2011 IUGG Melbourne
2 July 2011 U02-extension
Earth on the Edge - Recent
Pacific Rim Disasters

United Nations
Educational, Scientific and
Cultural Organization

Chain Reactions Happened in Great East Japan Earthquake and Tsunami

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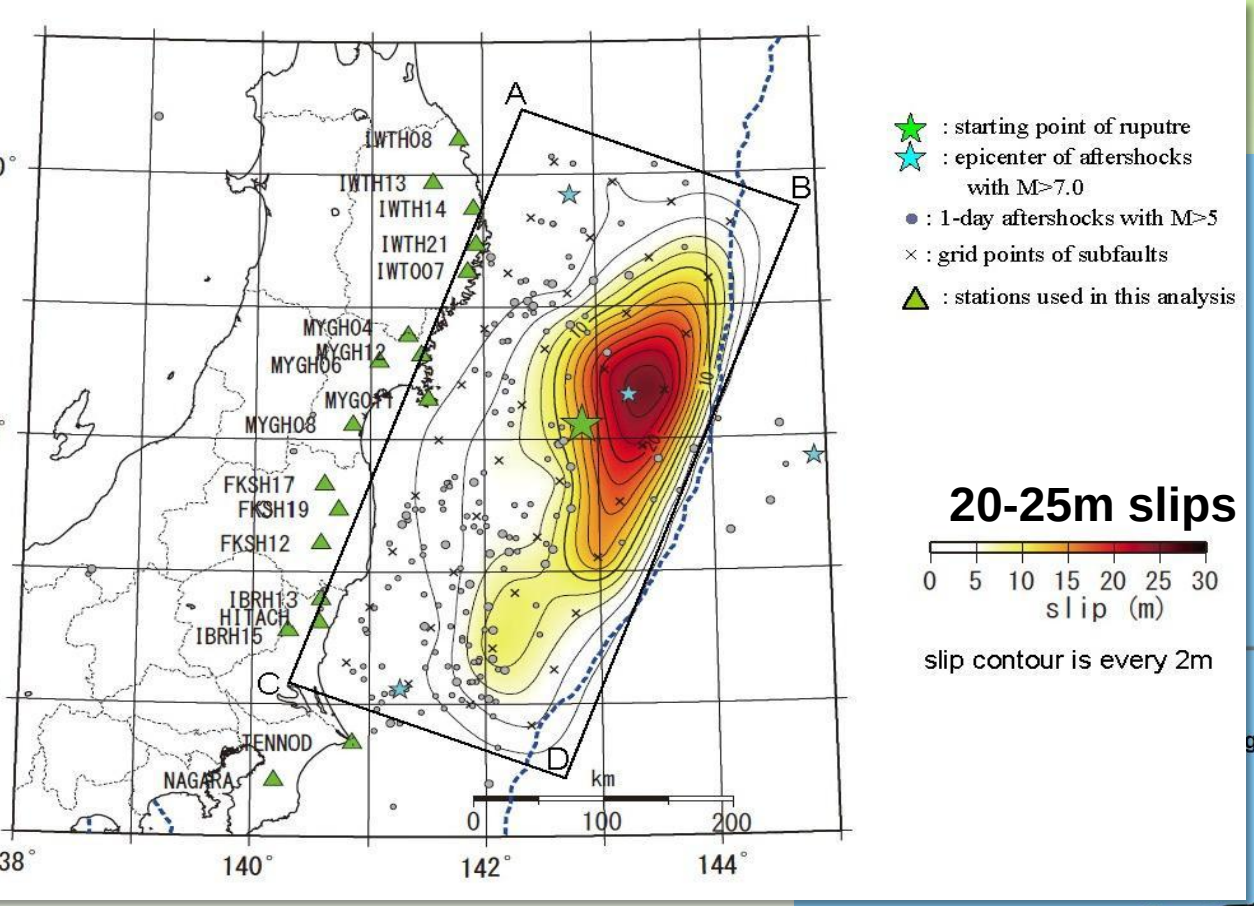
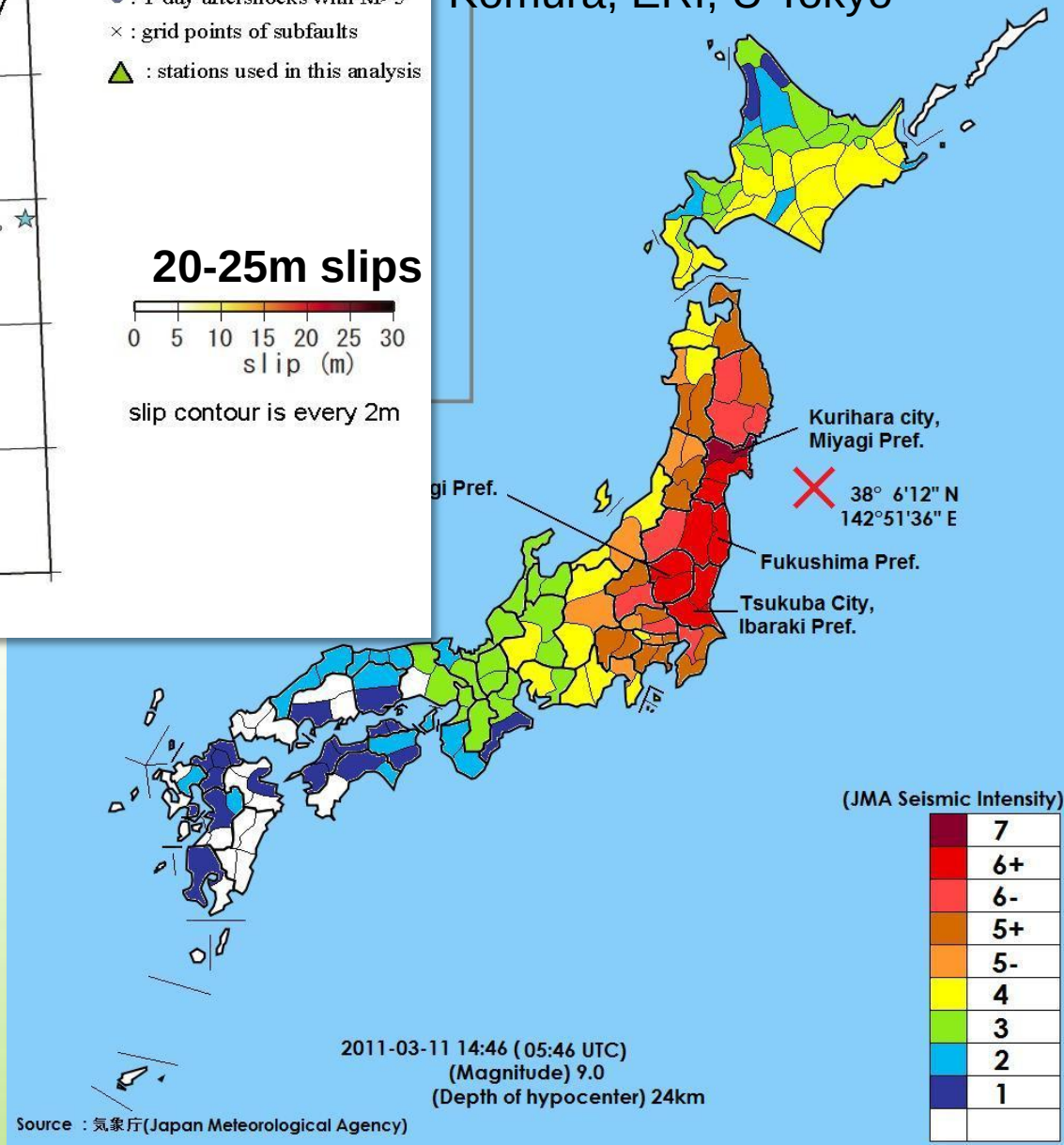


Ohotsuku plate slipped max 55m to SE
Simulation by Takashi Komura, ERI, U Tokyo



14:46 JST 11 March 2011
The main fault: 450km in length and 150km in width.

1. Hei River, Miyako; 2. Kamaishi Harbour; 3. Fukushima Daiichi by TEPCO

Photos from NASA Earth-watching satellites

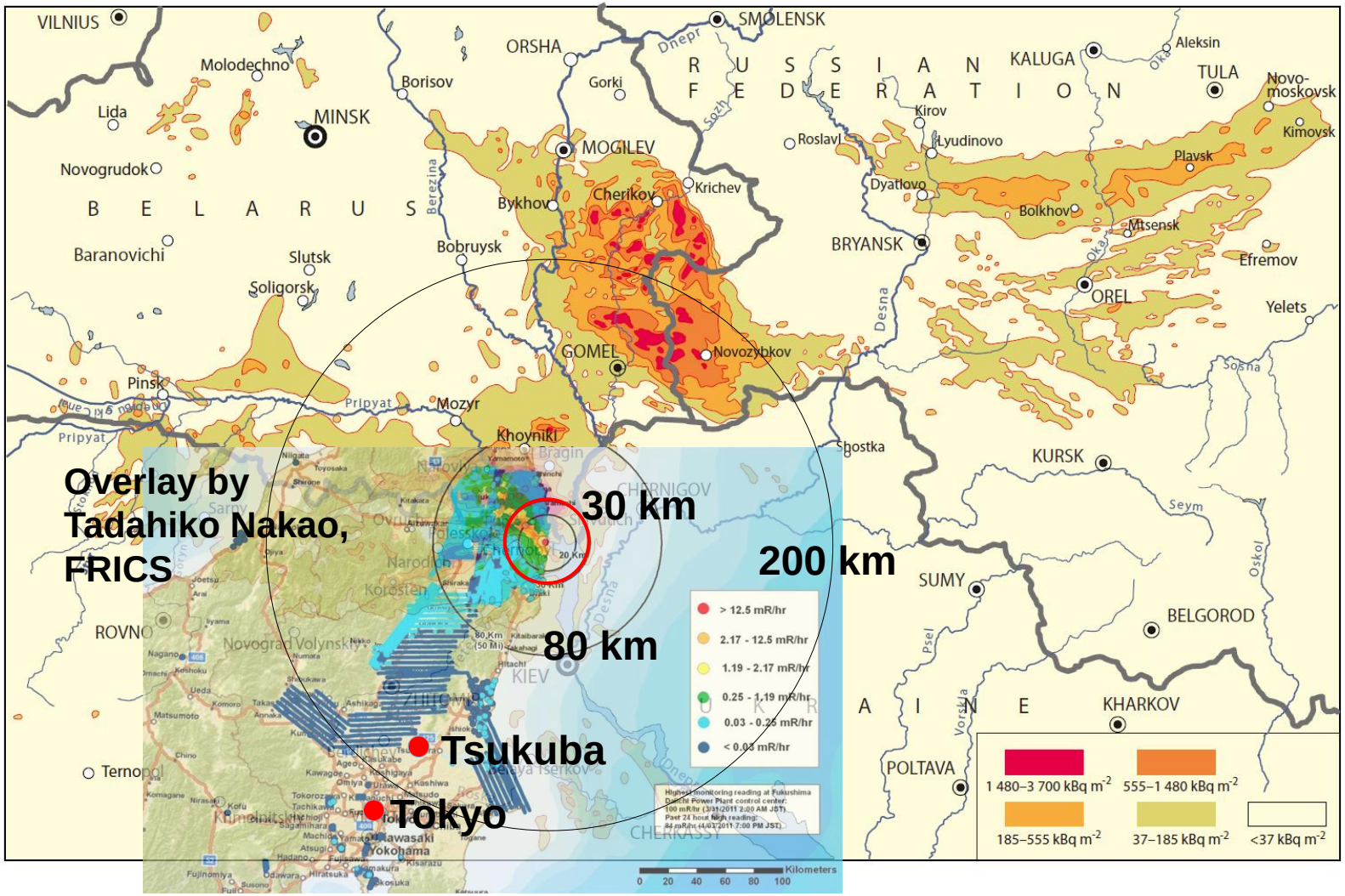
Fukushima Daiichi

INES Level 7

12 April 2011

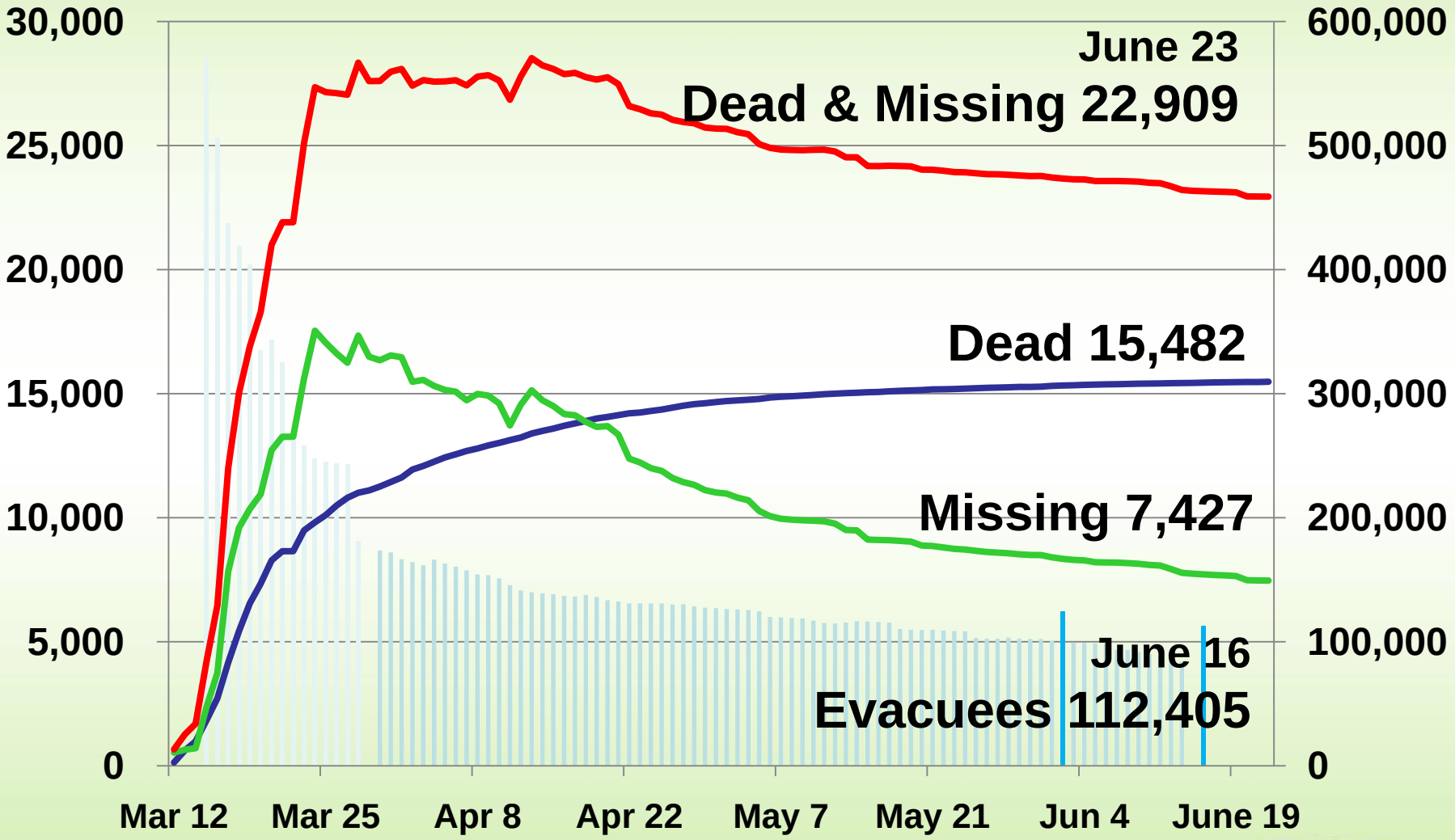
In comparison with Chernobyl case

Figure II. Map of ^{137}Cs deposition levels in Belarus, the Russian Federation and Ukraine as of December 1989 [I28]



Based on : http://www.unscear.org/unscear/en/publications/2008_2.html & http://blog.energy.gov/content/situation-Japan

3.11 Earthquake and Tsunami



source: National Police Agency, Asahi Shimbun (evacuees, before Mar 31) , Cabinet Office (evacuees, after June 2 with detail survey)

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Disaster losses and impacts

NPA 24 June

- Dead * 15,482
- Missing* 7,427
- Evacuees** 112,405 (CO 16 June)
- Houses damaged * 642,000
- Inundated 561km2
- Inundated paddy/field 236km2
- Debris 23.92Mt
- Roads * 3,559 pls
- Bridges* 77
- Landslides * 197
- River banks 4 pls

- Shinkansen damaged 1,200 pls
- Other JR trains 6,000 pls
- Highways 15 major lines
- National road stopped 161 intvls
- Fishing boats lost 18,880
- Fishery harbours damaged 325
- *Nuclear effects*
- Nuclear plants stopped 14
  eventually (35+5)/54
- Area evacuated 1,595km2
- Evacuees*** 97,183

Fk Pref. 13 June

Nikkei, Yomiuri, Asahi etc.

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Some tragedies

- In Taro, Miyako: Seawall called “Great Wall” of 10m high, 2.4km long survived but the town not.
  - Fudai, in the north of Taro, was saved by 15.5m Seawall.
- In Kamaishi: World tallest submerged seawall of 63m deep, 20m thick recorded in the “Guinness Book” was destroyed.
- 123 out of 959 authorized evacuation centers in Iwate and Miyagi Prefectures were hit by Tsunami and many evacuees were lost. (Minami Sanriku 31/78, Rikuzen Takata 35/68)
  - Limits in historical record based design

Taro, Miyako “Great Wall” (4 Apr Nikkei)

Some tragedies

- "Tsunami Tendenko" Everybody has to run away by itself without caring even parents or children at Tsunami **(1896 Meiji Sanriku)**
  - Tragedy in Sanrikutakada 13 community chiefs and many others lost lives by helping the elderly and handicapped
- "Tsunami 3m" was announced 3 minutes after the EQ and electricity went down. Corrections in 30' and 45' later never reached the people.
- Neglecting Jogan Tsunami (869) AIST engineers appealed TEPCO to renew the basis for the Jogan Tsunami in 2009 but the voice was not taken up.
  - In Fukushima Daiichi, the design Tsunami was 5.7m while what came was 15m.

Some reactions

- Much worse? if it happened in any other countries. How effective were the efforts taken in Japan so hard so far?
- If it happens in Tokyo, the impacts must have been much more destructive to the whole Japanese and international economy. How to design development to avoid chain reactions and network break in mutually dependent societies? How to keep the access available to resources such as water, foods, energy, information and transportation?
- Discipline and order: Is it surprising for survivors to be calm, patient, quiet and honest under the extreme suffering?
- Failure of EQ prediction? → EQ is not predictable.
- Depart from nuclear power?
  - Anti-nuclear commitments in Germany and Italy

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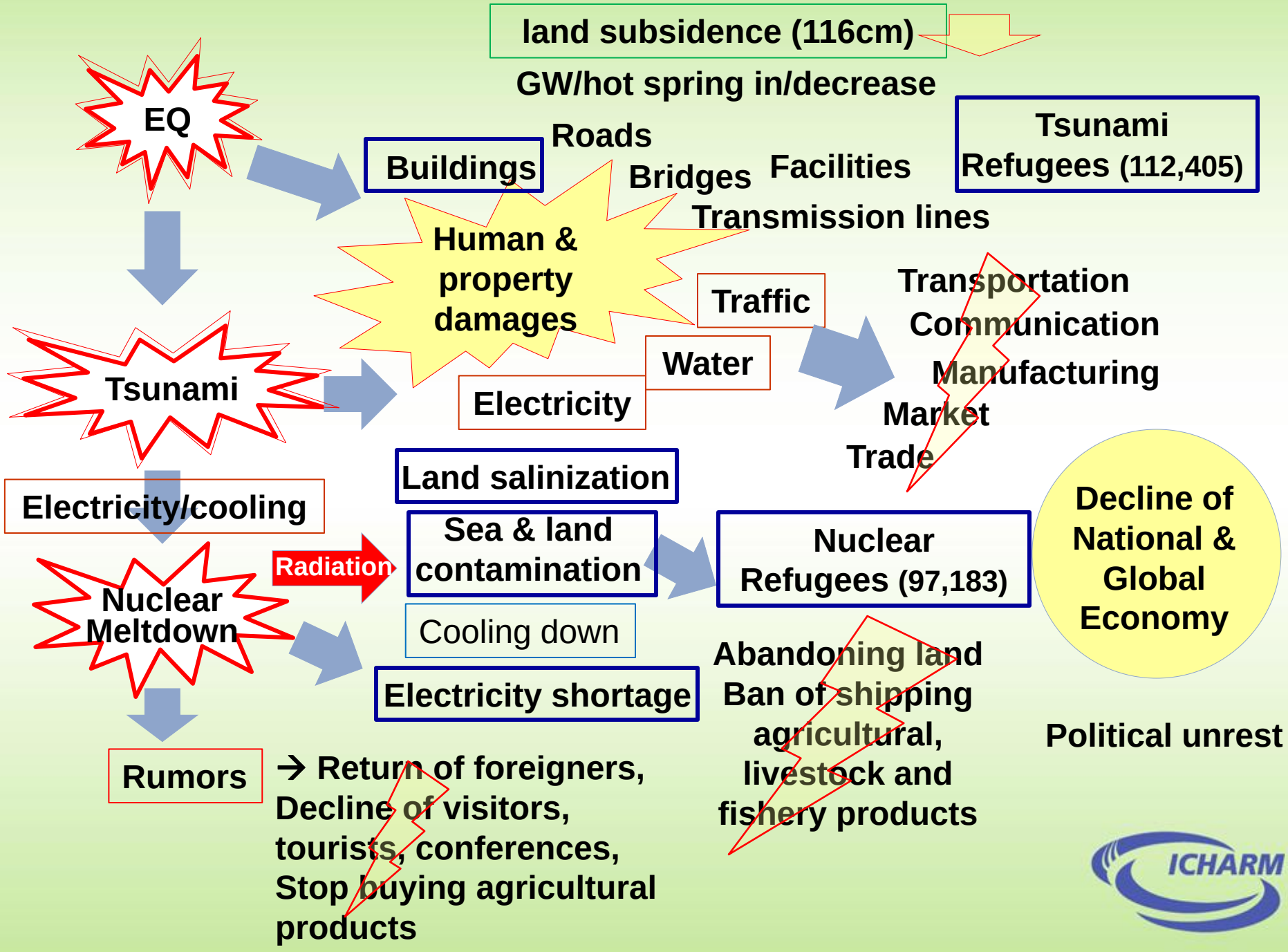
land subsidence (116cm)
GW/hot spring in/decrease
EQ
Buildings
Roads
Bridges
Facilities
Transmission lines
Tsunami Refugees (112,405)
Human & property damages
Traffic
Transportation
Communication
Manufacturing
Market
Trade
Water
Electricity
Tsunami
Land salinization
Electricity/cooling
Sea & land contamination
Radiation
Nuclear Refugees (97,183)
Decline of National & Global Economy
Nuclear Meltdown
Cooling down
Electricity shortage
Abandoning land
Ban of shipping agricultural, livestock and fishery products
Political unrest
Rumors
→ Return of foreigners, Decline of visitors, tourists, conferences, Stop buying agricultural products
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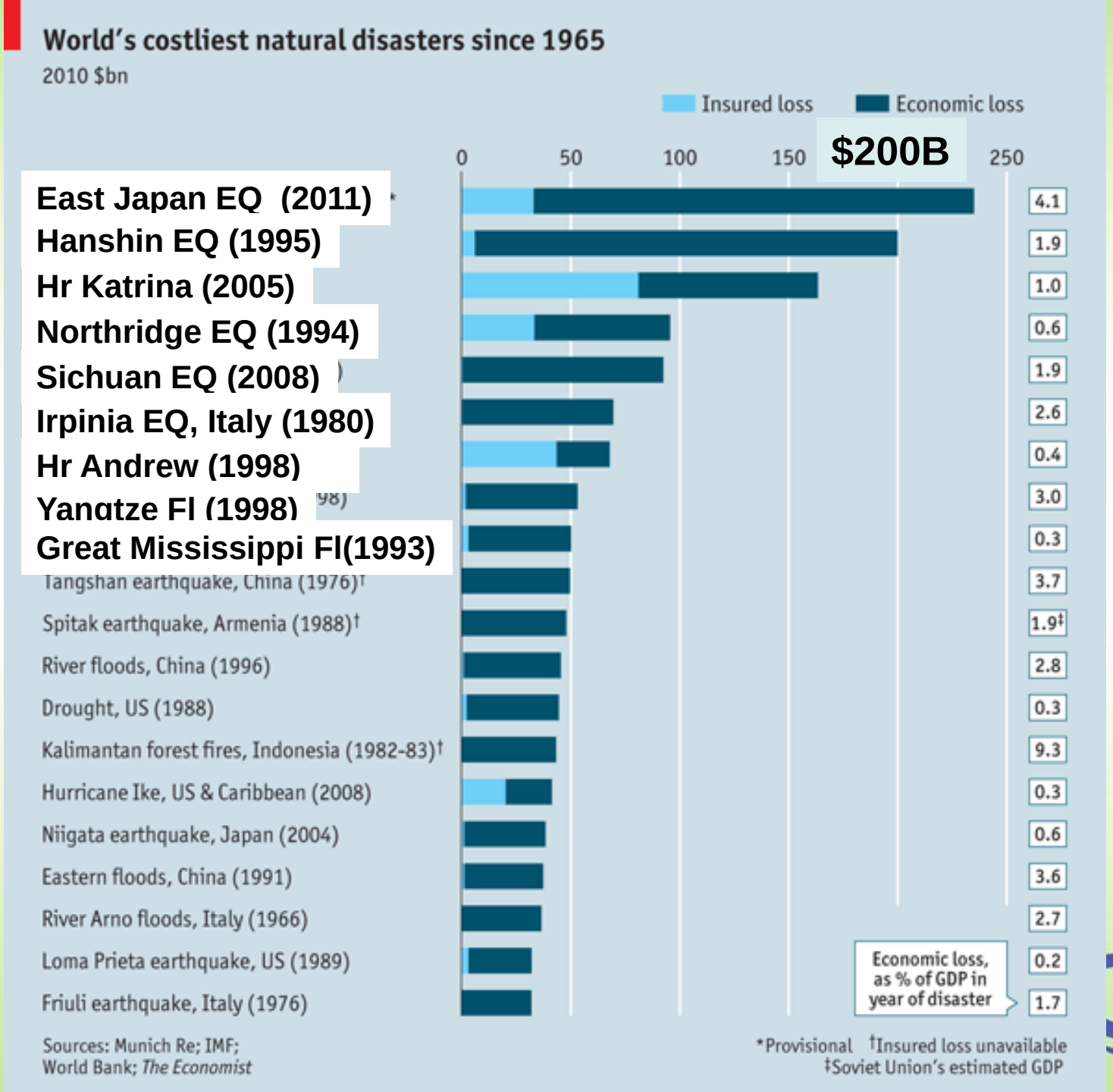
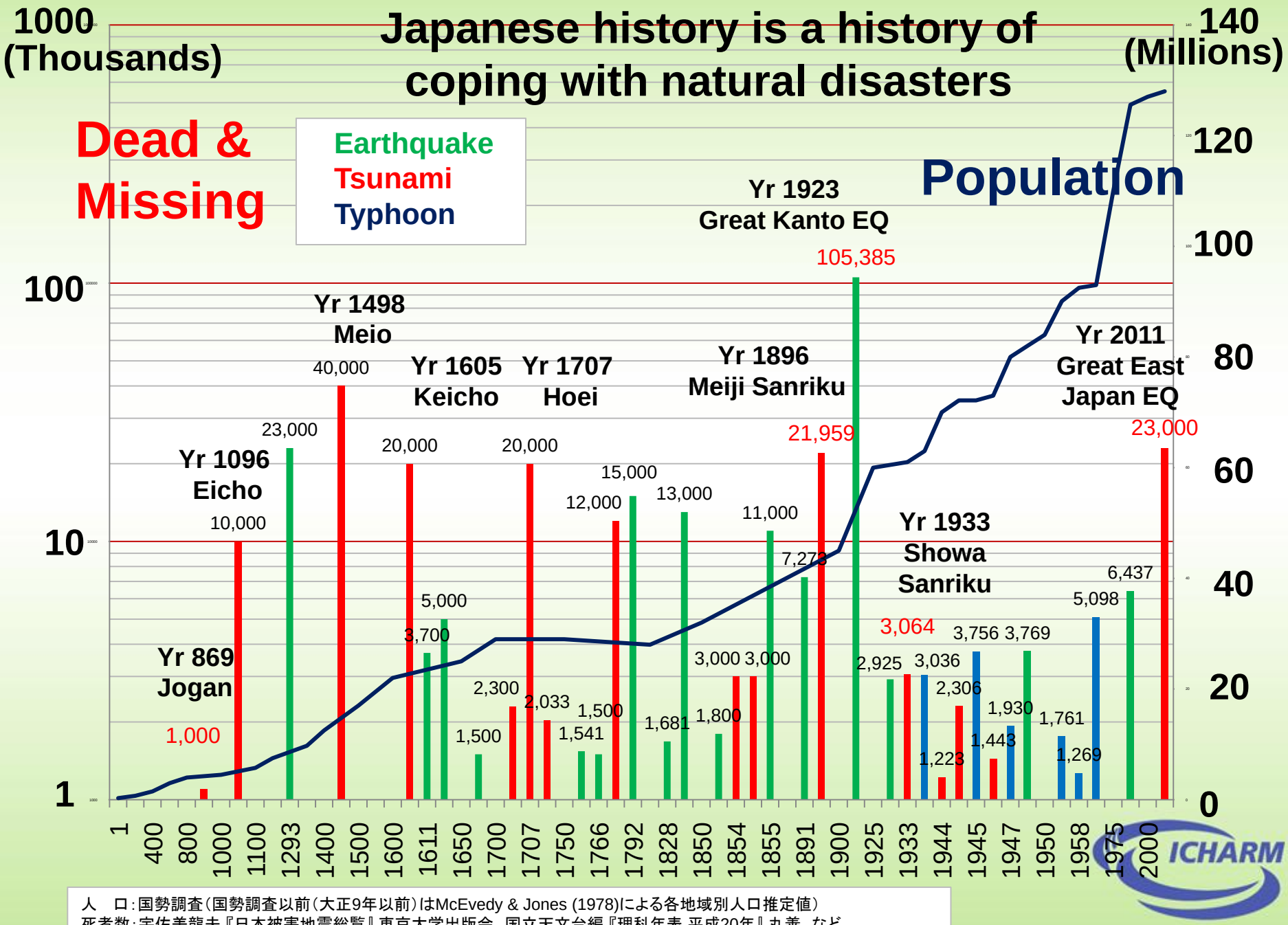

World's costliest natural disasters since 1965
2010 $bn
Insured loss
Economic loss
$200B
0
50
100
150
250
East Japan EQ (2011)*
Hanshin EQ (1995)
Hr Katrina (2005)
Northridge EQ (1994)
Sichuan EQ (2008)
Irpinia EQ, Italy (1980)
Hr Andrew (1998)
Yangtze Fl (1998)
Great Mississippi Fl(1993)
Tangshan earthquake, China (1976)†
Spitak earthquake, Armenia (1988)†
River floods, China (1996)
Drought, US (1988)
Kalimantan forest fires, Indonesia (1982-83)†
Hurricane Ike, US & Caribbean (2008)
Niigata earthquake, Japan (2004)
Eastern floods, China (1991)
River Arno floods, Italy (1966)
Loma Prieta earthquake, US (1989)
Friuli earthquake, Italy (1976)
4.1
1.9
1.0
0.6
1.9
2.6
0.4
3.0
0.3
3.7
1.9‡
2.8
0.3
9.3
0.3
0.6
3.6
2.7
0.2
1.7
Economic loss, as % of GDP in year of disaster
Sources: Munich Re; IMF; World Bank; The Economist
*Provisional †Insured loss unavailable ‡Soviet Union's estimated GDP



人　口：国勢調査（国勢調査以前（大正9年以前）はMcEvedy & Jones (1978)による各地域別人口推定値）
死者数：宇佐美龍夫『日本被害地震総覧』東京大学出版会、国立天文台編『理科年表 平成20年』丸善　など

Why it happened?

- Hazards were **extra large**: Mw9.0, run-up 38.9m, since 869
- It was "Beyond expectation **(Soteigai)**": Guinness, 123/959
- "Beyond expectation" was not expected nor prepared which was a violation of **law of living with nature**.

False comfort & Black swan events

- **Law of living with nature**

  However strong structural measures are, more destructive natural hazards will occur. Do not call them "beyond expectation" nor make them a black swan.

  Rare and difficult to predict but very high-impact events (Taleb, 2007)

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Strong amplifier: **Societal Vulnerability** allowed concatenation of disasters to happen

- Absolute dependence on **electricity**, **electronic communication**, network of efficient, massive & long-distance **transportation**.
- **Highly linked and less redundant society** with intra- & international **supply chain** of often irreplaceable high-tech parts or materials in production system.
- **Tohoku** is Japan's **center of high tech manufacturing**
  - Stop of manufacturing key engineering parts

  → Stopped auto & other IC & micro-computer dependent factories that eventually stopped all other factories supporting them

  → Impacts national and world economy

What to do for the future?

- Avoid “beyond expectation” to happen.
  - Prepare for the **probable maximum** (theoretical maximum), not only for the recently observed **historical maximum**.
- Avoid concatenation to happen.
  - **Resistible** key infrastructures (seawalls, traffic roads)
  - **Risk distribution**
    - **redundancy/back-ups** in utilities.
    - **Distributed** production & management system
  - **Emergency response system** for large scale devastating disaster.（**対口支援**）
    - **Prepared mutual help** society (social capital)

Basic Law of Reconstruction
(Passed 20 June 2011)

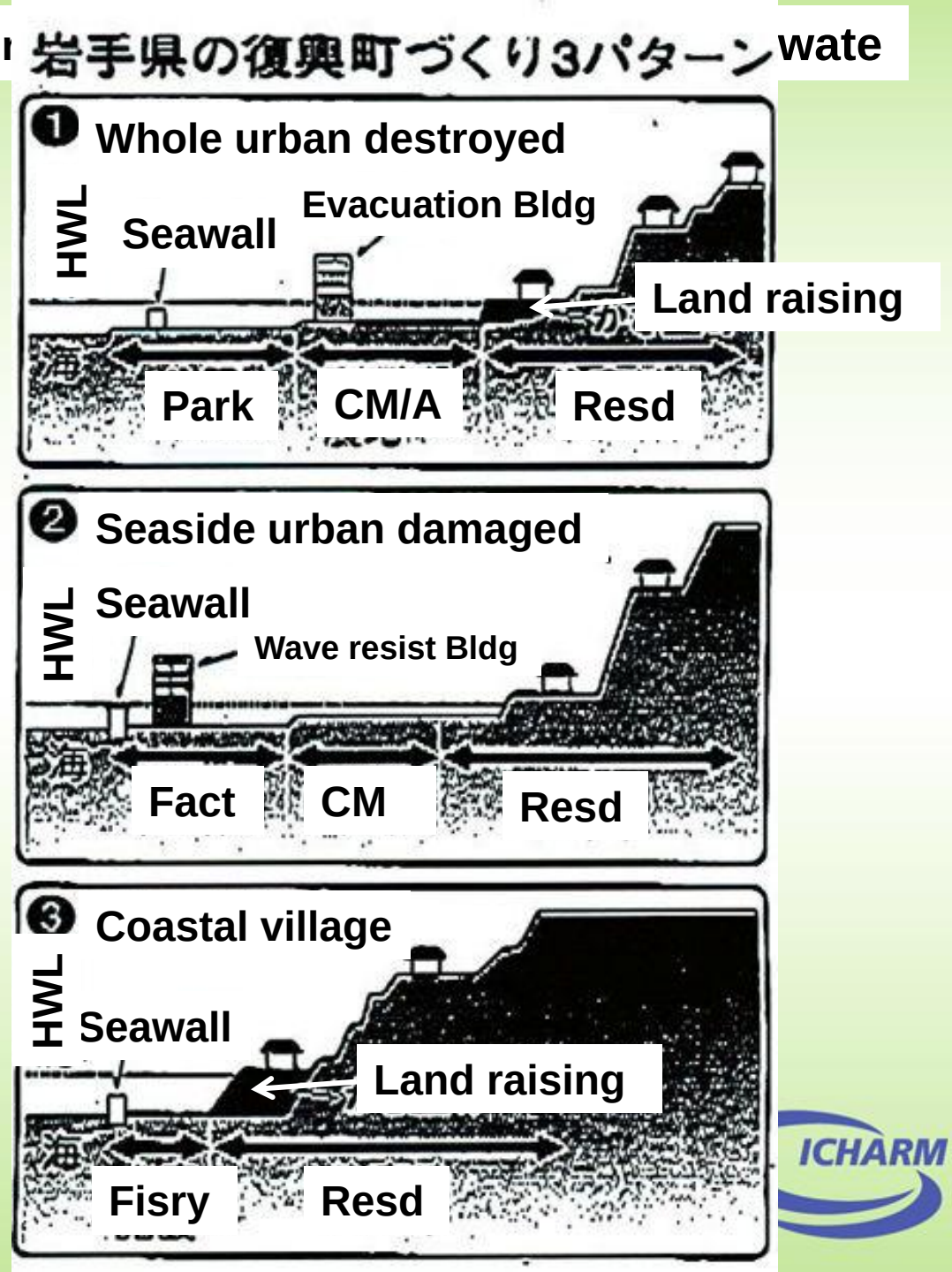
- **Aim:** Lively communities of the mid 21st Century of Japan
- **Secure:** safety, employment, symbiotic society with human bondage
- **Establish:** Reconstruction Bond, National Reconstruction Agency

  - Reconstruct a new way of **living with nature**.
  - → **Triple-loop learning**, 1st coping, 2nd adapting, 3rd transforming

Discussion of reconstruction

Combination of

- Move to higher lands
- Tall buildings to evacuate
- Tsunami dikes, highways: Where & how high to build?
- Landuse (park, factories, farmland, commercial/ business, residential areas)



6 June Hokkaido Shinbun

IRDR

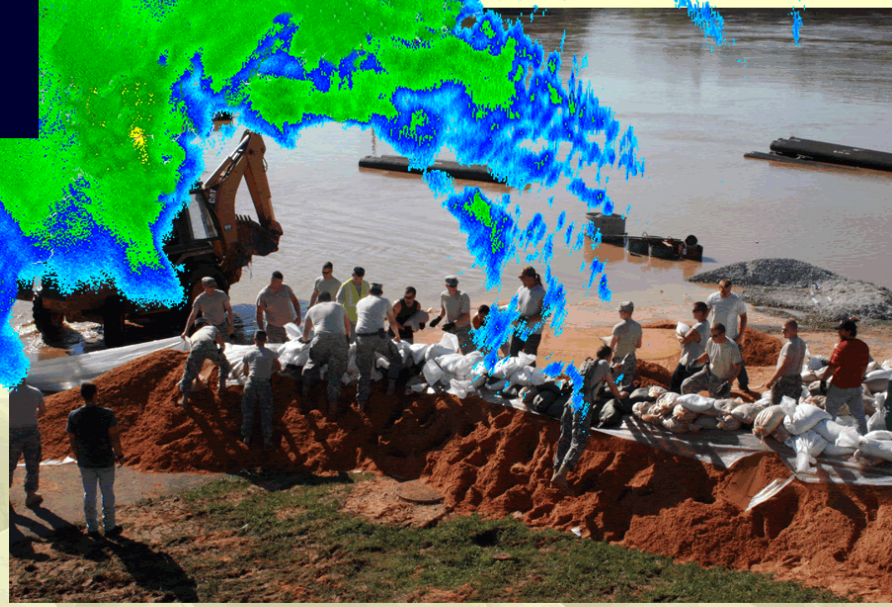
Integrated Research on Disaster Risk

SAVE THE DATE

IRDR Conference 2011

Oct. 31 - Nov. 2, Beijing

www.irdrinternational.org/conference2011



Why, despite advances in the natural and social science of hazards and disasters, do losses continue to increase?

To what extent is the world-wide growth in disaster losses a symptom and indicator of unsustainable development?

ICSU International Council for Science

ISSC international social science council

ISDR

CEODE

Disaster Risk: Integrating Science & Practice