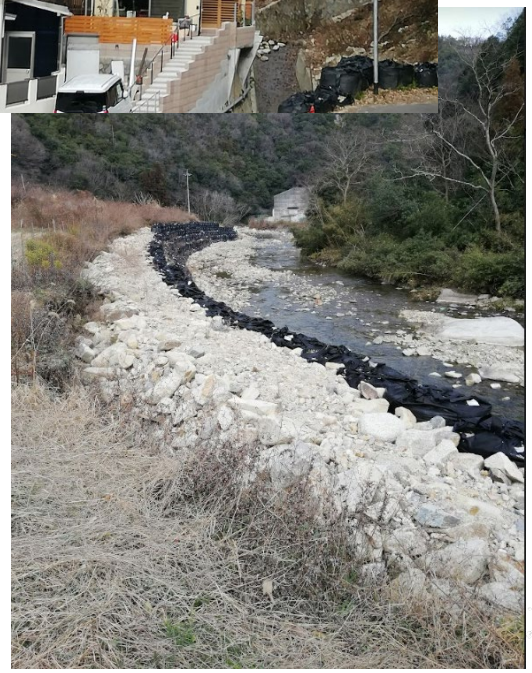
- During April-July 2020
- 38 responses from prefectures and capital cities

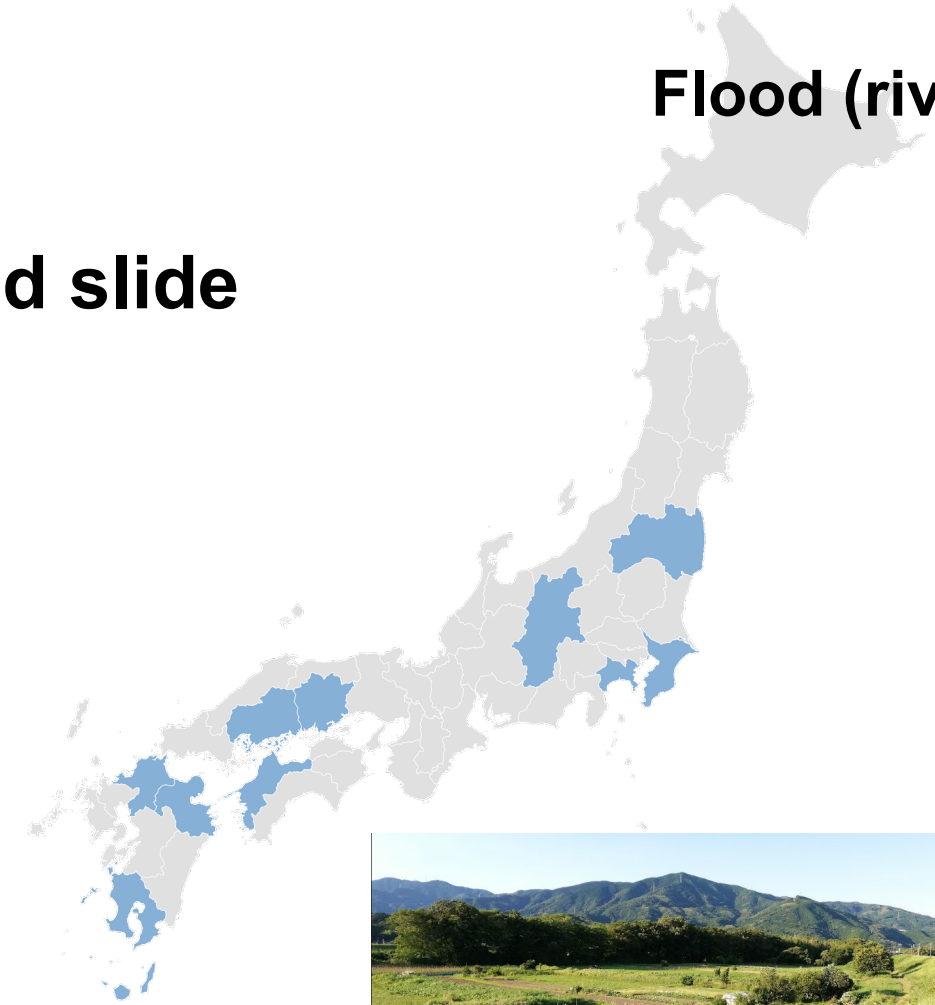
Qualitative analysis based on:

- Level of policy preparedness and implementation (Hardware, Software, and Transformative adaptation)
- Cognition on essential adaptive capacity elements

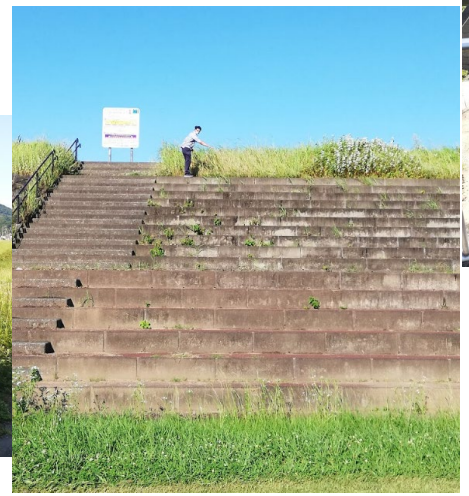
Field visit

Land slide





Flood (riverine/internal)



From downstream to upstream

Part 2: Quantitative analysis

Statistical model

- UNDP (2004), Japan society of natural disasters (2018), Hayashi (2014), etc.

$$Risk = f(Hazard, Exposure, Sensitivity, Adaptive\ Capacity)$$

Specification

$$Risk = Hazard \times Exposure \times Sensitivity\ /\ Adaptive\ capacity$$

($R, H, E, V \geqq 0, AC > 0$)

- Panel regression models:
  fixed effect (FE) model

$$y_{it} = \alpha_i + \lambda_t + x'_{it}\beta + \varepsilon_{it}$$

  pooled OLS (pool)

$$y_{it} = \alpha + x'_{it}\beta + \varepsilon_{it}$$

x'_{it}: vector comprising variables for hazard, exposure, vulnerability, and adaptive capacity,
β: coefficients for these variables,
i: prefectures, t: year

- Test **Log-log** or **linear-log** model

Data & Hypothesis

- Best available data (publicly available)
- 47 Prefectural-level data during 1976-2014 (n=1833) & 2000-2014 (n=705)
- No modification of outliers
- Explained variables
  - **Risk**: **Death rate** or **Death and injured rate** by hydrological disasters such as typhoon, riverine flood, and landslide
- Explanatory variables
  - **Hazard [+]** Precipitation (e.g., annual maximum daily precipitation)
  - **Exposure [+]** Population density in populated areas
  - **Sensitivity [+]** Age, House structure (one-story), etc.
  - **Adaptive capacity** [-] **Infrastructure, Information, Local governance (risk awareness), Institution, Finance**

Hardware measures (e.g., infrastructure) should be statistically significant especially in the long-term regression (1976-2014) and the role of software measures such as fire-fighting parties should be highlighted in more recent years (2000-2014).

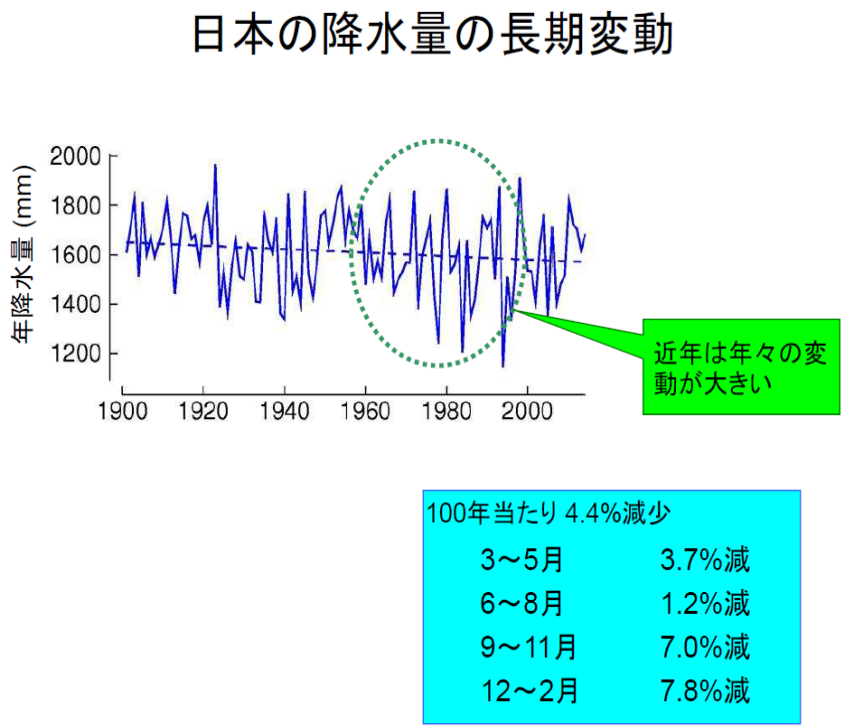
Data list for statistical (quantitative) analysis

		Quantitative analysis	Qualitative analysis	name
Hazard	Precipitation	Precipitation [(annual max) mm/24h]		precipitation1
		Precipitation [days over 100mm/24h]		precipitation2
Exposure		Population density per 1km^2 of habitable area		exposure1
		Population density in populated areas (per 1 km^2 of populated area)		exposure2
Sensitivity	Human	Percentage of households with elderly couples only [% households]	1. Age	human1
		Percentage of elderly single-person households [% households]	1. Age	human2
		Age: Proportion over 65 [% population]	1. Age	age1
		Age: Proportion over 75 [% population]	1. Age	age2
	House type	Wooden/one-storied house [% of all houses]	(Field and interview surveys)	house1
Adaptive capacity	Infrastructure	Hard infrastructure (coast, river, mountain) [JPY]	(Field and interview surveys)	infrastructure1
	Economy	Average annual income [1,000 JPY]	2. Income of household 3. Low income household	economy1
	Education		4. Education of household	
	Information		5. Disaster prevention radio of household (Early warning system)	
		TV broadcasting contracts [per person]	6.TV ownership rate of household	information1
		Mobile phones (including PMHS) owned [per thousand households of two or more people]	7.Smartphone ownership rate of household	information2
	Governance (Risk awareness)	Voluntary disaster prevention organization cover rate [%household]	8.Voluntary disaster prevention organization 9.Disaster prevention/evacuation training	governance1
		Fire fighting party [per thousand persons]	10.Numbers of fire fighting department, official, party and staff	governance2
	Institution	Fire station [per thousand persons]	10.Numbers of fire fighting department, official, party and staff	institution1
		Number of disaster prevention staff [per thousand persons]	11.Number of times of local briefing session by the staff 12.Number of residents participating in local briefing session 15.Number of DRR government officials	institution2
		Number of firefighting staff [per thousand persons]	15.Number of DRR government officials	institution3
	Finance	Fiscal power index	13.Financial status of local government	finance1
		Real balance ratio index of income and expenditure	13.Financial status of local government	finance2
		Disaster relief expenses (prefecture + municipality)	14.Local government disaster prevention budget scale	finance3
		Disaster recovery expenses (prefecture + municipality)	14.Local government disaster prevention budget scale	finance4
		Civil engineering costs (prefectures + municipality)	14.Local government disaster prevention budget scale	finance5
		Firefighting costs (prefecture + municipality)	14.Local government disaster prevention budget scale	finance6
	Environment	Forest coverage [%land]	(Field and interview surveys)	forest1

Data on precipitation

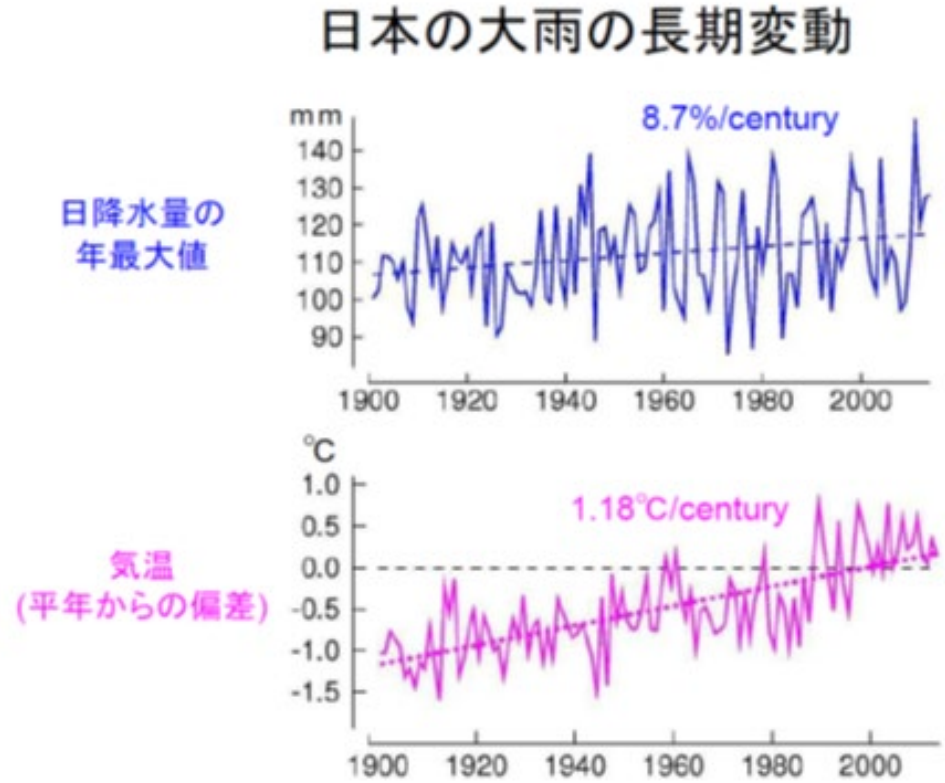
Long-term precipitation in Japan (Time-series)

Annual total precipitation



100年当たり 4.4%減少	
3～5月	3.7%減
6～8月	1.2%減
9～11月	7.0%減
12～2月	7.8%減

Annual maximum precipitation per day



Upward trend over the past 100 years

Results of regression analysis (1/2)

Table 1. Multi-regression results on the death rate or death&injured rate

		Time period :	1976-2014	1976-2014	2000-2014	2000-2014	2000-2014	2000-2014	2000-2014
			Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
		Dependent variable:	log-log death rate	log-log death&injured rate	linear-log death rate	linear-log death rate	linear-log death rate	linear-log death rate	linear-log death rate
			FE	FE	Pool	Pool	Pool	Pool	Pool
Category	**Sub-category**	**Independent variable:**	Coeff	Coeff	Coeff	Coeff	Coeff	Coeff	Coeff
		Intercept			-3.70E-06	-3.48E-06	-3.51E-06	-2.90E-06	-3.48E-06
Hazard	Precipitation	Precipitation [(annual max) mm/24h]	4.90 ***	4.64 ***	1.00E-06 ***	9.79E-07 ***	9.79E-07 ***	9.80E-07 ***	9.79E-07 ***
Vulnerability	Human	Proportion of Age (>75) [%]			1.35E-06 *	1.26E-06 *	1.27E-06 *	1.66E-06 **	1.85E-06 ***
	House type	Wooden/one-storied house [%]			4.47E-07 *	4.24E-07 *	4.25E-07 *	3.88E-07 *	4.45E-07 **
Adaptive capacity	Infrastructure	Hard infrastructure (coast, river, mountain) [JPY]	-1.48	-1.41 *	-2.78E-07	-3.23E-07	-3.23E-07	-5.73E-07 †	-4.01E-07
	Governance	Voluntary disaster prevention organization [number]			-5.89E-08	8.29E-09	8.29E-09	-1.67E-07	-1.93E-07
		Fire fighting party [number]	-6.05 †	-7.68 *	2.31E-07				
	Institution	Fire station [number]	-0.44		-6.98E-08				
	Finance	Fiscal power index	-2.69	-1.4	-3.80E-07	-7.64E-07	-7.57E-07 †		
		Real balance ratio index of income and expenditure	-0.02						
		Disaster relief expenses (prefecture + municipality) (2 years before)			-8.00E-08				-1.11E-07 †
		Disaster recovery expenses (prefecture + municipality)(2 years before)		-0.11	-1.62E-07	-1.88E-07 †	-1.88E-07 †		-9.98E-08
		Number of obs.	1833		705	705	705	705	705
		R-Squared	0.04		0.05	0.05	0.05	0.04	0.05
		Adj. R-Squared	0.01		0.04	0.04	0.04	0.04	0.04

***, **, *, † represent the levels of statistical significance of 0.1%, 1%, 5%, 10%, respectively.

FE: Fixed effect model, Pool: Pooled OLS

Precipitation, age (over 75), house type, infrastructure, fire fighting party, fiscal power index, fiscal spending are statistically significant.

Results of regression analysis (2/2)

- **1976-2014** ***Since premature stage of development***
  - Log-log fixed effect models are more suited
  - Death rate is explained statistically significantly by precipitation, fire-fighting parties
  - Death & injured rate is explained statistically significantly by precipitation, hard infrastructure, and fire-fighting parties.
- **2000-2014** ***Mature stage of development***
  - Age, house type, infrastructure, fiscal power index, and fiscal spending for disaster relief and recovery are statistically significant.
  - Linear-log pooled OLS models are more suited ➔ diminishing returns of adaptive capacity or adaptation measures as economy develops or time passes.

Determinants

Hardware & software measures

Vulnerability, exposure, and financial aspect of adaptive capacity

ICTs and fire stations were not found statistically significant

Result: Determinants of adaptive capacity and sensitivity

		Determinants in Questionnaire analysis (Part 1)	Determinants in Quantitative analysis (Part 2)	Determinants common in both analyses
Sensitivity	**Human (Age)**	**Age**	**Proportion over 75**	**Proportion over 75** (Age)
	House type		**Wooden/one-storied house**	
Adaptive capacity	**Infrastructure**		**Hard infrastructure (coast, river, mountain)**	
	Economy	Not much correlated		
	Education			
	Information	**ICT (radio, TV, smart phone)**	Not correlated	
	Local governance (risk awareness)	• **Fire fighting party** • **Voluntary disaster prevention organization cover rate** • **Number of residents participating in local briefing session**	**Fire fighting party** No data	**Fire fighting party**
	Institution	• **Fire station** • **Number of times of local briefing session by the staff** • **Number of DRR government officials**	Not correlated No data	
	Finance	• **Financial status of local government** • **Local government disaster prevention budget scale**	• **Fiscal power index** • **Disaster relief expenses** • **Disaster recovery expenses**	• **Fiscal power index** • **Disaster relief expenses** • **Disaster recovery expenses** (Financial status of local government, Local government disaster prevention budget scale)

Note: More than 50% of “highly correlated”

Determinants on **information** and **institution (local governments)** have yet to be found statistically correlated. Further tests are necessary.

2. Implication to respond to COVID-19 risk

Implication to respond to COVID-19 risk

Pandemic	Climate-related disaster

Social distance
(Teleworking, masks, separation, less communication, etc.)
➔ **Weaker bond of community**

Common elements of vulnerability need to be targeted by policy

Age (Proportion over 75);
Wooden/one-storied house,

Exposure

Sensitivity

COVID19

Hazard

Adaptive Capacity

Jurisdiction/location

Jurisdiction/location

Jurisdiction/location

prefecture

city

district

community

prefecture

city

district

community

prefecture

city

district

community

prefecture

city

district

community

Hard infrastructure (coast, river, mountain);
Fire fighting party;
Fiscal power of local governments;
Disaster relief expenses;
Disaster recover expenses

individuals

DRR & CCA Action

Risk

(Human Damage)

Increasing vulnerability

➔ **Enhancing local bond (social relation capital) is essential**

- **ICT (radio, TV, smart phone)**
- **Voluntary disaster prevention organization cover rate**
- **Number of residents participating in local briefing session**
- **Fire station**
- **Number of times of local briefing session by the staff**
- **Number of DRR government officials**

3. Discussion & conclusion

- **Summary of the integrated analysis on adaptive capacity and sensitivity to climate disasters in Japan**
  - ➢Combination of hardware and software measures are essential to reduce disaster risks on human for the period 1976-2014, while vulnerability in aging society, exposed residents (house type), and the role of fiscal spending for DRR are vital for the period 2000-2014
  - ➢Institutional measures such as DRR plan, disaster pact, and support for developing district disaster management plan (a kind of community-based DRM) are vital.

- **Implication to respond to COVID-19**
  - COVID-19 had a direct impact of deaths and indirect impact of social isolation, weakening the bond of local communities, causing mental illnesses.
  - In addition to national-level actions such as providing vaccination and waterfront measures at airport as well as individual actions such as wearing masks, enhancing local bond (social relation capital) is essential.
  - Municipalities' networking with NPOs and citizen/religious groups might help.

Thank you very much

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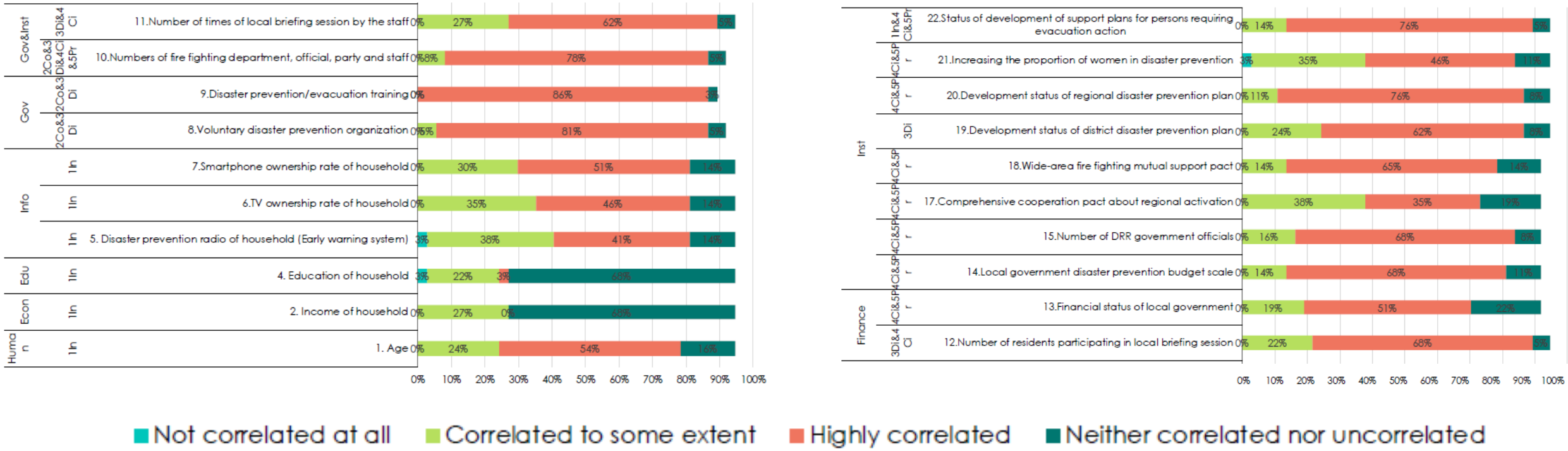
Appendix

Results of qualitative analysis (questionnaire)

Subjective judgments on the determinants of subnational adaptive capacity to reduce deaths were answered by the local government officials in municipalities (prefecture, capital cities and ordinance-designated cities)



Note: Number of valid responses is 38 out of 98 sent (rate of valid response is 39%).

- Education and income of households are not correlated to death rate.
- ICTs, local governance (e.g., voluntary disaster prevention organization, evacuation training), institution (e.g., DRR government officials, Disaster pact, regional disaster prevention plan, local disaster prevention plan), and finance/fiscal spending are considered important.