

# Paradigm shift of Japan's tsunami disaster management for enhancing disaster resilience



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Revisit the lessons from the  
2011 Great East Japan  
Earthquake Tsunami disaster

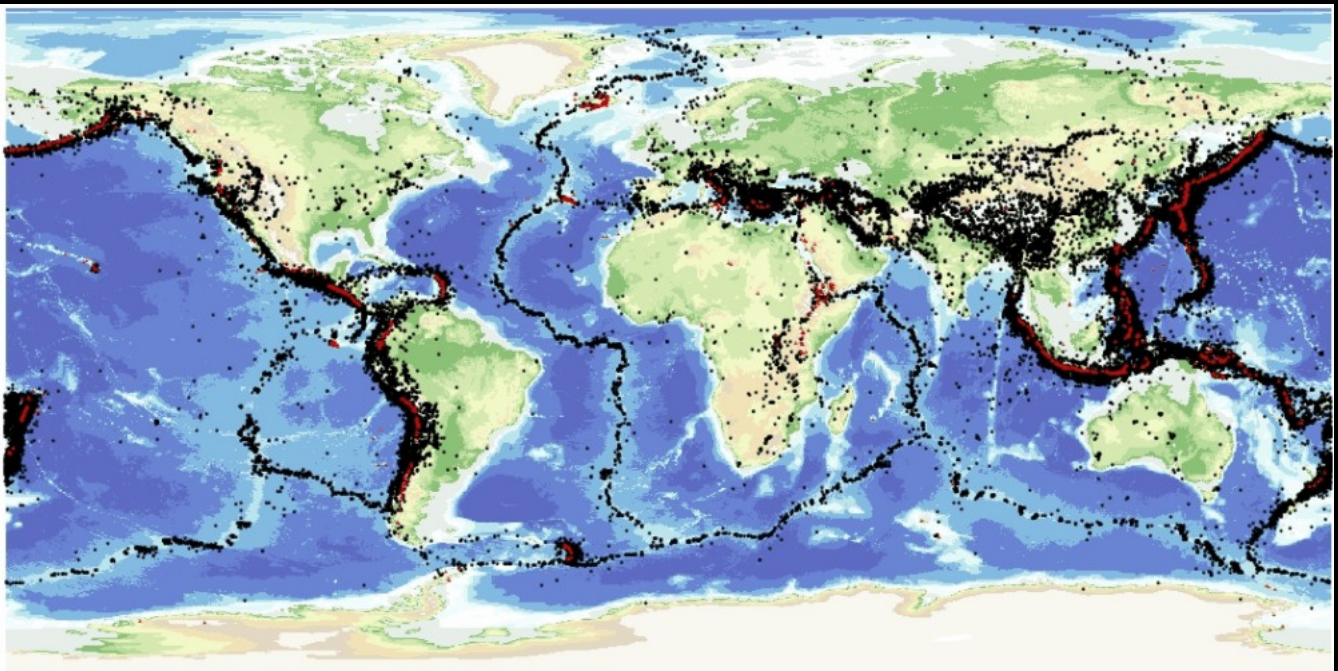
# The 2011 Tohoku Tsunami (NHK)

15:59:24;28

Inundation of 561 km<sup>2</sup> , highest run-up of 40 m  
18,549 fatalities (3 % in the inundation zone)  
120,000 buildings destroyed  
23 mil. tons of debris, 1/2 of annual waste amount  
25 trillion JPY, 1/4 of annual budget (250 billion \$)

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## *Earthquakes in the world*



Source : British Geological Survey

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58  
260,000  
100

5

58 tsunamis  
260,000 deaths  
in 100 years

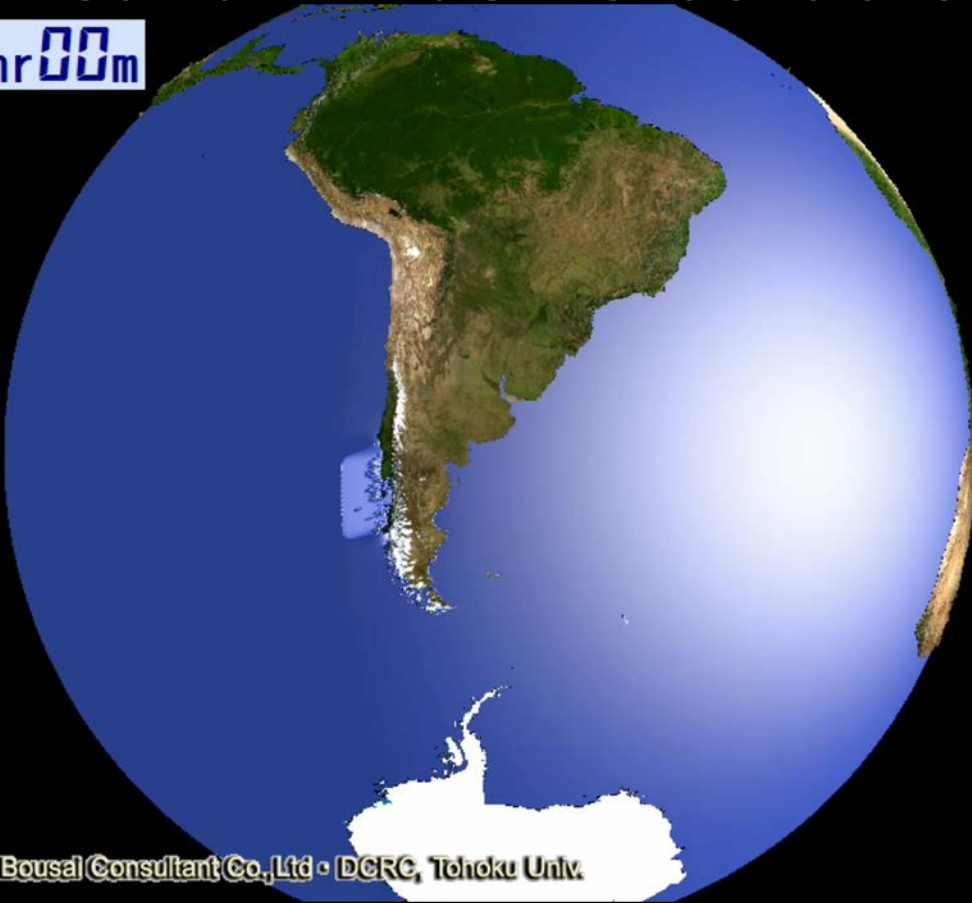
Source : D. Guha-Sapir, R. Below, Ph. Hoyois, EM-DAT

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# *Tsunami has no borders*

0hr00m



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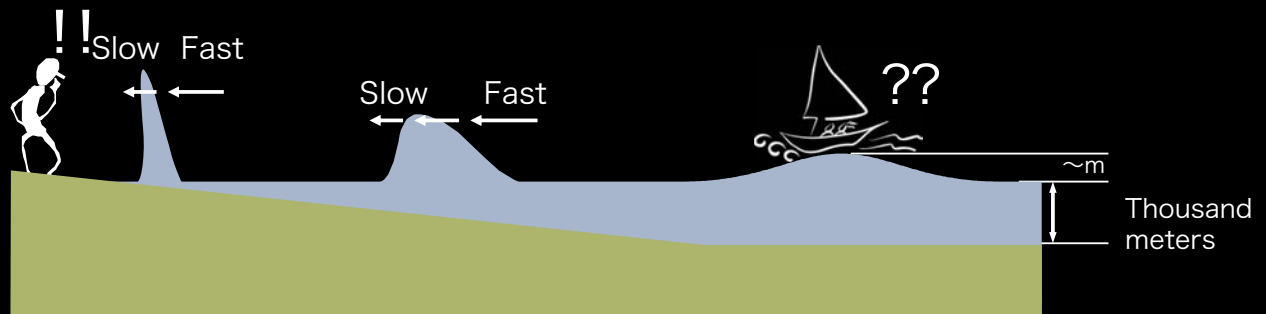
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Big wave and big **tsunami** wave,  
what's the difference ?



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$$\text{Speed of tsunami [m/s]} = \sqrt{9.8 \times \text{Depth [m]}}$$



### Tsunami Speed

Pacific Ocean (h=4000m)	450 mph [Jet plane]
Offshore (h=100m)	70 mph [Car on freeway]
Inside Bay (h=20~30m)	38 mph [Car on road]
On Land (h=5m)	17 mph [Small Motorcycle]

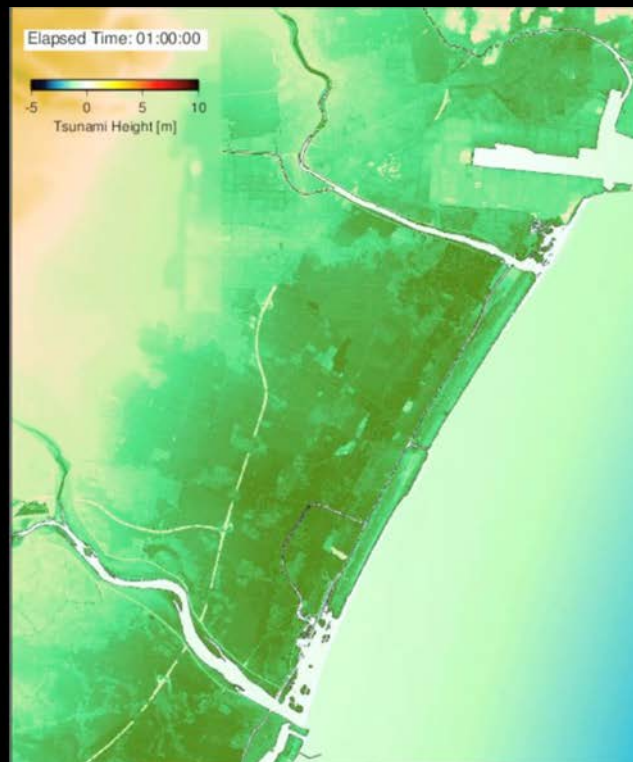
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## Lesson

**NEVER** go to the coast to watch a tsunami.

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# ***The 2011 Tsunami in Sendai***



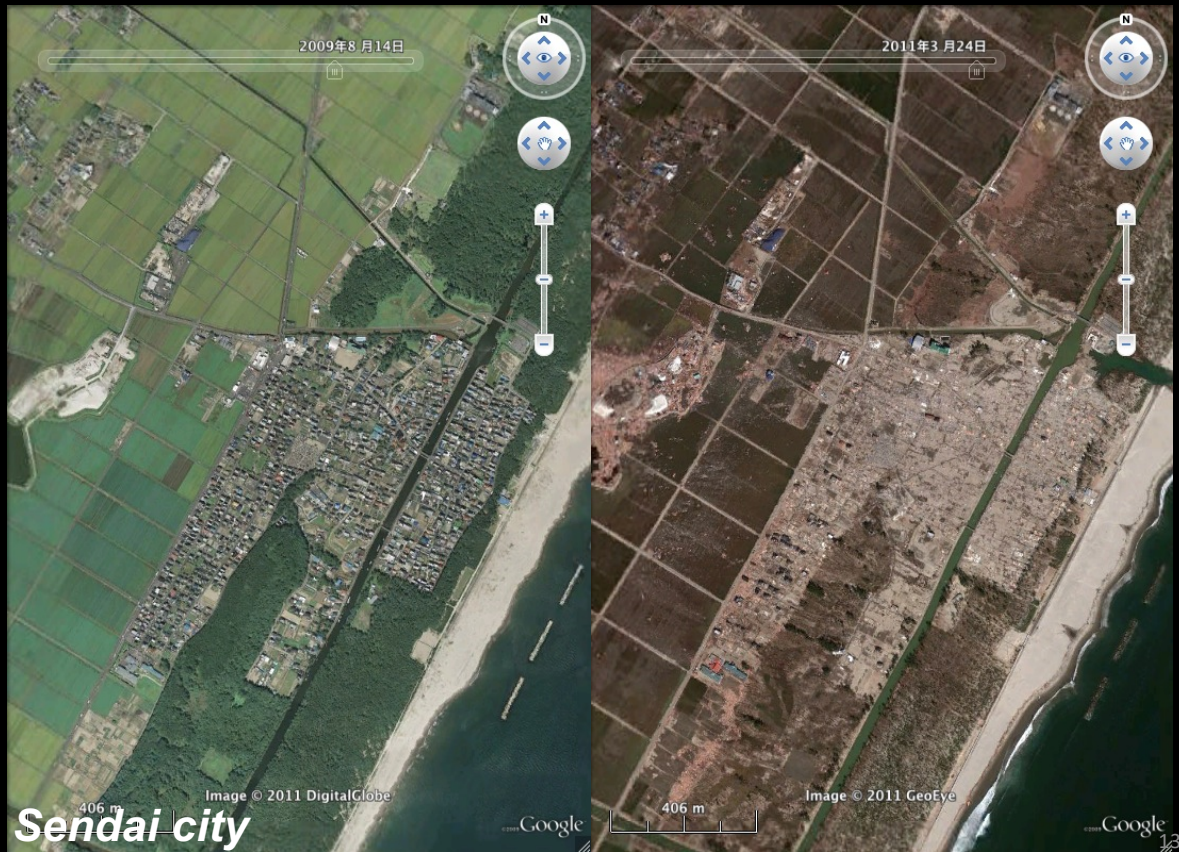
11

***12 March 2011***

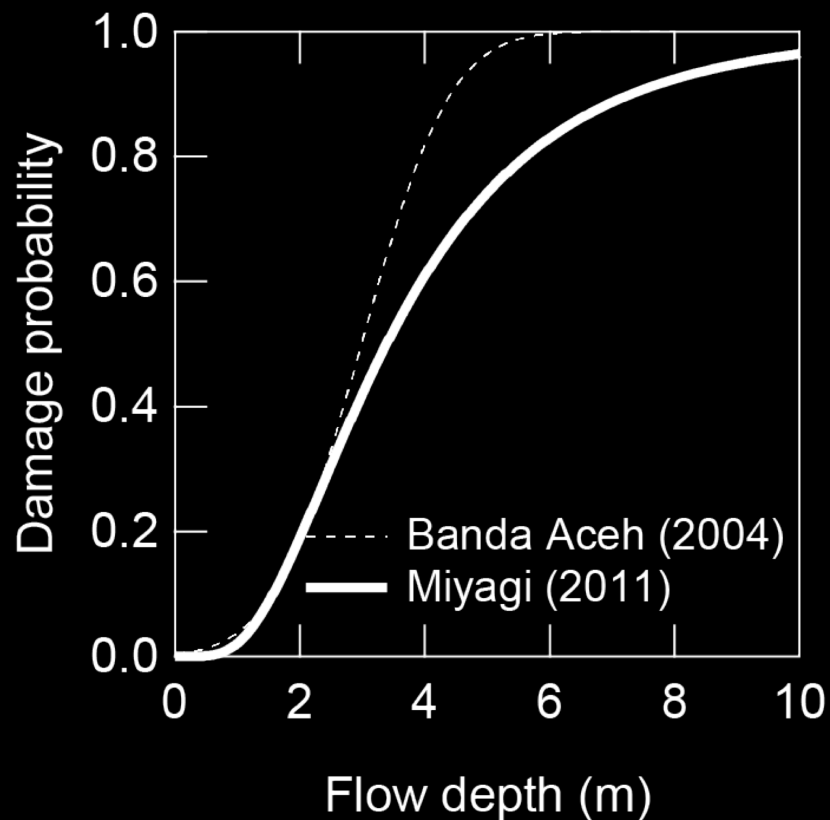




# Devastated coastal communities



## Structural Vulnerability Tsunami Fragility Curve



# Lesson

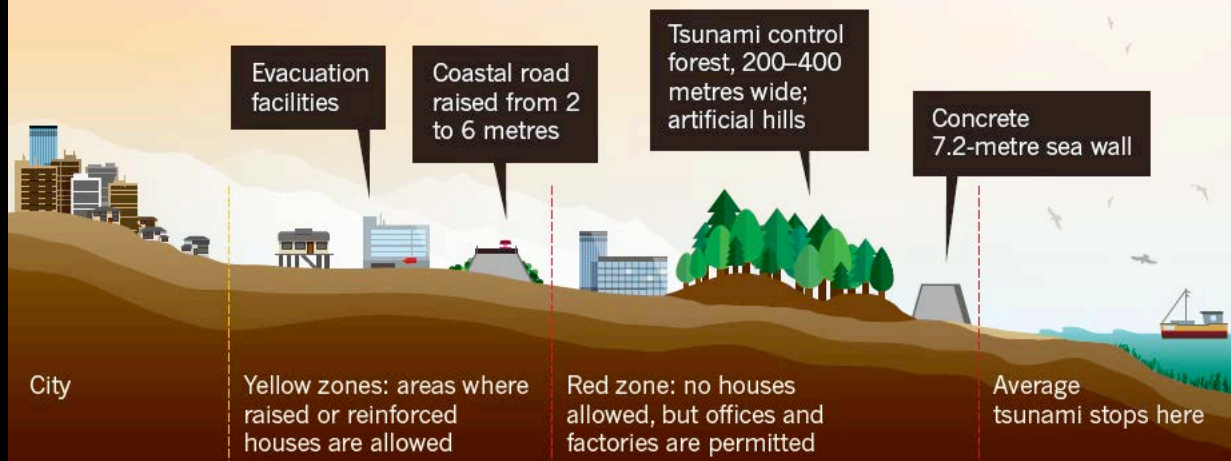
Over 2 m tsunami flow depth potentially causes severe damage on houses or may devastate.

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## *Sendai city's reconstruction plan Multiple protection to minimize losses*

### PLAN FOR A TSUNAMI-RESISTANT CITY

Sendai is considering refashioning its coastal area. A raised sea wall would block typical tsunamis and an elevated coastal road would protect against giant ones. A new law mandating zoning restrictions aims to lower the number of fatalities.



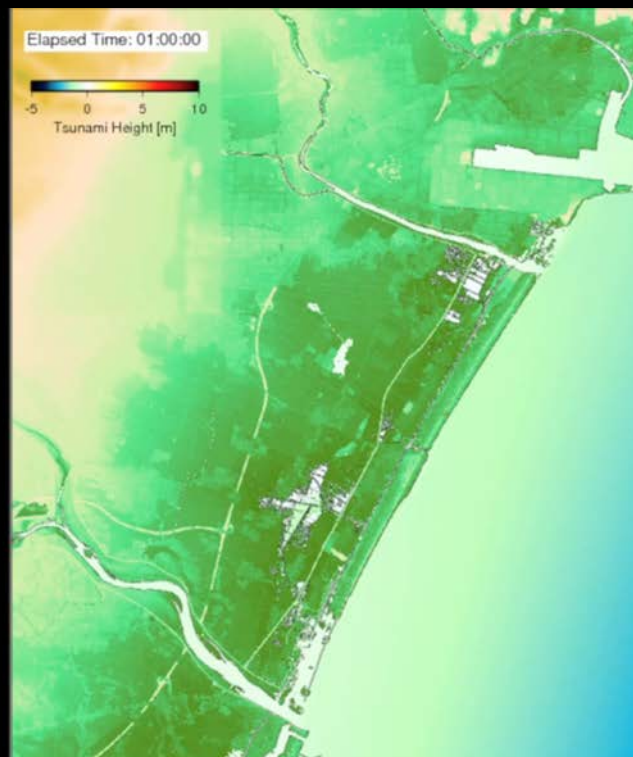
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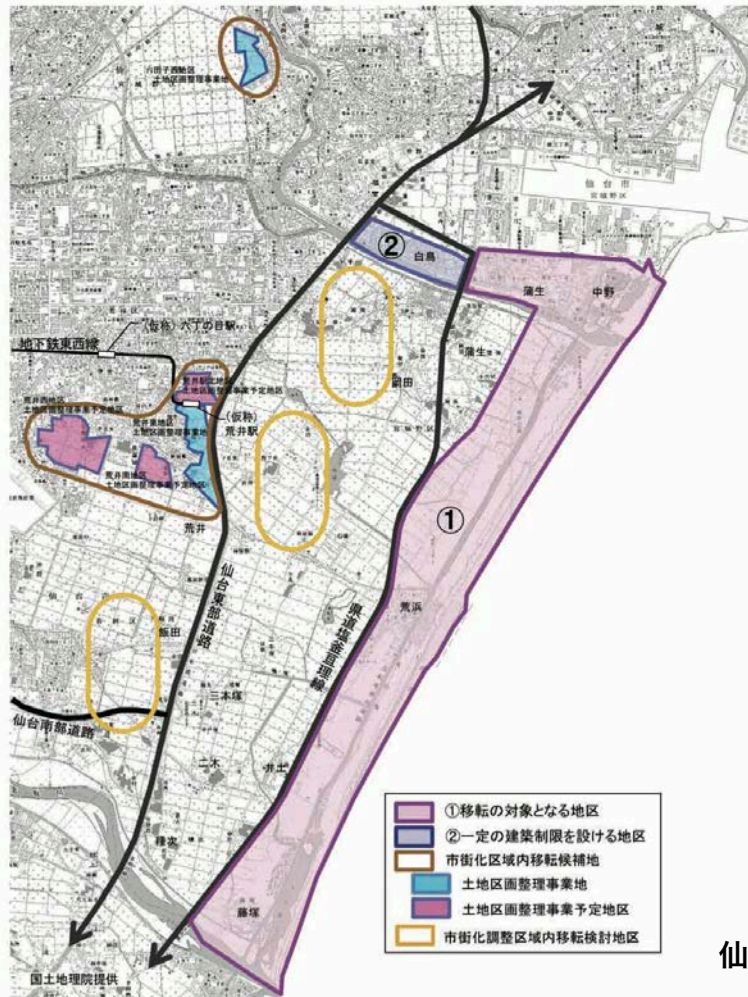


***The prefectural road (10 km) to be elevated  
Height : 6m, Width 30 m  
12 billion JPY (120 million \$)***



***How the multiple protection works ...***





## Land Use Plan (Sendai city)

仙台市

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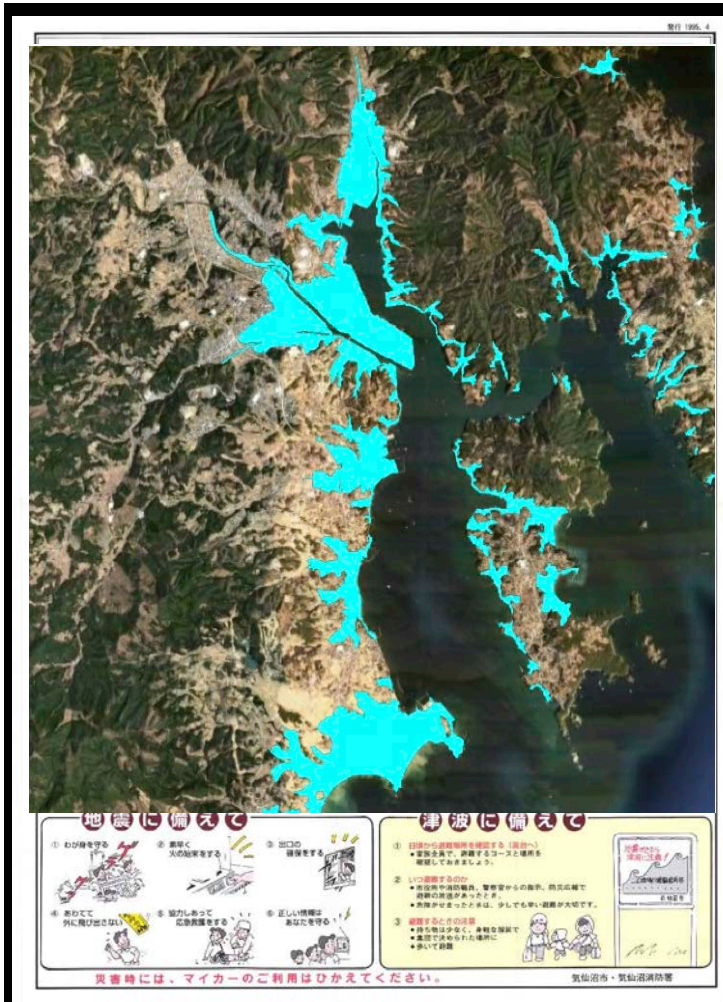
How can we find a safe place ?

Hazard maps/Evacuation maps

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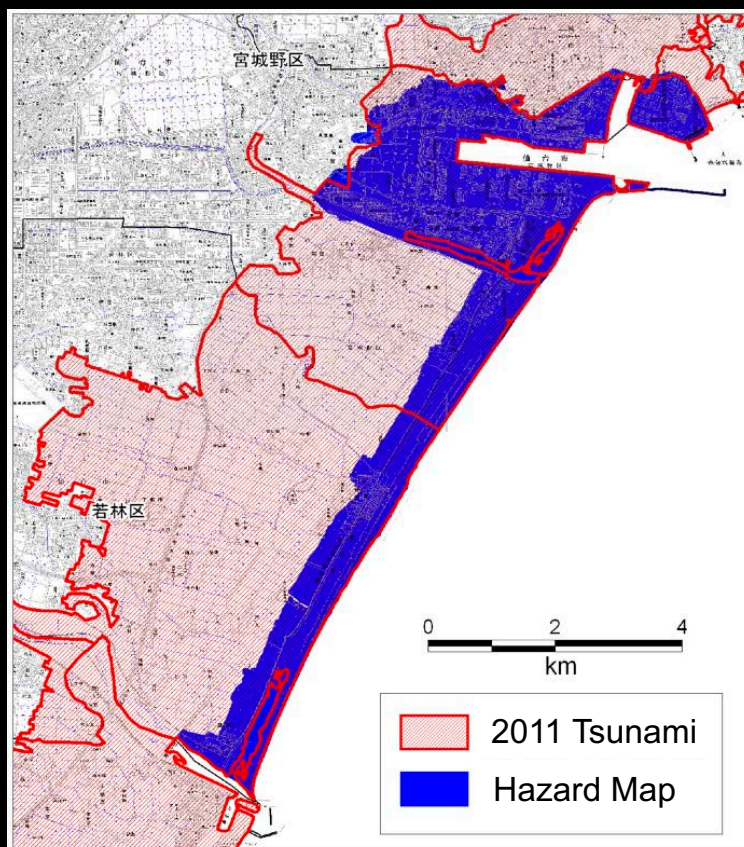
# Kesen-numa Fatality : 1467



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*The tsunami was far more extensive than expected*

# Sendai Fatality : 755



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# Lesson

Hazard maps have two functional aspects ...

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**If you can walk or run, driving is not a good idea**



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# ***Tsunami disaster countermeasures in Japan***

## **1. Coastal protection**

**Building seawalls and break waters to protect life and property**

## **2. Building tsunami-resilient community**

**Urban planning, land use, relocation.**

## **3. Emergency response and preparedness**

**Tsunami warning, evacuation (horizontal and vertical), public education.**

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## ***Tsunami breakwater in Kamaishi***

***Length : 2km, Surface height above sea level : 8m, Width : 20m***



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# Seawalls down



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## *Lesson*

**Even great seawalls can fail.**

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# ***Relocation Kamaishi [Iwate Pref.]***

**The 1933 Showa tsunami**  
(50 days after the event occurred)

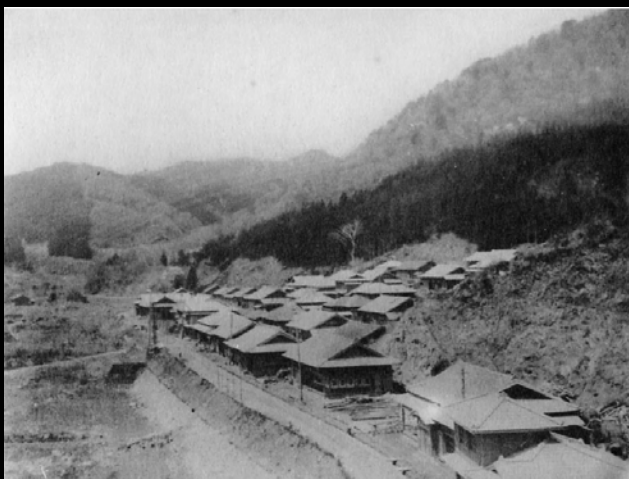
Source : B.E.R.I



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**1934**

**2009**



30

**2011**

2009



31

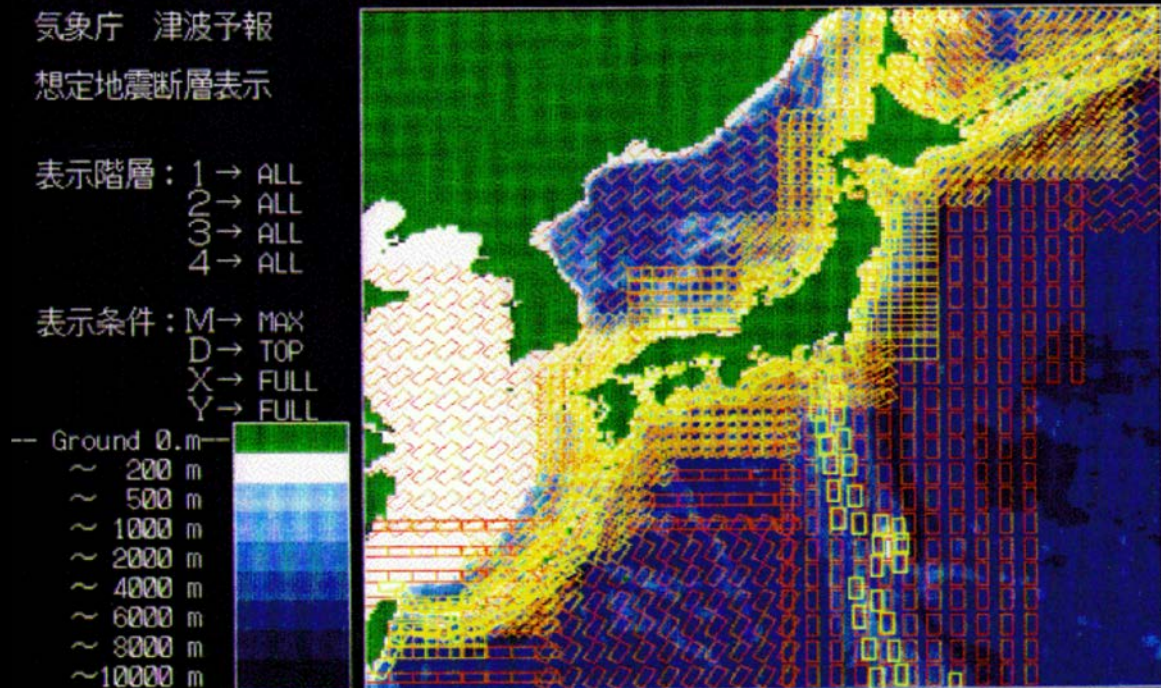
## ***Lesson***

**Tsunami-resilient  
communities NEVER forget  
the memories of disasters.**

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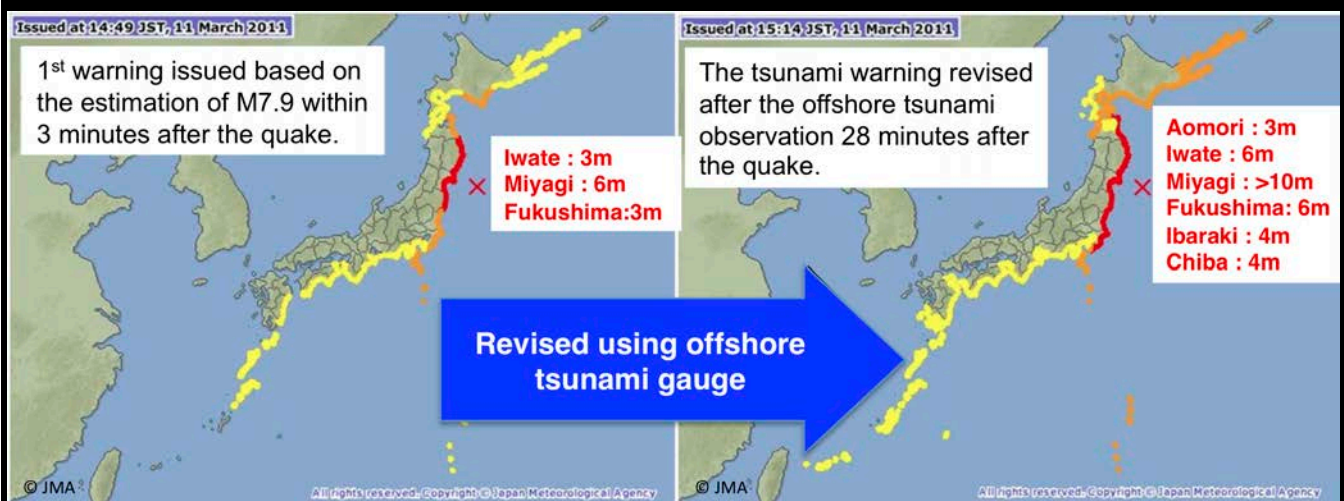
# JMA Tsunami warning ; more than 100,000 cases of pre-computed database



Source : JMA

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# JMA Tsunami warning issued based on 100,000 cases of pre-computed database of tsunami forecasting



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## ***Lesson***

**Still limitations exist on reliability of science and technology used in the limited amount of time.**

**Tsunami warning information is to know we are in danger, but it does NOT guarantee our safety.**

**Do NOT wait for official information.**

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## ***Summary***

- **Knowing risks**
  - Important to know risks but sometimes the nature is beyond our science and technology.
  - Two functional aspects of hazard maps.
  - Computer simulation can NOT predict whole picture of disaster.
- **Structural vulnerability**
  - Even great sea walls can fail.
  - Over 2 m tsunami flow depth potentially causes destruction on houses.

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# *Summary*

- **To survive**
  - Go to higher place as soon as possible. Strong ground shaking is the 1<sup>st</sup>. alert to take action.
  - NEVER go to the coast to watch a tsunami. Otherwise, you must run faster than motorcycles.
  - If you can walk or run, do not use a car.
- **Tsunami warning and information**
  - Increasing the reliability with quick, accurate and robust disseminations system. But limitation exists.
  - Attitude NOT to rely on official information.