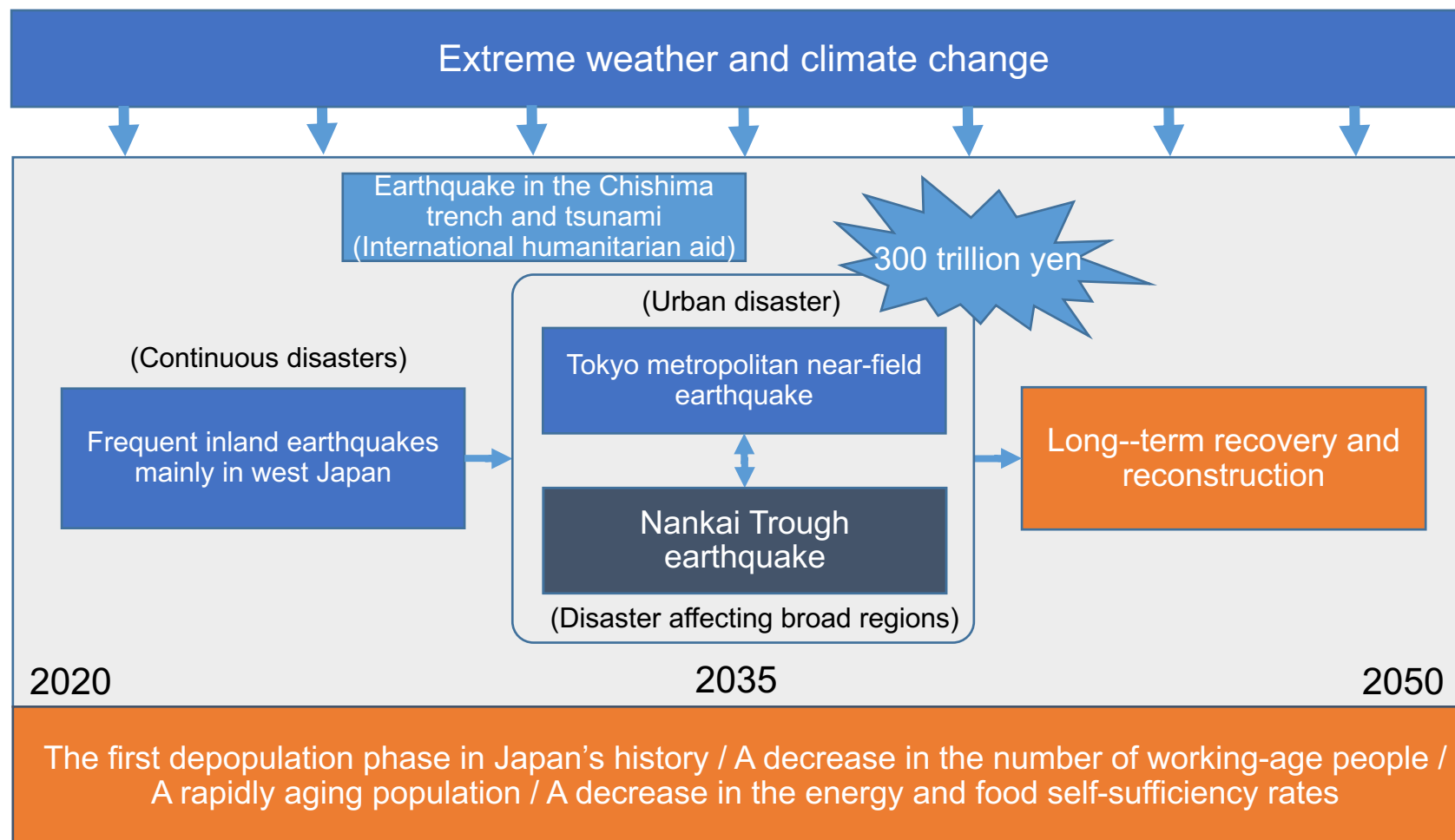


# Preparation for Catastrophic Disasters

National Research Institute for Earth Science and Disaster Resilience (NIED)

Haruo Hayashi

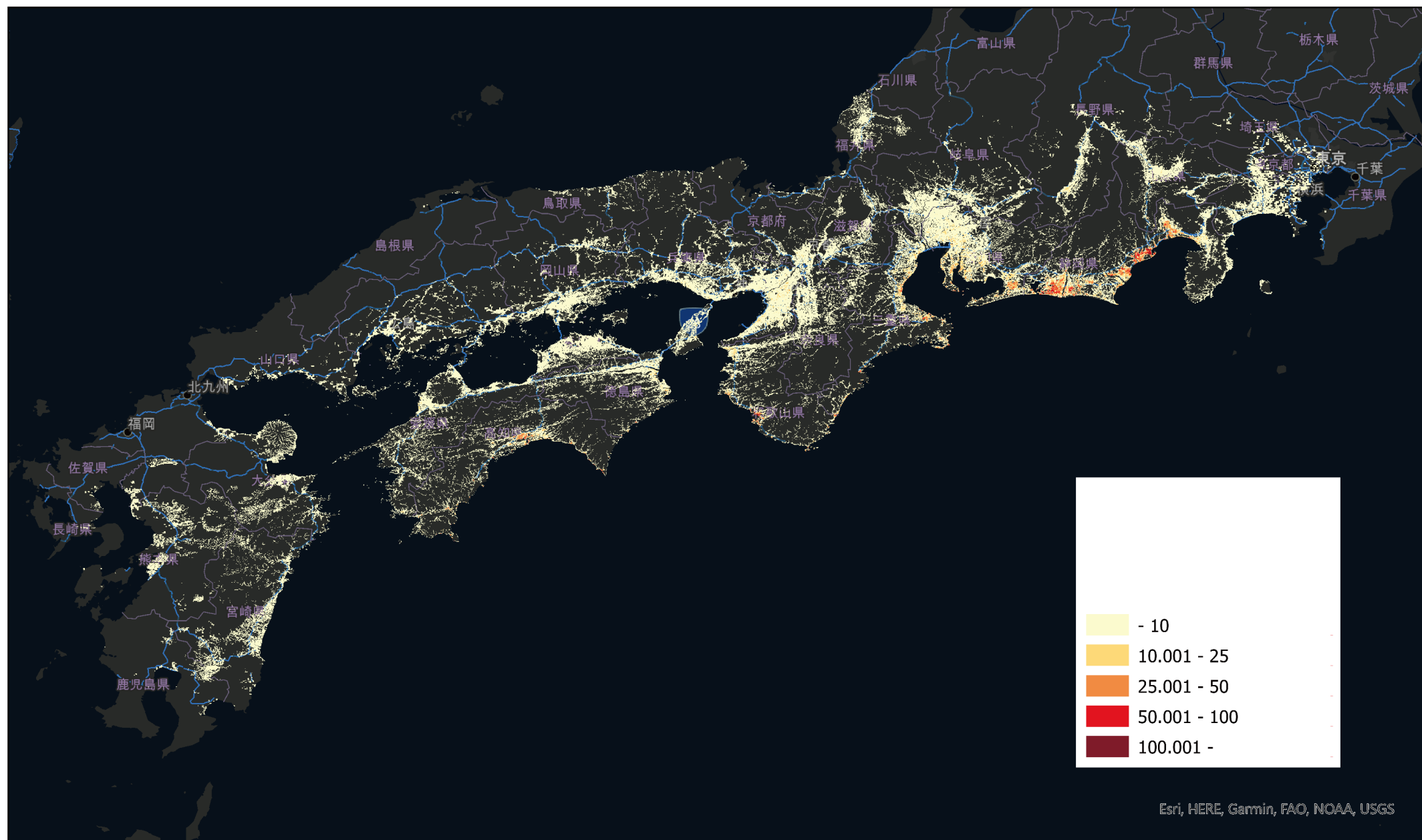
# Gaining Resilience That Can Overcome Catastrophic Disasters and Recovery in the First Half of the 21st Century



# Catastrophic disaster: An incommensurable disaster that cannot be compared to anything else in the past

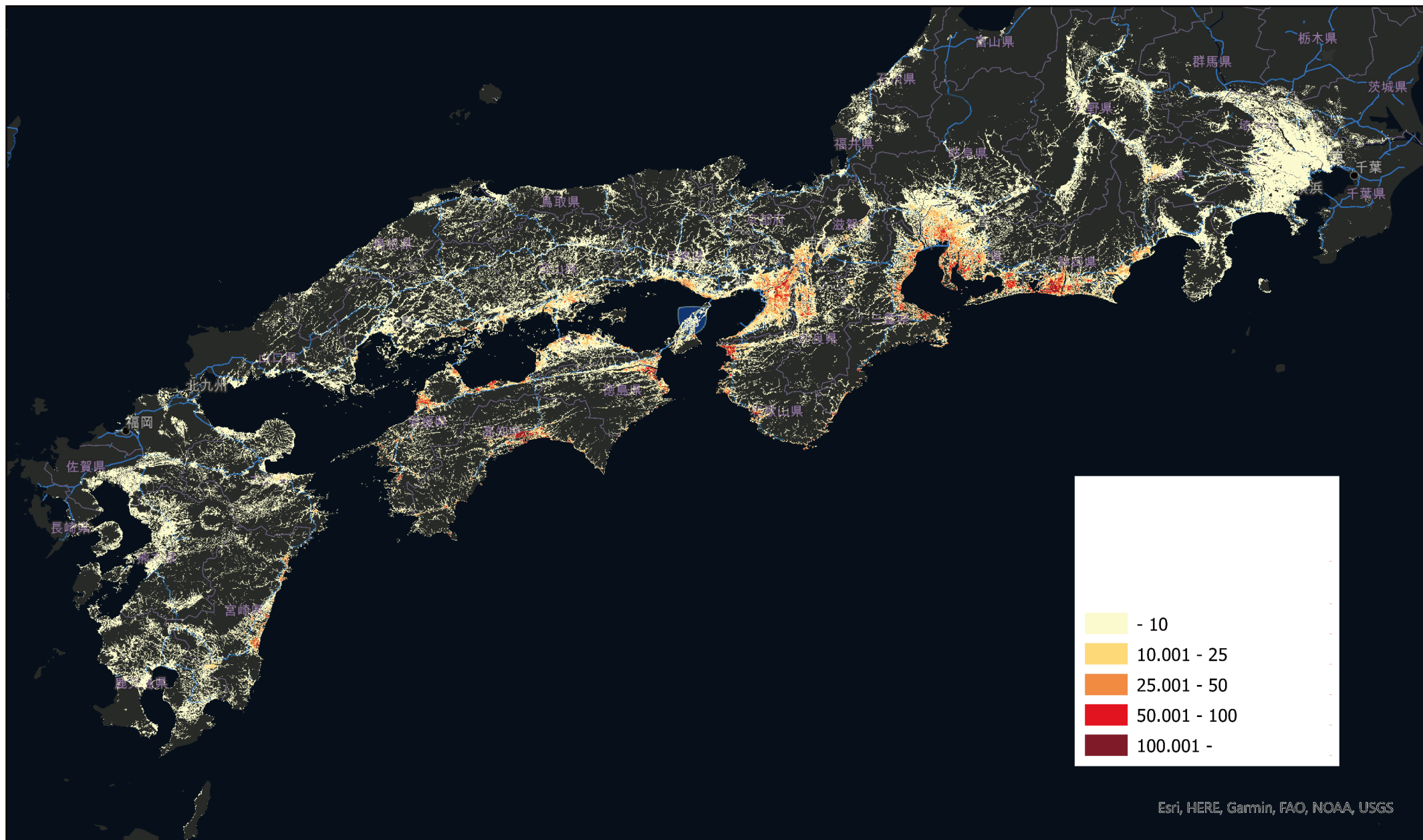
Earthquake	Nankai Trough		Tokyo metropolitan		Great East Japan Earthquake 2011	Great Hanshin Earthquake 1995
	2012 (L2)	2003 (L1)	2013	2005		
Magnitude	M 9.0	M 8.7	M7.3	M 7.3	M 9.0	M 7.3
People dead or missing	80,000 - 320,000	24,000	5,000 - 22,500	11,000	19,294	6,434
People injured	257,000 - 623,000	300,000	90,000 - 120,000	240,000	6,100	44,000
Collapsed buildings	627,000 - 1,346,000	450,000		200,000	126,500	105,000
Burnt buildings	50,000 - 750,000	90,000	38,000 - 412,000	650,000	---	7,400
Evacuees (at maximum)	----	6,000,000	7,200,000	7,500,000	480,000	320,000
Direct damage (trillion)	220	81	95	112	17	10

L1 Scenario  
M=8.7



Esri, HERE, Garmin, FAO, NOAA, USGS





L2 Scenario  
Mw=9.0

Esri, HERE, Garmin, FAO, NOAA, USGS

Year	Name of disaster	No. of municipalities subject to the Act
2019	Disaster due to Typhoon No. 19 in 2019	390
2011	Great East Japan Earthquake in 2011	241
2018	Hokkaido Iburi Tobu Earthquake in 2018	179
2018	Torrential rain disaster in July 2018	110
2020	Disaster caused by heavy rain from July 3, 2020	98
2004	Niigata Chuetsu Earthquake in 2004	54
2016	Kumamoto Earthquake in 2016	45
2019	Power outage caused by Typhoon No. 15 in 2019	42
2004	Typhoon No. 23 in 2004	40
2016	Typhoon No. 10 in 2016	32
2015	Torrential rain disaster in the Kanto and Tohoku regions in September 2015	26
1995	Great Hanshin Earthquake in 1995	25
2004	Typhoon No. 16 in 2004	25
2011	Torrential rain disaster in Niigata and Fukushima in 2011	24
2000	Heavy rain due to an autumn rain front and Typhoon No. 14 in 2000	22
2019	Heavy rain due to a rain front in August 2019	20

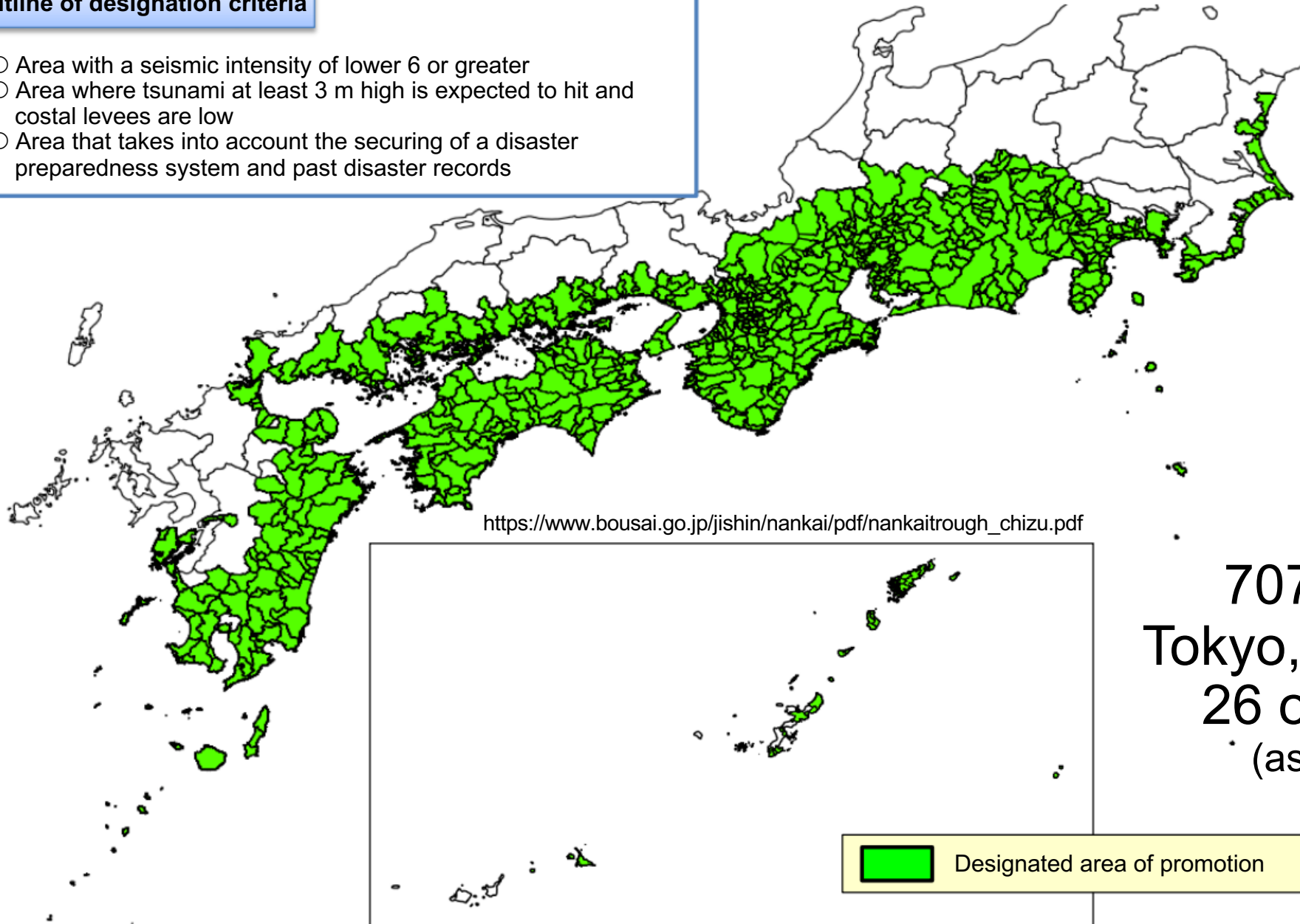
## Cases subject to the Disaster Relief Act from 1995 to 2020 (N = 117 cases)

- Disasters are becoming remarkably widespread recently.
- Over 100 municipalities have been damaged simultaneously by a disaster.
- Multiple prefectures have been damaged simultaneously by a disaster.
- Comprehensive adjustment by the government is necessary.
- We are not ready for a disaster.

# Designation of areas to promote measures to reduce Nankai Trough earthquake disasters

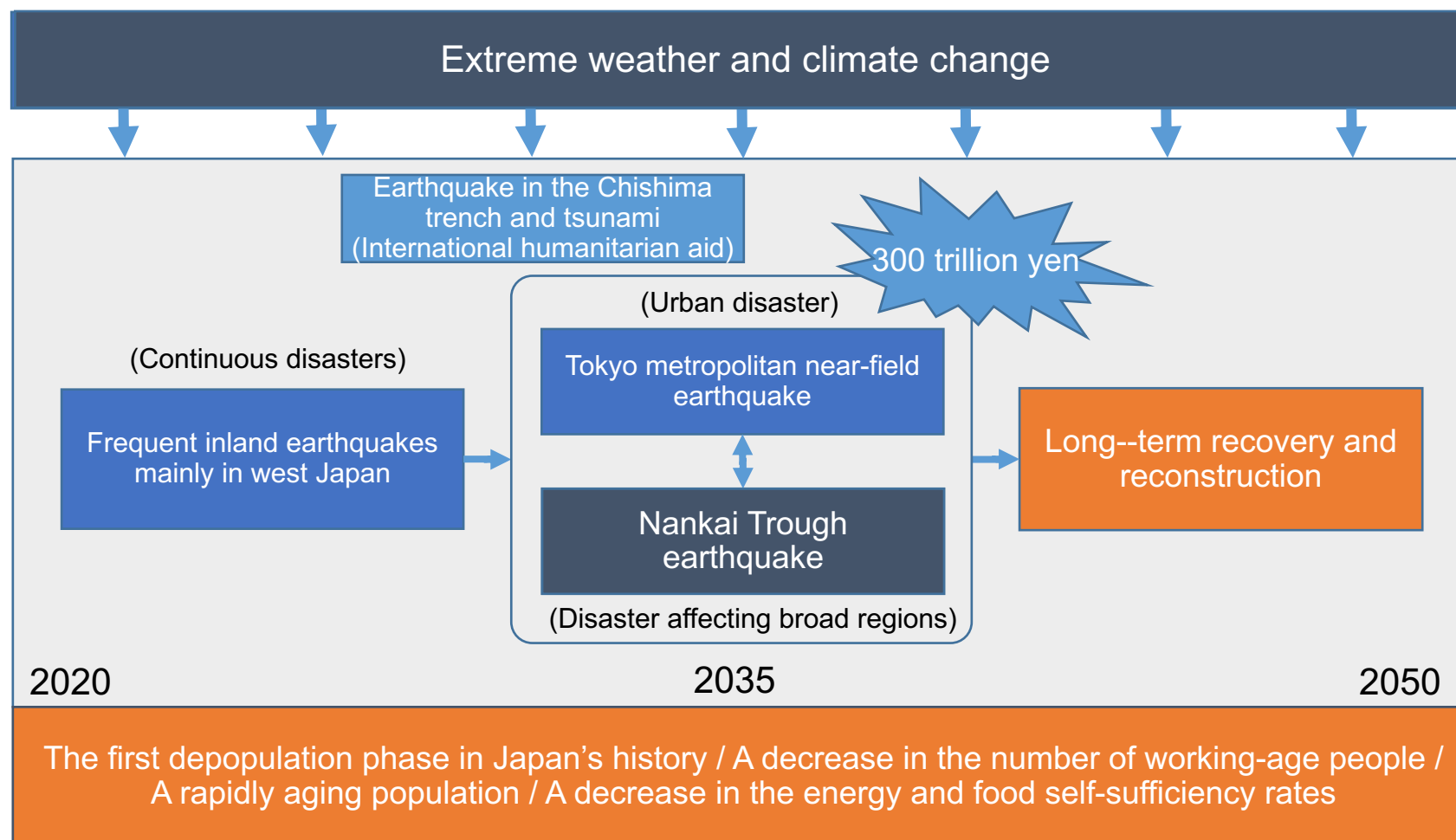
## Outline of designation criteria

- Area with a seismic intensity of lower 6 or greater
- Area where tsunami at least 3 m high is expected to hit and coastal levees are low
- Area that takes into account the securing of a disaster preparedness system and past disaster records

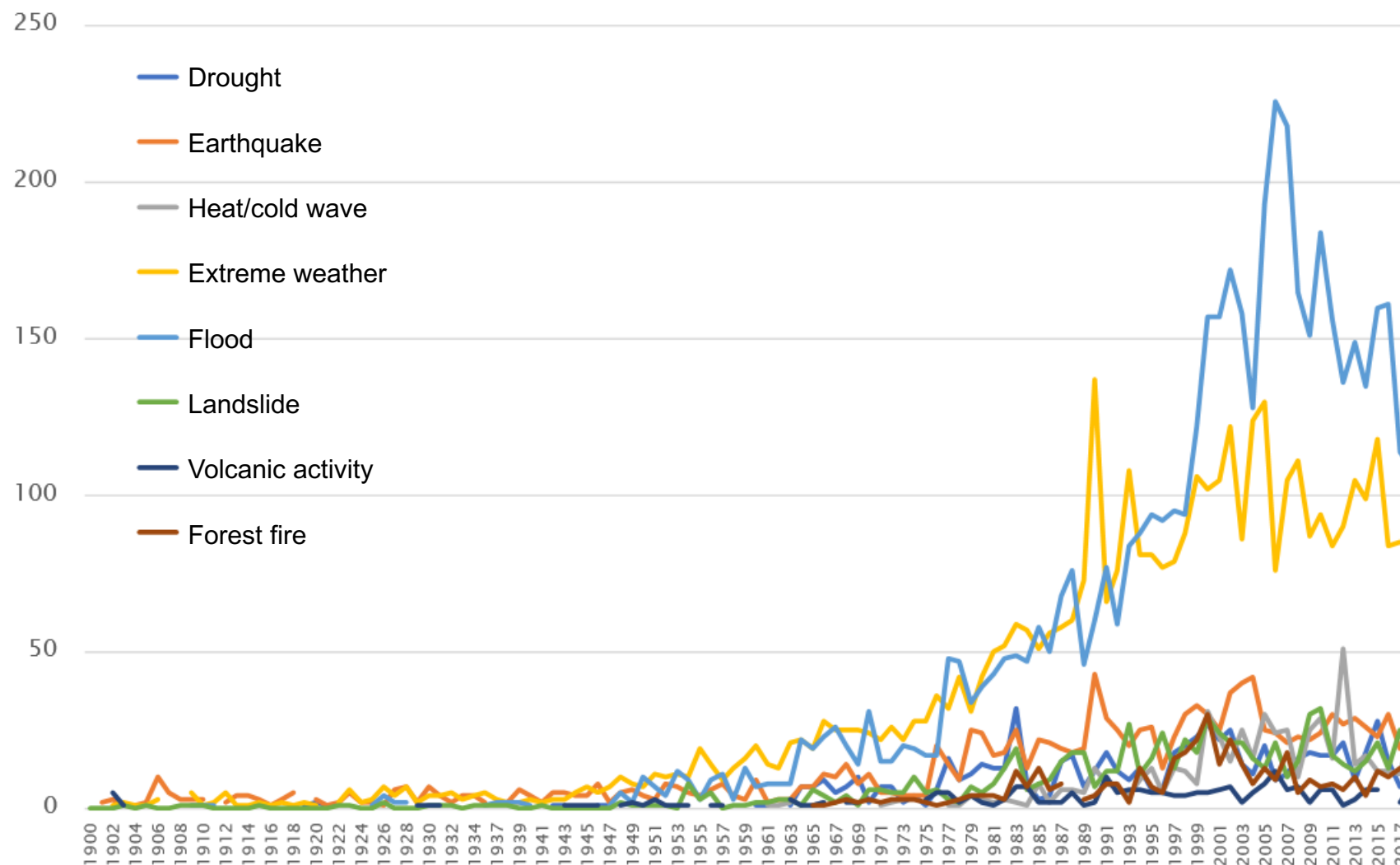


707 municipalities in  
Tokyo, Osaka, Kyoto and  
26 other prefectures  
(as of March 28, 2014)

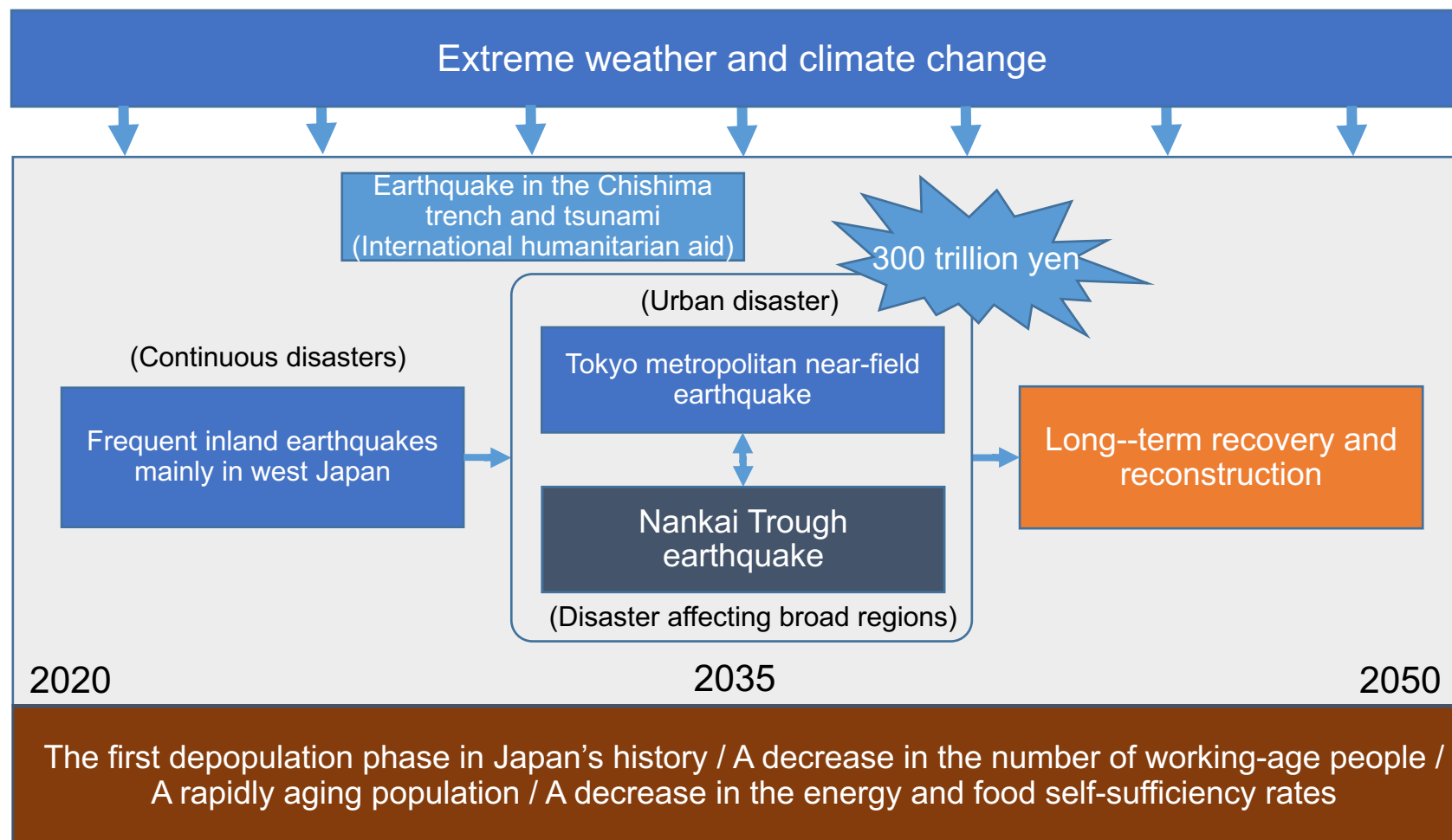
# Gaining Resilience That Can Overcome Catastrophic Disasters and Recovery in the First Half of the 21st Century



# Disasters have increased rapidly since the 1970s.

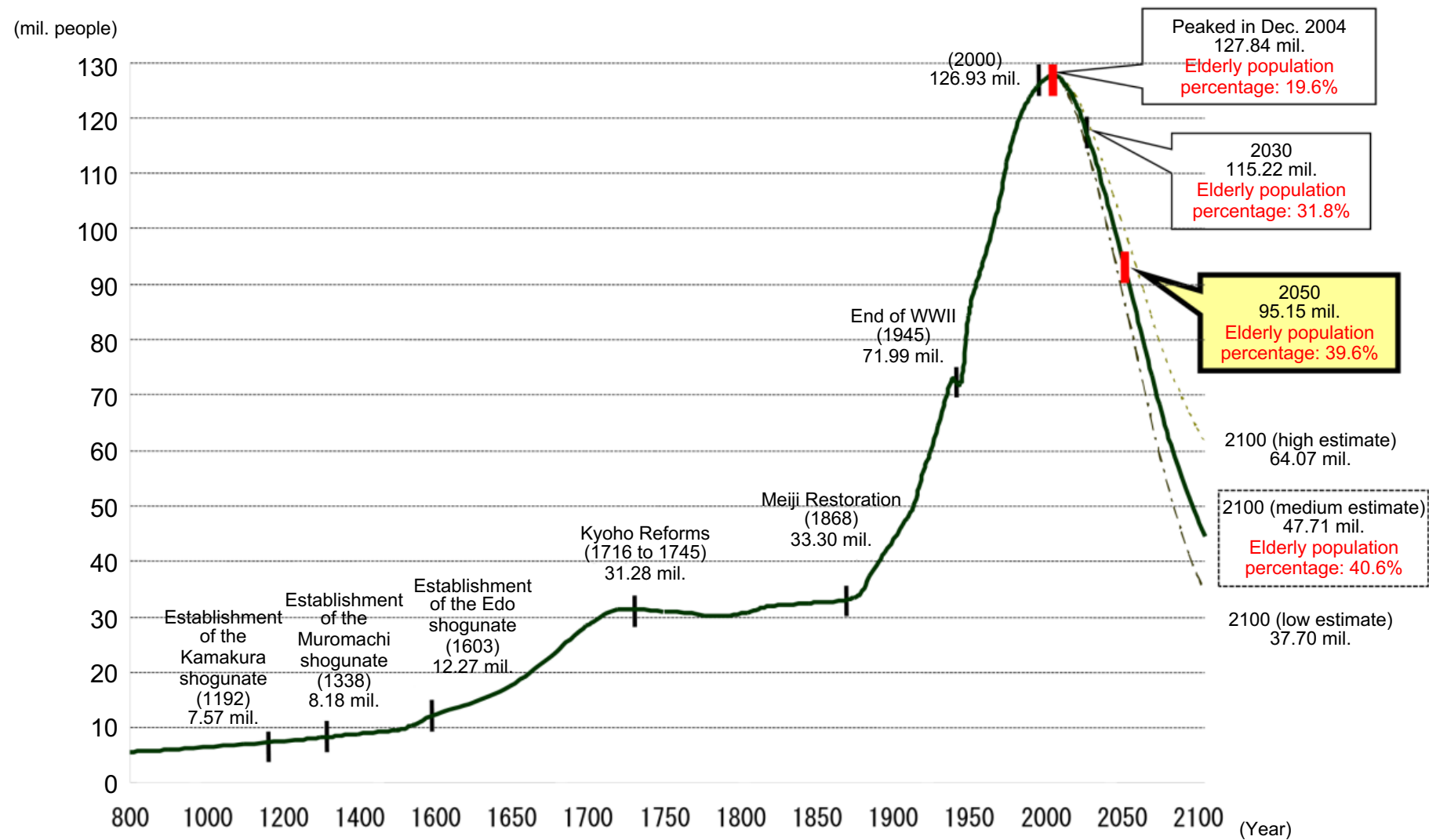


# Gaining Resilience That Can Overcome Catastrophic Disasters and Recovery in the First Half of the 21st Century





For the first time in history, Japan is in a depopulation phase, and people’s spontaneous activities and the power of mutual assistance and public assistance are expected to weaken.



Source: Outline of the interim draft of the “national long-term outlook” (long-term committee of the policy subcommittee of the National Land Development Council on February 21, 2011)

# Issues of Long-term Recovery and Reconstruction Resulting from Catastrophic Disasters

- A total of 300,000 people dead or missing mainly due to tsunami
- Overcoming of direct damage totaling 300 trillion yen
- Elimination of the paralysis of capital functions
- Decline in transportation capacity between eastern and western Japan due to unavailability of the Tokaido Shinkansen Line and the Tomei Expressway
- Destruction of the industrial foundations of the San-on region
- Increase in sovereign risk: Increase in the long-term interest rates of government bonds and the yen's depreciation
- Shortage of workers to deal with reconstruction demand

# Expected Significant Change Scenario of the Structure of Japan

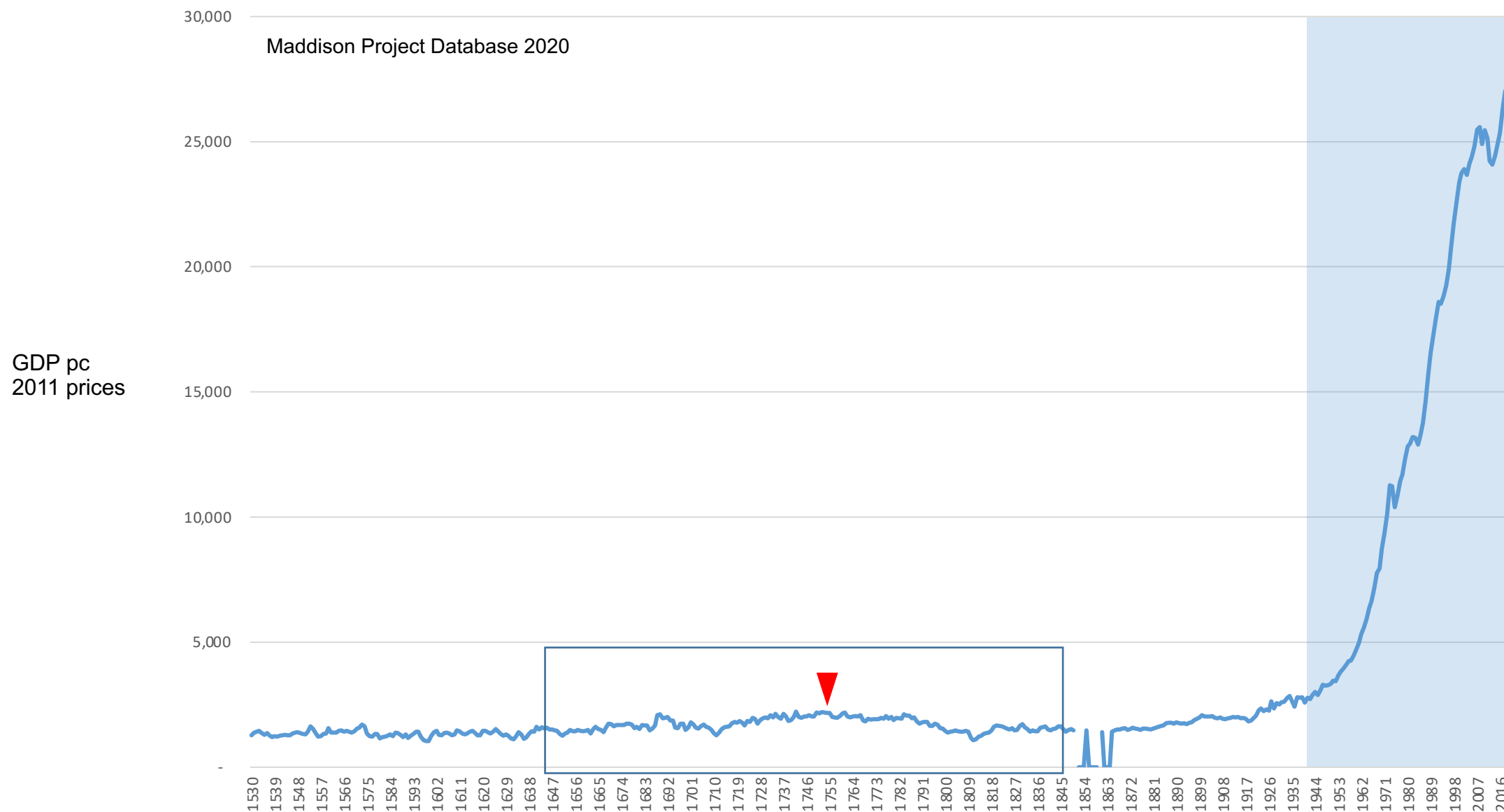
- [1] **Diaspora:** Japan no longer exists, and the people disperse and live in other countries around the world: Jewish diaspora and overseas Chinese
- [2] **Becoming dependent on or colonized by another country:** Japan becomes under the control of a major power and loses sovereignty.
  - The U.S. military's withdrawal from Afghanistan in 2020 and the Taliban's recapture of the whole nation
  - Deprivation of the right of autonomy in Hong Kong
- [3] **Change of government:** The counterbalancing force seizes power, and the power structure changes.
  - Change in the framework of Japan in the aftermath of many previous Nankai Trough earthquakes
    - Keicho earthquake in 1605
    - Ansei earthquake in 1854 and Ansei Edo earthquake in 1855
    - Tonankai earthquake in 1944, Mikawa earthquake in 1955, Nankai earthquake in 1946
  - Military coup in Myanmar
- [4] **Decline in the power of the nation:** There are no significant changes in the framework of Japan, but it declines at a moderate pace.
  - Genroku earthquake in 1703, Hoei earthquake and the volcanic eruption of Mount Fuji in 1707
  - Great Kanto earthquake in 1923

# Decline of Portugal in the Aftermath of the Lisbon Earthquake in 1755



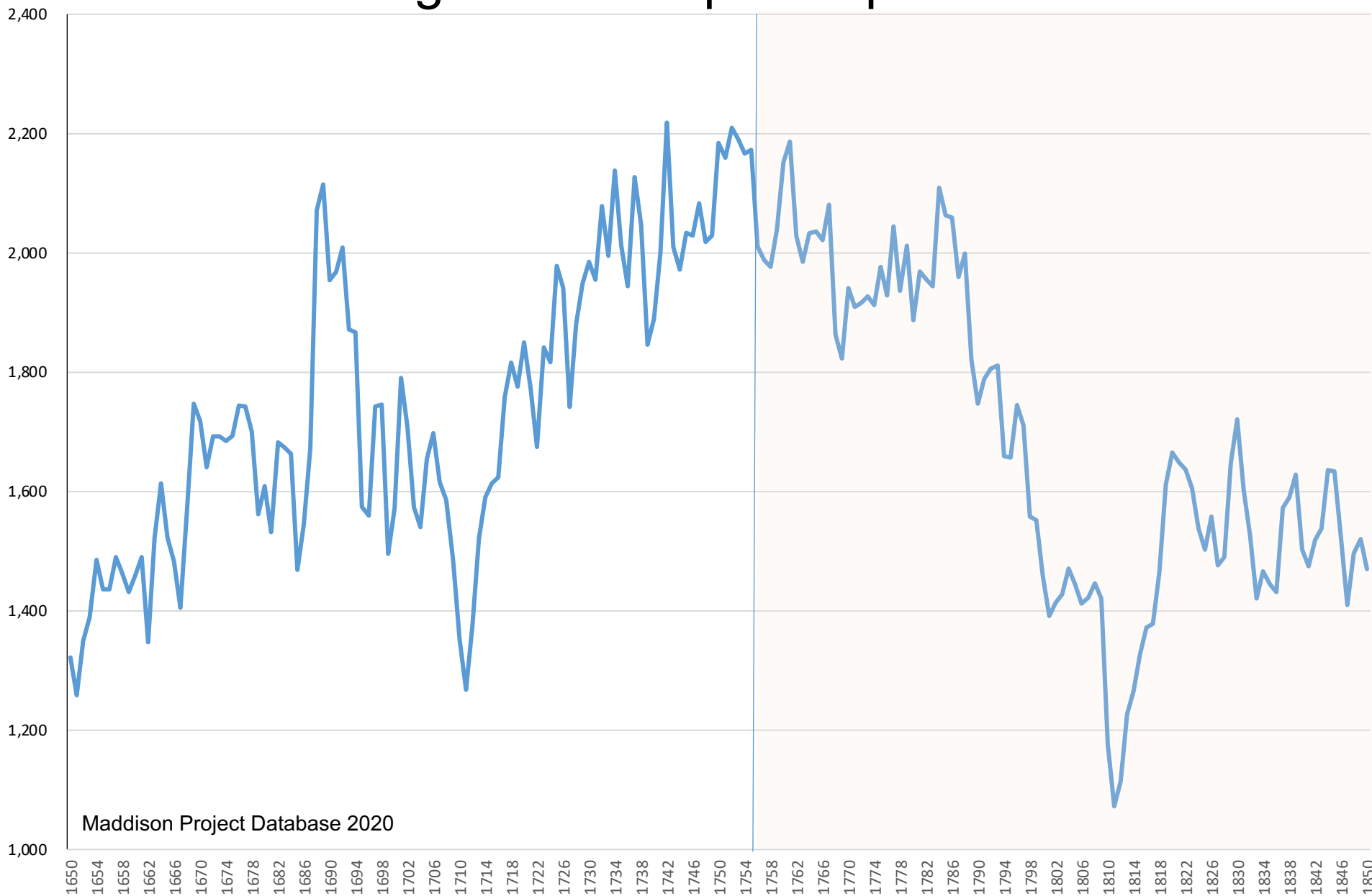
<https://the-criterion.jp/mail-magazine/20180501/>

# Changes in GDP per Capita



# Changes in GDP per Capita

GDP pc  
2011 prices



Maddison Project Database 2020



# Enhancement of Ability to Overcome Disasters

- Damage expected from national disasters in the early 21st century cannot be fully prevented in the remaining time.
- If that's the case, we have to achieve the following three goals:
  1. Continue to make efforts to reduce the occurrence of damage as much as possible.
  2. Have the strong ability to continue business operations for important social functions.
  3. Achieve prompt recovery and reconstruction as a society as a whole.

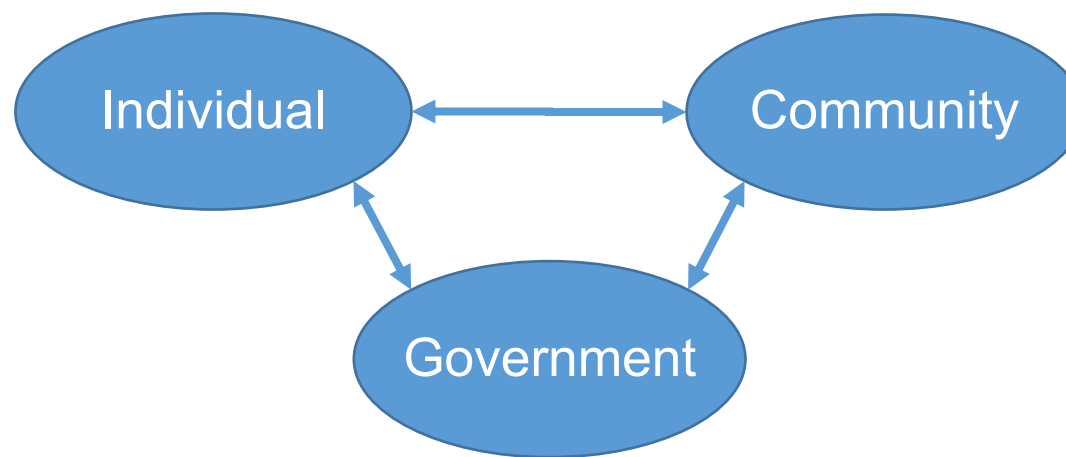


Resilience

# Resilience Is Formed with Three Levels: Individual, Community, and Government, Which Are Connected with Each Other.

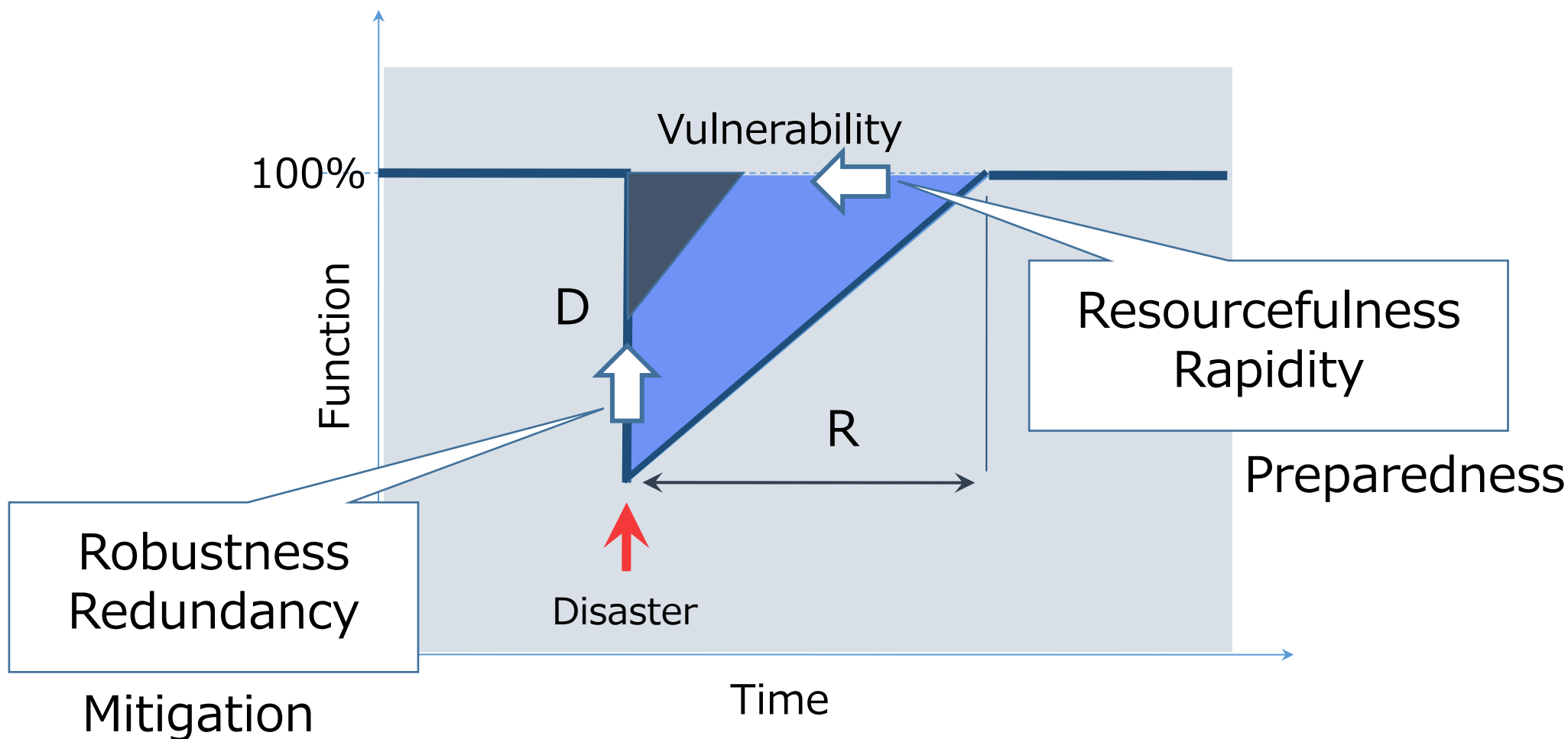
Human being as an indivisible entity  
Self-help

Gathering of people having interpersonal connections, such as families, relatives, companies, local communities, attribute communities, and property communities  
Mutual assistance and public assistance



Impersonal entity formed by the legal system and taxes  
Government, city, infrastructure, and structure  
Public assistance

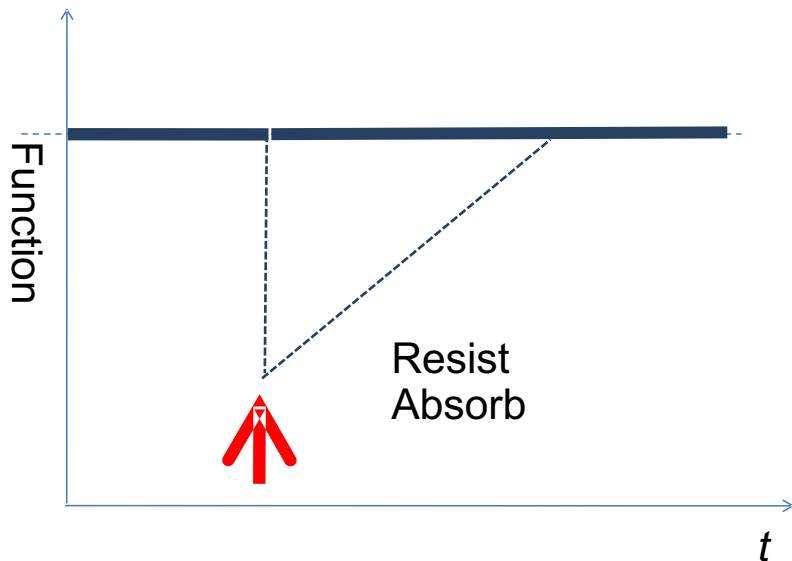
# Introduction of Disaster Resilience



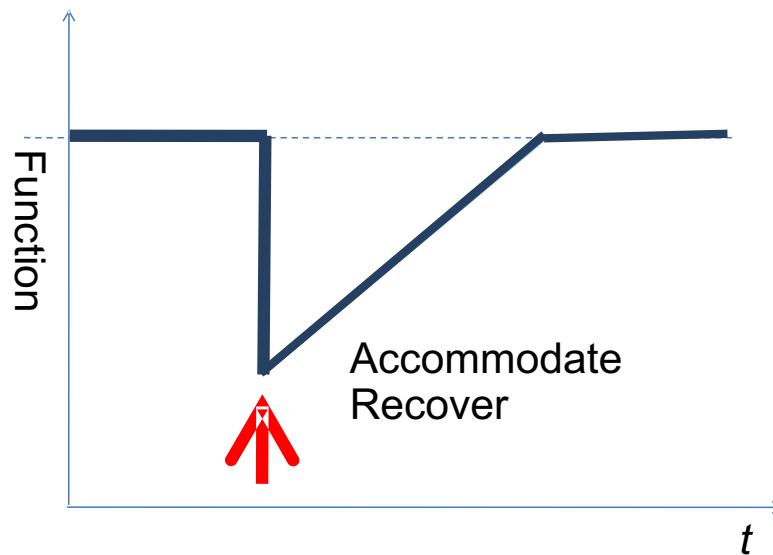
Adapted from MCEER model on Lifeline

# There are Three Types of Responses to Hazards: No Transformation, Temporary Transformation, and Permanent Transformation.

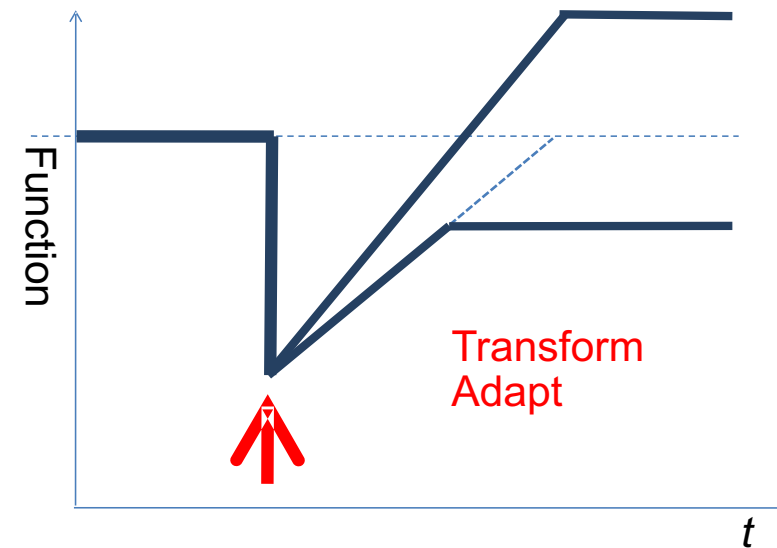
to resist, absorb, accommodate, **adapt to**, **transform** and recover from  
the effects of a hazard



No transformation  
(Absorptive capacity)

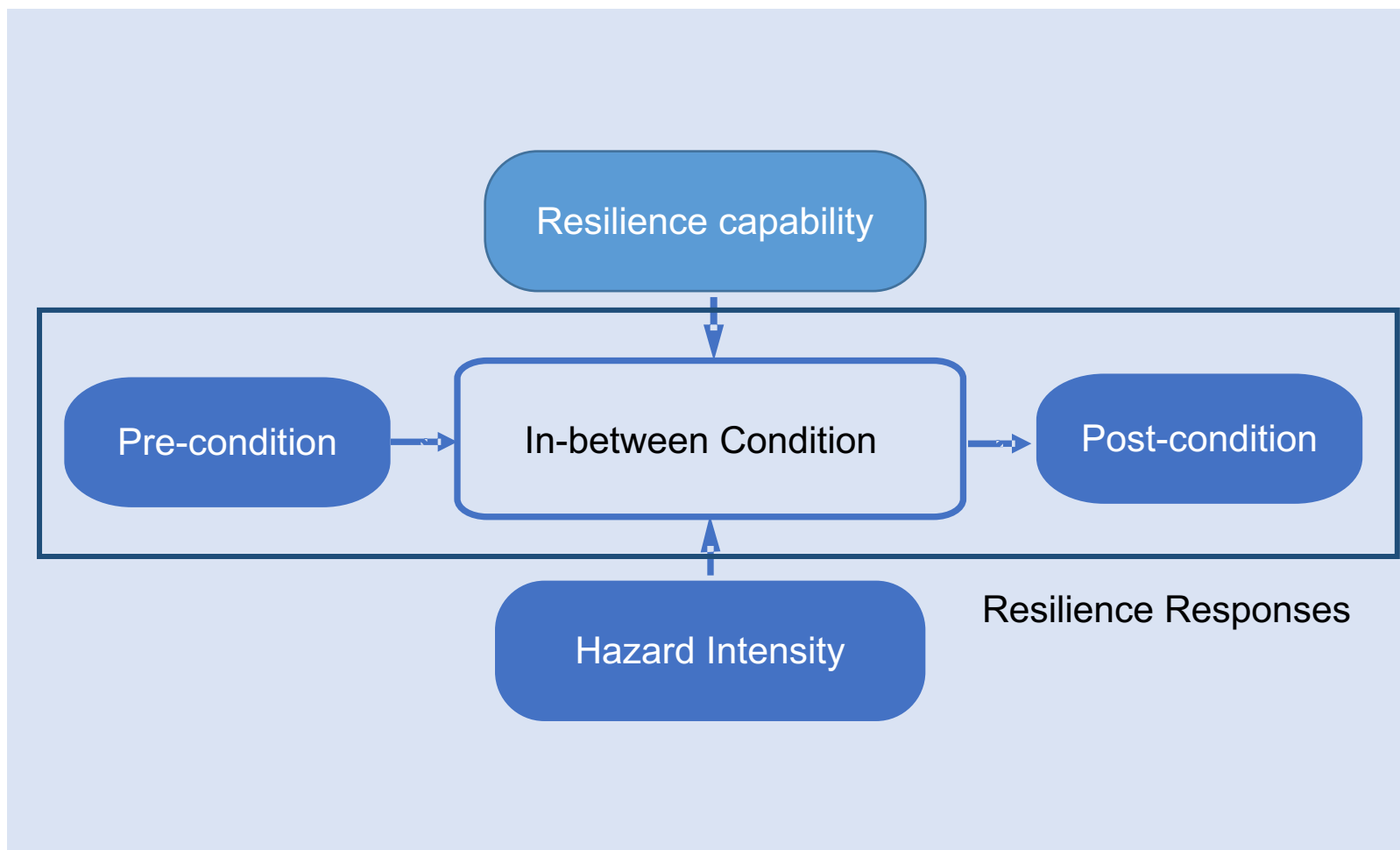


Temporary transformation  
(Recoverable capacity)


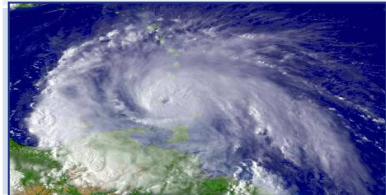

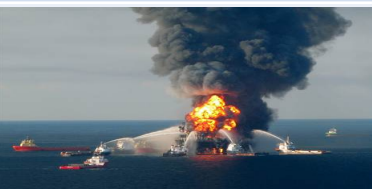
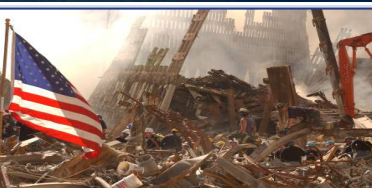
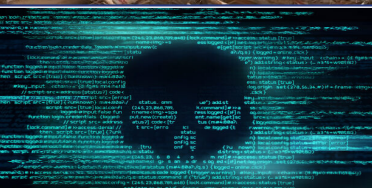


Permanent transformation  
(Transformative capacity)

# A resilience Response Is a Core Entity's Behavior against Hazards.



# Scope of centralized disaster and crisis response

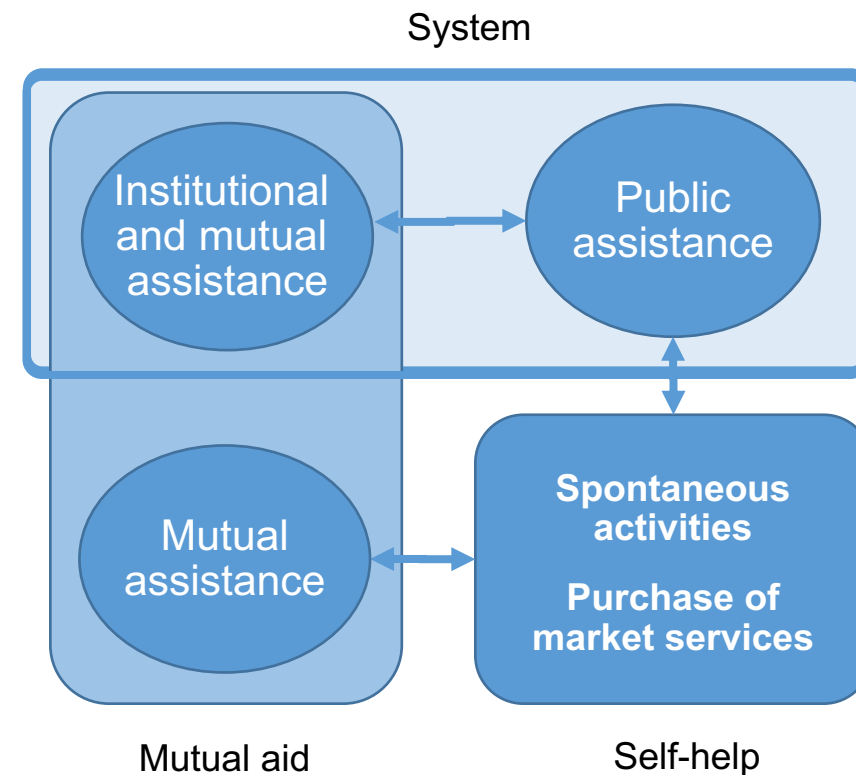
Types of Events			Nature of events		
			Planned	Forecasted	No-notice
Events					
Incidents	Natural				
	Unintentional				
	Intentional	CBRNe			
		Cyber attack			



# Resilience Capability

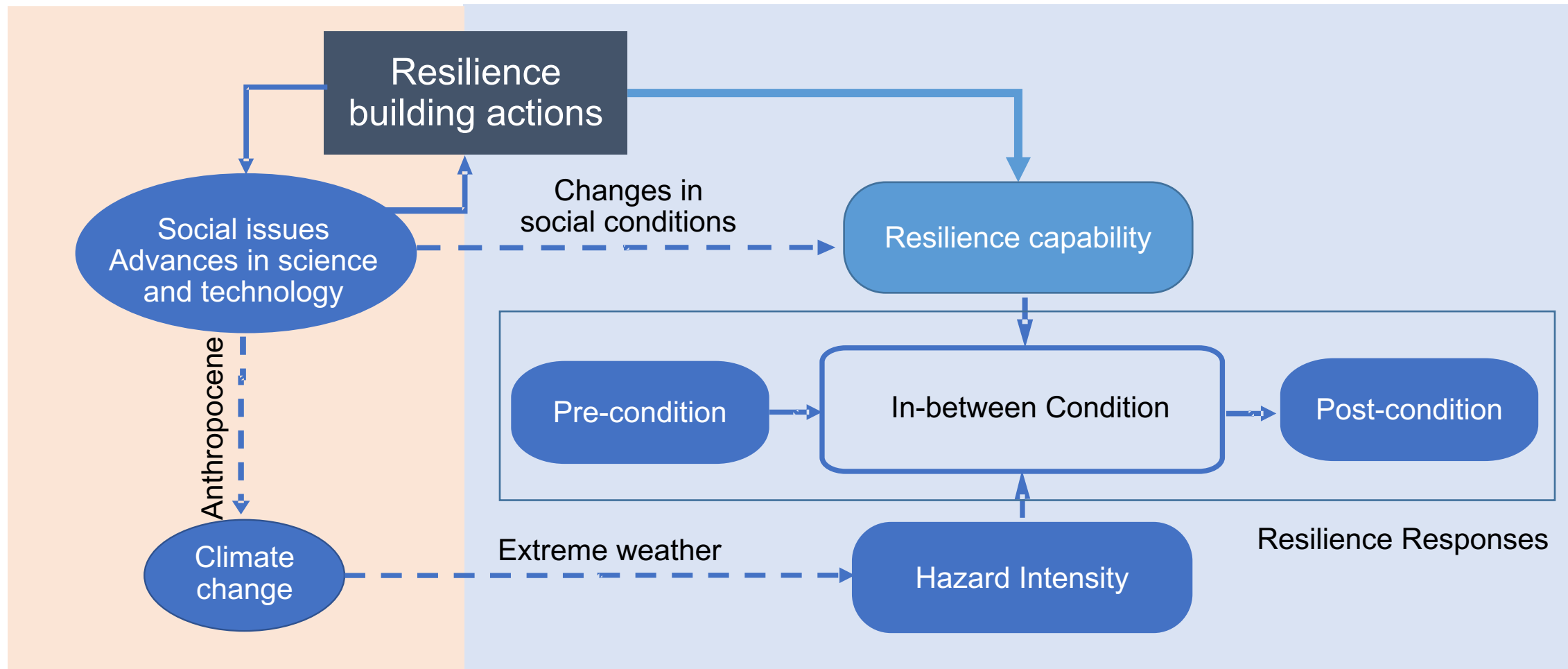
Operationalize by focusing on the way self-help, mutual assistance, institutional and mutual assistance, and public assistance should be (using welfare discussions as references.)

=  $\Sigma$  Self-help: Spontaneous activities +  
 Self-help: Purchasing market services +  
 Mutual assistance: Mutual aid based on goodwill  
 without institutional involvement  
 (families, relatives, and friends) +  
 Institutional and mutual assistance:  
 Institutional and mutual aid  
 (insurance/mutual relief) +  
 Public assistance: Institutional (legal) assistance  
 based on the use of taxes



# Disaster Resilience Building Actions

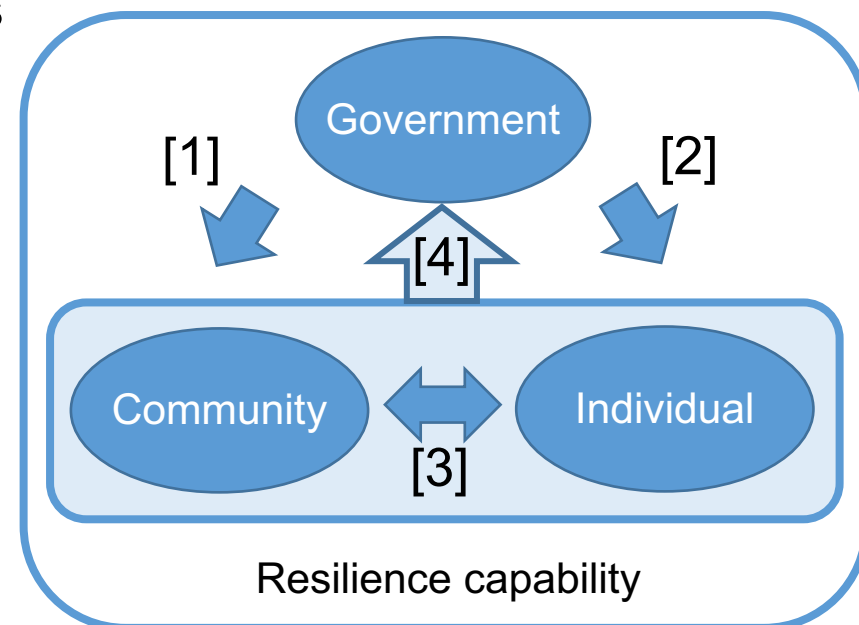
## NIED model of Disaster Resilience



# Resilience Building Actions

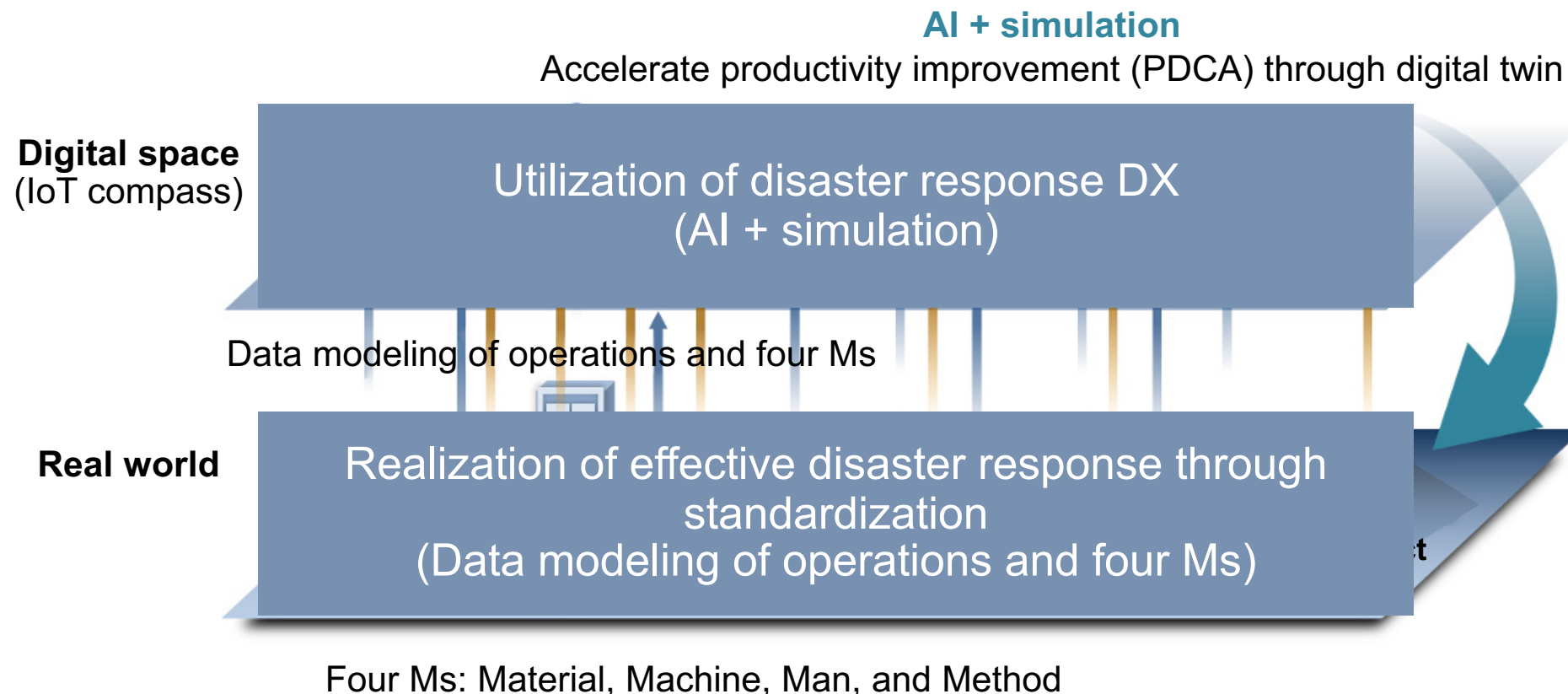
The relationship between individual, community, and government, which are the core entities of resilience, leads to an interesting conclusion about building resilience capabilities.

- [1] Government → Community: Government-oriented initiatives to boost disaster reduction capabilities in society
- [2] Government → Individual: Government-oriented initiatives to boost each individual's disaster reduction basic capabilities
- [3] Community ↔ Individual: The private sector's own initiatives to boost disaster reduction capabilities
- [4] Individual → Government / Community → Government: Various initiatives to reform existing disaster reduction frameworks

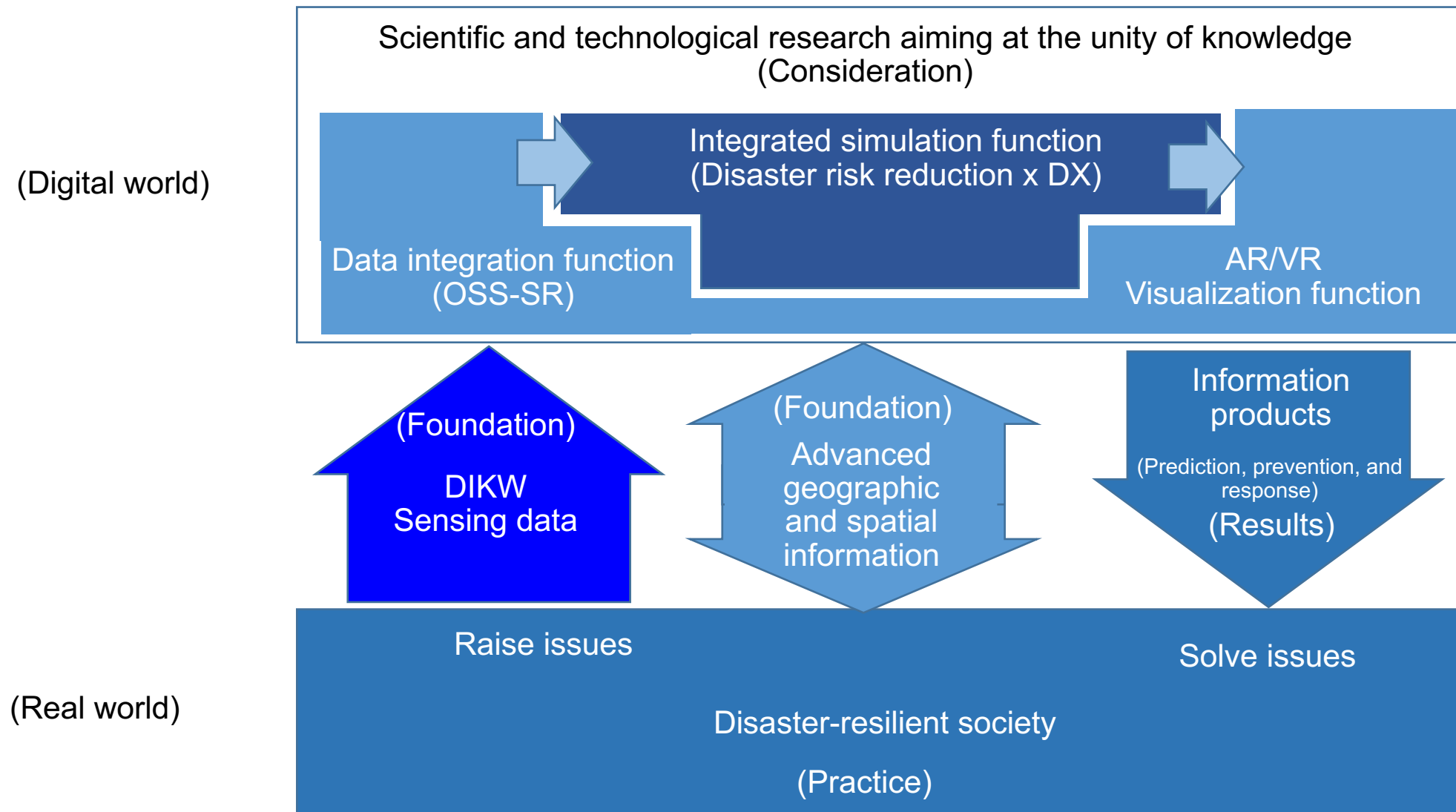


However, a large-scale disaster rarely occurs.

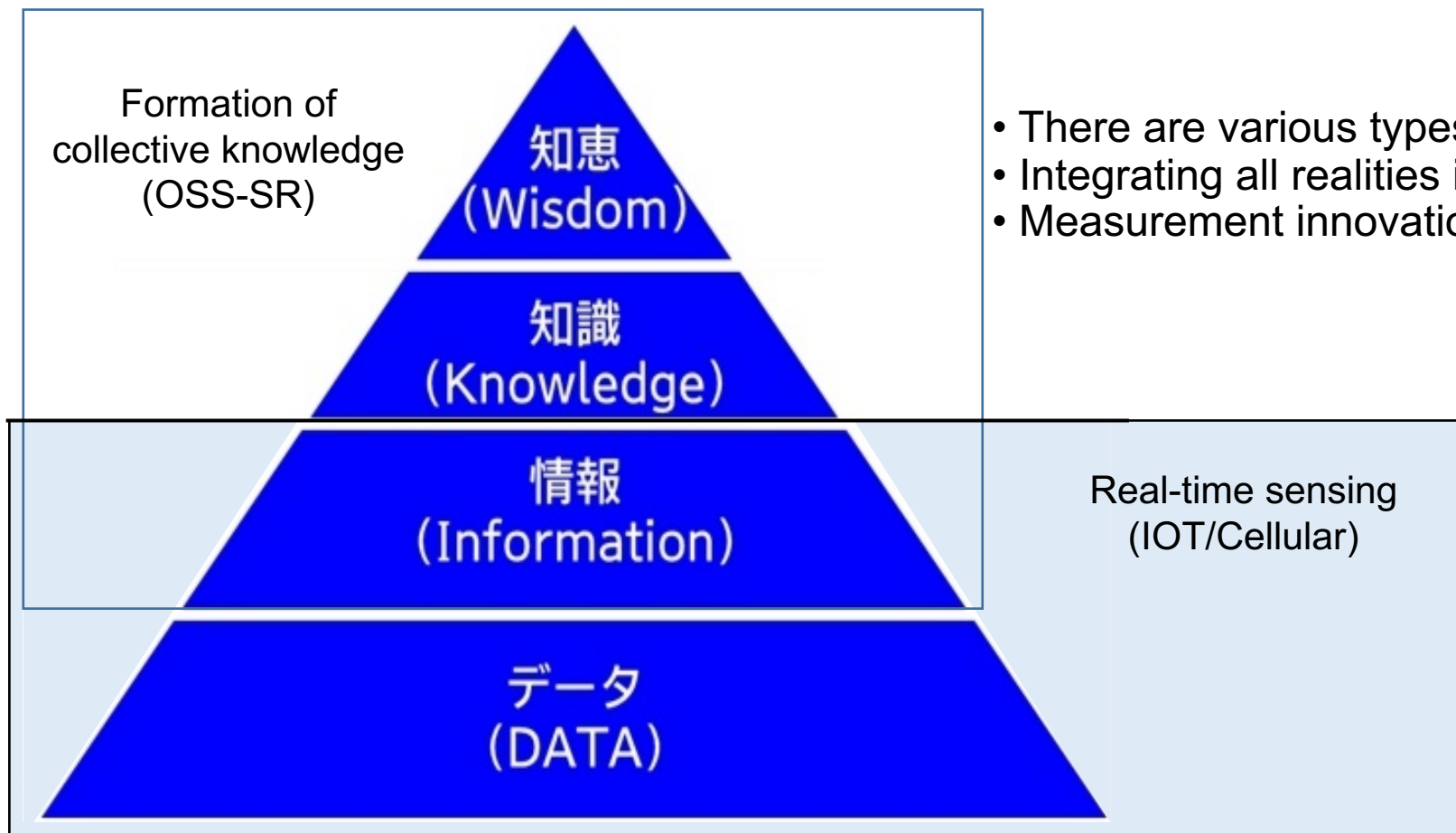
# Image of Digital Twin



# Digital Twin to Build Disaster Resilience OSS-SR



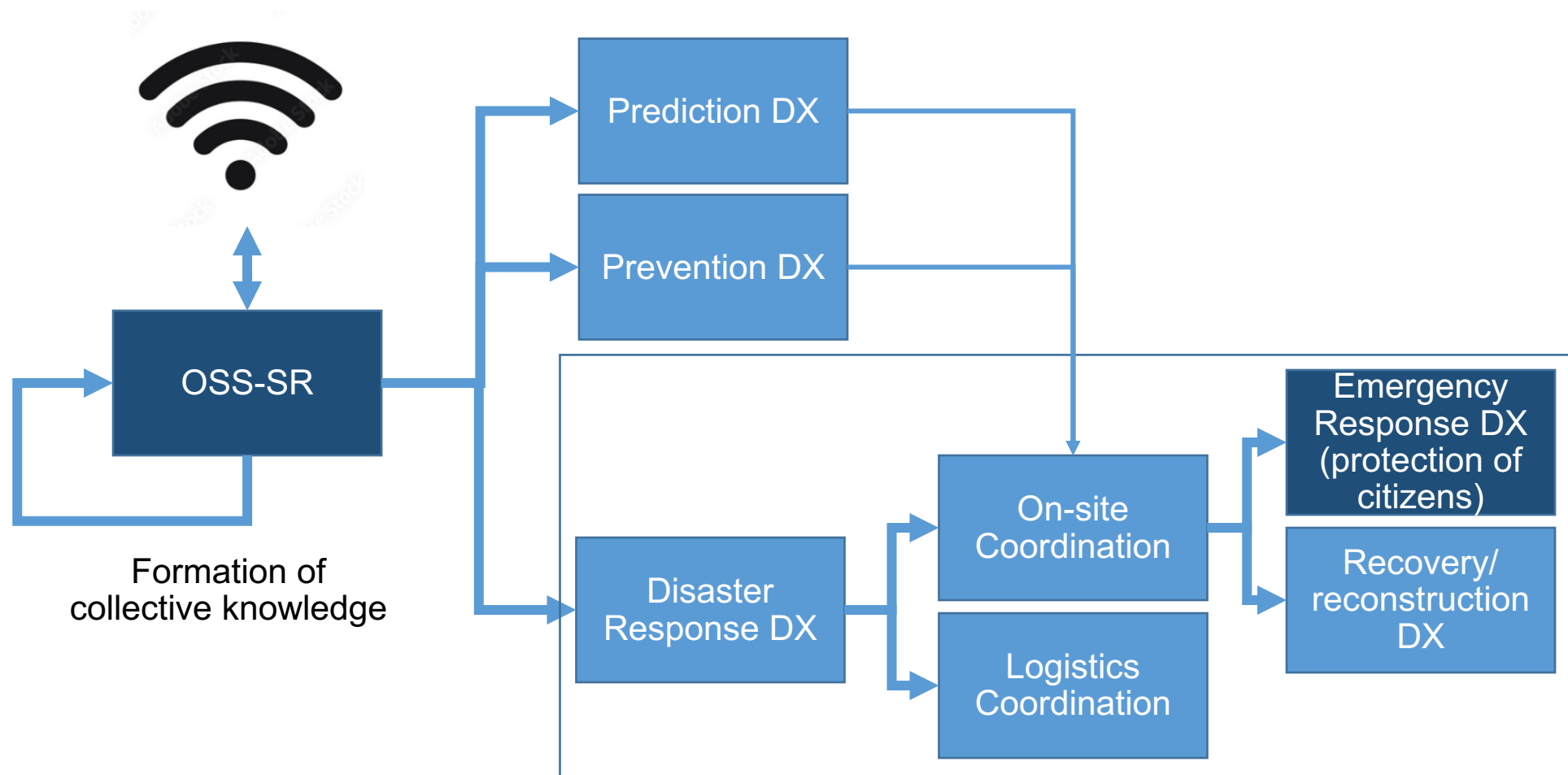
# Four Types of Sensing to Measure the Real World —DIKW sensing—



- There are various types and levels of knowledge.
- Integrating all realities into the digital world
- Measurement innovation



# Digital Twin to Build Disaster Resilience —OSS-SR and Emergency Response DX—

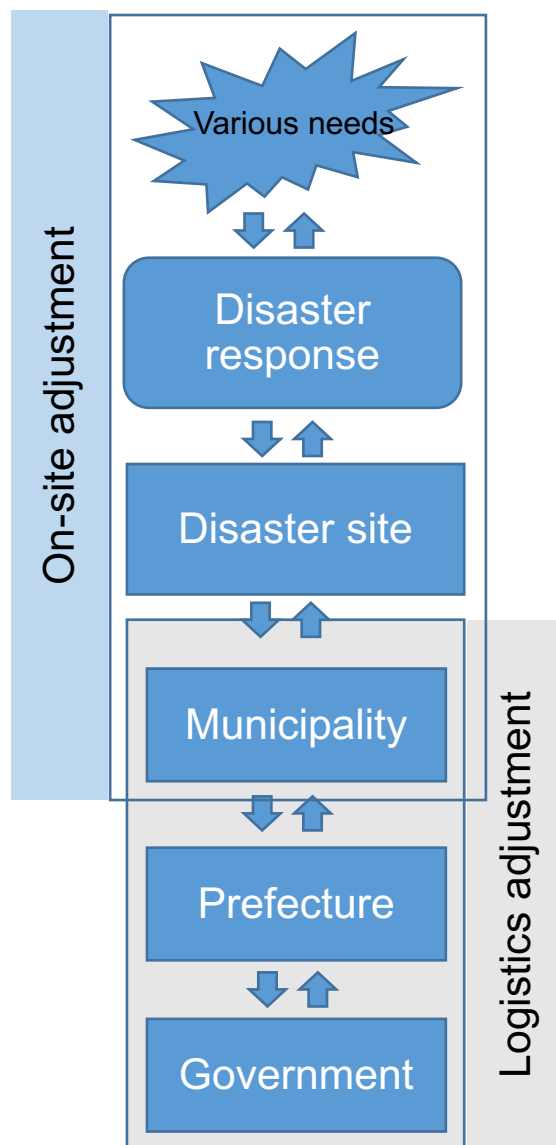


OSS-SR: Online Synthesis System for Sustainability and Resilience

# Roles of Governments at Disasters of Different Scales (Municipal governments always play a role as an interface.)

Scale of event				
	In municipality (and ward)	In prefecture (ordinance- designated city)	Simultaneous damage in multiple prefectures	Multiple countries
Municipality	Responsible entity	Partially grant subsidy	Partially grant subsidy	On-site coordination
Prefecture	Support	Responsible entity	Partially grant subsidy	
National		Support	Responsible entity	Partially grant subsidy
Application of the Disaster Relief Act				
(117 cases of application between 1995 and 2020)				
National-crisis- level disaster				
(4 national-crisis-level disasters between 2011 and 2020)				

# A Model for Effective Disaster Response of Any Scale

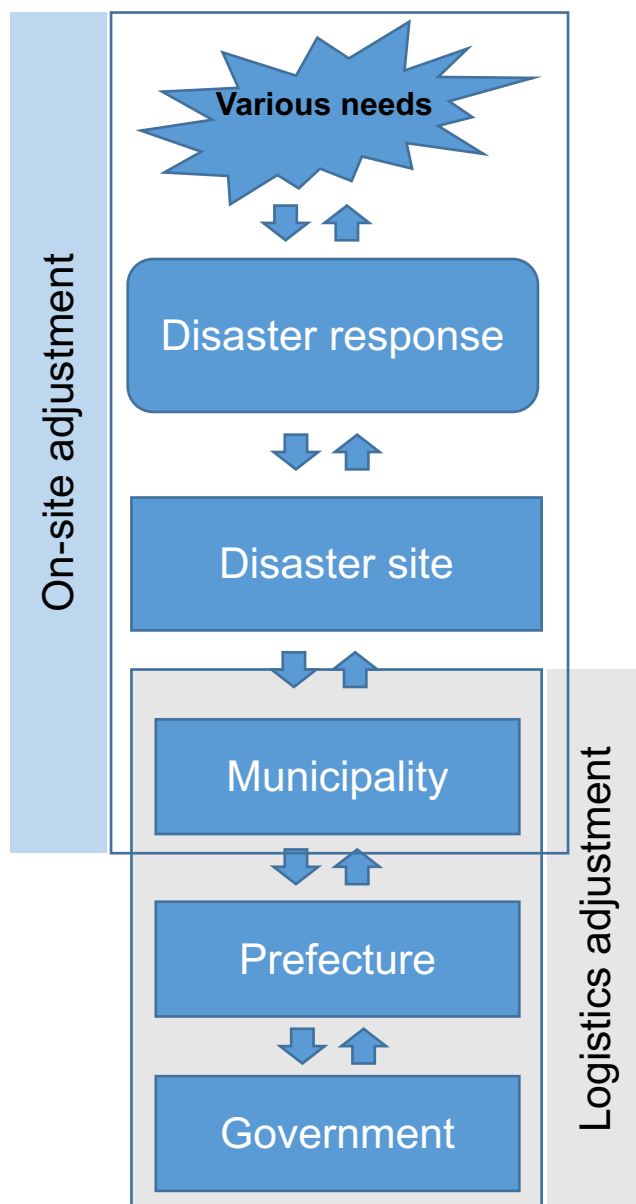


- Objective: To increase the effectiveness of activities at disaster response sites.
  - Clarification of the roles of the government, prefectural governments, and municipal governments in disaster response
    - The government, prefectural governments, and municipal governments have different roles to play depending on the scale of the disaster in disaster response.
    - Taking appropriate action is required even in case of a national-crisis-level disaster that damages multiple prefectures simultaneously.
    - Municipal governments at each level do not clearly understand what they have to do in the event of a disaster.
    - Many people engaging in disaster response arbitrarily invent their tasks to deal with a disaster.
  - Who conducts disaster response? → Municipal governments (basic municipalities) are primarily responsible for disaster response.
    - Municipal governments serve as an interface with disaster-affected people for disasters of any scale.
    - The government and prefectural governments support effective response in disaster areas.
      - Human support
      - Material support
- ↓
- **Standardization of disaster response operations where municipal governments play a central role: On-site adjustment**
  - Development of a mechanism that supports the effective implementation of these operations: Logistics adjustment

# Role of Municipal Governments as an Interface with Disaster-affected People

Crisis response system

Basic disaster reduction plans + lessons learned from recent disaster responses (●)



## (On-site effective response)

1. **6 + 1 operations where basic municipalities play a central and active role**  
(Operation that has no jurisdiction in normal times)  
(Operation where workloads in normal times increase)  
(To prevent disaster-affected people from being sent from department to department.)
2. **Operations handled by experts**
  14. Rescue and first aid activities, and medical and firefighting activities (Fire and Disaster Management Agency)
  19. Activities related to the maintenance of social order, stability of prices, etc. (National Police Agency)
  20. Activities related to first-aid training (education ministry)
3. **Activities to prevent the spread of a disaster and secondary disasters and to carry out emergency restoration (13) (METI)**

## (Adjustment to facilitate the smooth operation at disaster sites)

1. Establishment of response system (12)
2. Acceptance of spontaneous support (21)
3. Planning of recovery and reconstruction

## (Adjustment to support disaster sites)

1. Emergency transport (15)
2. Procurement and supply of necessary goods (17)
3. Human support
4. Pullout management

6 + 1 operations where basic municipalities play a central and active role

- (Operation that has no jurisdiction in normal times)
11. Warning/evacuation
  16. Sheltering of evacuees and provision of information
- Investigation into damage to buildings and issuance of disaster certificates

(Operation where workloads in normal times increase)

18. Health and hygiene, epidemic prevention, and handling of victims' bodies
- Debris control  
● Support of Persons with Special Needs

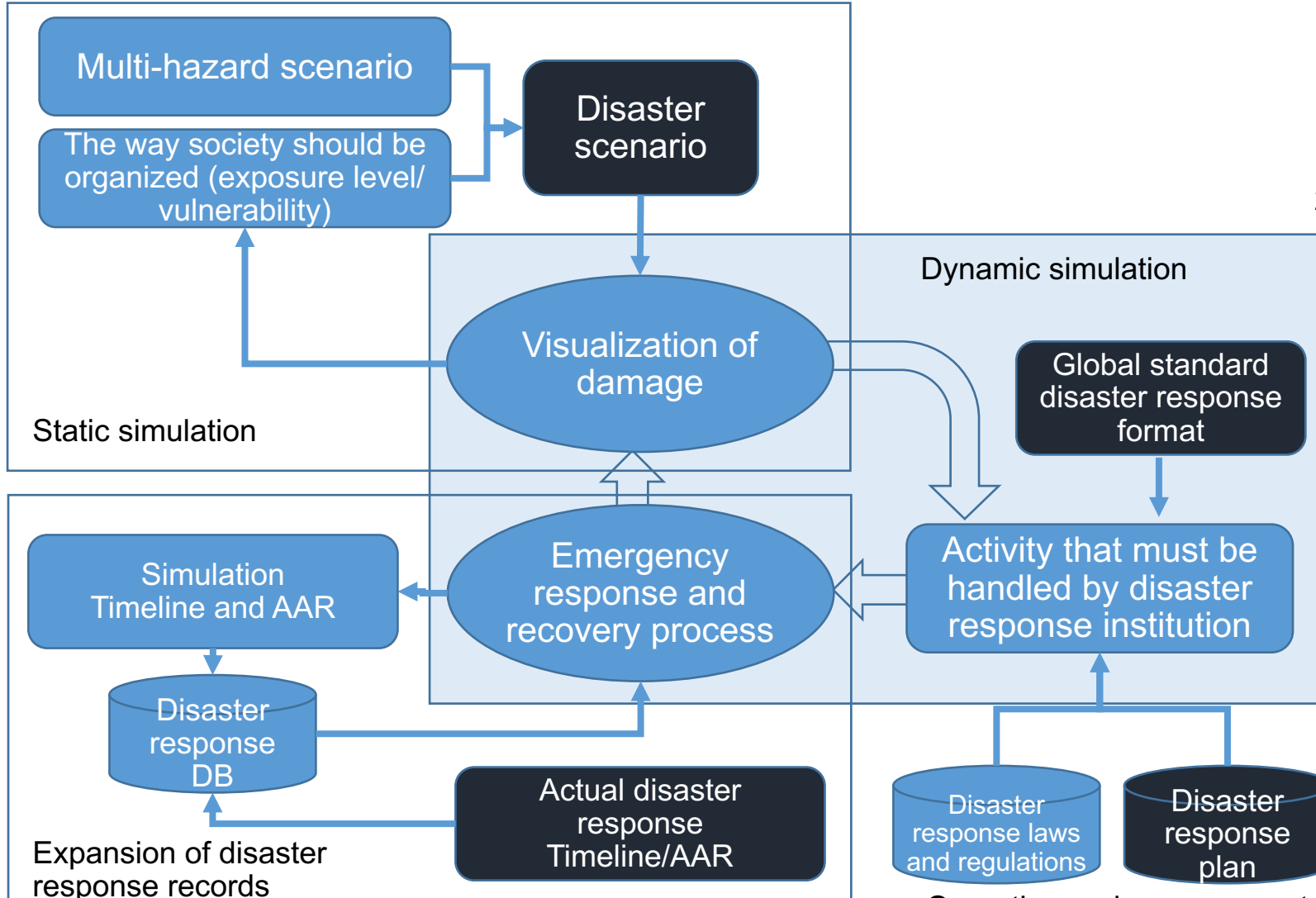
(To prevent disaster-affected people from being sent from department to department)

- Comprehensive consultation service



# Dynamic Simulation of the Response of Emergency Operation Center in Emergency Response DX

## 1. Sophistication of decision-making using simulation technology

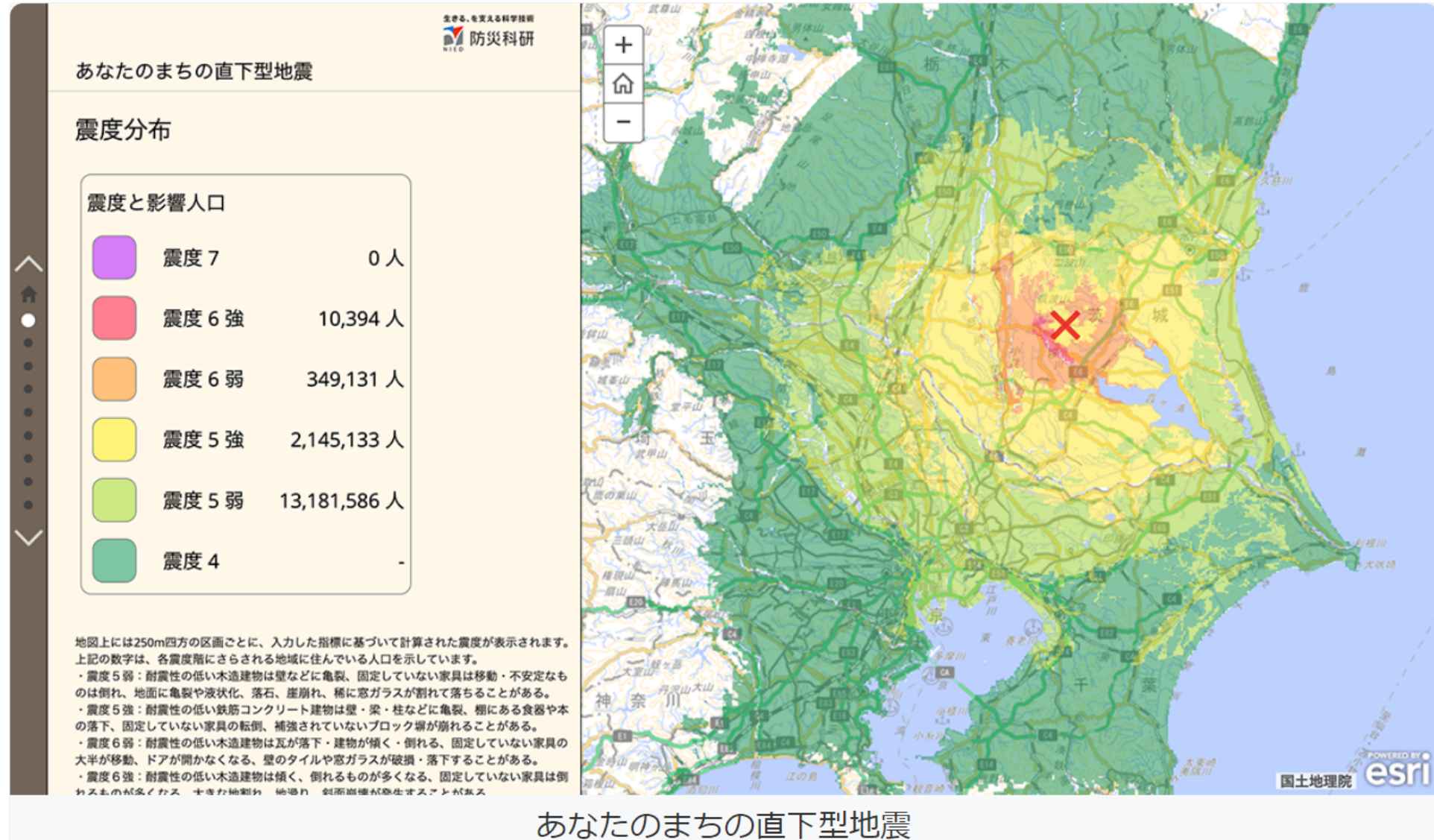


## 2. Structuralizing of disaster response operations in line with global standards

## 3. Expansion of disaster response records through automation



# Sophistication of Decision-Making Using Simulation Technology





# Structuralizing of Disaster Response Operations in Line with Global Standards

—Collaboration with e-learning in training of disaster management specialists  
hosted by the Cabinet Office—

WP1 Livelihood recovery support operation Chief supervisor	WP2 Investigation to recognize housing damage Supervisor	WP3 Investigation to recognize housing damage Team	WP4 Investigation to recognize housing damage Management rep
			WP5 Investigation to recognize housing damage Operation rep
		WP6 Digitization of investigation results Team	WP7 Digitization Management rep
			WP8 Digitization Operation rep
	WP9 Issuance of disaster certificates Supervisor	WP10 Issuance of disaster certificates Team	WP11 Issuance of disaster certificates Management rep
			WP12 Issuance of disaster certificates Operation rep
	WP13 Support operation for disaster-affected people Supervisor	WP14 Register of disaster- affected people Team	WP15 Register of disaster- affected people Management rep
			WP16 Register of disaster- affected people Operation rep
		WP17 Support operation for disaster-affected people Team	WP18 Support operation for disaster-affected people Management rep
			WP19 Support operation for disaster-affected people Operation rep

Establishment of a work breakdown structure (WBS) for 6 + 1 operations

# Creation of a Disaster Response Operation Manual

## Utilization of WBS-M/ACE

### WBS-Manager



Reflecting to WBS

Review of WBS



Reflect on with WS and review WBS.

Based on the WEB descriptive method,  
• organize structurally and hierarchically  
• without missing anything out.

Trial in training within organizations, etc.

The screenshot shows an action card form titled '0-1 避難支援・学校部が避難所を開設する'. It contains a list of tasks with checkboxes for completion. The tasks are: ①避難所班が避難者の安全を確保する, ②避難所班が避難施設の安全を確保する, ③避難所班が避難所の設備を確保する, ④避難所班が避難所の開設を報告する, ⑤避難所班が避難者台帳を作成し避難者を収容する, and ⑥避難所班及び統括班が移転避難者を誘導する. The first three tasks are marked with red checkmarks, indicating they are completed.

Record response processes using an action-card.



WBS-M/ACE  
Centralized operation  
management DB

Standardizing

Action-Card-Editor

The screenshot shows the Action Card Editor interface. It includes fields for 'From' (発注者), 'To' (担当者), and '発行日時' (発行日時). Below these fields is a table with columns for '内容' (内容) and '完了確認' (完了確認). The table contains six rows of tasks, each with a checkbox for completion. The tasks are: ①避難所班が避難者の安全を確保する, ②避難所班が避難施設の安全を確保する, ③避難所班が避難所の設備を確保する, ④避難所班が避難所の開設を報告する, ⑤避難所班が避難者台帳を作成し避難者を収容する, and ⑥避難所班及び統括班が移転避難者を誘導する. The first three tasks are marked with red checkmarks, indicating they are completed.

Write using the action card format to:  
• check details at hand and  
• understand workloads. (WP)

# Cloud-EOC: Expansion of Disaster Response Records through Automation

**連絡処理票**

操作テスト 新規作成

重要 | 緊急 | 全部局 | 自部局宛て | **自部局から依頼** | 本文検索 | 検索 クリア | ID検索 | 検索 クリア | 対応状況 | 送信元 or 送信先

レコードNo.	ID	重要	緊急	対応状況	起票日時	更新日時	送信元/送信者	送信先	件名	内容	回答	回答画面
188	187	重要	緊急	完了	2015/03/03 14:54:18	2015/03/03 15:57:30	本部統括班 権原 太郎	*福祉救護部 要援護者支援班	避難所の開設について	全ての避難所の開設準備を至急整えて、報告ください。報告を待って、避難勧告を発令します。	■03/03-14:55【福祉救護要援護者班 福祉太郎】確認 ■03/03-14:58【本部統括班 権原太郎】よろしく願います。 ■03/03-15:55【福祉救護要援護者班 福祉太郎】福祉避難所の開設準備が整いました。 ■03/03-15:57【本部統括班 権原太郎】了解しました。 ■03/03-14:55【避難支援統括班 学校太郎】確認	
187		重要	緊急	完了	2015/03/03 14:51:46	2015/03/03 15:52:30	本部統括班 権原 太郎	*避難支援・学校部 避難所班	避難			
80		緊急	未対応		2015/03/01 09:28:08	2015/03/03 14:51:36	本部統括班 権原 太郎	*生活基盤部	○○川			

**連絡処理票 (新規)**

ID: \_\_\_\_\_

起票日時: **必須** 2015/04/20 19:32:32

送信元: **必須** 避難支援避難所班

送信者: **必須** 権原太郎

送信先: **必須** \_\_\_\_\_

重要: (事態の深刻性) ☐ 影響が大きい場合はチェック

緊急: (時間的切迫性) ☐ 他の仕事を中断してもやるべき要件の場合はチェック

対応状況: **必須** ☒ 未対応 ☐ 対応中 ☐ 完了 ☐ 周知

件名: **必須** \_\_\_\_\_

内容: **必須** \_\_\_\_\_

承認者: \_\_\_\_\_

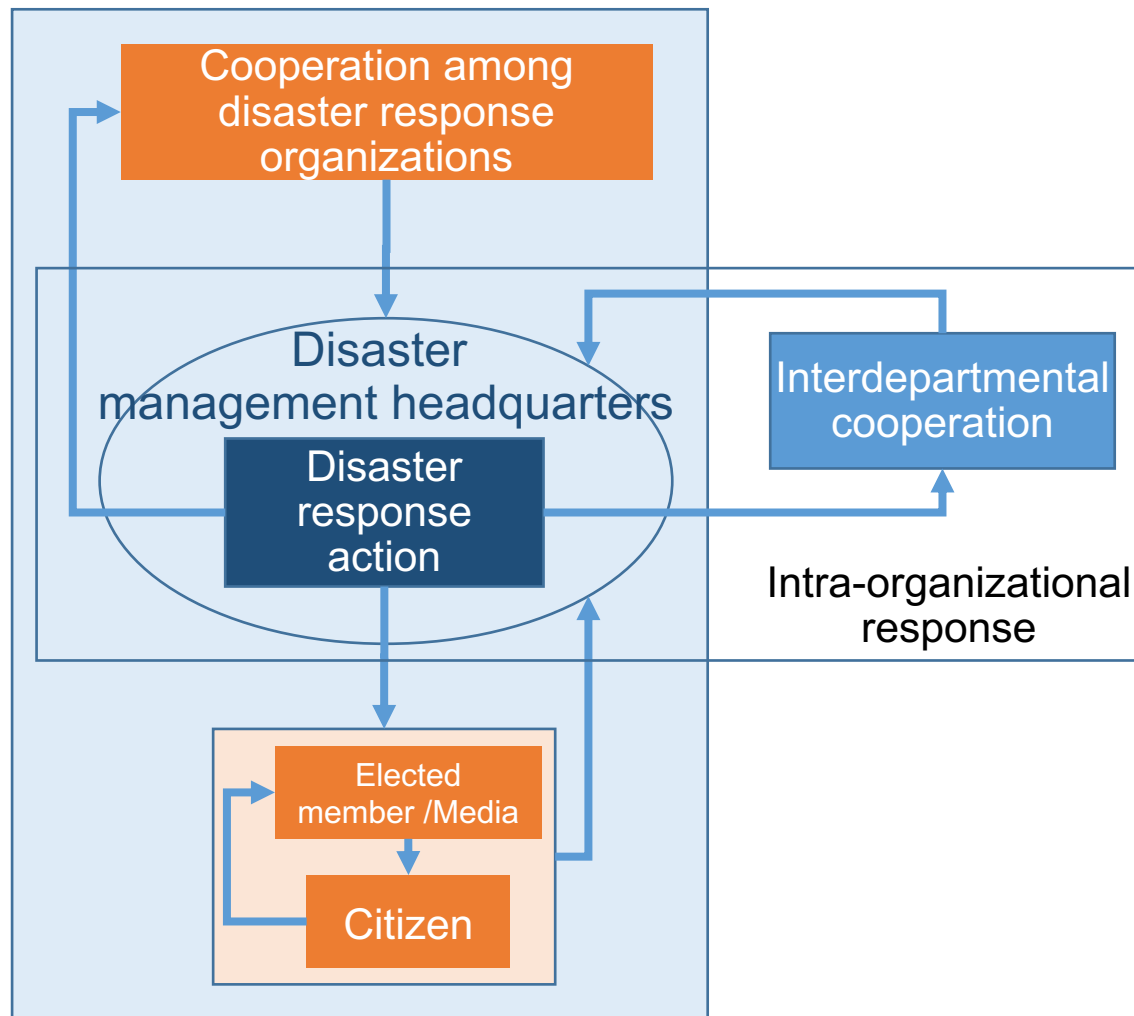
添付:

Example of a logger UI that supports intra-organization use

- Entering information in this UI embodies disaster response activities.
- All action taken by each department in training or actual operations is recorded as data and leads to improved next disaster response.

Example of an input UI used by each user

# Three Types of Coordination Required for Emergency Operation Center in Emergency Response DX.



1. Activities at disaster management headquarters
2. Intra-organizational cooperation
3. Inter-organizational cooperation
  - 1) Cooperation among disaster response organizations
  - 2) Cooperation between assembly members/media and citizens

# Dynamic Simulation Level in Emergency Response DX

Event			Level 3
Operational Period		Level 2	
Decision	Level 1		
Time/Scope	Department	Intra-Organization	Inter-Organization

- Level 1: Disaster response process

How decision-making regarding intradepartmental operations should be made

- Level 2: Planning of Incident Action Plan

How intra-organizational operations per operational period should be conducted

- Level 3: AAR (After Action Review)

How operational plans that enable effective inter-organizational cooperation should be developed based on disaster response

Operational period: Unit of activity cycle at disaster management headquarters (Planning P), 12 hours in the initial response phase, a day in the emergency response phase

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