大津波の実態調査と教訓の整理に向けて

Compiling the all data on earthquake & tsunami in Pacific coast of Tohoku region

緊急地震被害調査報告会
今村文彦(東北大学大学院工学研究科)
F.Imamura, DCRC, Tohoku University

- Mechanism of earthquake & tsunami in Pacific coast of Tohoku region
- History of earthquakes and tsunamis in the region
- Countermeasure at Tsunami prone area
- City of Sendai, development, prevention work and damage
- http://www.dcrc.tohoku.ac.jp/

DCRC TSUNAMI ENGINEERING

TOHOKU UNIVERSITY

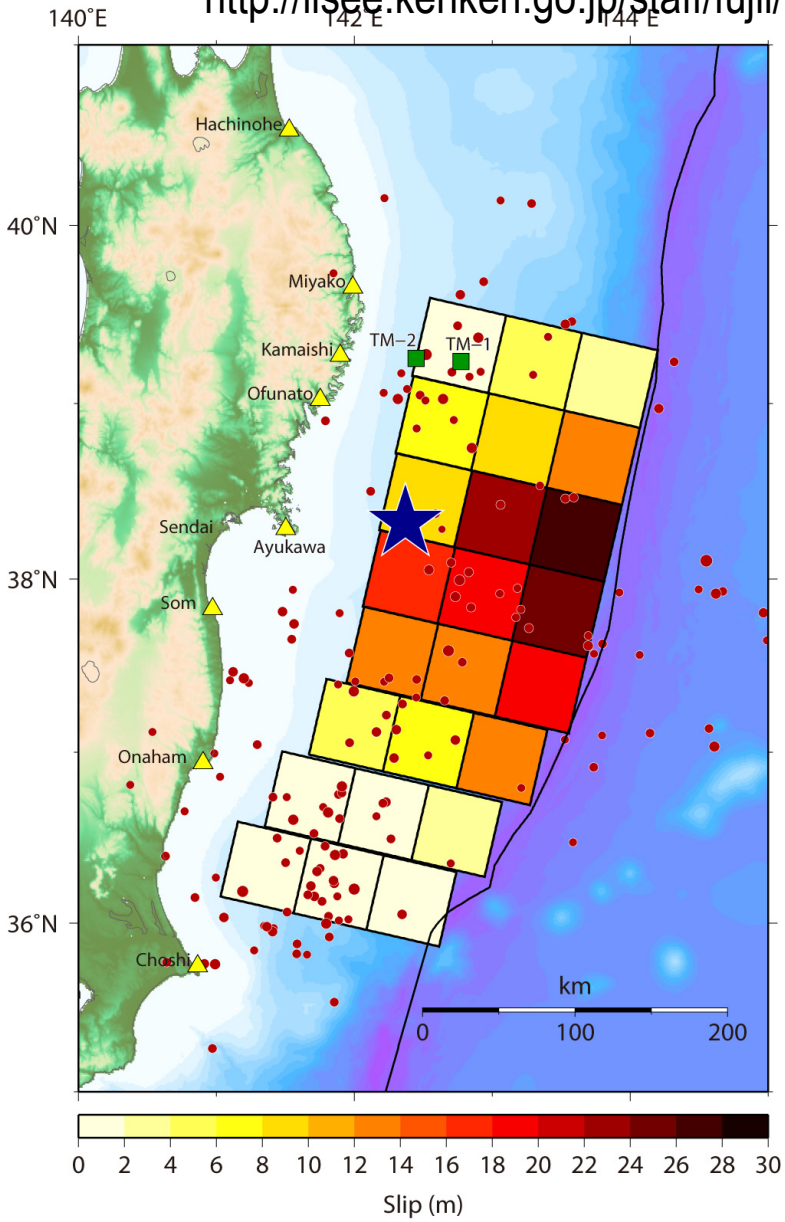
Summary of 2011 March Earthquake
地震について

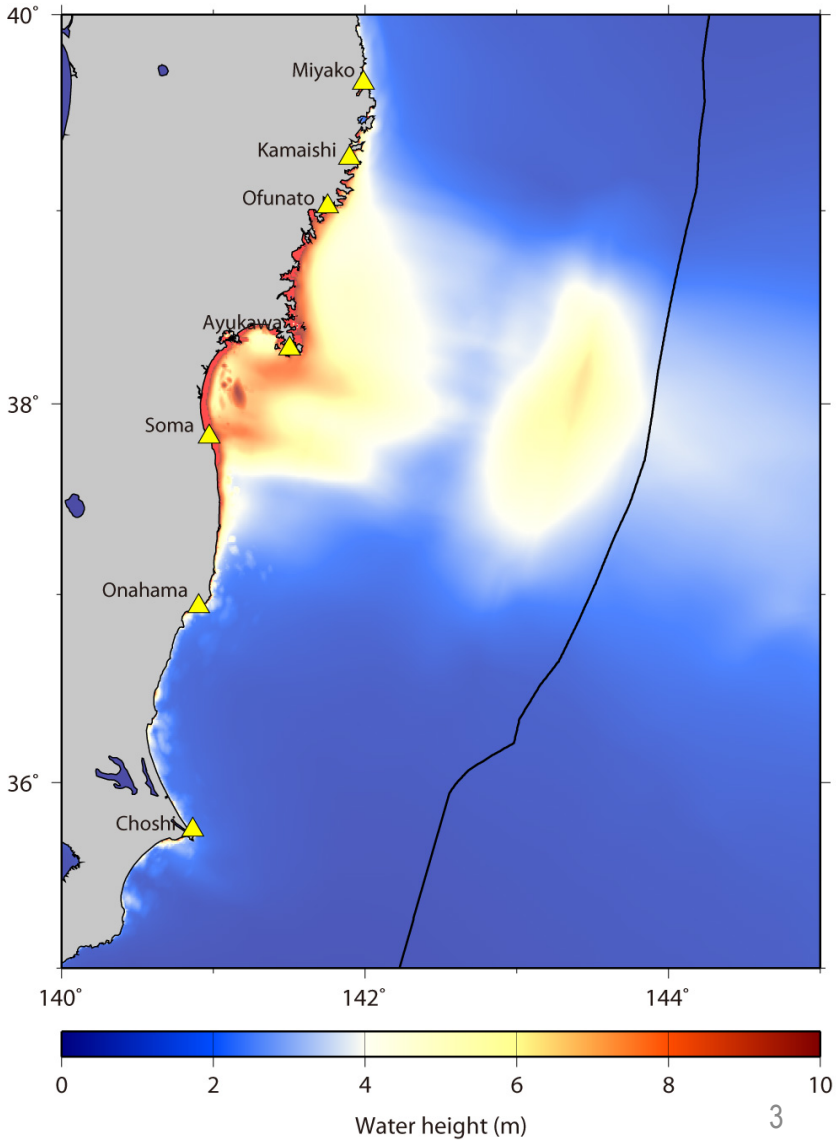
- Time
  - 11 March 2011 at 14:46 JST (5:46 GMT)
- Type of earthquake:
  - Plate-boundary thrust-faulting in subduction area of Japan
- Hypocenter and depth:
  - region (38°N, 142°E), 24km depth
- 130km off the Pacific coast of Tohoku
- Magnitude:Mw9.0
- Damage:
  - The destruction of social infrastructure, housing and corporate facilities would cost between 16 and 25 trillion yen (Cabinet Office's estimate)
  - 27,000 death and missing, 140,000 cars in Miyagi only

津波解析の為の断層モデル

Example of faults model for tsunami(Fujii&Satake,2011)

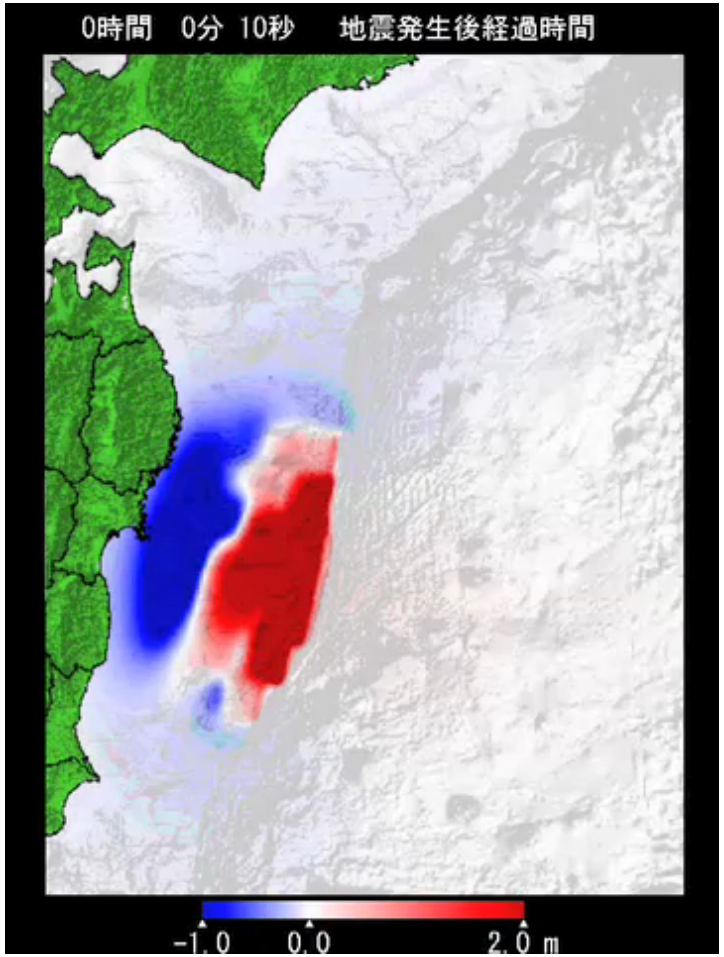
http://iisee.kenken.go.jp/staff/fujii/OffTohokuPacific2011/tsunami_ja.html





津波数値解析例

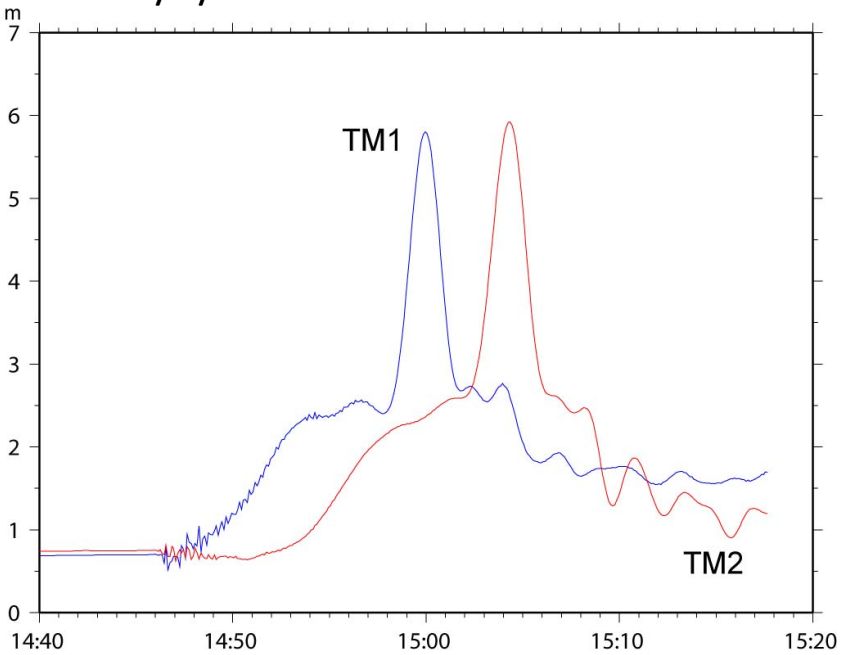
Numerical simulation of the 2011 tsunami, generation and Propagation

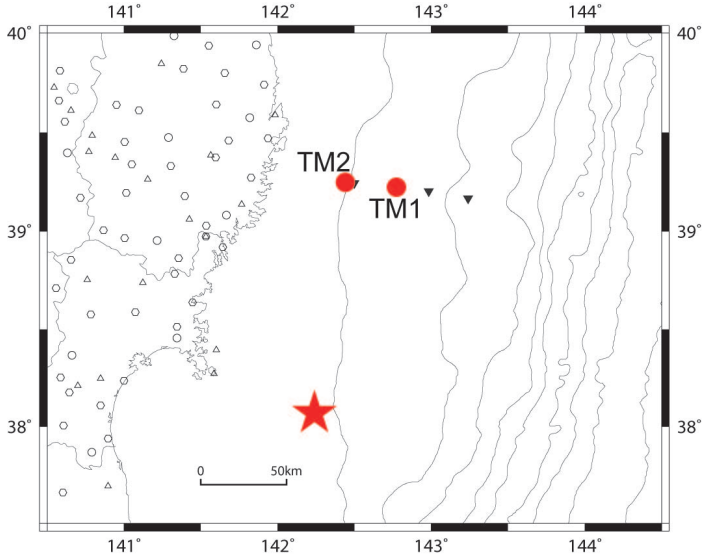


国際航業作成
東北大学協力

沖で観測された津波記録（釜石沖海底ケーブル津波計＋GPS波浪計波浪計）

2011/3/11　14:40～15:20

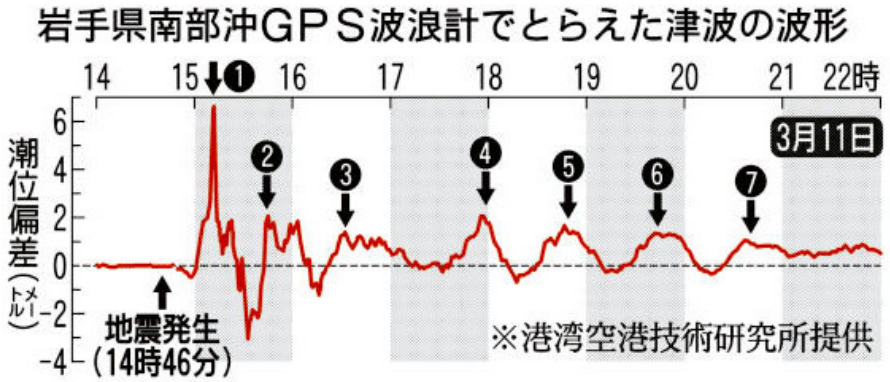




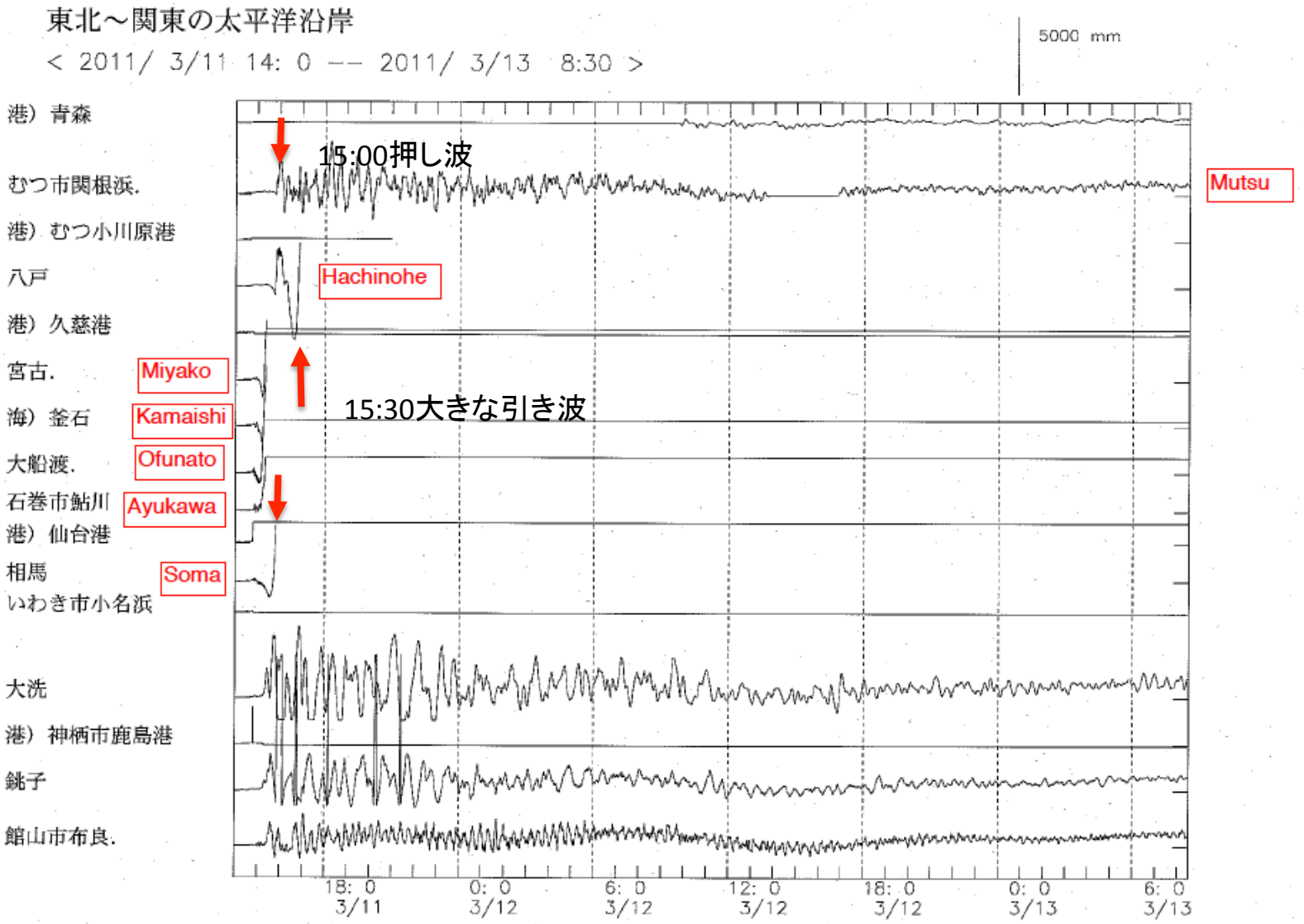
TM1（海溝寄り）では14時46分頃にP波が到達し、14時58分頃に約3.5mの津波（押し）が到達した。その4分後にTM2（陸寄り）ではほぼ同振幅の津波が観測された。

TM1（海溝寄り）では11時45分頃にP波が到達し、その7分後に約7cmの津波（押し）が到達し、その4分後にTM2（陸寄り）では約10cmの津波が観測された。

東京大学地震研究所



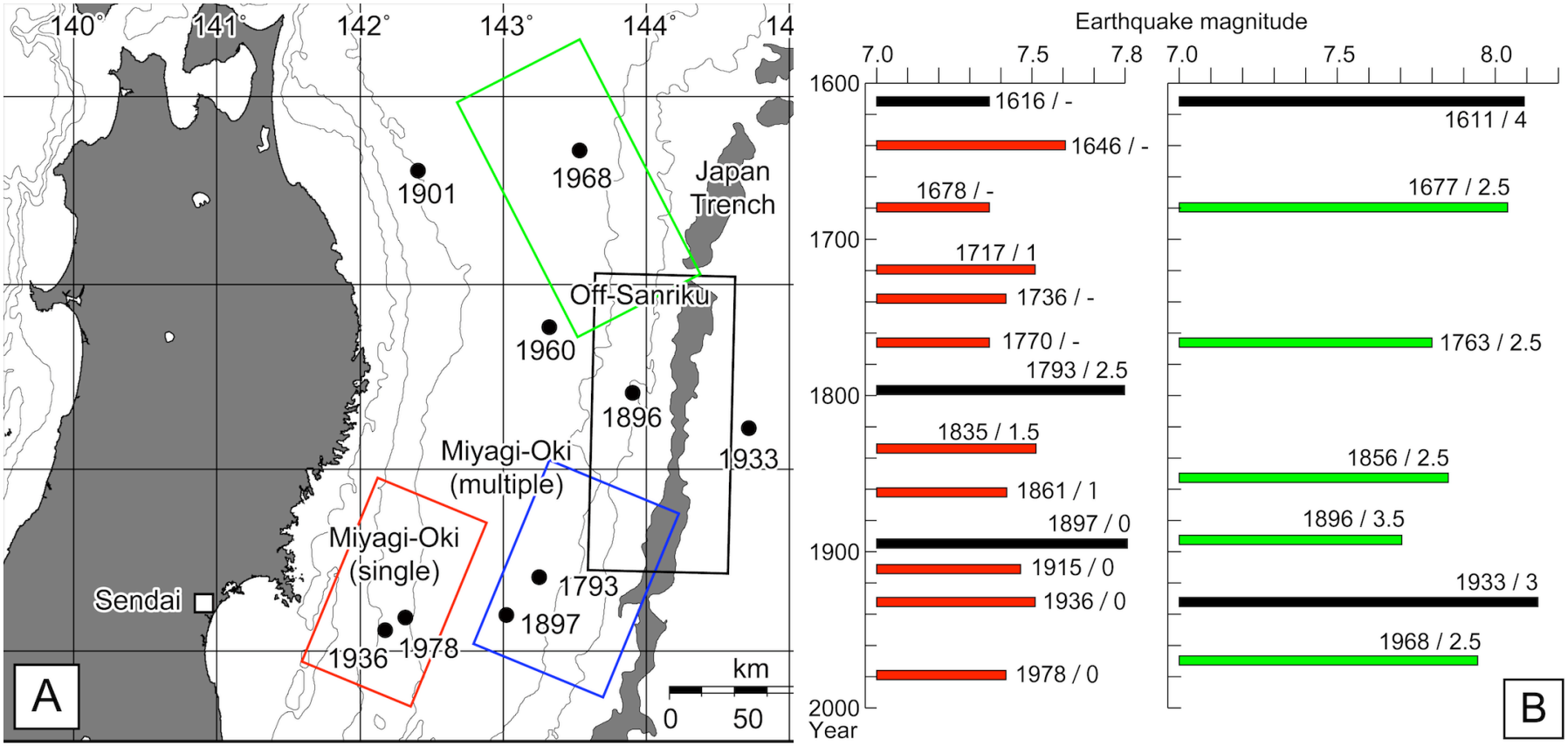
沿岸各地で観測された津波波形（気象庁）



気象庁資料

三陸沖での歴史地震と津波

Historical tsunamis in Sanriku for 400 years



- T.Hatori, Distributions of Seismic Intensity and Tsunami of the 1793 Miyagi Oki Earthquake, Northeastern Japan, *Bulletin of Earthquake Research Institute, University of Tokyo*, **62**, 297-309 (1987).

津波防災の取組
Tsunami Countermeasures

- ハード対策 Structures; sea wall, break water, dike, controlling forest, started in 1930's and 1960 after Chilean tsunami
- ソフト対策 Non-structures; Tsunami warning, Evacuation building, Education and awareness, monuments

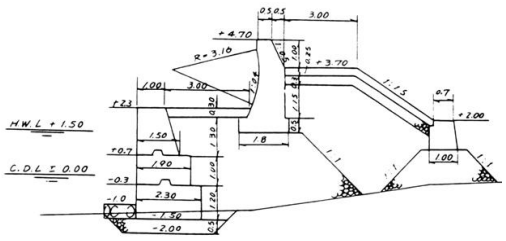
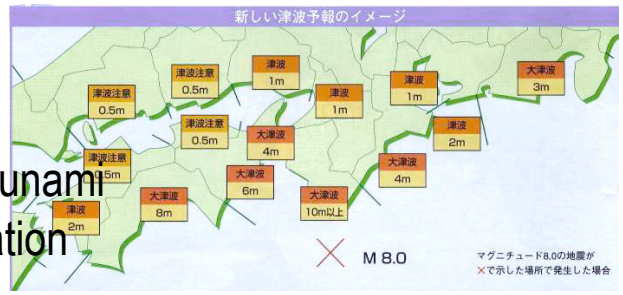


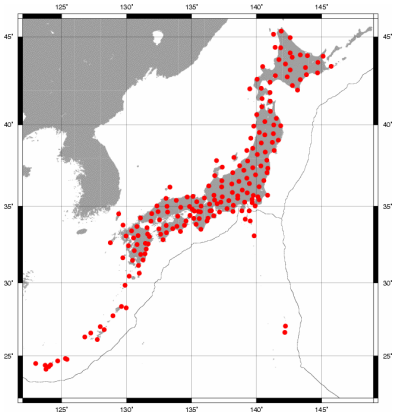
Fig. 2. Dual purpose structure (composite type tsunami wall).

Photo 2. Typical fishing village, (Ryoishi), on the Sanriku coast.

Sea wall protecting the fishery harbor



JMA Earthq.&Tsunami monitoring &Tsunami Forecasting system to provide information



津波被害の特徴
Tsunami Disasters

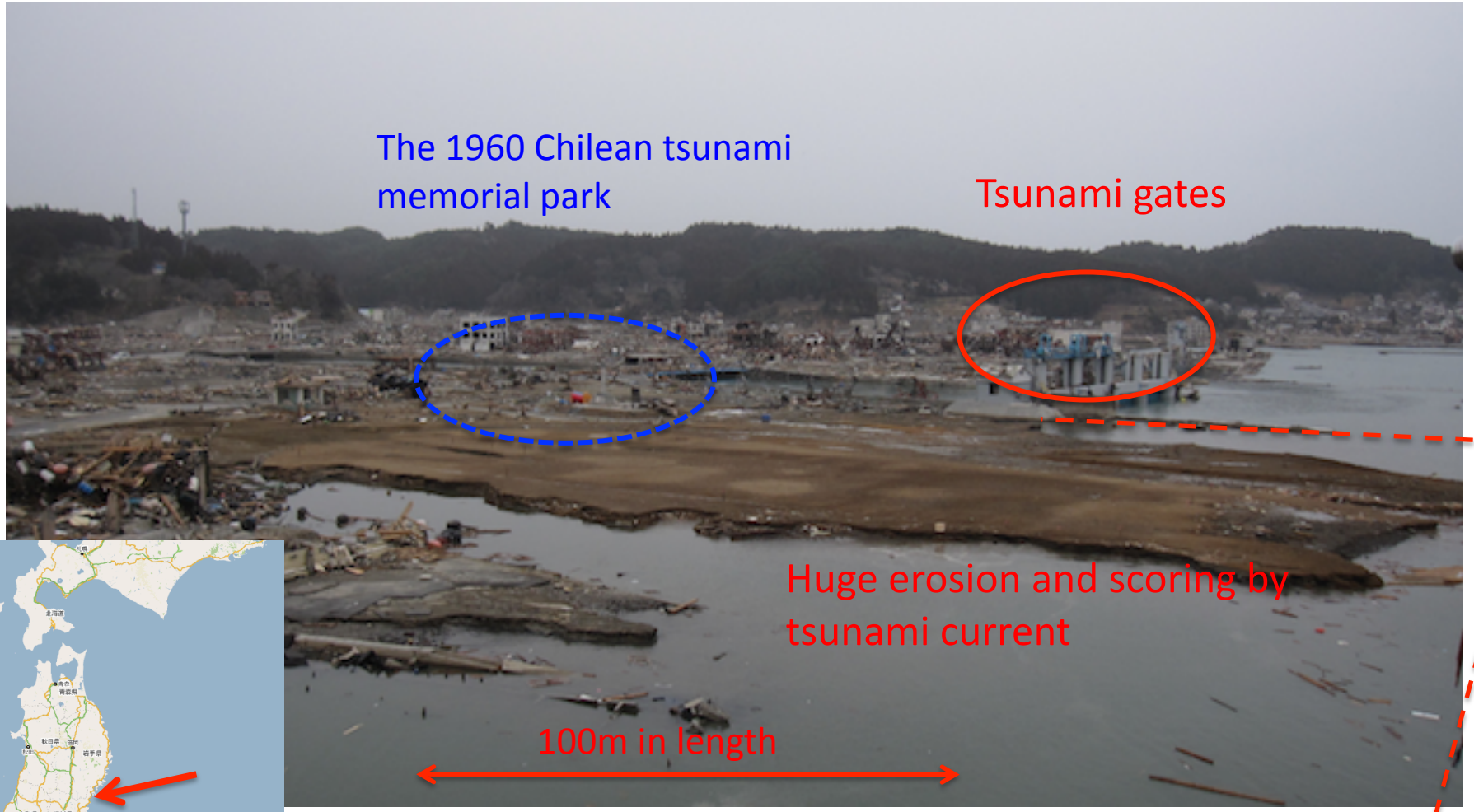
- 広域浸水 Huge amount of inundation (443km^2)+ destructive wave force
- 直接間接 Floating of debris, ships, cars and tanks
- 火災，　塩水浸水 Fires by attack of ships, and sea water
- 地形変化 Change of topography and Geometry due to erosion and deposition


Ships and fire at Kesennuma


Destruction on community at Sendai

地形変化・沿岸防護施設の被害（南三陸町）

Change topography, erosion, destruction on the gates and sea wall at Minami-Sanriku, Miyagi



燃料タンク(気仙沼朝日地区)

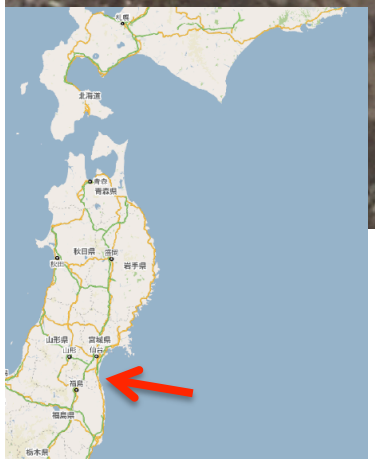
Damage at industrial area, oil tanks and facility at Kesennuma

交通被害（鉄道，港湾，空港及び施設）

Destruction on the coastal villages and rail at Higashi Matsushima, Miyagi

交通被害（鉄道及び車両）新地駅

Destruction on the rail ways and cars at Shinti, Fukushima

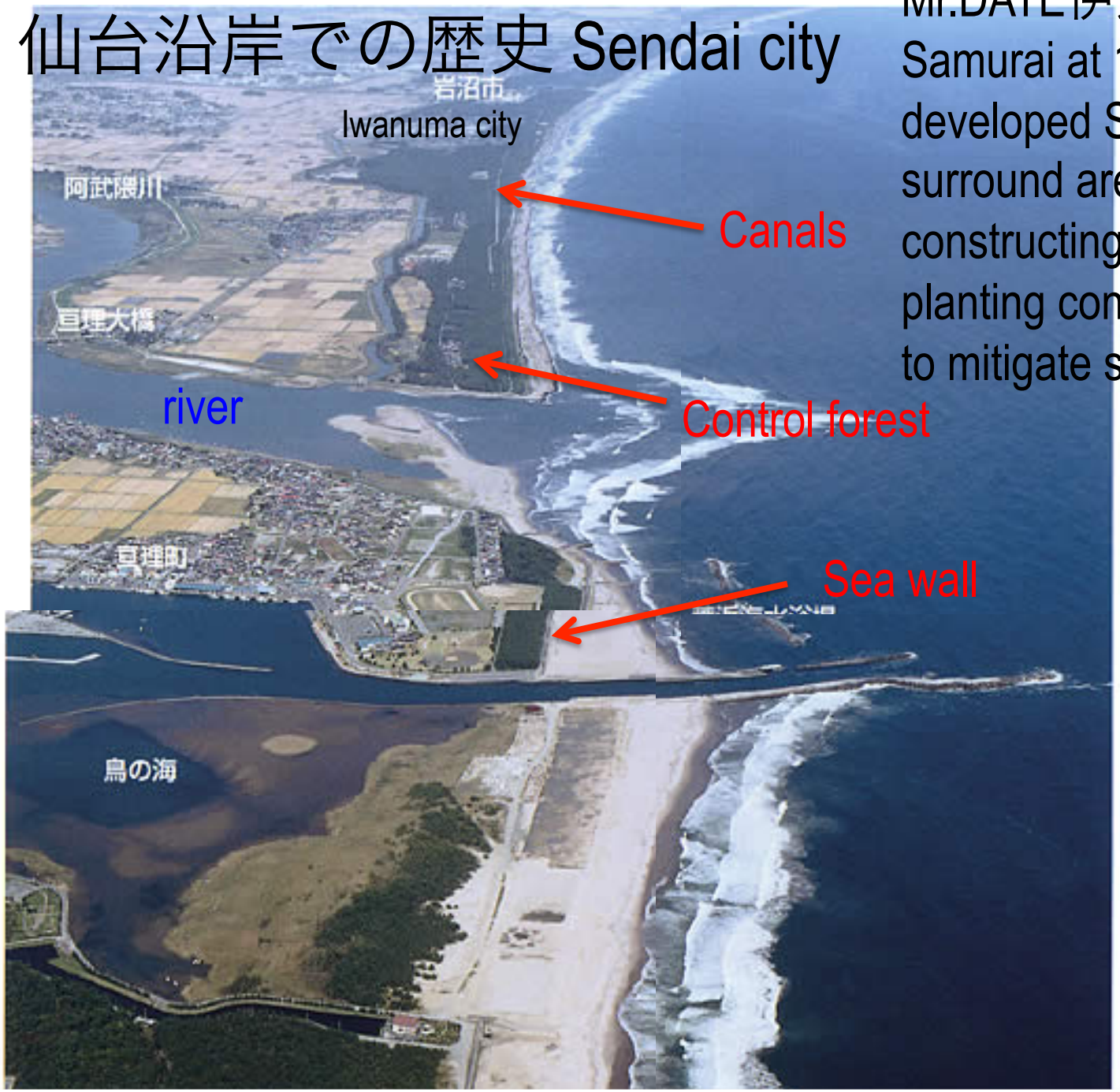


37.54’59”
140.55’05”

Direction of tsunami attack
From coast to inland

Station, 500 m
far from the coast,

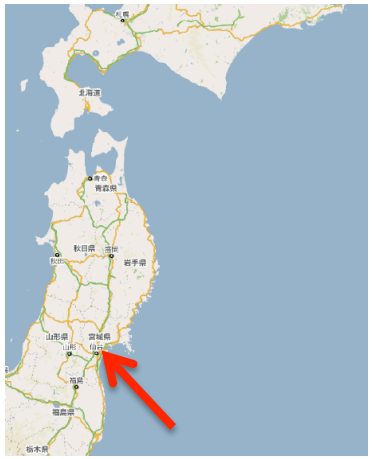
仙台沿岸での歴史 Sendai city



Mr.DATE伊達政宗,
Samurai at 1601,
developed Sendai city and
surround area,
constructing Canals and
planting control forest
to mitigate storm and tsunamis


Tsunami Evacuation Building (School 4F)
Canals
Control forest
Sea wall


Around 80 % houses washed away




Huge amount of debris
Huge amount of debris
tion
Sendai port
Tsunami Evacuation
Building (School 4F)
Inundation area
4-5km
High ways
Control forest
Rescue and search activity, 6,000 missing at Miyagi

現地ヒアリング（杉下）

- 2011年4月5日(木)
- 階上，杉下地区（高さ15m）の高台を津波避難場所に指定
- 今回は，この高台を津波がのみ込んでいった.
（4/5/10:30,17.5m潮位補正未）
- 地震後，引き波が生じ，その後に第一波，第2波（最大と思われる）が来襲
- 3方向（お伊勢浜海水浴場，岩井崎，波路上漁港）から津波が来襲，
- 陸上で渦を巻いていた
- 気仙沼向洋高校が避難場所（3階まで浸水）


長磯前林
階上保
浜街道
階上中
長磯原ノ沢
長磯下原
長磯浜
陸前階上
(休止中)
岩井崎入口
長磯牧通
波路上内田
Road of national 45
波路上後原
Rail way
波路上保
長磯二本松
波路上原
波路上牧
気仙沼向洋高
波路上瀬向
波路上野田
波路上向田
吉町後田
波路上向原
御伊勢
浜海水浴場
> 3m
17.5 m above sea
杉下高台（津波避難場所）
向洋高校12.5m潮位補正未
12.5m above sea

Our Plan on Research

- Rapid and proper recovery and re-construction for long term safety
- Observation and documentation of the tragedy with several viewpoints; natural, social and human sciences
- Evaluation of the past countermeasures to identify the issues to solve the problems and develop
- Advance for recovery and re-construction for long term safety