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Tsunami Disaster Mitigation in Japan

Lessons learnt from the Great East Japan Earthquake

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The devastating East Japan Earthquake and Tsunami which occurred on March 11,2011 severely impacted the North Pacific Coasts in Japan.

We, especially as researchers related to coastal disaster prevention, have been profoundly moved by the tragic disaster. We would like to express our sincere sympathy to the victims and their families and friends.

Also we would like to thank all of you for your support for the recovery from the disaster.

Do you know the meaning of tsunami?

Tsu = Port
Nami = Wave

Tsunami = Port Wave

Ports are located in sheltered areas from storms, but a tsunami can attack ports easily.

Port areas are usually low lying areas and many people live there, resulting devastating disaster due to tsunami.

Coastal disaster mitigation is one of the major subjects at the Port and Airport Research Institute.

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1. Review of Tsunami Disasters in Japan

Japan was frequently attacked by large tsunamis and after the tsunami disasters the technology for disaster mitigation was developed significantly.

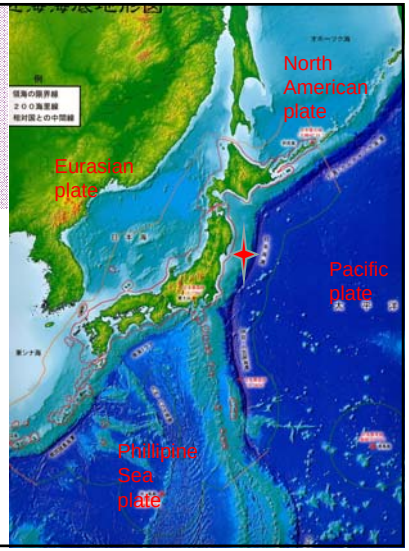
Map of seas surrounding Japan

(Deep Trenches : Subduction Zones)

Epicenter
130km from Sendai

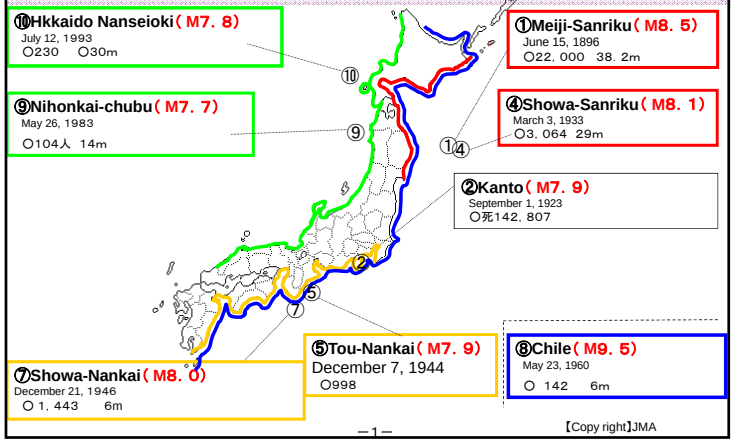
Sanriku Coasts

Tohoku Region
Iwate Prefecture
Miyagi Prefecture
Fukushima Prefecture



Major Tsunamis in Japan(1896-2005)

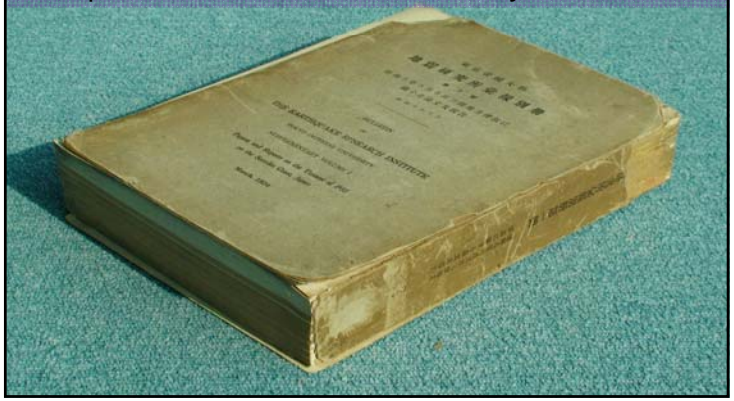
One large tsunami for ten years
One devastating tsunami for one hundred years



Start of Modern Tsunami Research

Report on 1933 Showa Sanriku Tsunami

Earthquake Research Institute, U of Tokyo



What is the most significant difference between Earthquake and Tsunami Attacks?

TIME

We can have a time for evacuation against tsunami attack !
We can reduce the casualty by tsunami into zero by proper evacuation.

Non-structural Countermeasures

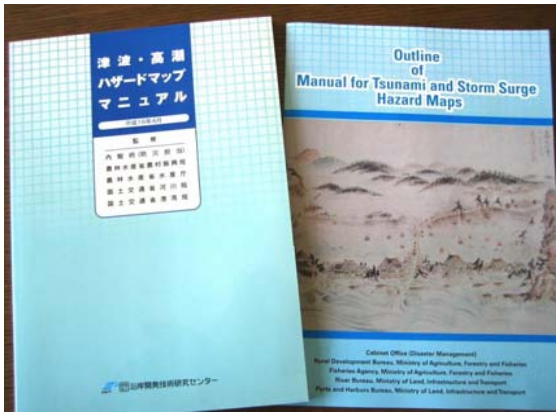
1.Effective Evacuation
@Tsunami Warning System
@ Hazard Map
@ Evacuation Facilities(Building,Tower etc)
2.Dissemination of Tsunami Knowledge
3. Land Usage Planning

Tsunami Warning System

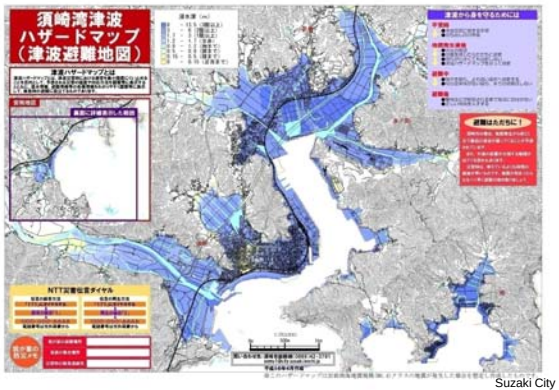
- **Warning**
  - Warning=Large Tsunami(3,4,6,8,10m above)
  - Tsunami (1,2m)
  - Caution=0.5m

· Local Earthquake Tsunami(1954)
· □ New system (1999) JMA
· Tsunami Database
· (100,000 Calculated Tsunamis)
· Within 3 min.
· Distant Earthquake Tsunami(1960)
· □ International Cooperation
· Tsunami Early Warning System

Manual for Tsunami and Storm Surge Hazard Map



Tsunami Hazard Map of Suzaki Bay



Suzaki City

Hazard Map Workshop by All Stakeholders

Other measures for safe evacuation

Seminars and Lectures for disaster education

Installation of Evacuation sign boards

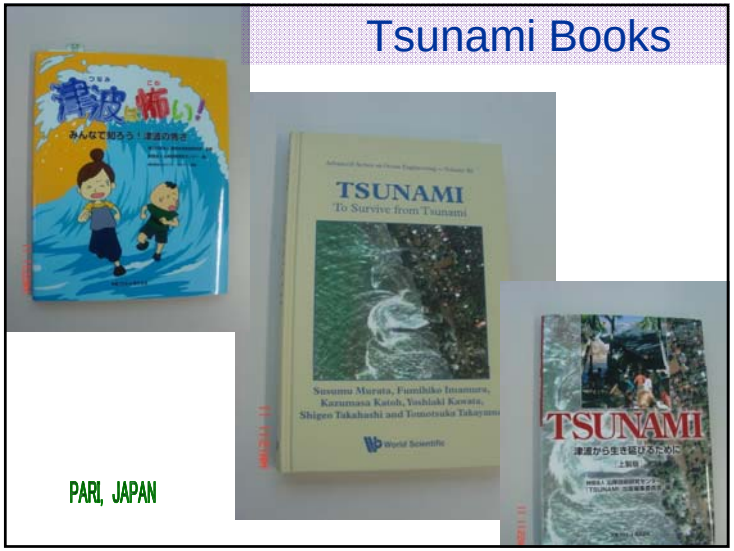
Improvement of evacuation places

Transmission of tsunami experiences

Preparation of evacuation buildings

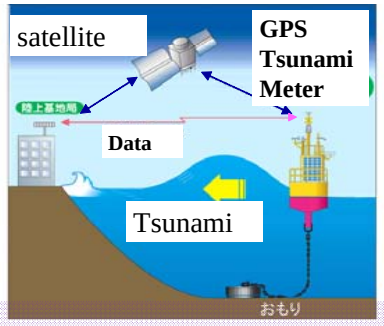
Improvement of evacuation routes

Tsunami Books



PARI, JAPAN

GPS Buoy (Wave andTsunami Meter)



Observe a tsunami in offshore 10 min. before its attack.

Structural Countermeasures

- Tsunami Seawalls
- Tsunami Dike
- Tsunami Breakwater
- Tsunami Gate
- Artificial High Ground
-

Tsunami Seawall

12.8m seawall at Funakoshi bay in yamada-town

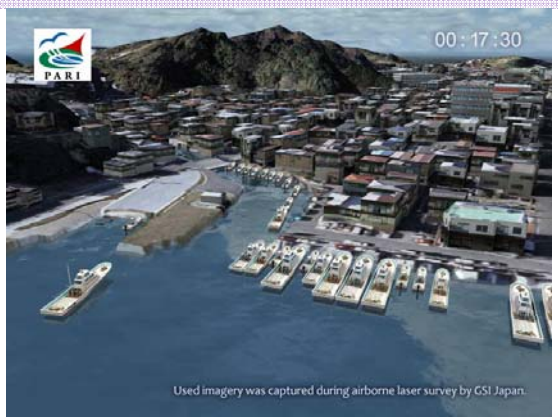
Tsunami Gate near Hirokawa Town

PARI, JAPAN

Studies on Tsunami
Experiment on Wooden House Destruction

A video of Experiment on Falling Down of Human Body by Tsunami

Simulation of Tsunami intrusion into a port town



Disaster mitigation starts from people's understanding of the disaster.

The people in the Sanriku Coasts were relatively well-prepared for the tsunami but the tsunami caused a devastating disaster.

Why?

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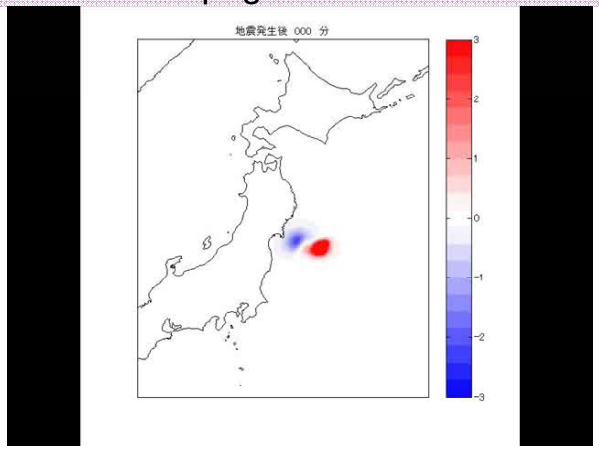
2. 2011Earthquake and Tsunami Disaster

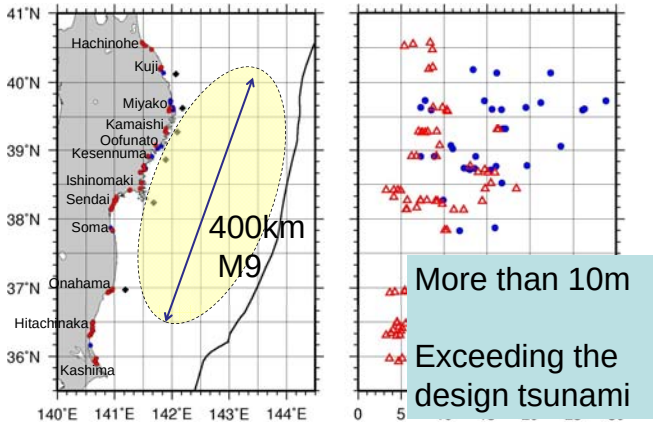
The tsunami exceeded significantly the design tsunami causing very large casualties.

We could not prepare for the worst case!

Numerical Simulation of Generation and Propagation of Tsunami



Rapture area and Measured Tsunami height



10m Tsunami Causes all types of the tsunami damages.

It destroyed all the town including tsunami defenses

General	Destruction and washed-away of houses
	Drift and crash of cars
	Fires
	Destruction of tanks and oil spill
	Destruction of Railways, roads and bridges
	subsidance of ground
	Inundation of rice paddles
Ports and Coasts	Drifting and collision of ships
	Destruction and inundation of port faciliteis
	Drifting and collision of timbers and containers
	Debris deposit in ports
	Scouring and deposit in ports
	Scouring of sandy beaches and destruction of green belts
	Destruction of acuaculture facilities
Coastal Defenses	Scouring and sliding of Breakwaters and quaywalls
	Destruction of jetties and detached breakwaters
	Destruction (scouring) of Dykes and Seawalls
	Destruction of water gates

Tsunami Damages on People and Houses

Total Inundated area 535km^2

Population in the Inundated area (600,000)

Dead and missing people 20,000

Total Damaged Houses (completely) 120,000
(partially) 100,000

･Rikuzen-Takada

Rikuzen-Takada

Rikuzen-Takada(Video by Iwate Prefectural Police)

Kamaishi port

Tsunami at Kamaishi (a video by MLITT)

Fires at Kesen-numa

Drifted Oil Tank (Kesen-numa)

Stranded Cargo Vessel (Kamaishi)

Stranded Fishery Boat (Kesen-numa)

Drifted Containers (Sendai Port)

Concrete Apartment Buildings at Rikuzen-Takada

- Inundated but Remained

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3. Lessons Learnt from the Disaster

We are now discussing the Improvement of Tsunami Preparedness

People criticize the government not to prepare for the worst case.

We are reviewing the tsunami disaster and discussing the future countermeasures in many government committees :

1. Central Disaster Management Council of Cabinet Office :
   Tsunami Disaster Prevention Committee
2. Ministry of Land, Infrastructure, Transport and Tourism:
   Tsunami Disaster Prevention Committee
3. Local Governments:
   Recovery and Reconstruction Committees

Preparedness for future tsunami disaster

Preparedness for the worst case

Level 1 tsunami and Level 2 tsunami (Disaster prevention and Mitigation)

Early Warning and Evacuation

- Observation of Tsunami in offshore using GPS buoys
- Secure and reliable warning systems in consideration of blackout
- Vertical evacuation with high buildings

Urban Planning of Tsunami Prone Areas (Resilient Coastal Towns)

- No-built zones (House Relocation)
- Higher grounds
- Concrete houses
- Tall apartments and high business buildings

Hambantota, Sri Lanka, 2004 Indian Ocean Tsunami M9.1 , 22.000 casualties

1952 Kamchatka M9.0
1960 Chile M9.5 1964 Alaska M9.2

Recently we had huge tsunamis and storms which exceeded our design level.

We have to consider the worst case to mitigate the disaster.

We need the worst case scenario.

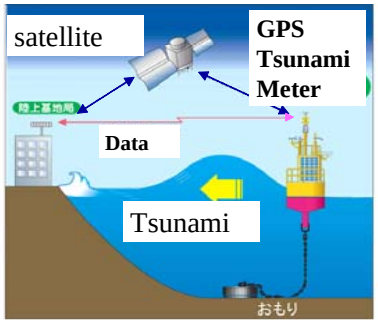
Performance design for tsunami disaster mitigation

	Design tsunami	Required performance
Level 1 Tsunami	Largest tsunami in modern times (return period: around **100** years)	**Disaster Prevention** • To protect human lives • To protect properties • To protect economic activities
Level 2 Tsunami	One of the largest tsunamis in history (return period: around **1000** years)	**Disaster Mitigation** • To protect human lives • To reduce economic loss, especially by preventing the occurrence of severe secondary disasters and by enabling prompt recovery

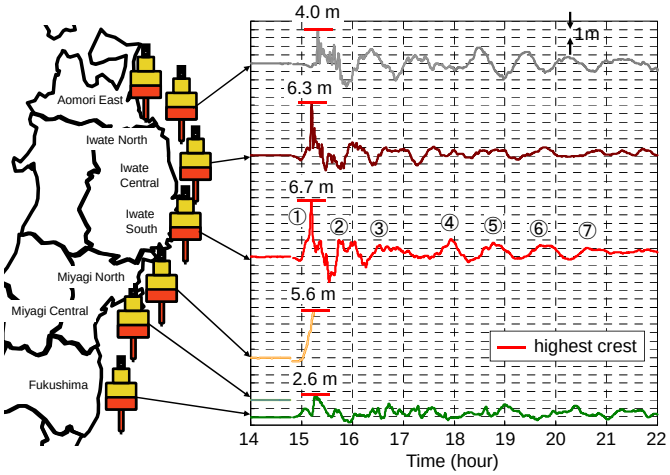
We are now making the worst case scenarios.

GPS Wave (Tsunami) buoy

12 buoys 20km off the coasts at a depth of about 200m



GPS wave buoys measured the tsunami.

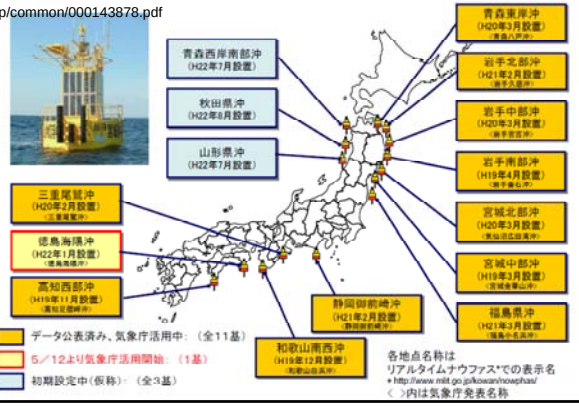


Improvement Tsunami Warning

More accurate tsunami prediction

Offshore Tsunami Observation Using GPS Buoys

http://www.mlit.go.jp/common/000143878.pdf



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Improvement of Evacuation

Not Horizontal but Vertical Evacuation

5 Minutes Evacuation by Emergency Refuge High Buildings

Modern concrete buildings were inundated but remained.

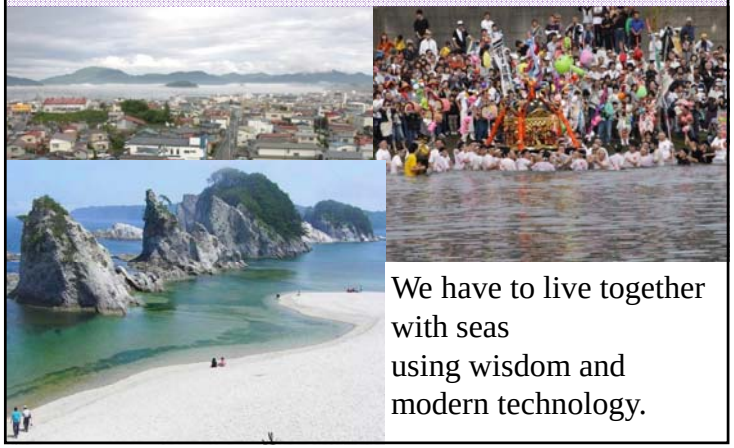
Resilient Coastal Towns

Early Recovery by Disaster Reduction(Mitigation)

Compact Town using High Buildings and House Relocation

We learned harsh nature of seas this time

But we all know richness of seas.



We have to live together with seas using wisdom and modern technology.

Storm Waves and Their Overtopping

Tsunami Wave and Overtopping

Tsunami is long and therefore, powerful

International Workshop on Coastal Disaster Prevention


Summary of the 4th International Workshop on Coastal Disaster Prevention (Direction of tsunami disaster mitigation)

1. The primary objective of disaster management is to save human lives. Additionally, disaster management is critical for mitigating damages to property and society especially from tsunamis and storm surges. Providing the most effective prevention and management demands that governments use the best existing technology and science available. All countries in the Asia-Pacific region are affected by tsunamis and storm surges and they should work together through international cooperation and collaboration to provide the best disaster management and risk mitigation possible with existing technology and science.

Summary of the 4th International Workshop on Coastal Disaster Prevention (Direction of tsunami disaster mitigation)

2. Although basic tools for disaster management are available, it is imperative that we, researchers, scientists and engineers, should develop more advanced technology, not only to reduce the casualties but to maintain the people's activities (to continue their business activities) more effectively and economically. Prediction is key to the effec-tive evacuation and prevention of losses. International cooperation and collabora-tion including sociologists are needed to develop and use the technology effectively.

Summary of the 4th International Workshop on Coastal Disaster Prevention (Direction of tsunami disaster mitigation)

3. To provide the best service to the people of the Asia-Pacific region, we need to enhance disaster preparedness with holistic and resilient disaster mitigation measures. It is no longer acceptable to consider disaster management on a local scale, our vision must extend across the horizon. Solutions to mitigation must be resilient and robust. Participation by people is fundamental to effective disaster preparedness and post-disaster management. Dissemination of the knowledge and cooperation with people at all levels is especially important.

Thank you for your kind attention.