EAS Congress 2015
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DANANG CITY, VIETNAM
NOVEMBER 16 - 21

Date : 18 Nov., 2015
Venue : Furama Ballroom 1

SESSION 1 : A Decade of Partnerships in Sustainable Development of the Seas of East Asia: Synergies and Achievements
WORKSHOP 1.1 : Managing Risks in Climate Change and Disasters in the Seas of East Asia

Post-tsunami Recovery of Port and Harbor areas in Japan from the 2011 Great East Japan Earthquake Tsunami

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N I L I M

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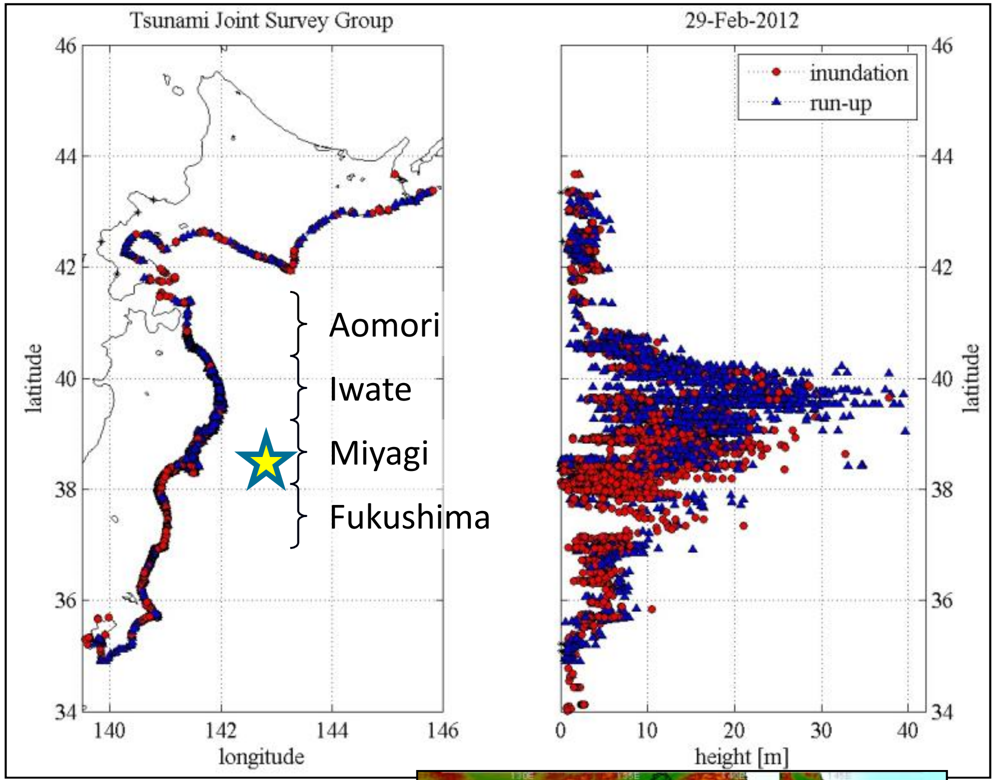
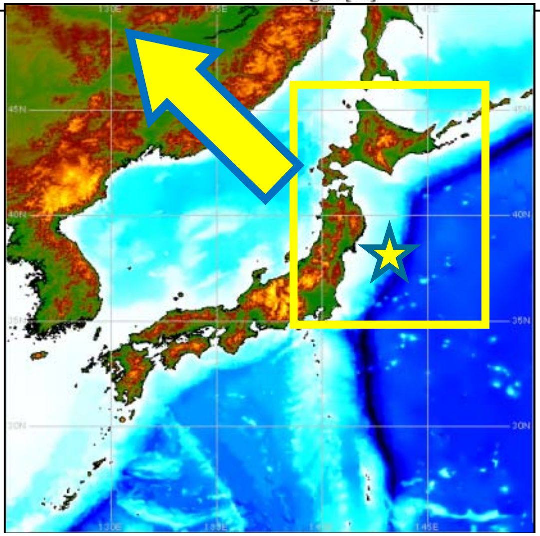
2011 Great East Japan Earthquake Disaster

[Earthquake]
Time : 14:46 JST,11 March 2011
Length : 500km
Width : 200km
Mw : 9.0
The greatest earthquake ever recorded in Japan

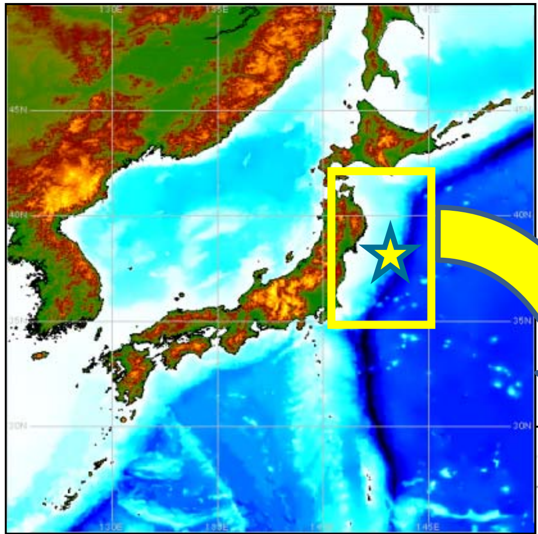
[Tsunami]
The earthquake generated large tsunami source offshore.
Tsunami tends to be larger in ria coast areas than in normal ones. Ria coast areas extend in Miyagi and Iwate.





Prefecture	dead	missing	*total*
Iwate	4,673	1,126	*5,799*
Miyagi	9,541	1,237	*10,778*
Fukushima	1,612	200	*1,812*
others	67	4	*71*
total	*15,893*	*2,567*	*18,460*

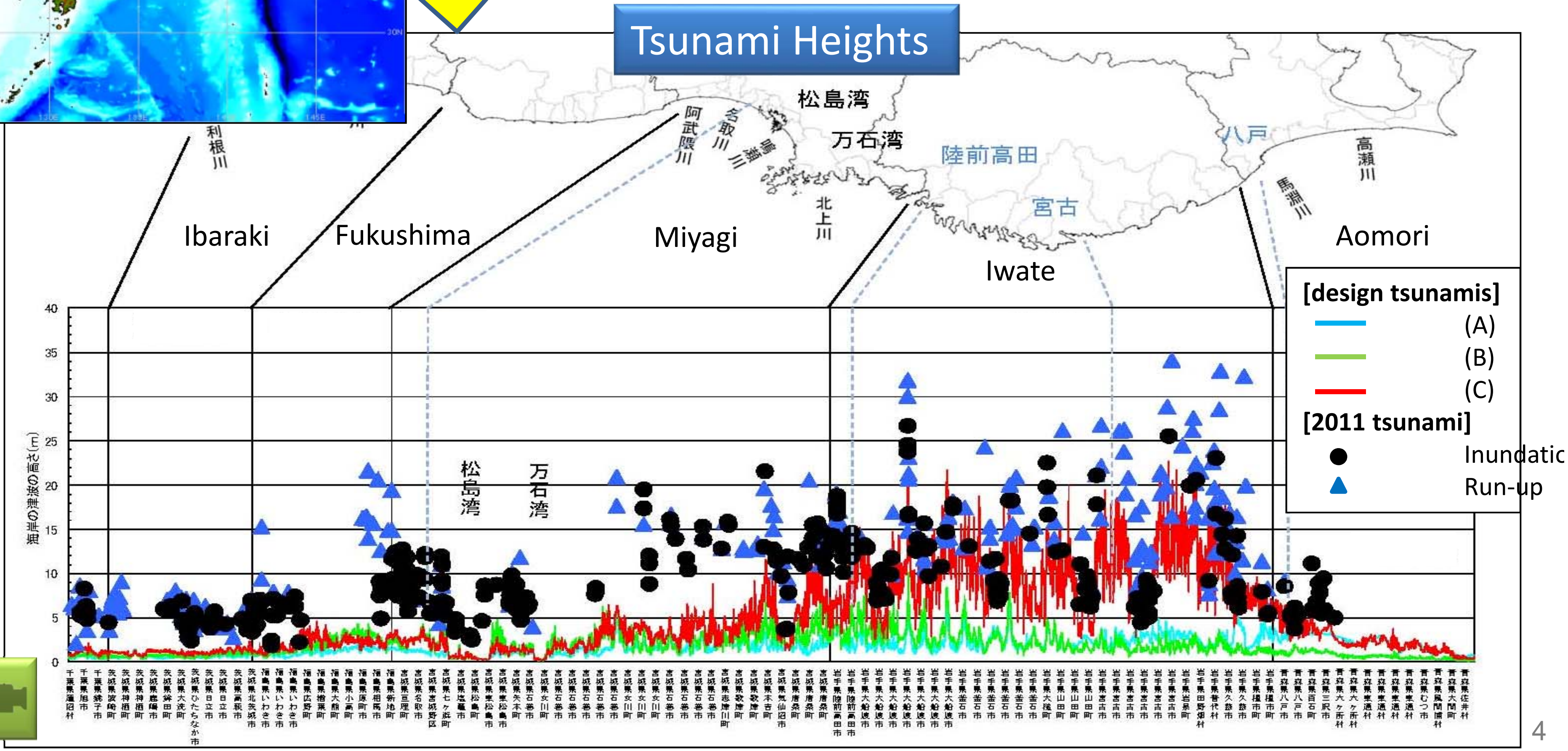
2011 Great East Japan Earthquake Disaster



The 2011 tsunami significantly exceeded the design tsunamis: approx. 2-5 times.

[three kinds of design tsunami in Tohoku Region until 2011]

(A) The off Northern Sanriku Earthquake
(B) The off Miyagi Earthquake
(C) Meiji-Sanriku Earthquake type



Damage and Recovery of Ports and Harbors

Port Facilities

Tilted breakwater

Collapsed coastal dike

Drifted cargo vessel (4,724GT, Length=97m, Drift=7.2m)

Inundation Depth : 6-8m

- **Severe damage to port facilities:** breakwaters, coastal dikes, berthing facilities, warehouses, cargo handling equipment, etc...
- **Sedimentation, and sunk or drifting obstacles in waterways:** Containers, cars, etc.

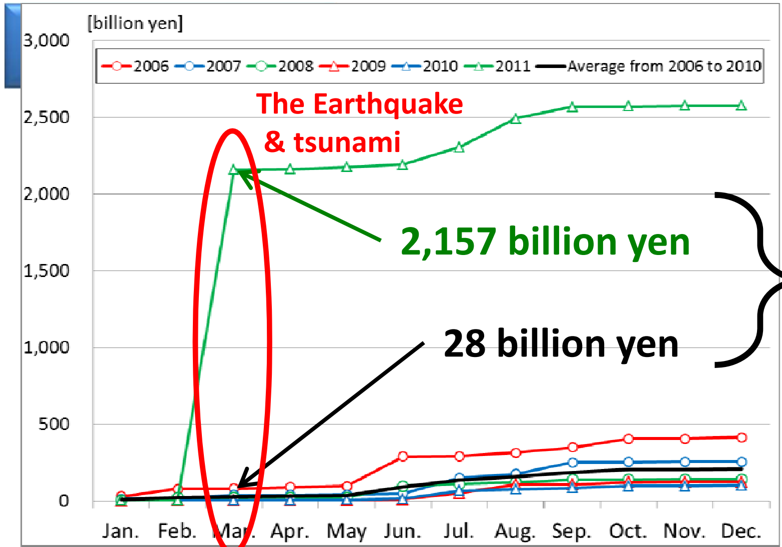
Operation of the disaster-affected ports disrupted severely.

Damaged warehouse

Sunk car

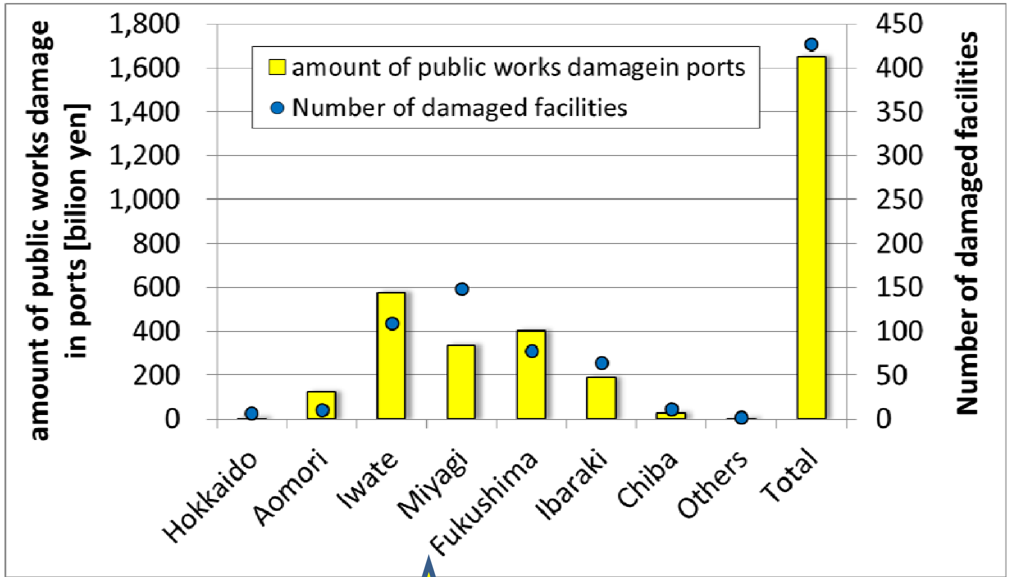
Sunk container

Damage and Recovery of Ports and Harbors



Monthly accumulated public works damages

Public works damages:
2,129 billion yen
= 0.4% of Japan's GDP



North ← Epicenter → South

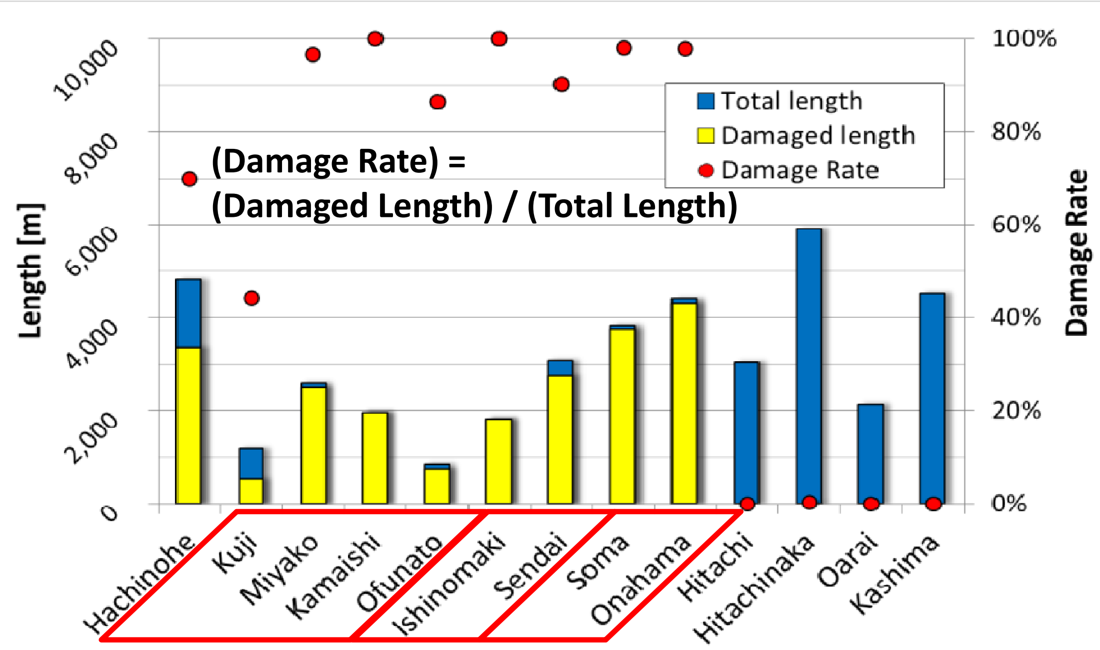
Port public works damages

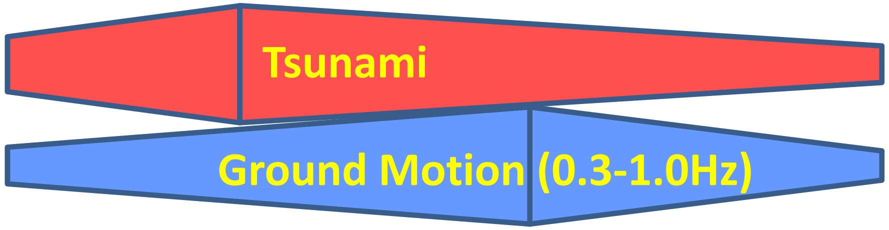
Port public works damages :
413 billion yen
= 20% of public works damages

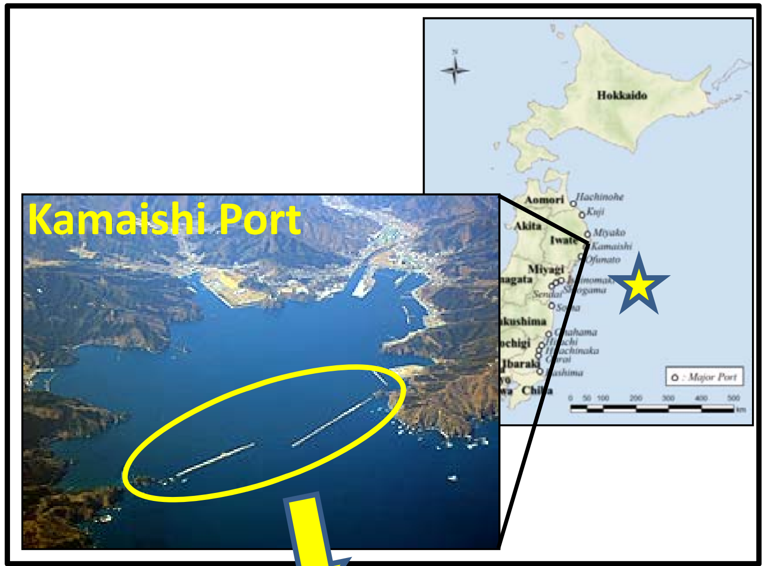
Damage and Recovery of Ports and Harbors

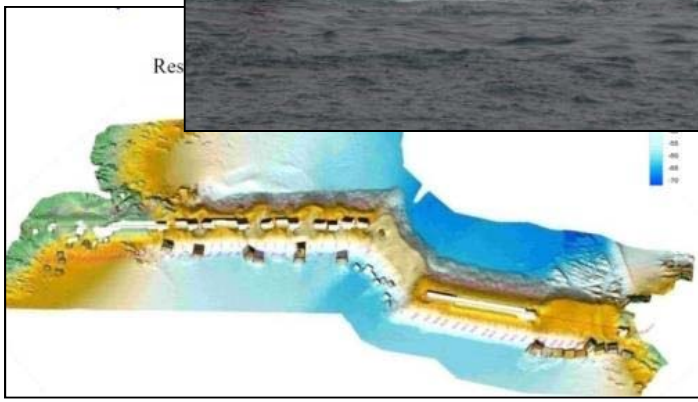
Port Facilities

Front-line Breakwaters









"Damage" includes ...

- caused by **ground motion** & **tsunami**
- **serious** (caisson) & **slight** (armor material)

Damage and Recovery of Ports and Harbors

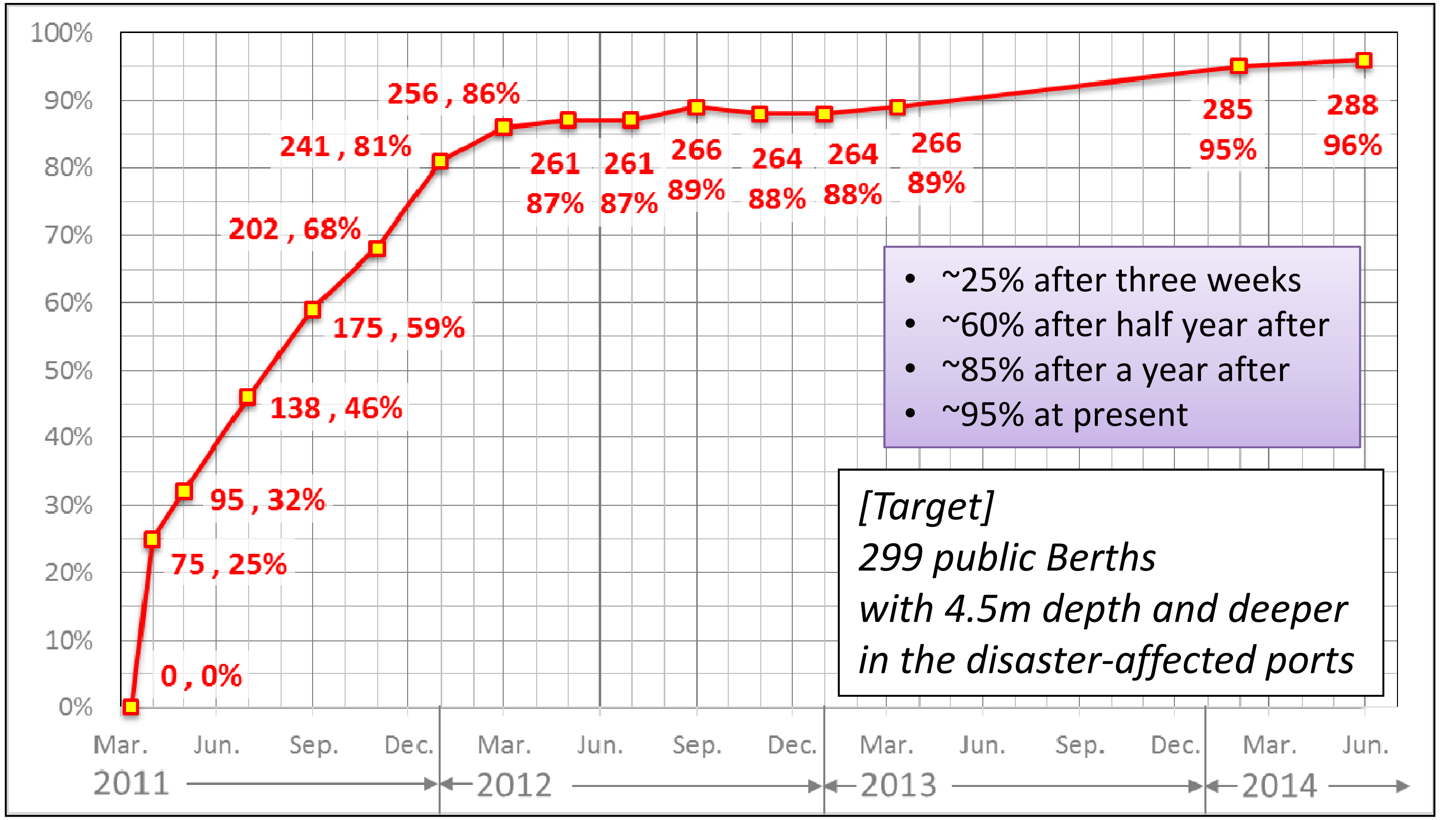
Port Facilities

Damage of berths

- Damaged berthing facilities
- Sunk or drifting obstacles in waterways
- Sedimentation
- Land subsidence due to co-seismic deformation

Response

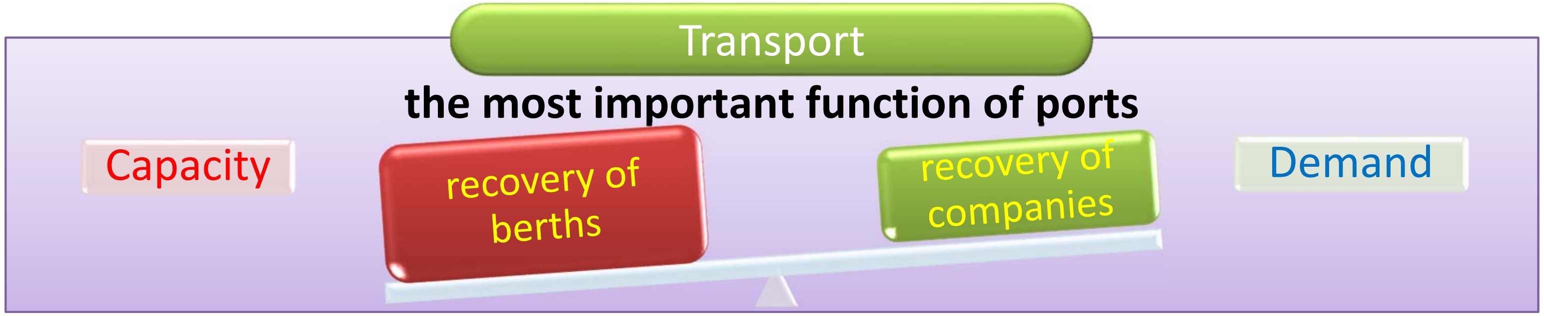
- Removing obstacles
- Temporary limitations:
  - draft restriction for vessel
  - loading limitation on berth
- Restoration, Reconstruction

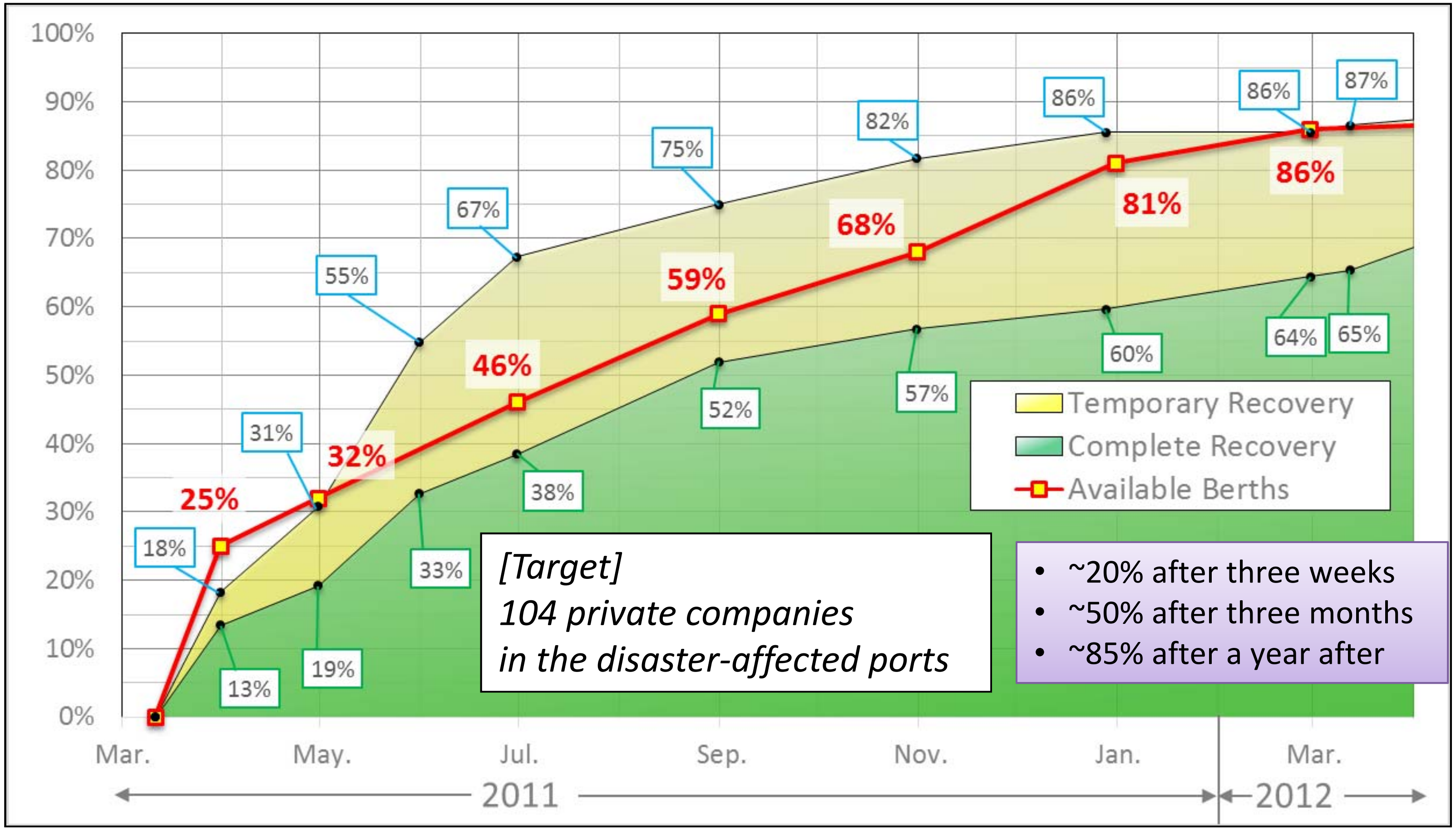


Number and Rate of Available Public Berths (including berths available temporarily)

Damage and Recovery of Ports and Harbors

Port Function





- ~20% after three weeks
- ~50% after three months
- ~85% after a year after

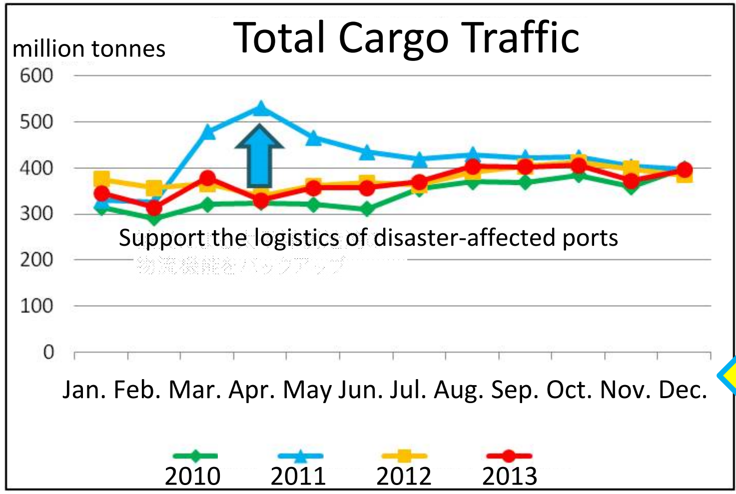
Recovery Rate of Private Companies in Ports & Rate of Available Public Berths

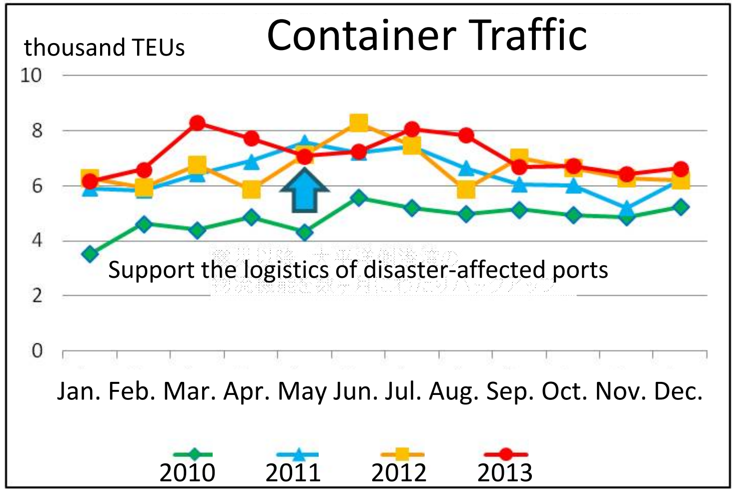
Damage and Recovery of Ports and Harbors

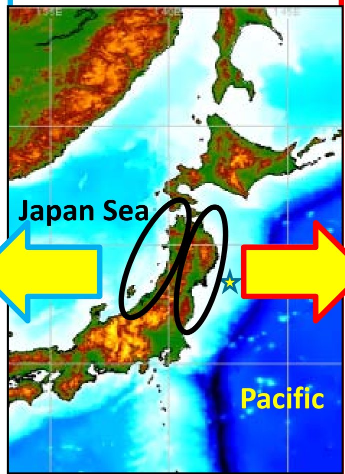
Port Function

- **The Cargo traffic of disaster-affected ports had been significantly decreased** immediately after the disaster, and **was almost recovered after a year**.
- The transport function of disaster-affected ports had been **supported by the other ports**.

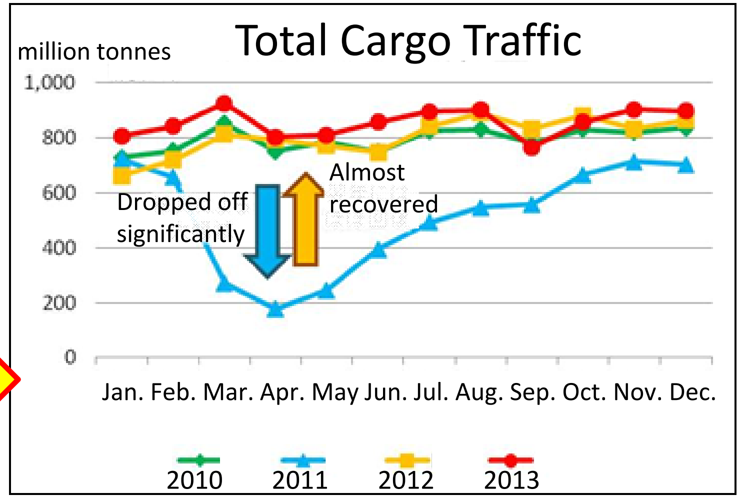
Ports on the Japan Sea Coast

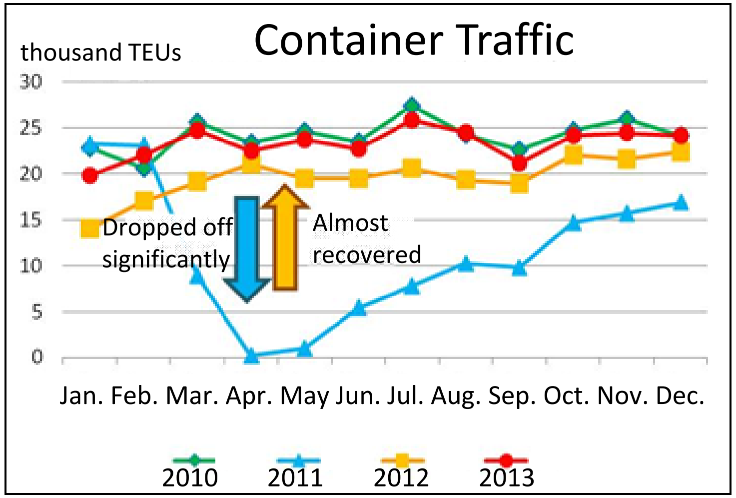






Disaster-affected Ports





Lessons Learnt from the 2011 Event

Worst Case Scenario

Tsunami Disaster in 2011

[Conventional Tsunami Disaster Management]
Single tsunami level

[Performance Design Scheme]
Two or three tsunami levels
Each level is based on each scenario including the worst case.

	Design tsunami	Required performance
Level 1 Tsunami	**Larger tsunamis** • Occurring frequently • Causing major damage **(return period: ~100 years)**	**Disaster Prevention** • **To protect human lives** • To protect assets • To stabilize economic activities • To secure industrial bases
Level 2 Tsunami	**Largest-possible tsunamis** • Extreme low possibility • Devastating **(return period: ~1,000 years)**	**Disaster Mitigation** • **To protect human lives** • To reduce economic loss: especially by ✓ preventing severe damage ✓ enhancing prompt recovery

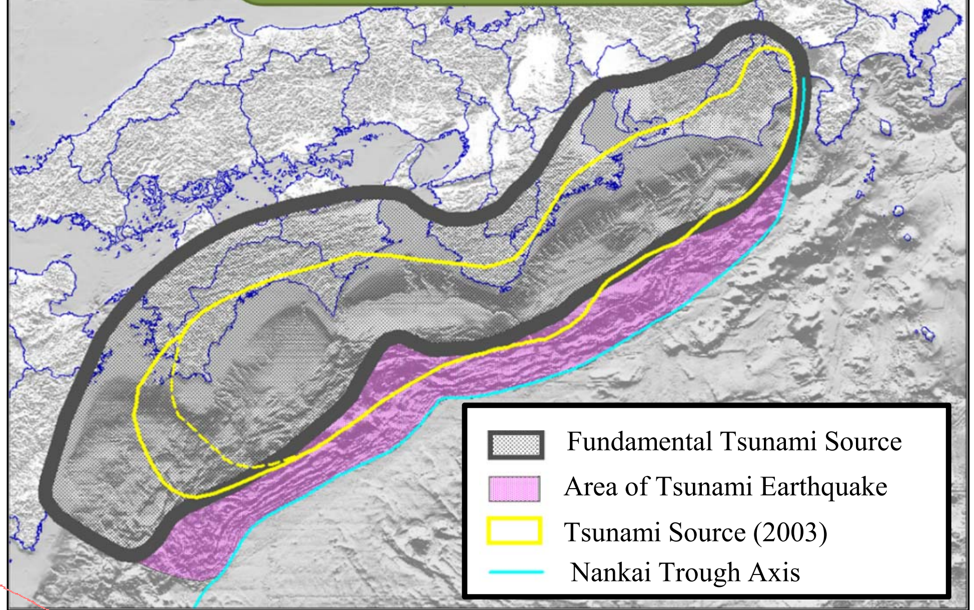
Level 2 tsunami is the worst case.
We are now making the worst case scenarios for each coastal areas.

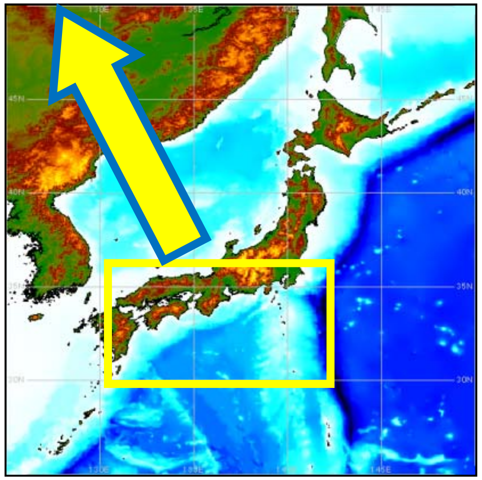
Lessons Learnt from the 2011 Event

Worst Case Scenario

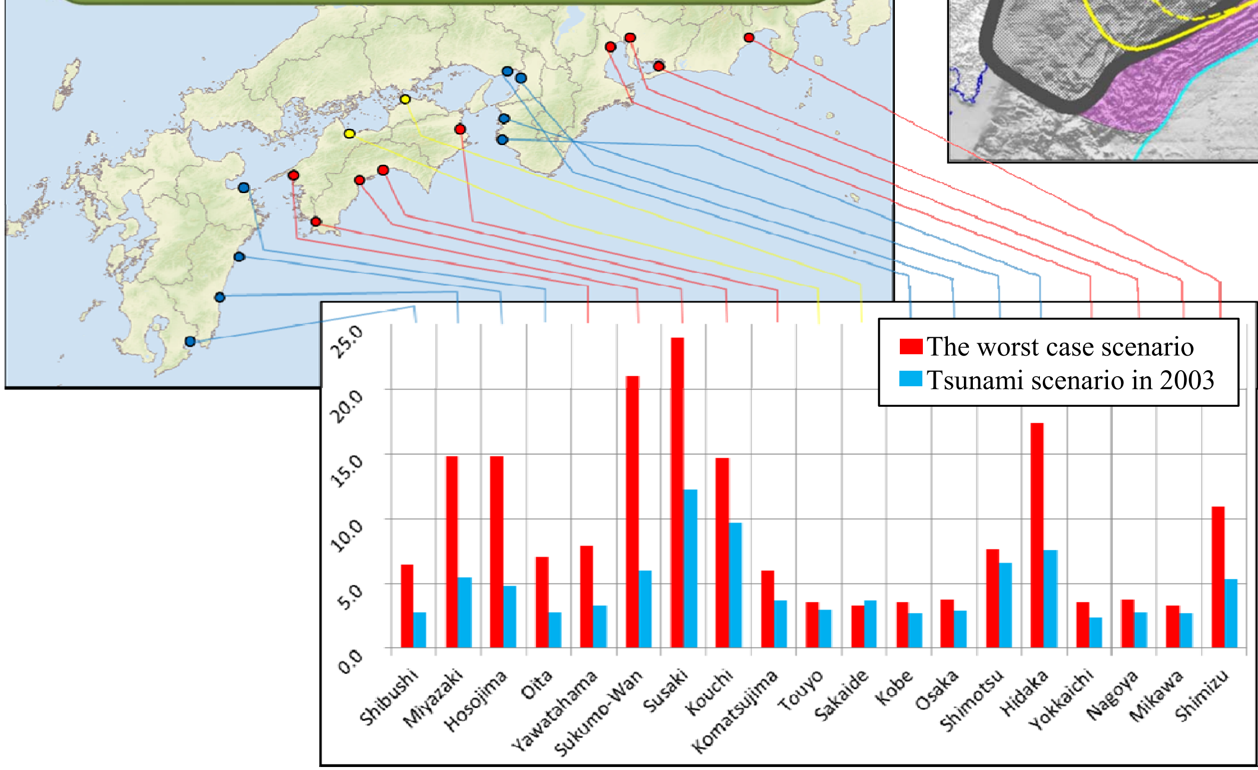
[Nankai Trough Earthquake Tsunami]
Tsunami scenario had been assumed in 2003, and was revised as the worst case after the 2011 event.

The Worst Case Scenario





Tsunami Heights due to the Scenarios



Lessons Learnt from the 2011 Event

Resilient Coastal Communities

Safe Evacuation + **Damage Mitigation** = **Early Recovery = Resilience**

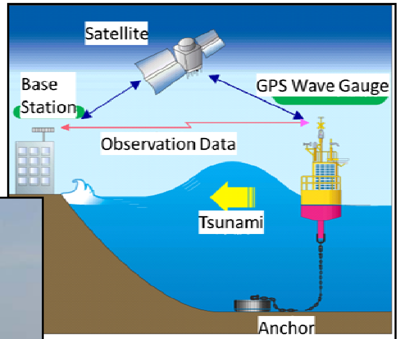
Extending the lead time for evacuation

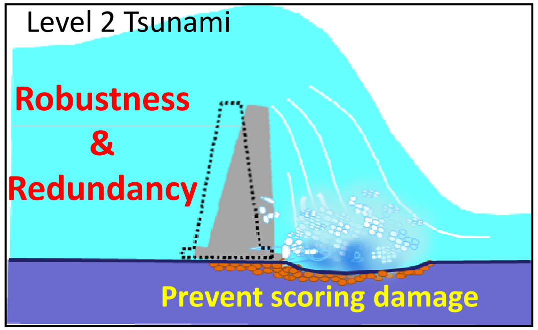
Efficient evacuation

- **Coastal protection facilities**
  - Robustness, Redundancy
- **Multi-layer protection system**
  - Coastal protection facilities
  - Transportation infrastructures: Raised roads etc.

- **Facilities of public organization**
  - National and local government
  - Hospital, Power companies, etc.
  - To be built in areas with low risk or improvement
- **City planning**
  - Link to disaster prevention plans

- **Warning delivery system**
  - Multiplex: mobile phones, TV, etc.
- **Offshore observation system**
  - Accuracy of tsunami prediction
- **Evacuation buildings and sites**
  - Vertical evacuation
- **Raising disaster awareness**
  - Hazard maps, Education





Lessons Learnt from the 2011 Event

Port-BCP

Ports are important for transport.

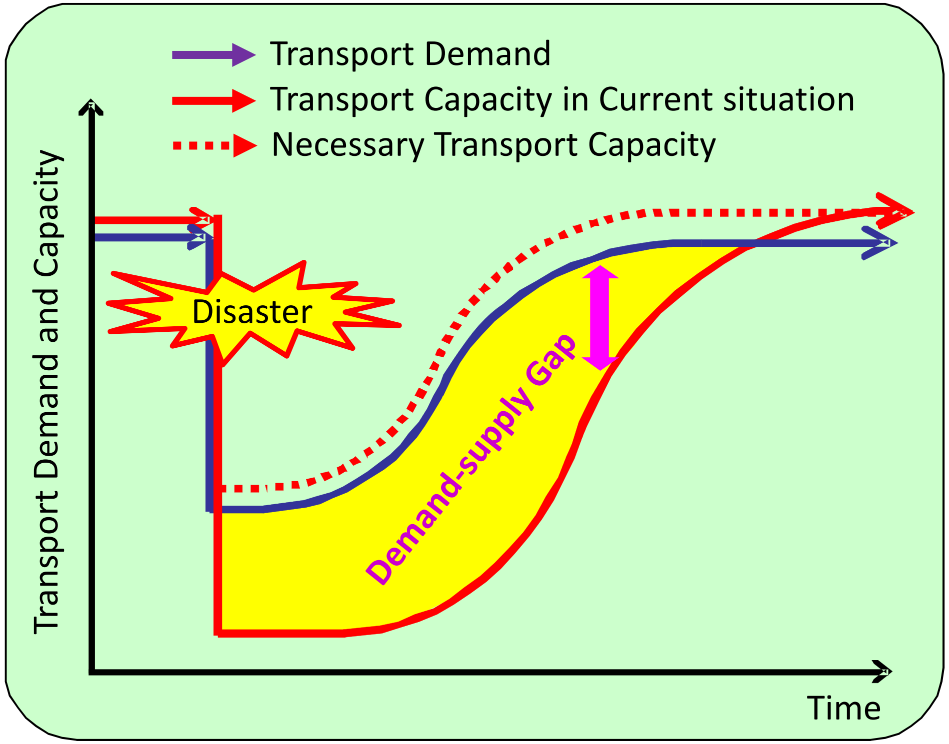
Short Term : Emergency Supplies (foods, water, etc.)

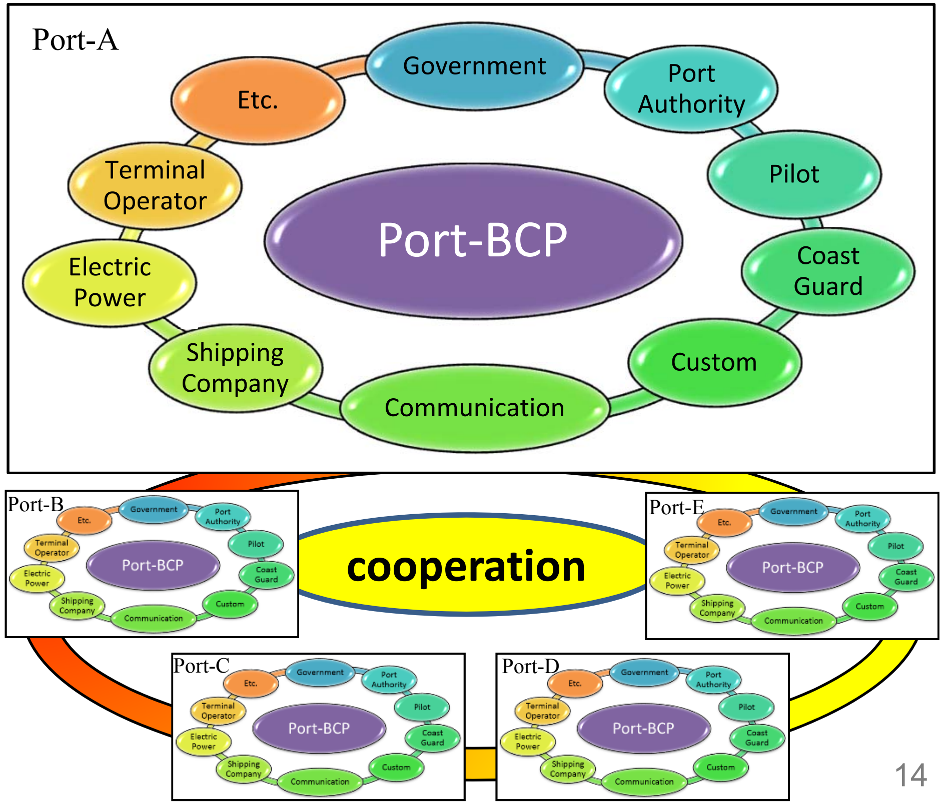
Middle Term : Industrial Supplies (general cargo)
Construction Materials

Port Business Continuity Plan (Port-BCP)

- **Several scenarios**
- Transport-demand curve for each scenario
- Eliminate "Transport Demand-Supply Gap"
  [Transport capacity] > [Transport demand]

- Port-BCP is based on the BCPs of some sectors.
  - Many port-related sectors
- Cooperation of Port-BCPs
  - **Alternative ports** for severe scenario





Concluding remarks

- The 2011 Great East Japan Earthquake Tsunami was much larger than the design tsunamis, and caused severe damage to the Pacific coast of Tohoku Region.
- It is necessary to design several tsunami levels with different scenarios including the worst case scenario.
- There are some measures to make coastal communities, including ports, resilient: vertical evacuation, early warning system with offshore tsunami observation, and preparedness for early recovery.
- Port-BCP (Business Continuity Plan) is a measure to ensure early recovery of ports.

THE EAST ASIAN SEAS CONGRESS
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Thank you for your kind attention.

I'd like to express my sincere sympathy
to the victims, their families, and their friends
due to the 2011 Great East Japan Earthquake Tsunami.

Ministry of Land, Infrastructure, Transport and Tourism

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