

March 15, 2015

国難、巨大災害を迎え撃つ
Mega-Disaster Resilience for
Interception of *National Crisis*

Prof. Yoshiaki KAWATA, PhD

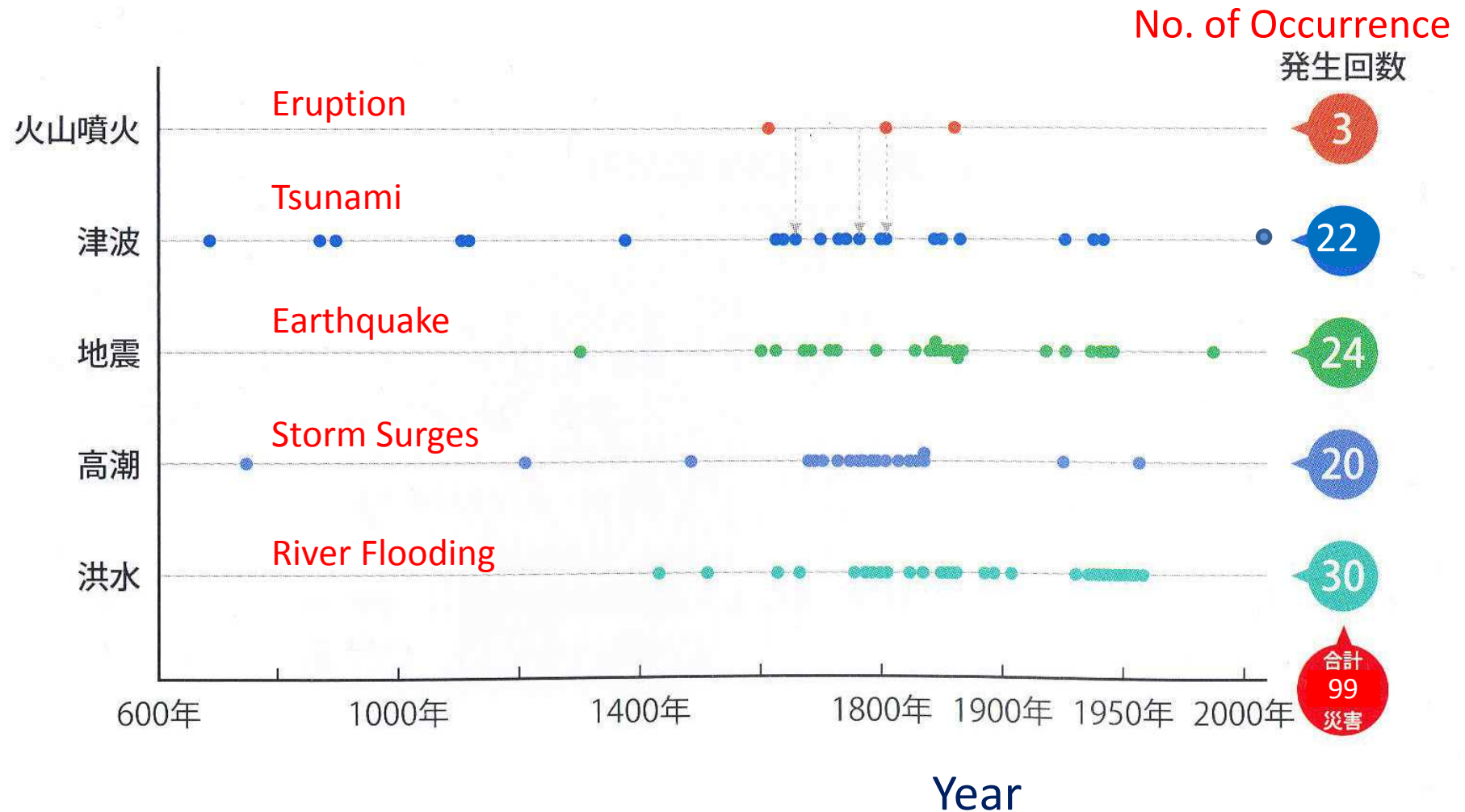
教授 河田恵昭 工博

Faculty of Safety Science Kansai University

関西大学社会安全学部

Catastrophic Disasters in Japan (Death toll >1,000)

わが国の巨大災害(死者千人以上)



わが国の長期的な災害発生傾向

Trend of Occurrence of Natural Disasters in Japan

1. 地球温暖化による風水害の激化

Intensification of storm and flood due to global warming

2. 高潮の脅威の増加

Increase of storm surge menace

3. 2100年頃まで続く地震・火山噴火活動の活発化

Full activity of earthquake and eruption until around 2100

年々、災害にもろくなっている日本社会

Japanese society has become vulnerable against disasters

1. 成熟社会での縮災の明確な低下傾向

Marked lowering of disaster resilience in mature society

2. 高度・複雑化経済社会での被害の多様化

Diversification of damage in highly complicated economic society

3. 発生外力(ハザード)が巨大化

Increased scale of natural hazard

We are much anxious about next “National Catastrophe (Crisis)”.

- **Tokyo Metropolitan Earthquake**

(M7.3, Occurrence probability within 30 years:70%, Seismic Intensity: 7, Population in seismic intensity 6- or larger: 30million, The dead estimated: About 23,000 (more than 100,000 with city fire), Debris: 98million ton, Economic damage:\$950billion, **Super-Urban disaster**

- **Nankai Trough Gigantic Earthquake**

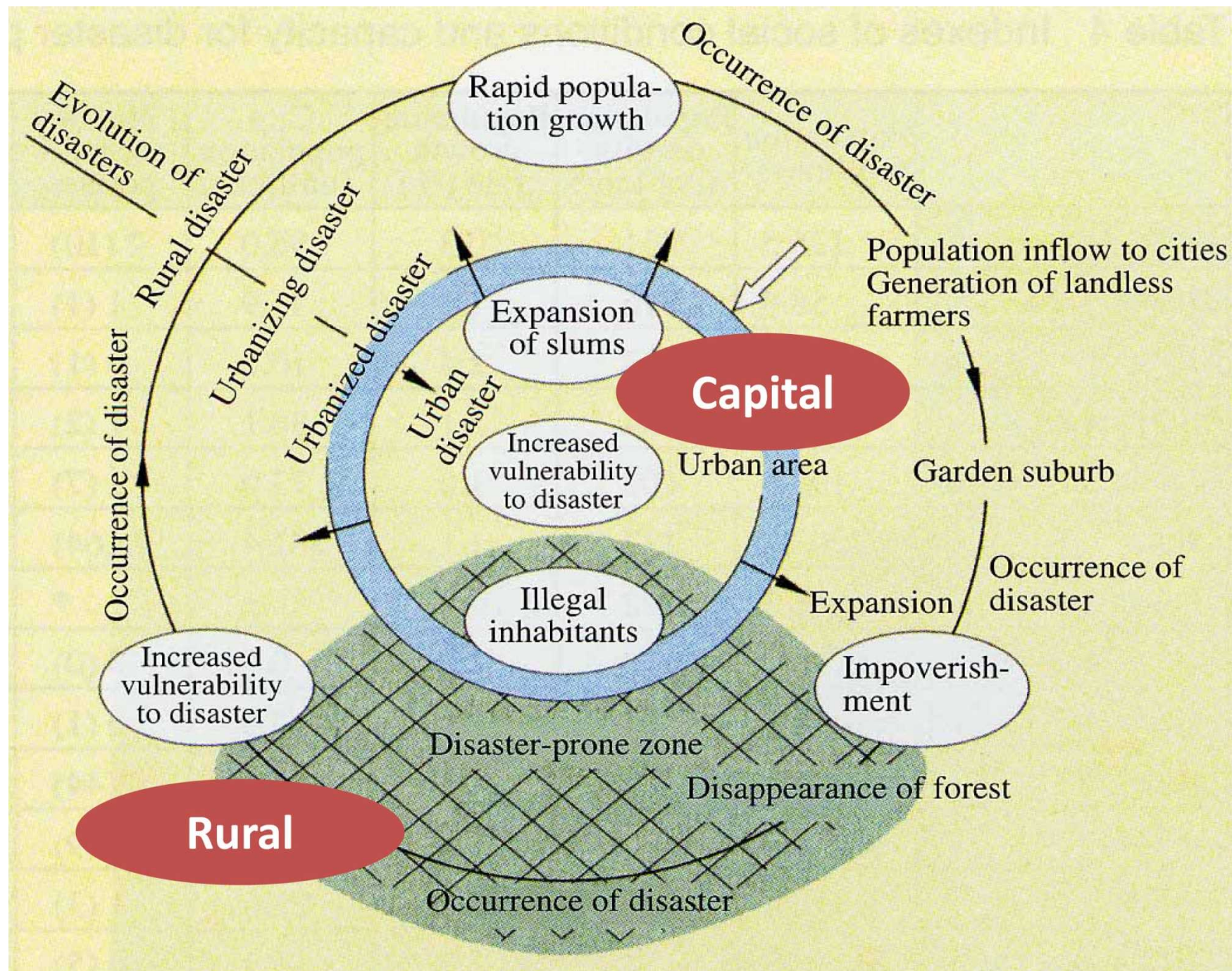
(M9.0, , Occurrence probability within 30 years:60 to 70%, Seismic Intensity: 7, Population in seismic intensity 6- or larger: 61million, The dead estimated: About 320,000, Debris: 310million ton, Economic loss : \$2,200billion, **Super-Extensive disaster**

Characteristics of disasters in urban area

1. Disasters have evolved in accompany with growth of population。
2. Our society has a vicious cycle between mega-city and rural area, and disaster vulnerability becomes large in both areas.

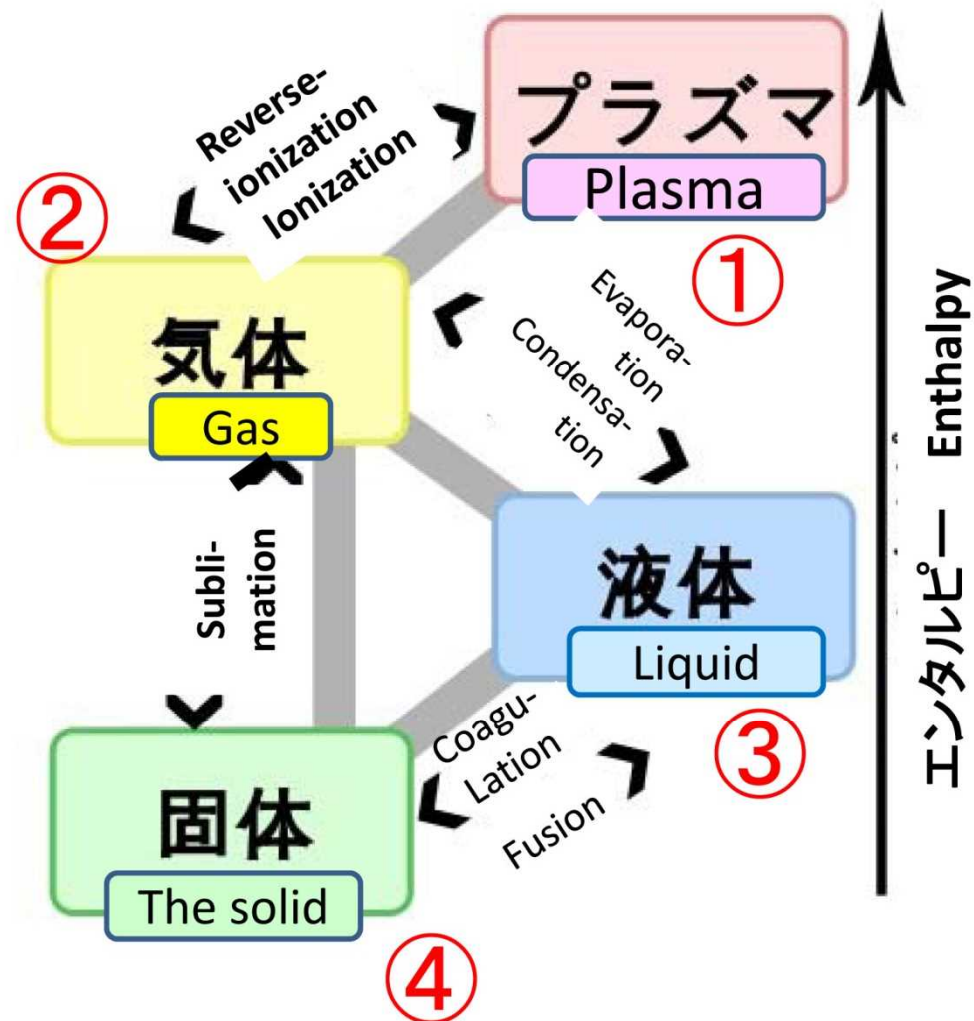
Japan: Vicious cycle of Tokyo overconcentration
(precedence) and local impoverishment
(population decrease)

Developing country: local impoverishment
(population increase)(precedence) and capital
overconcentration



都市で起こる災害の相転移現象

Phase transition in urban area



①スーパー都市災害
Super-urban disaster

②都市災害
Urban disaster

③都市型災害
Urbanized disaster

④都市化災害
Urbanizing disaster



田園災害
Rural disaster

The largest seismic areas due to Nankai trough earthquake and Sagami trough earthquake

0 200.0
km

Tokyo

Japan trench

Sagami trough

Nankai trough

Izu-Ogasawara trench

		Nankai trough	Sagami trough
Area	Total	約14万km ²	約4万km ²
	10km>	約11万km ²	約3万km ²
Length of trough axis		約8百km	約3百km

Moment Magnitude Mw9.0
Gigantic tsunami height: 34.4m
Affected area people: 60 million
Economic loss: About ￥22Billion

Scenario Toward “National Catastrophe”

Compound disasters at the end of Edo era around 1850s'

- **23 and 24 Dec. 1854**
Ansei-Tokai (M8.4) and Ansei-Nankai Earthquake (M8.4) with 32 hours gap (The dead: About 30,000)
- **11 November 1855**
Ansei Edo Earthquake (M6.9)
The dead:10,000, Damaged houses:14,000
- **23 September 1856**
Ansei Edo Typhoon Disaster (Storm surges and heavy rainfall)
Damaged houses:150,000

Civil war among Tokugawa Samurai government and radical local governments, and forced opening against developed countries such as U.S.A., UK and France.

Catastrophic Compound Disasters in Japan

- 864~887:
Mt. Fuji erupted, East Japan earthquake (Jogan earthquake) and Nankai trough earthquake (Pop. 6.5 million)
- 1703~1707:
Edo earthquake, Mt. Fuji erupted and Nankai trough earthquake (Hoei earthquake) (Pop. 28 million)

Edo: old name of Tokyo

Compound disaster reduction in age of frequent occurrence

- We will have not single disaster but double or triple disasters as a compound disaster and total damage will become huge.
- Compound disaster reduction is defined as an obstruction of the worst damage scenario of compound disaster.
- Occurrence probability of compound disaster has been increased year by year due to lack of time and budget of recovery and reconstruction.

National catastrophe ▪ ▪ ▪ Occurrence of Super mega-scale disaster (1)

- Tokyo metropolitan earth. : Super-urban disaster
- Nankai trough gigantic earth. : Super-extended disaster
- Recurrence of historical national catastrophe such as Tokyo metropolitan earth., Nankai trough earth. and Mt Fuji eruption.
- **Catastrophic disaster 1**: A series of compound disasters occurs and some municipalities will be destroyed. ▪ ▪ ▪ ▪ Uemachi active faults earthquake, The Yodo river flooding and Storm surge in Osaka bay

National catastrophe ▪ ▪ ▪ Occurrence of Super mega-scale disaster (2)

- **Catastrophic disaster 2** : After Nankai trough earth. , large scale typhoon hits and runs through west Japan.
- **Catastrophic disaster 3** : New crater of Mt. Fuji will appear at its south slope and destroyed Fuji city and its around. Simultaneous occurrence of suspensions will appear such as Tomei and Daini-tomei express ways, National road No.1 , Tokaido shinkansen, Tokaido railway.
- **Catastrophic disaster 4** : A compound disaster in Tokyo metropolitan area occurs, a series of other disasters will occur due to over concentration in one place in Tokyo.

Super-urban disaster in Tokyo (Single occurrence case)

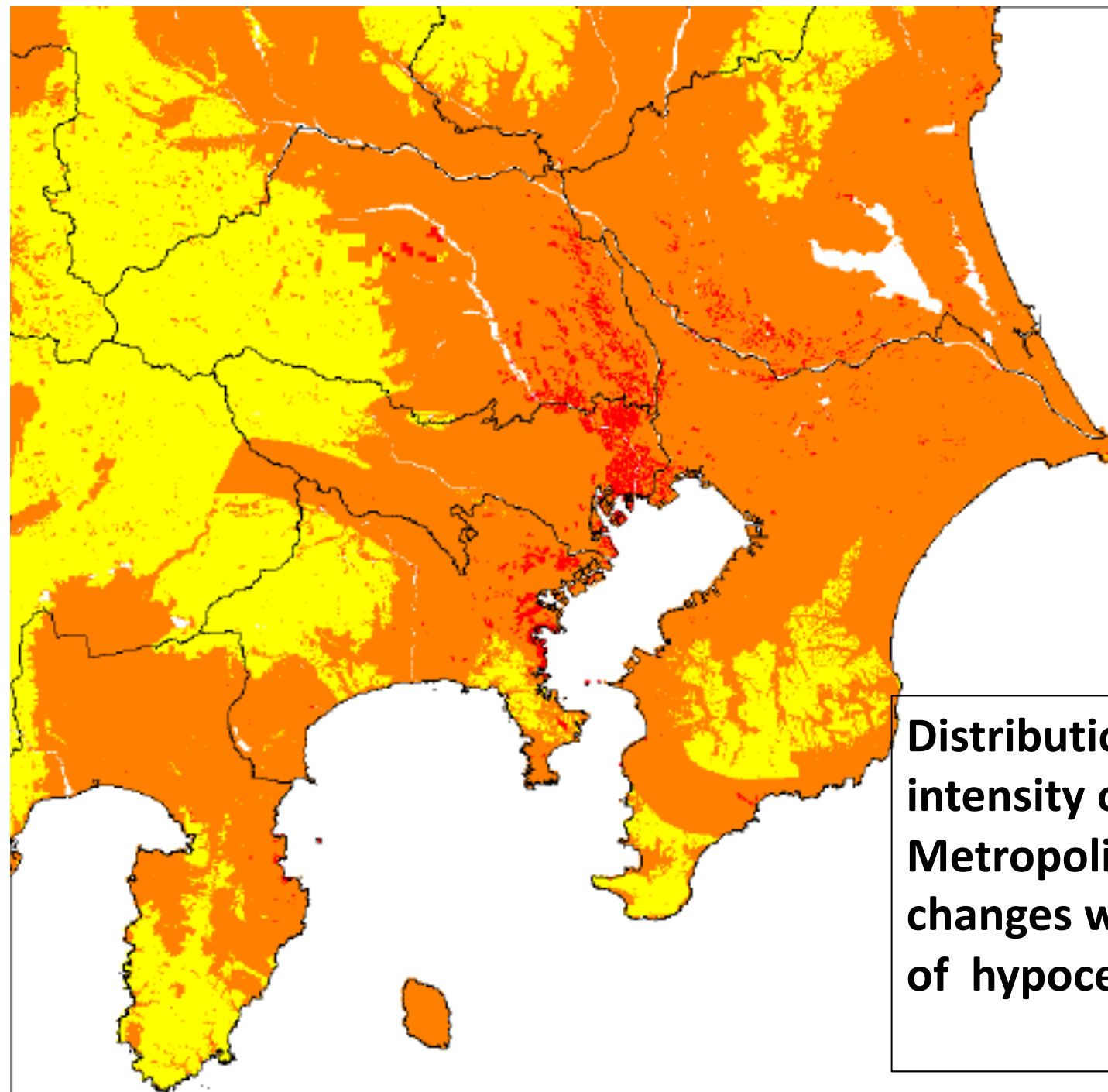
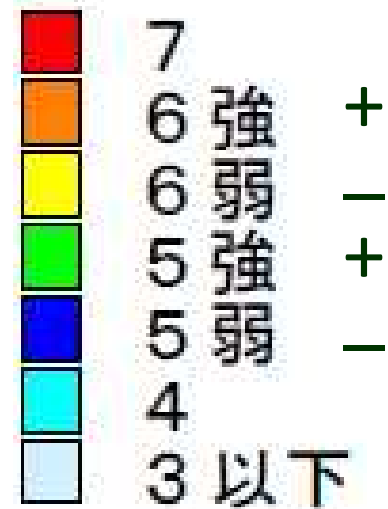
- Tokyo metropolitan earthquake (Vertical thrust)
- Tokyo metropolitan earthquake as plate boundary earthquake with tsunami
- Large-scale flooding in the river Arakawa and the river Tonegawa
- Large-scale storm surges flooding in Tokyo bay accompanied with huge typhoon due to global warming

Several combinations with above mentioned disasters

The disasters have characteristics of extended, compound and long-term ones.

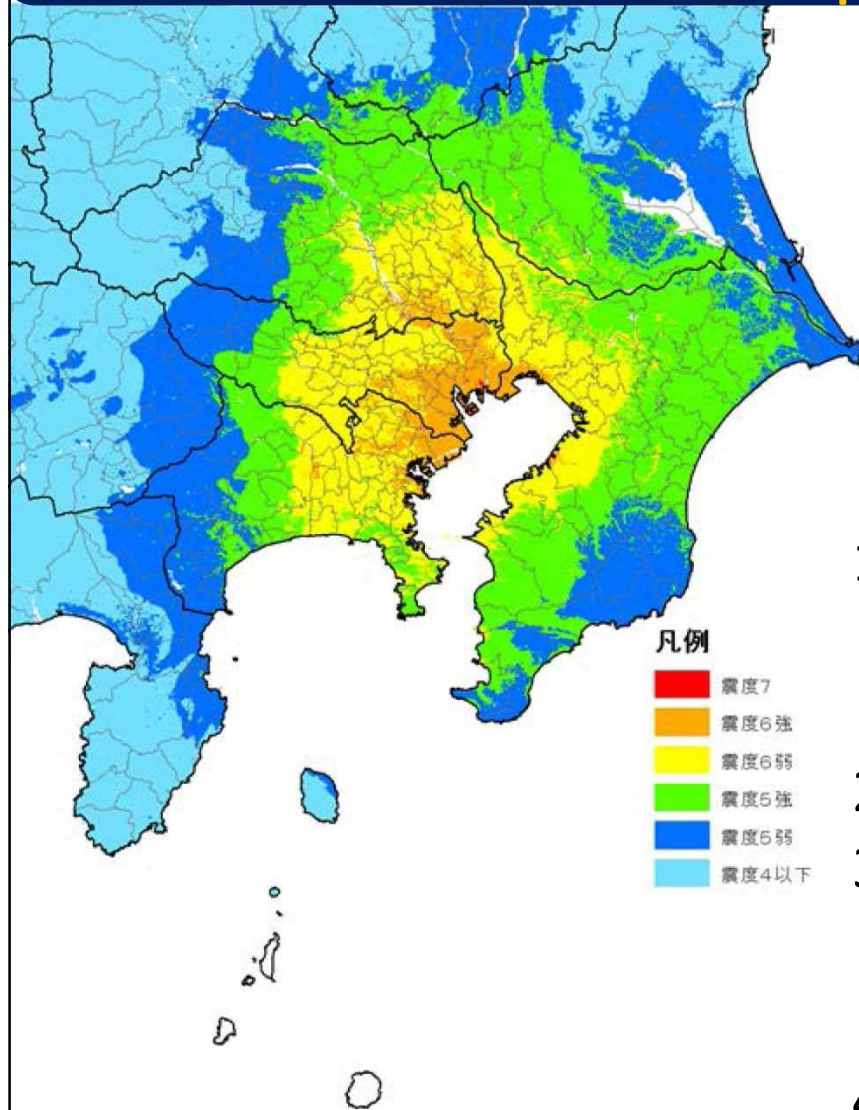
Seismicity

震度



Distribution of seismic intensity of Mw7.3 Tokyo Metropolitan earthquake changes with 19 locations of hypocenter(震源)

Damage Estimation Due to Tokyo Metropolitan Earthquake of M7.3



Tsunami height will be less than 1m when Tokyo-to heart southern earthquake (M7.3)

Estimated maximum damage

1. The number of collapsed and burnt down houses:
About 610,000
2. The dead: 23,000
3. The people of an escape of efforts due to a difficult linchpin savior:
72,000
4. Economic loss : About ￥9.5billion

Characteristics of damage due to Tokyo Metropolitan earth.

① Large scale direct loss · · · · Mega-city Disaster

- Huge damage of housings and buildings in wooden crowd area
- Human damage due to collapsed houses and buildings and city fire
- Much living difficulty due to dysfunction of lifelines and housing loss

② Catastrophic indirect loss · · · · Capital Disaster

- The worst damage scenarios in damage estimation
- Troubles of the capital functions bring bad influence domestic and abroad
- They have a bad influence on a financial central function and manufacturing function
- -----on a political central function and the administrative function

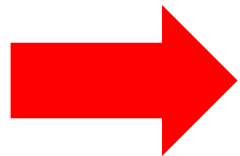
Some examples of catastrophic disasters in Tokyo

Case 1 : Occurrence of earthquake in Tokyo after several months or one year from Nankai trough earthquake (Historically, in 1854, this compound disaster occurred.

Case 2 : Simultaneous occurrence of Tokai earthquake and Mt. Fuji eruption (Historically, in 1707, 49 days after, Mt Fuji erupted as called Hoei eruption)

Case 3: Within several months after Tokyo metropolitan earthquake, occurrence of typhoon landing in Tokyo

Case 4: Short-term interval occurrence between Tokyo metropolitan earthquake and Nankai trough gigantic earthquake



Paradoxically, promotion to do research on how to do to reduce Tokyo to ruins

Future aspects of gigantic disaster

~Learn from leading disaster in the world~

- **2002 West Europe Flood Disaster** (The amount of the damage :\$100billion):Three subway lines were perfectly inundated in Prague, the Czech. Recovery works need 6 months and city activity was lost
- **2005 Hurricane Katrina** (The amount of the damage : \$1,250billion):Storm surge flood disaster in New Orleans. The dead was about 1,800. Inundation continued three weeks. Compound disaster with Hurricane Rita. BCP contributed to reduce enterprise damage.
- **2012 Hurricane Sandy**(The amount of the damage: more than \$800billion): Lower Manhattan was inundated by storm surge. Disaster lessons learned by hurricane Katrina were effective to reduce damage. AAR on ESF and timeline systems were useful.

Lessons learned by disasters in the USA

- **2001 September 11 attacks (The dead:3,025)**
(Changes from Federal Response Plan to National Response Plan, Shift to Preparedness and Mitigation before disaster, Homeland Security Department with 180 thousand officers was established.)
- **Unsuccessful response of 2005 Hurricane Katrina**
(In the case of wide-area disaster, decision making in governments was so complicated with inadequate information.)
- **Successful pre and post response of 2012 Hurricane Sandy** (In Manhattan, they had only flood hazard map to use evacuation without any hard countermeasure. The dead was 132. Timeline, AAR, 15 ESF's activities, Collaboration and adjustment with FEMA leadership and establishment of State government initiatives)

Reconstruction of damaged areas after storm surge disasters

- New Orleans : (\$14Billion Anti-storm surge systems, 100 year and 500 year return periods were applied to hard countermeasure and urban drainage systems respectively. \$17 Billion deficit finance in flood insurance)
- New Jersey State : Beach nourishment with higher mound against 100 year storm surges. \$24 Billion Deficit finance increased .
- New York State and City : Under planning of countermeasures with about \$30 billion

Characteristics of E.M. in the USA (1)

1. USA is federal nation. Every state is first responder at disaster.
2. With President Declaration, FEMA and every federal department has initiatives.
3. Governor is a commander with police, fire fighters and the National Guard.
4. County is very useful to promote collaboration and coordination among federal, state and city government as table top.
5. Several specialists attend meeting to discuss deeply and get agreement to get decision making.

Characteristics of E.M. in the USA (2)

- 6. Intervention of federal government means FEMA leadership with fund and coordination and cooperation with state government
- 7. Basic area unit is county in every state.
- 8. Contents of 15 ESF are very soft and relates to several departments.

どのようにして減災社会を実現するか

How to get resilient society

1. 想定外となるような巨大災害の発生を抑止

Mitigation of occurrence of unexpected gigantic disasters

2. 大都市での被害拡大を抑止

Control of damage enlargement in mega cities

3. 公共施設の維持と強化、地域社会の活性化

Intensification and maintenance of public facilities and activation of local community

わが国の災害対策の特徴

Characteristics of Japanese disaster countermeasure

- 災害先行型の対策 Disaster-oriented countermeasure
- 1961年災害対策基本法による再度災害の阻止
Recurrence of disaster prohibited by the 1961 Basic Act of disaster Reduction
- 対症療法中心の対策に終始 Hit-or-miss treatment as countermeasure
- 対策先行型社会に脱皮 “Ecdysis” from countermeasure-oriented society

南海トラフ巨大地震対策計画

Countermeasures for Nankai trough earthquake

1. 素早い津波避難を支援 Support for quick tsunami evacuation
2. ライフラインの安全・利用確保 Establishment of lifeline systems with passengers
3. 情報の収集・伝達・共有化 Smooth management of information systems
4. 広域被災地での救助活動支援 Support for search and rescue activities in widely damaged area
5. 被害の拡大阻止 Stop of damage enlargement
6. 民間事業者の協力の下、被災者・被災自治体の支援 Support for damaged people and damaged local government with public sectors
7. 被害の早期回復 Promoted disaster resilience

首都直下地震対策計画

Countermeasures for Tokyo Metropolitan earthquake

1. 地震や津波から命を守る Survive from earthquake and tsunami
2. 過密都市空間の安全確保 Keep safety in densely urban area
3. 被災者・避難者の安全確保 Safe treatment for damaged people and evacuated people
4. 地震後の二次災害や複合災害阻止 Stop the second disaster and compound disaster after earthquake
5. 首都中枢機能の維持 Maintenance for capital functions such as political, economical, financial ,manufacturing and culture activities
6. 首都中枢機能の迅速な回復 Disaster resilience for quick recovery of capital functions
7. 首都圏の望ましい復興 Sustainable and resilient reconstruction of Tokyo Metropolitan area

国土交通省による (by MLIT)