# Lessons learned from the Great East Japan Earthquake

## -Concerning road network system-

April 2013 Bali Indonesia

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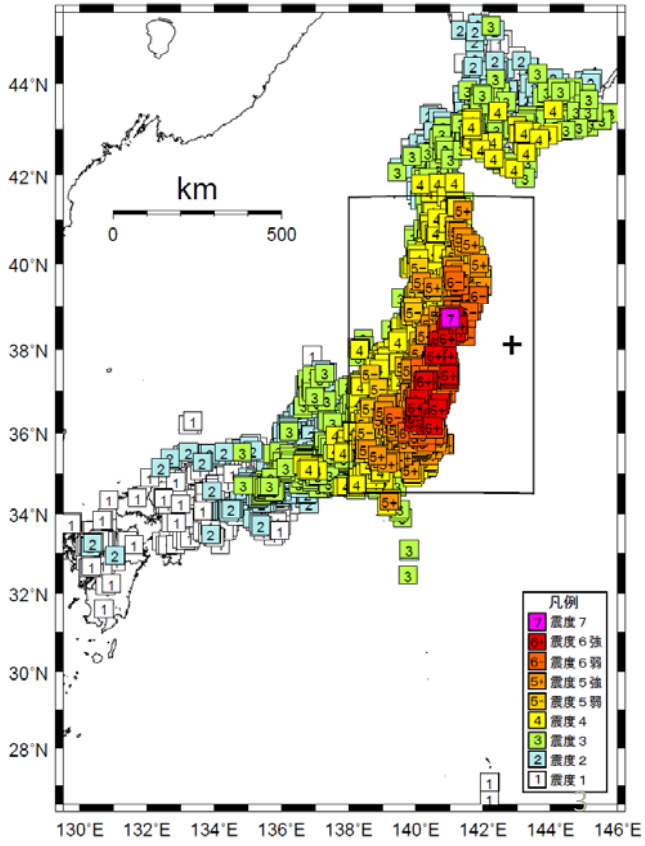
# The earthquake in summary

(Official) name of the earthquake: Earthquake off the Pacific Coast of Tohoku Region

Time and date of occurrence: 2:46pm, March 11th JST, 2011

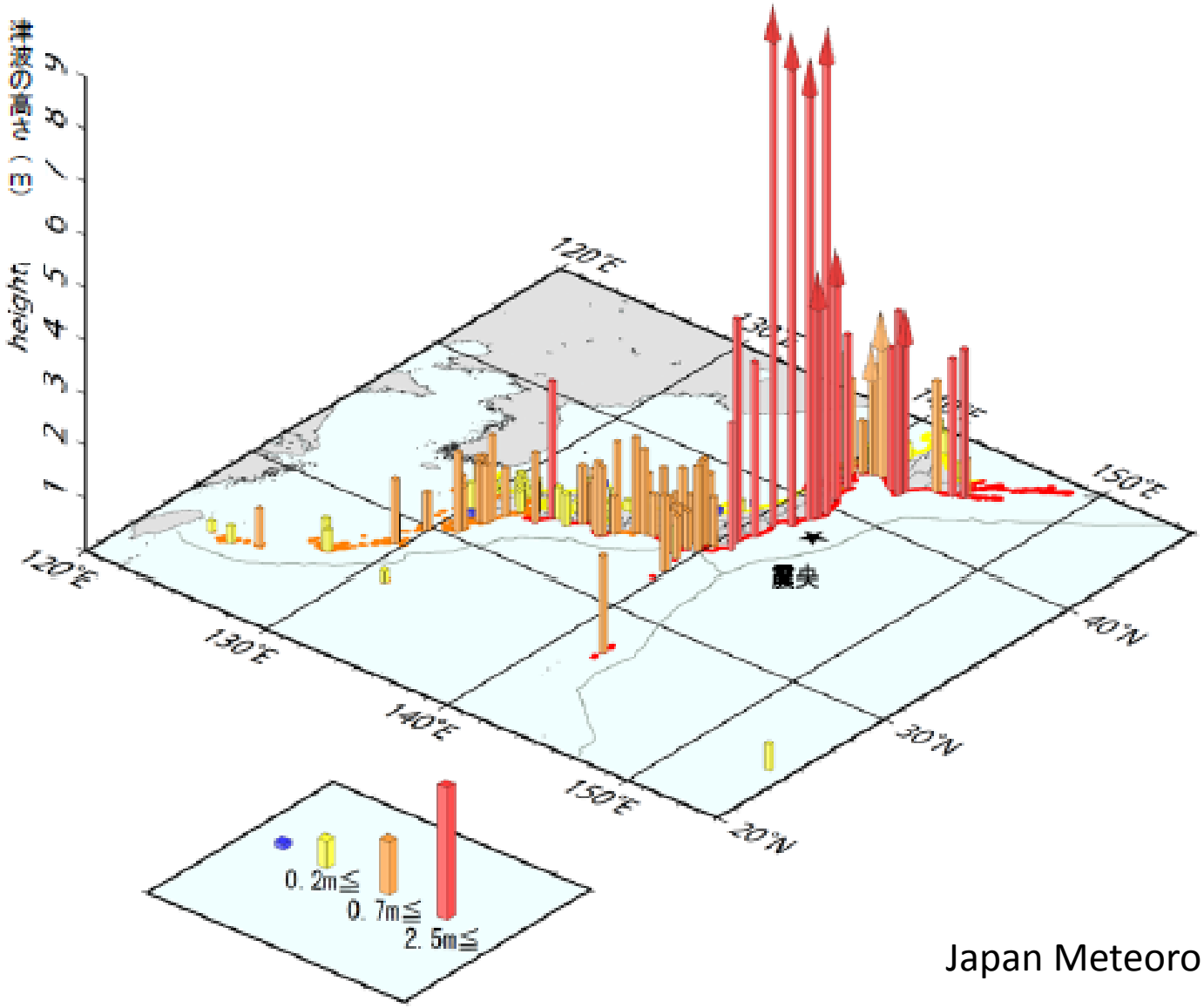
* The fourth greatest earthquake observed in the whole world, in and after 1900

| | Time and date | Earthquake's name | Magnitude (Mw) |
|---|---|---|---|
| 1 | May 23, 1960 | Chili Earthquake | 9.5 |
| 2 | March 28, 1964 | Alaska Earthquake | 9.2 |
| 3 | December 26, 2004 | Sumatra Earthquake | 9.1 |
| 4 | November 5, 1952 | Kamchatka Earthquake | 9.0 |
| | March 11, 2011 | Earthquake off the Pacific Coast of Tohoku Region | 9.0 |




Distribution of earthquake intensities (From the website of the Japan Meteorological Agency)

# The massive tsunami hit




Japan Meteorological Agency

# The massive tsunami hit

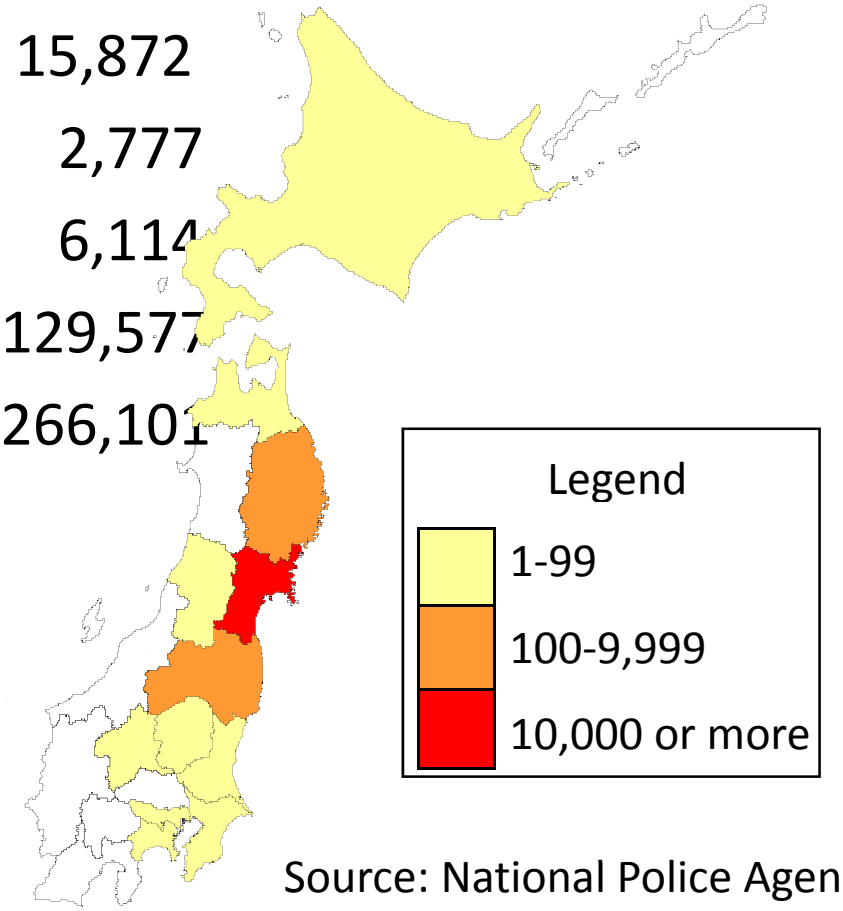
# The massive tsunami hit

# Damages in summary

- Casualties : 15,872
- Missing : 2,777
- Injured : 6,114
- Fully destroyed buildings : 129,577
- Partially destroyed buildings : 266,101

(As of October 24, 2012)

Casualties and missing people in each Prefecture affected




Source: National Police Agency

Ohtsuchi Town


Kamaishi City

Rikuzentakata City

# Examples of damage of road maintenance office

Tohoku Regional Bureau of MLIT, Sendai River and National Road Office, and Kesennuma National Road Maintenance Branch Office

# Situations of downtown Tokyo on March 11, 2011

National Road 246 (Akasaka 7-chome, Minato Ward)

National Road 246 (Akasaka 8-chome, Minato Ward)

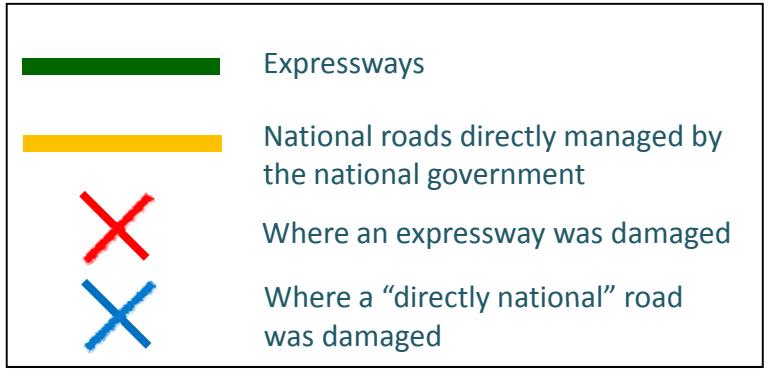

National Road 246 (Dogenzaka 1-chome, Shibuya Ward)

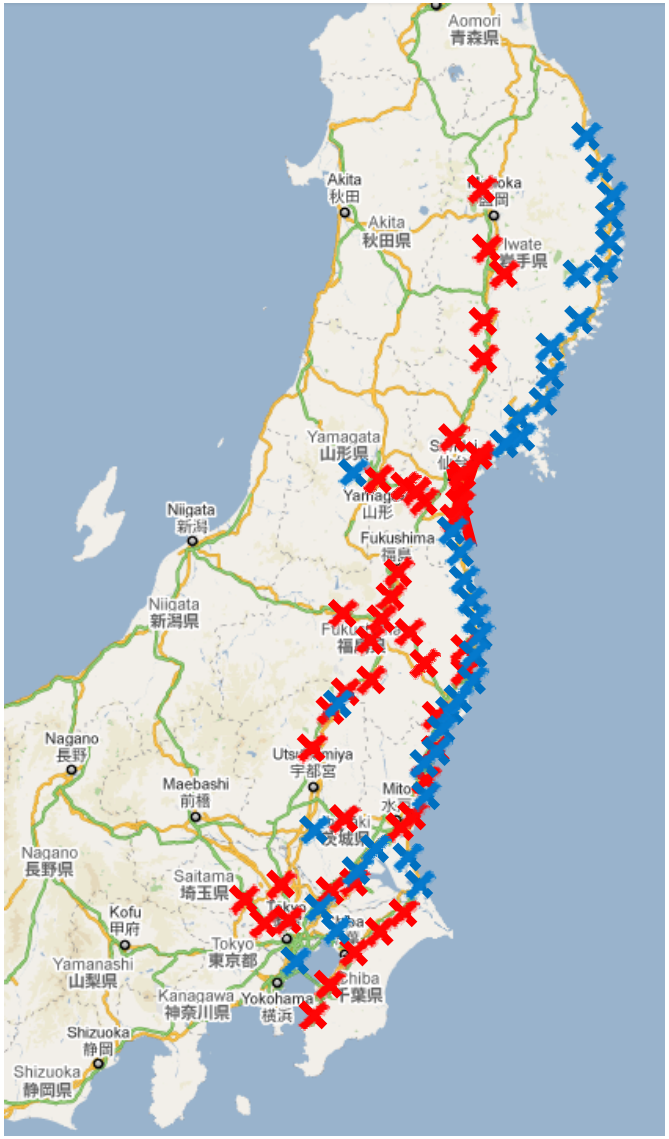
National Road 254 (Kasuga 1-chome, Bunkyo Ward)

# 2. Road damages in summary

# Distribution of road damages

- Roads were damaged in a very large area.
- Ordinary vehicles were shut out of the road in 15 expressway routes and 69 segments of roads managed by the national government, mainly in Tohoku Region.

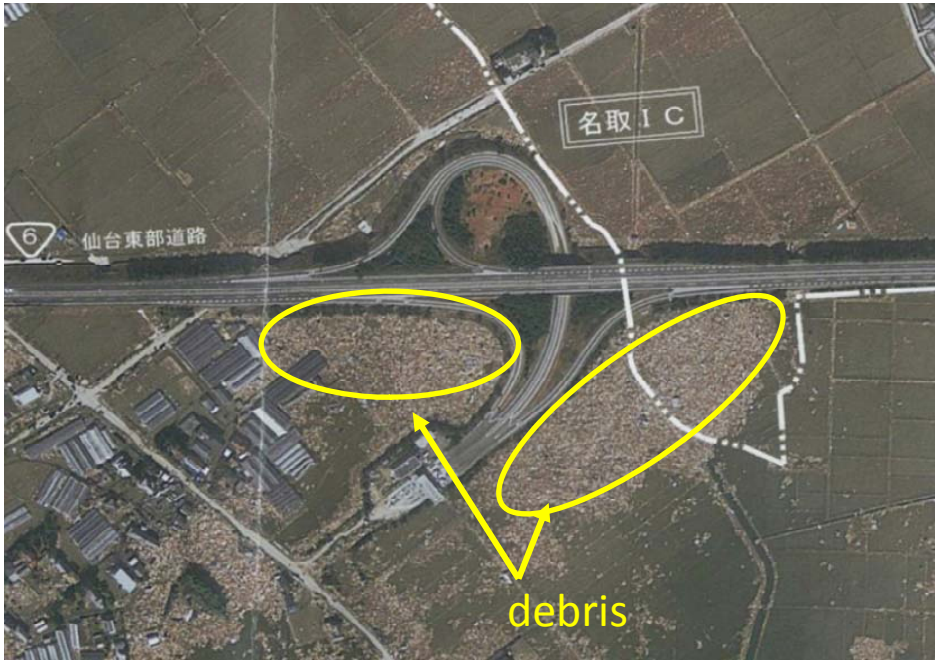


# Examples of damage

- Some 100km of roads directly managed by the national government were inundated by the tsunami.
- Enormous volume of debris from buildings, ships, boats, etc. Covered up many roads and farms.

Wakabayashi Junction, Sendai Tobu (East) Road




Natori Interchange, Sendai Tobu Road

# Bridges washed away by the tsunami

- On the roads directly managed by the national government, the tsunami washed away five bridges.





Collapse of Railway Bridge in Ohtsuchi Town

# 3. (Re-)opening roads and their temporary recoveries

# Steps of road recovery

- In case of a major disaster, roads are restored in the three steps below:

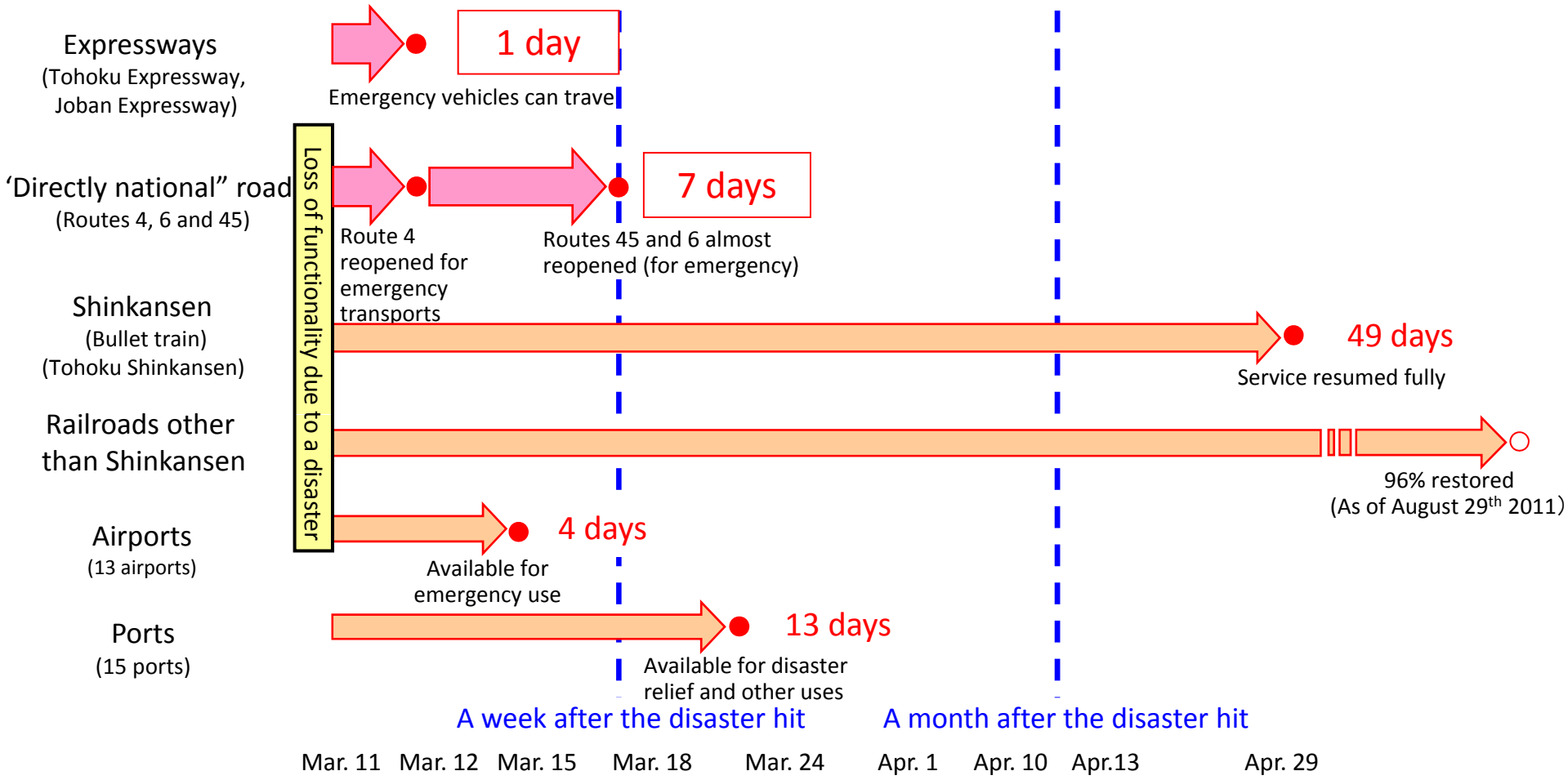

**1) Reopen the road for emergency vehicles** → Enable emergency transports on the road.

**2) Temporary recovery** → Let general vehicles travel on the road.

**3) Full recovery** → While general vehicles travel on the road, restore it to its original shape and functionality.

# Time length until a damaged road was reopened for emergency use

- Among the different types of transport infrastructure, roads can recover for emergency use sooner than the others.

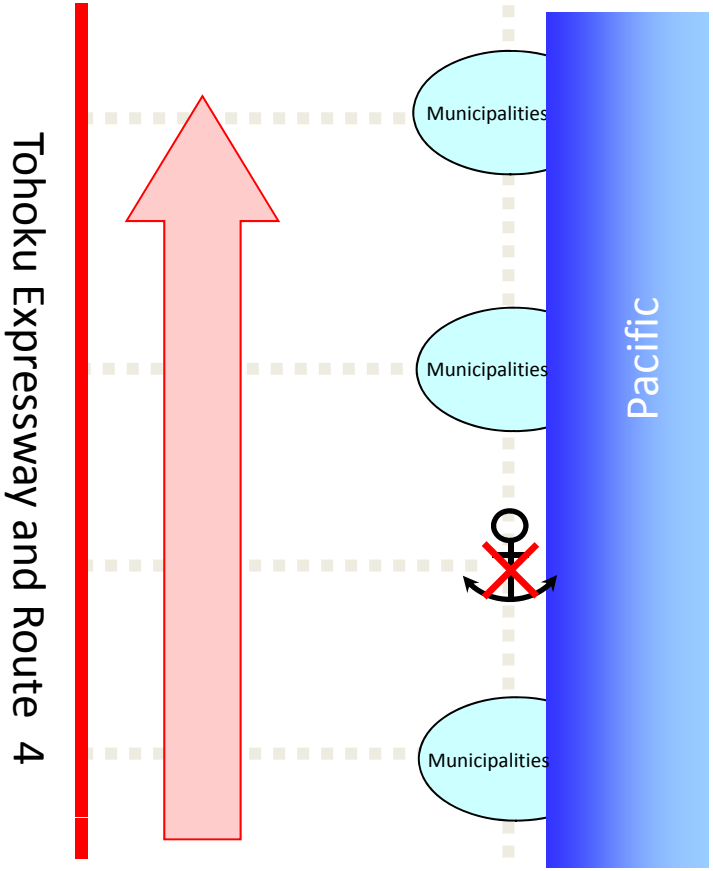


# Heap of debris left by the tsunami

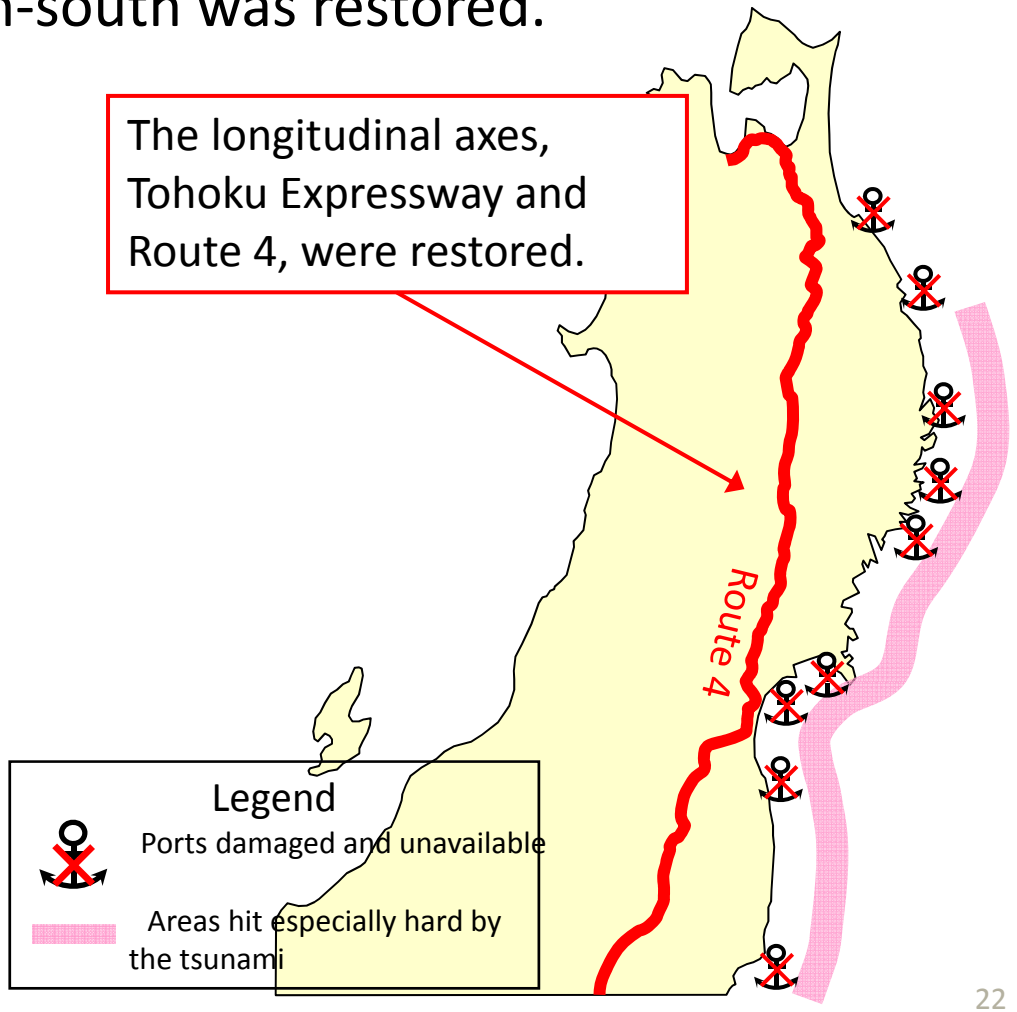
# “Comb Formation” - 1

## 1) Day after the earthquake (March 12)

- First, on the day after the earthquake,  the emergency transport route on an inland, north-south was restored.



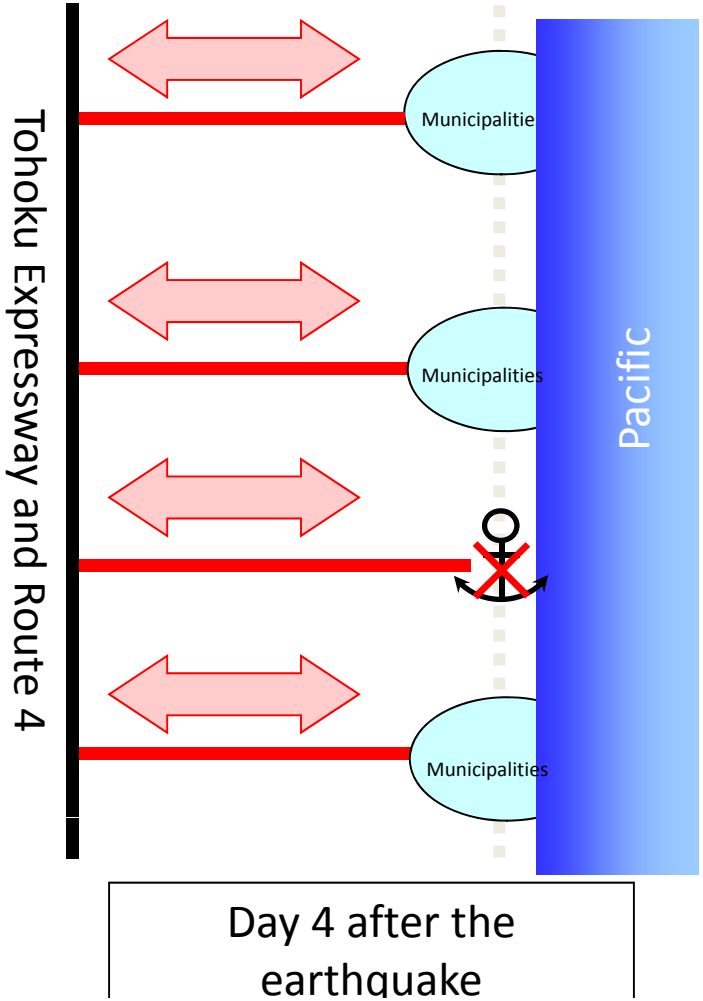

Day 1 after the disaster

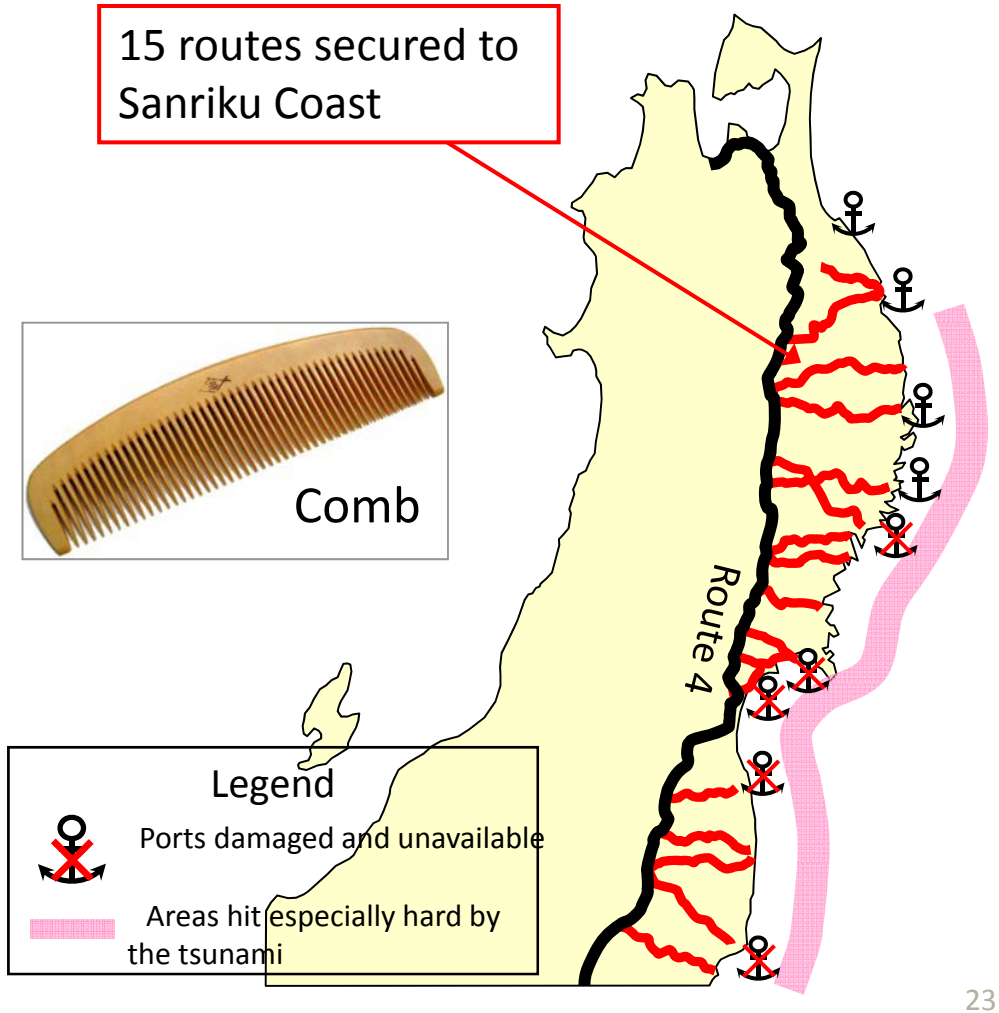


# “Comb Formation” - 2

## 2) Day 4 after the earthquake (March 15)

- Next, multiple transport routes between the inland axes and the Pacific Coast were secured.

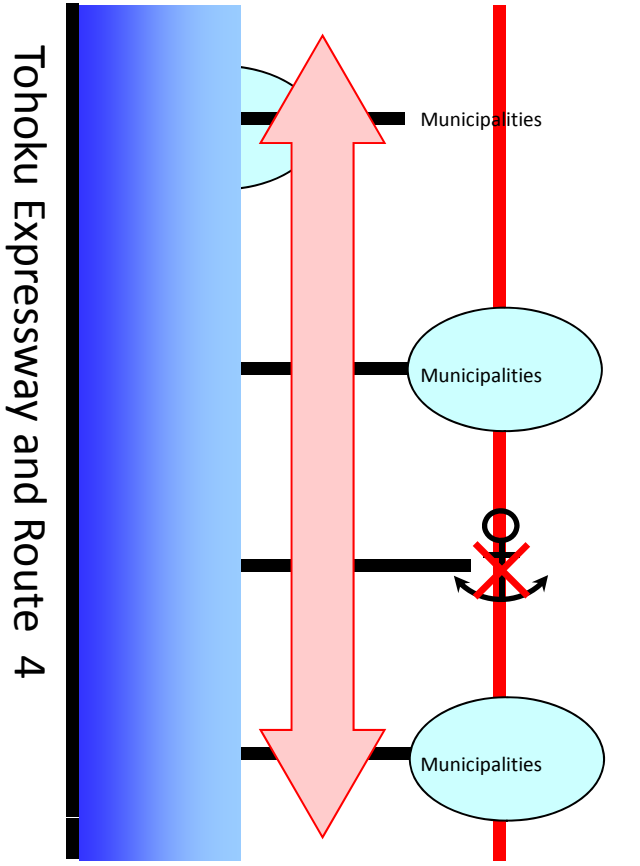


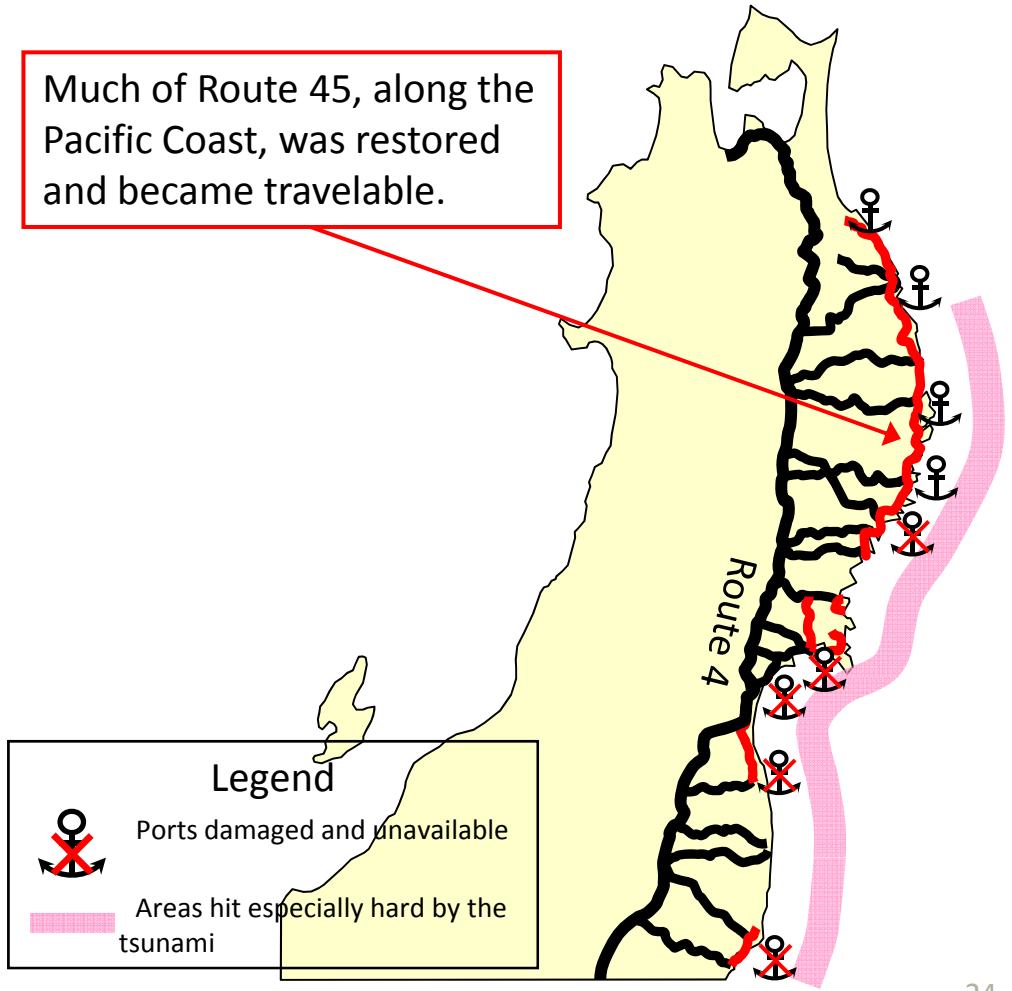
# “Comb Formation” - 3

## 3) A week after the earthquake (March 18)

- Finally, the north-south roads along the Pacific Coast were restored.




Day 7 after the earthquake



# Reopening roads for emergency transports

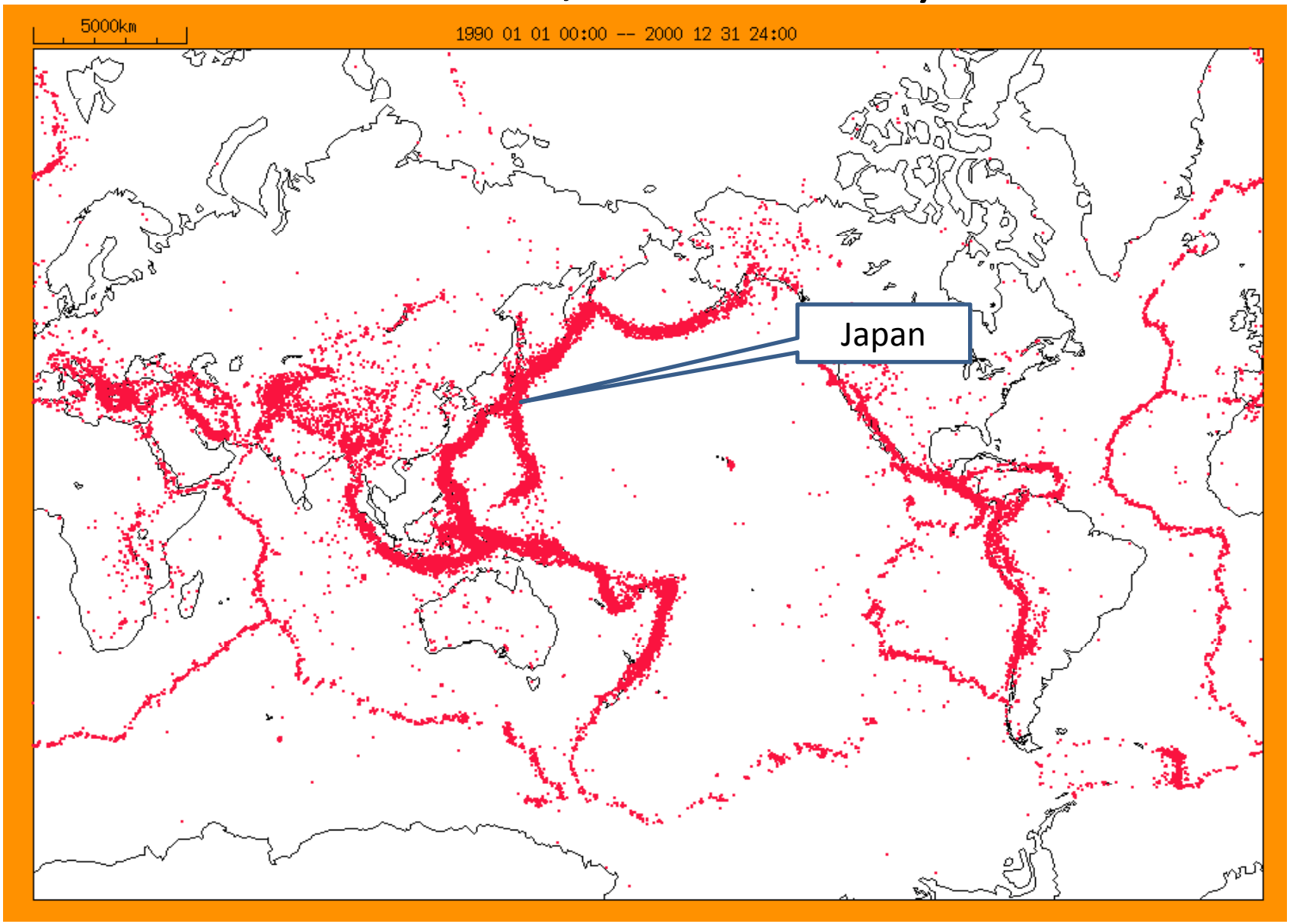
Reopening work in progress,
Within Rikuzentakata, Iwate Pref.

# Reopening roads for emergency transports

Before and after reopening work (Tagajo, Miyagi Pref.)

# 4. Lessons and issues related to road infrastructure

# Distributions of Hypocenter of Earthquakes （M>4.0, 1990-2000)



# Lessons from earthquakes of the past

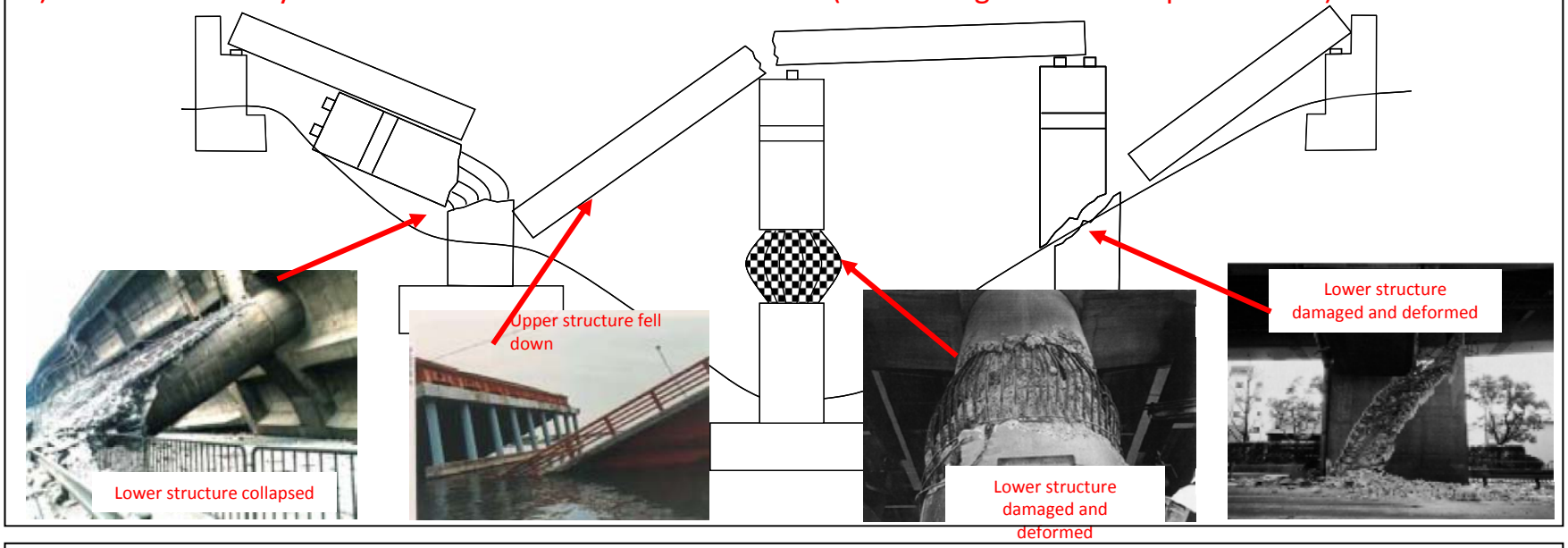
- 1995 In the Great Hanshin-Awaji Earthquake of 1995, some elevated roads and other structures collapsed.

- Architectural standards revised
- Measures taken to improve earthquake resistance

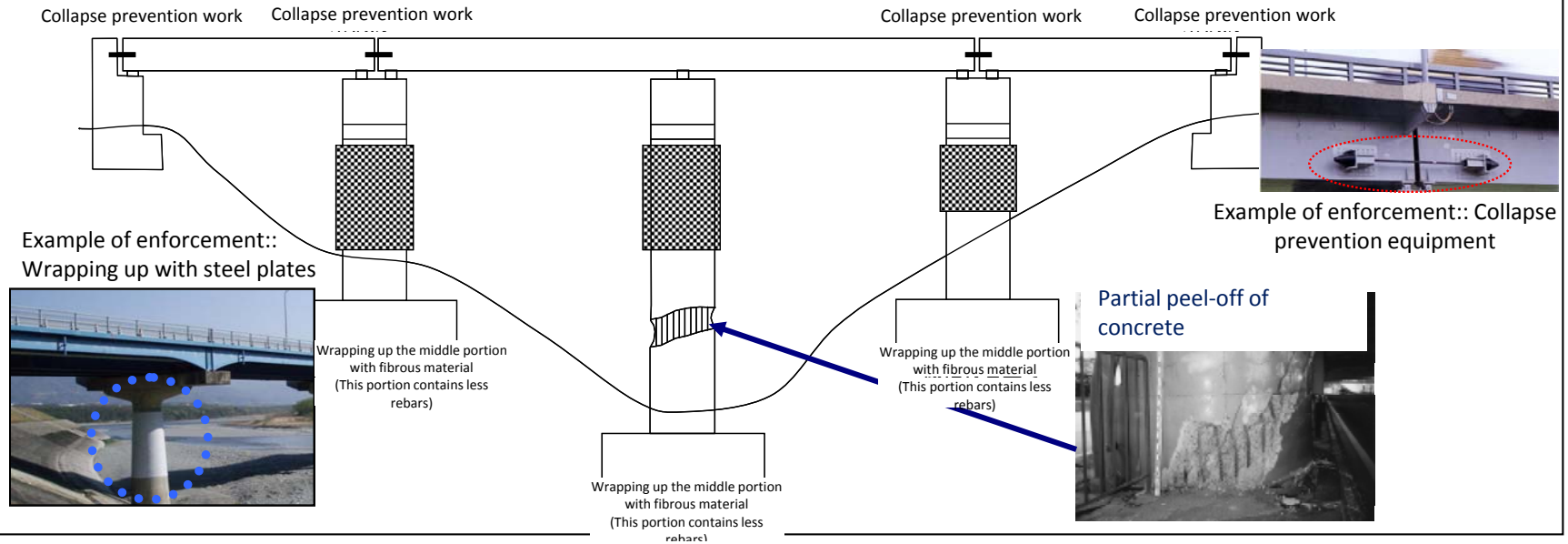
Disaster of the Hanshin-Awaji Earthquake (1995)

# Measures to improve earthquake resistance

## 1) Structure built by the architectural standard before 1980 (Such bridges were collapsed or fall.)




## 2) Structure built by the architectural standard after 1980 (Such bridges were suffered little damages.)



# Effects of bridge reinforcement, etc.

- Learning from the road damages caused by the Hanshin-Awaji Earthquake, measures of earthquake resistance improvement were applied. These measures should prevent fatal damages like a bridge collapse and let SDF, police, fire department, and other rescue and recovery teams to travel on such roads for early rescue and recovery work.

Route 45 (Observed intensity: 6-)


[Reinforced with a steel plate wrap-up]
Unaffected by the earthquake

Prefectural road (Observed intensity: 5-)


[Without reinforcement]
The earthquake damaged columns.

○ Collapse preventions worked.
- Part of such preventions were damaged. (middle of the photo)
- The rubber shoe supporting the beam (the black portion) remained sound.

Partial damage to a prevention ▶


Azuma Elevated Road, part of Fukushima Nishi (west) segment, Route 13

# Damages to road embankments in the East Japan Earthquake

○ Example of Joban Expressway (Between Mito and Naka Interchanges)

Soon after the earthquake, on March 11, 2011

Fully restored, on March 17, 2011

# Damages to road embankments in the East Japan Earthquake

○ Example from Route 6, in Kamikoriyama, Tomioka-machi, Fukushima Pref.

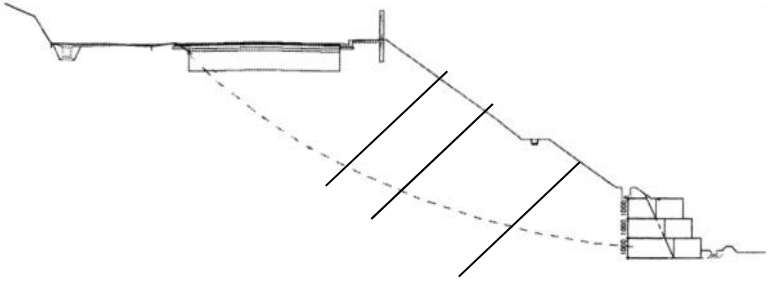
Soon after the earthquake, on March 11, 2011

Fully restored, on December 26, 2011

# Examples of reinforcement to a embankment

Gabions installed

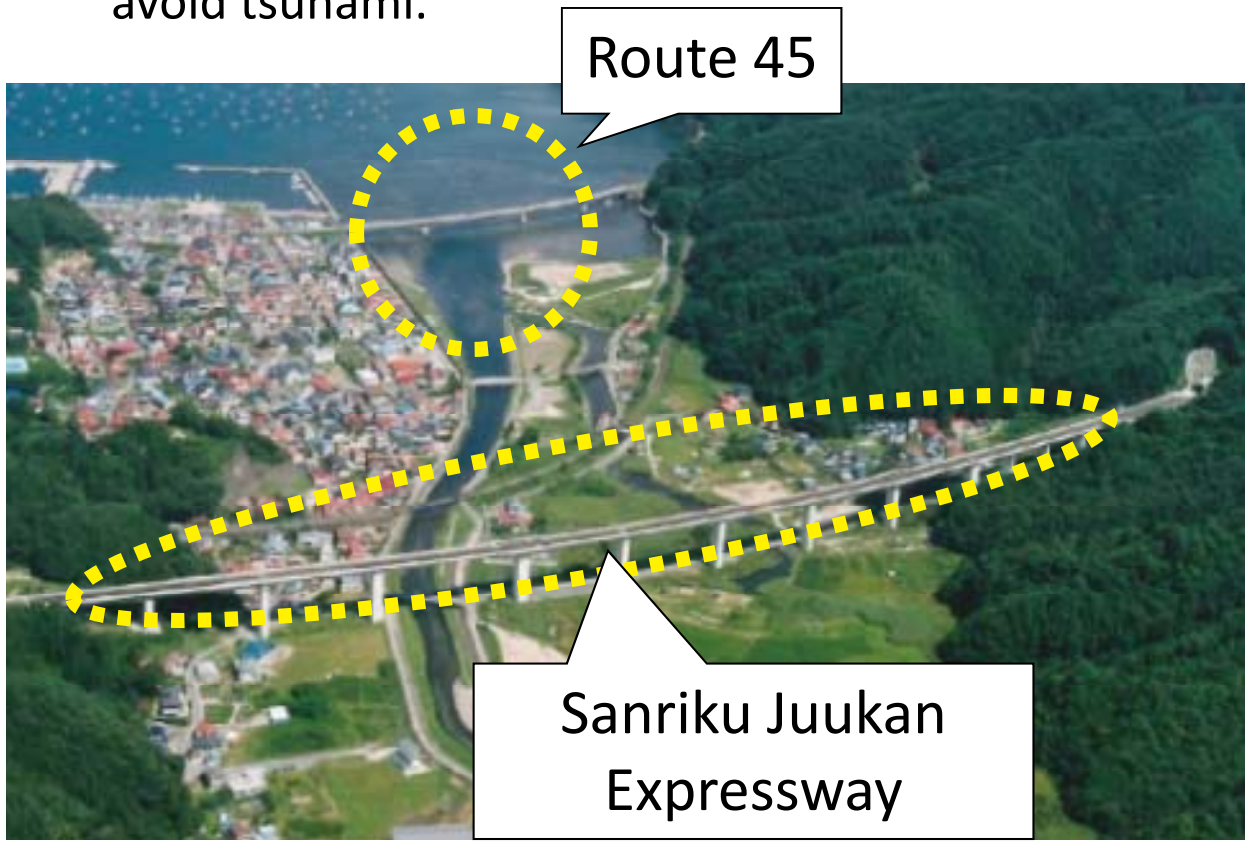
Drainage pipes installed



Reinforcement with anchors

# A road separated from the tsunami

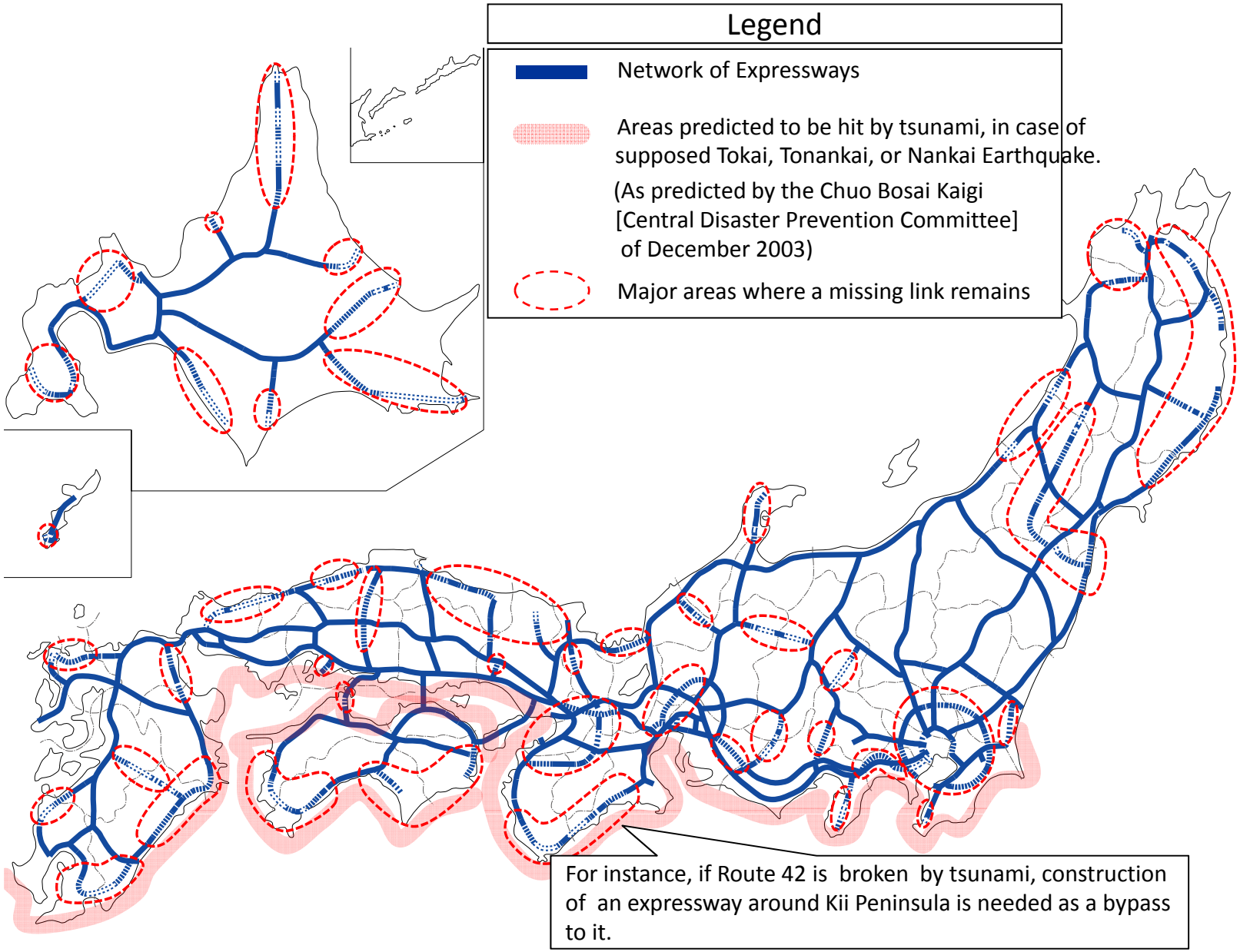
- Sanriku Juukan (longitudinal) Road, which runs along the Pacific Coast, was designed to avoid tsunami, based on experiences. It successfully avoided tsunami damages.
- An important lesson was road infrastructure must be planned and built to avoid tsunami.




Route 45 damaged by the tsunami

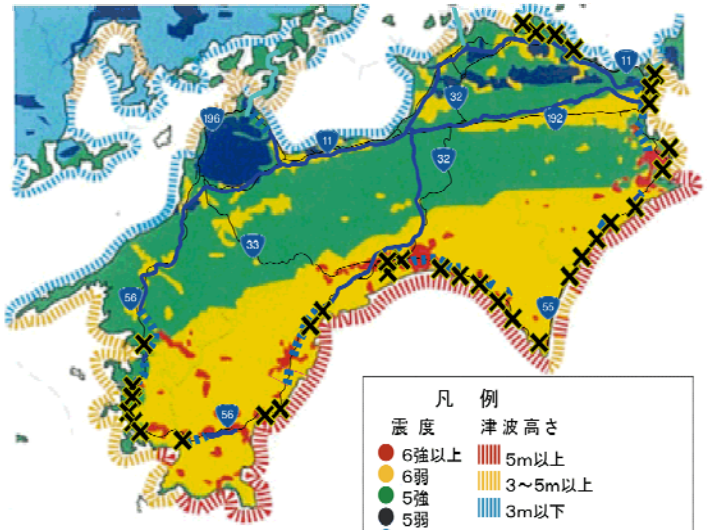
Sanriku Juukan, free of tsunami damages

# Filling missing links



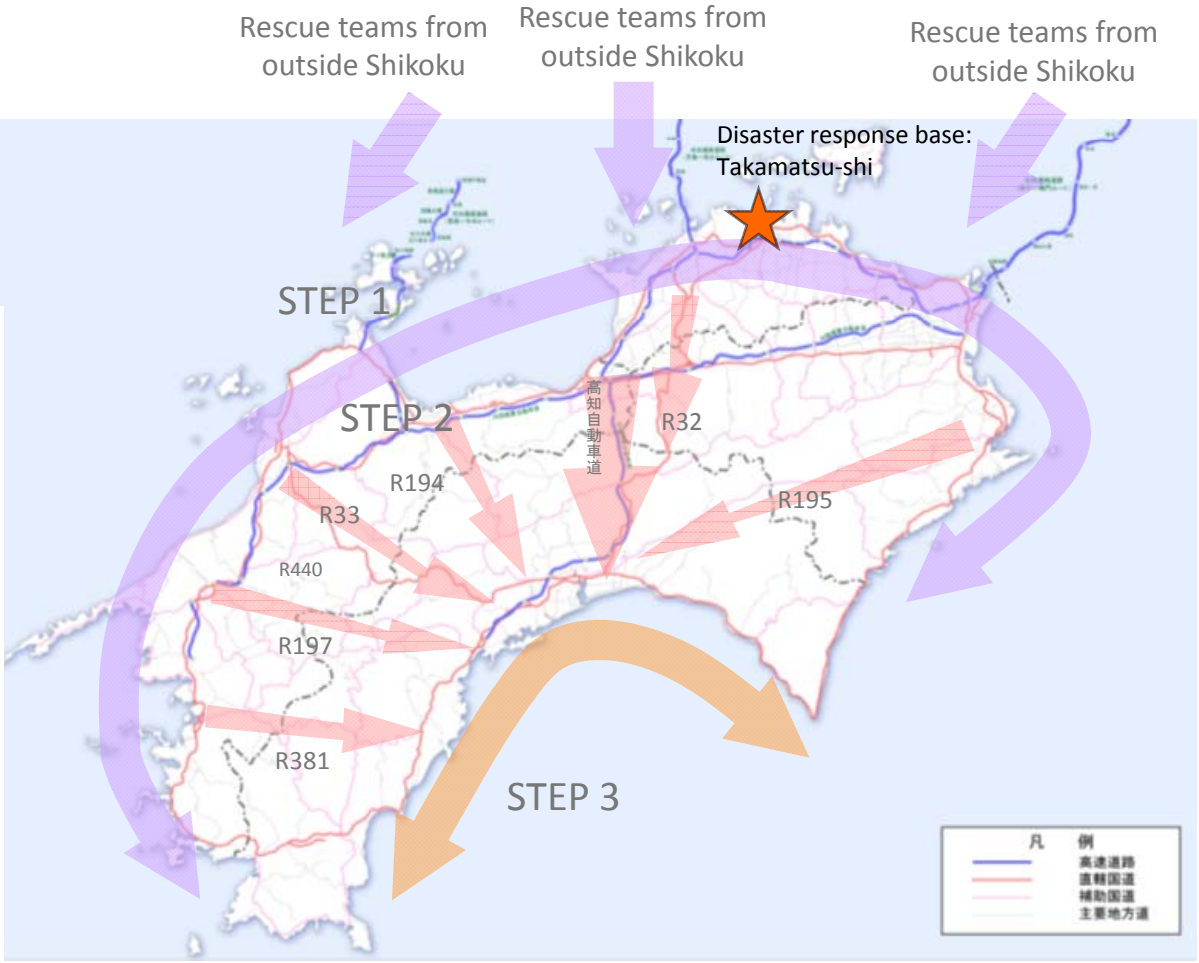
# Emergency Transports Securing Scheme in Shikoku (Draft)

- Shikoku Regional Bureau has prepared a plan to reopen roads, in case of disaster to secure transports of aids and rescues to the Pacific Coast areas of Shikoku, which are considered to be seriously damaged by supposed Tonankai or Nankai Earthquake.




図：中央防災会議資料を参照して作成
東南海・南海地震（M8．4前後）を想定

東南海・南海地震の震度分布と津波による被災地図



# Road infrastructure played additional roles as well.

- In Sendai Plain, where the end of the tsunami invaded 4km inland, Sendai Tobu (East) Road, whose embankment structure was 7 to 10m above the surrounding ground, provided a shelter to some 230 citizens.
- The embankment of Sendai Tobu Road also functioned as a surge barrier, which alleviated the inflow of the tsunami into the inland downtown.

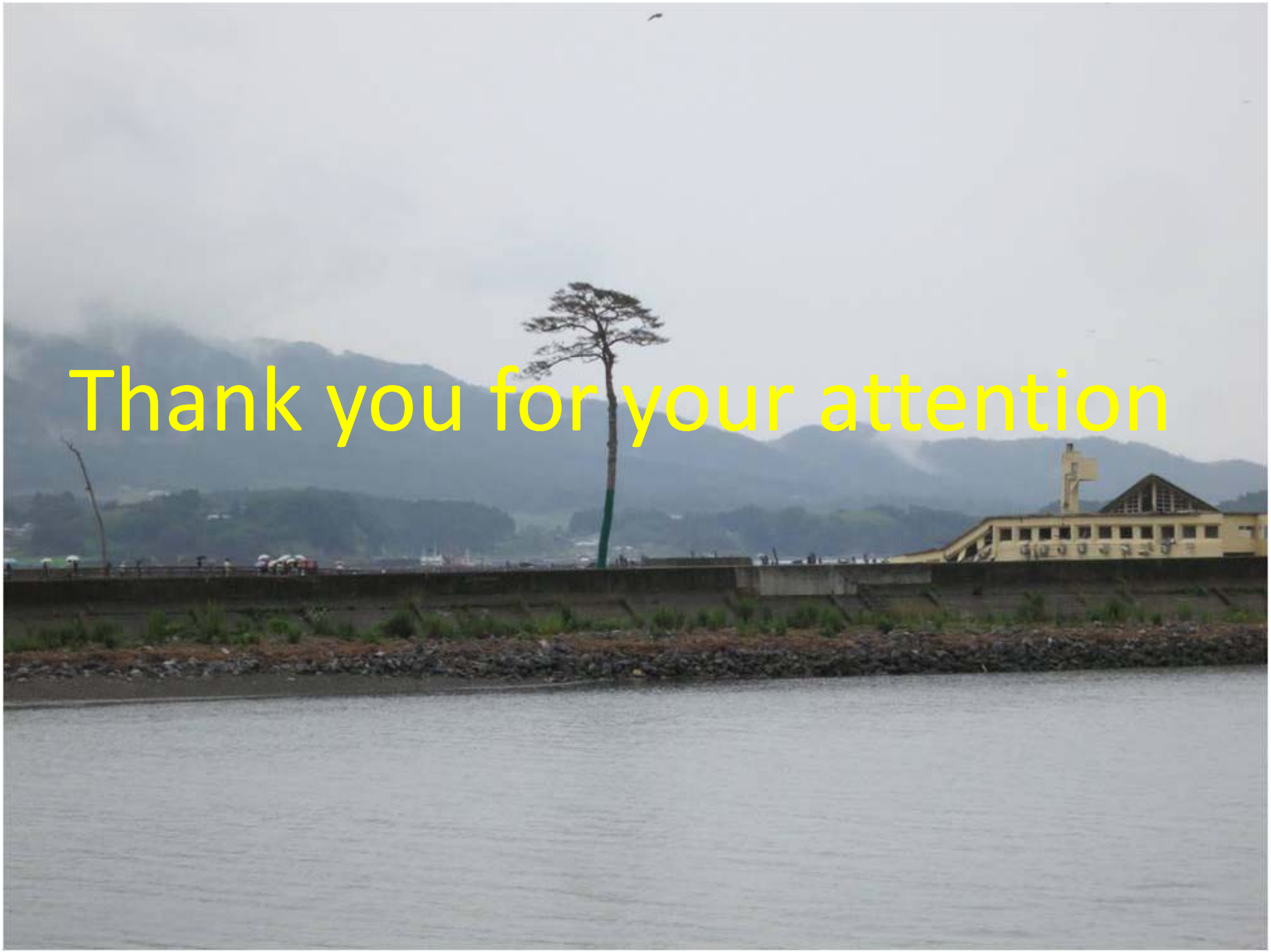
Inundation around Sendai Tobu Road


Around Iwanuma Interchange


Around Natori Interchange

# Summary

- New standard bridges were safe by earthquake and were used for recovery work
- Renewing of bridge standards by earthquake lessons is effective and important
- Re-opening of road network needed strategies
- Filling of missing link of highway network is effective for disaster mitigation
- Secondary merit of highway structure was found for tsunami prevention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