Geotechnical damage caused by the recent gigantic earthquake in Japan

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April Issue, Bulletin, ISSMGE

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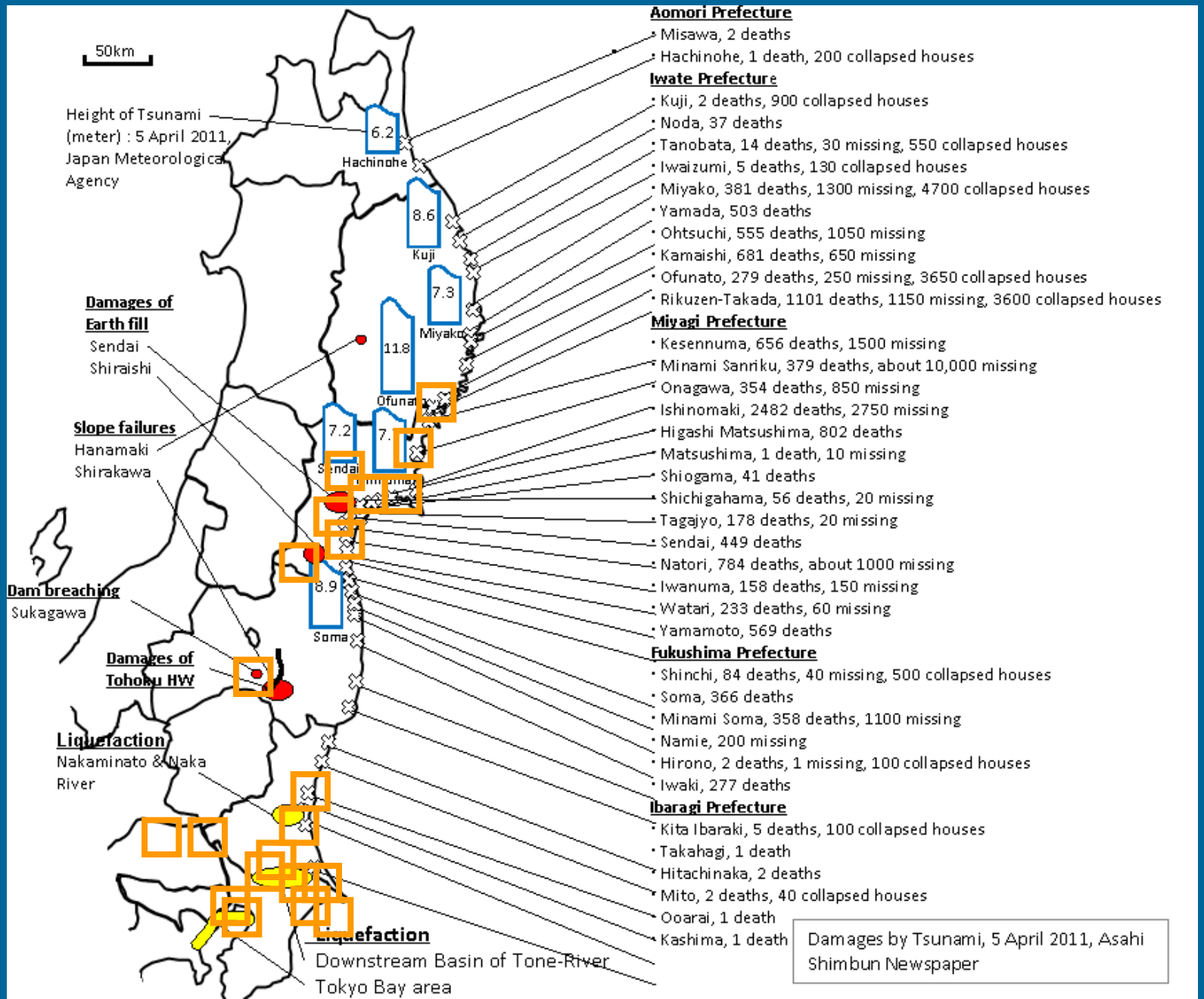
Special feature of the damage

- The affected area was vast.
- Number of damage was huge; e.g. nearly 2000 damages in river levees
- Damages affected each other and made the entire effects more significant: delay and difficulty in emergency action and restoration.

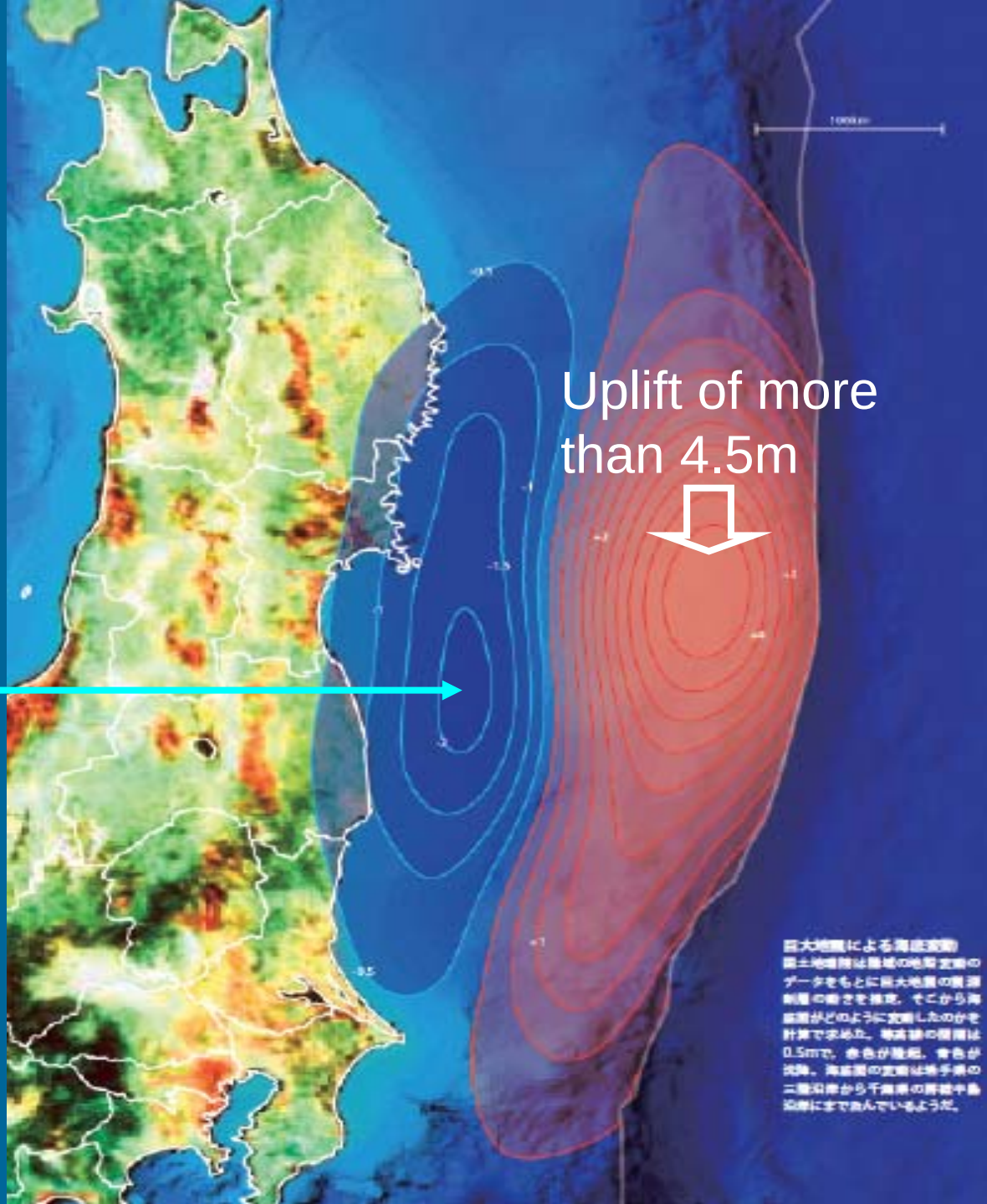
I have visited the following places: □



Tectonic movement

Subsidence of more than 2m in sea floor

Subsidence of coast was max. 1.2m



After Nikkei Science Magazine

Coseismic subsidence in coastal area

Photos by Mr. Daiken Suzuki, former master student, Univ. Tokyo

Ground level is lower than before;
Difficulty in drainage
Risk of flooding in typhoon season

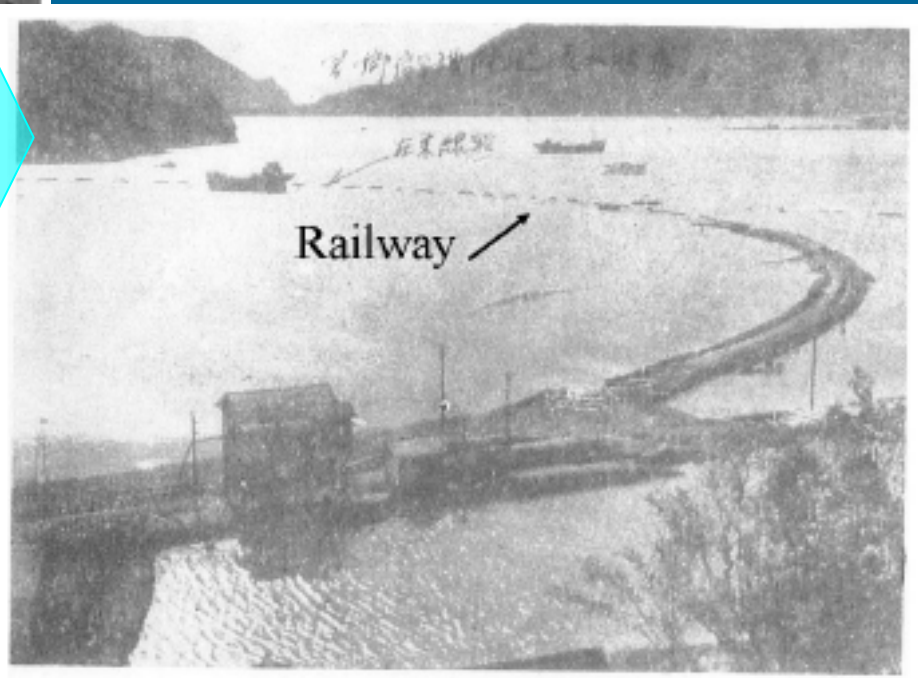
Situation was made worse by tectonic subsidence: insufficient levee height

Coseismic subsidence during past earthquakes

Valdivia 1960, Chile、Kohchi, 1946, Japan,

1999 Izmit Bay, Turkey, 1964 Alaska

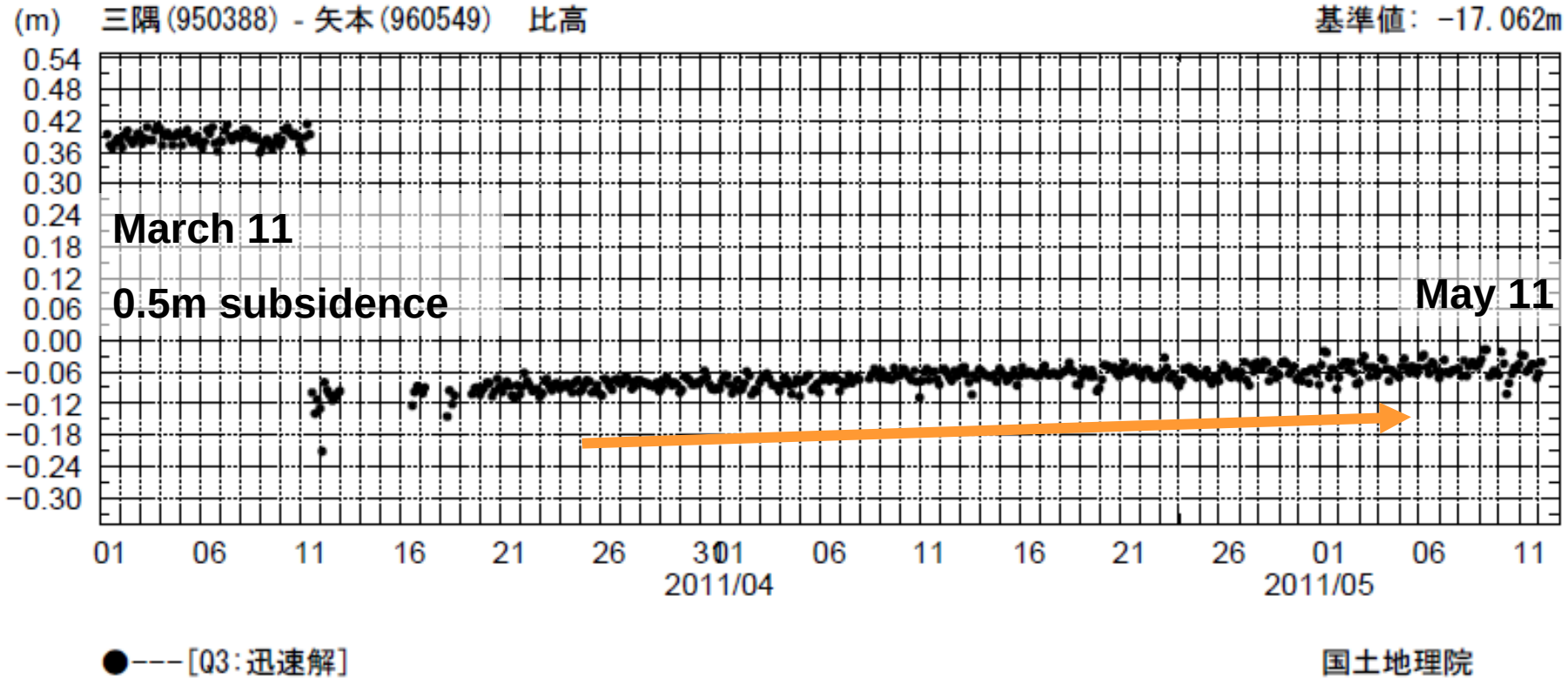
Fig. 16.55 Inundation of Valdivia City (Soto Melo)



大海原と化した多ノ郷駅附近より須崎湾をのぞむ

Later, ground came up.

Tectonic motion of coast after March 11
Near Sendai City, ground is coming up but very slowly



Types of geotechnical damage

- Liquefaction in young sandy deposits
- Lifeline
- Embankment: road and levees
- Failure of residential development fills

Note: the large number of damage in each category above made restoration very difficult or still impossible.

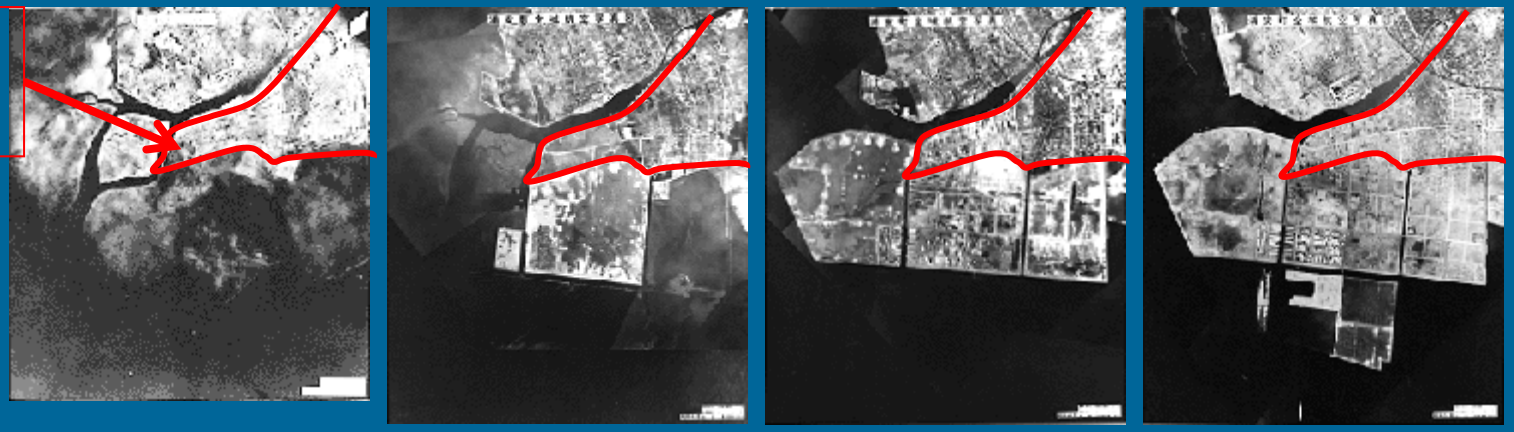
Liquefaction in young sandy deposit (Urayasu City near Tokyo)

Lifeline damage

Floating of sewage manhole caused by liquefaction of ground and backfill

History of land reclamation and manmade land construction in Urayasu City

Original coast



1948 1968 1971 1975

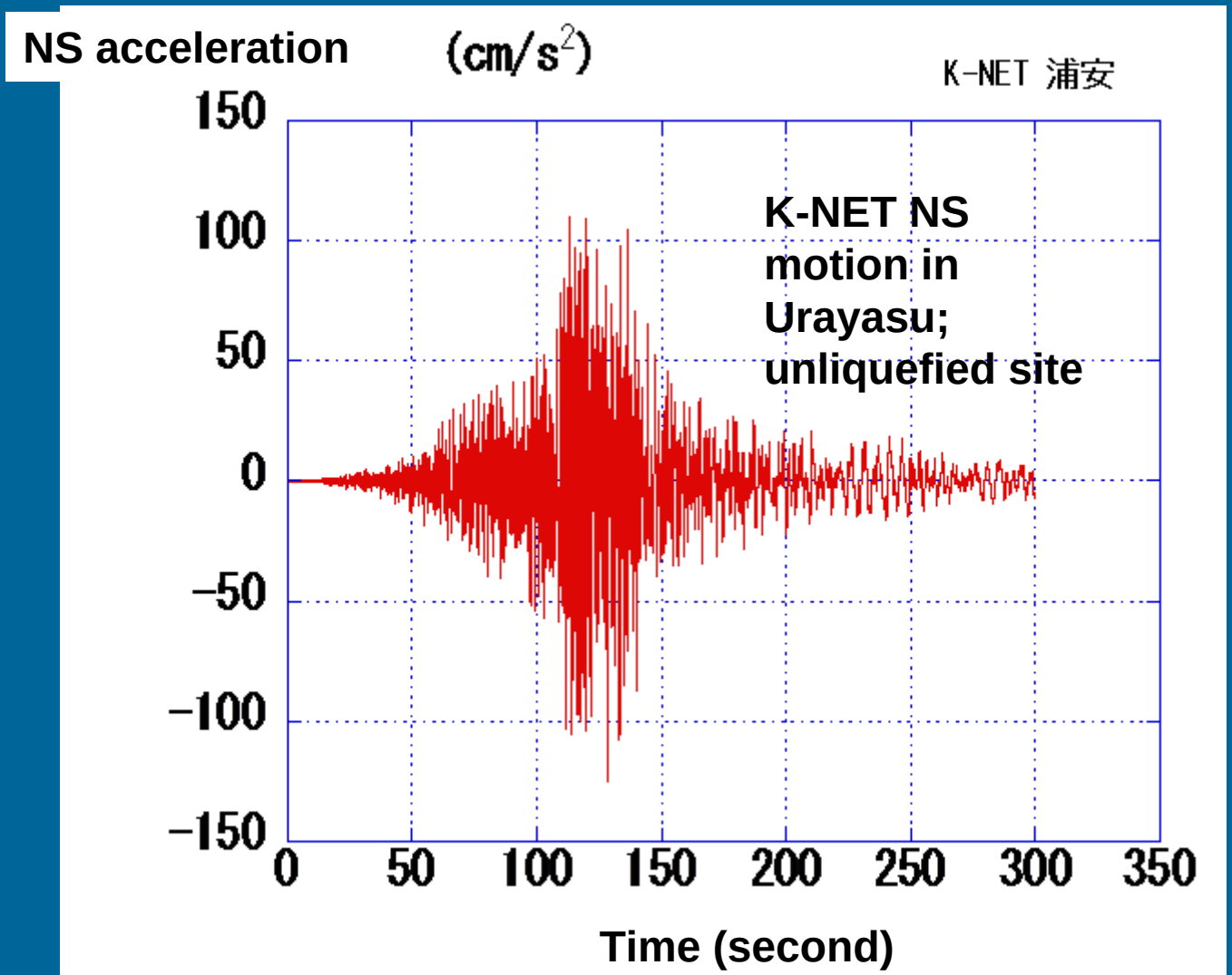
1978 1979 1980 1981

浦安市面積　48年　4.43km²　⇒　56年　16.98km²

浦安市HPより転載（http://www.city.urayasu.chiba.jp/menu2863.html）　二次配布不可！！

Feature of earthquake motion in Tokyo Bay area

Magnitude = 9.0; Long duration of shaking and many number of cyclic shear; liquefaction easy to occur.

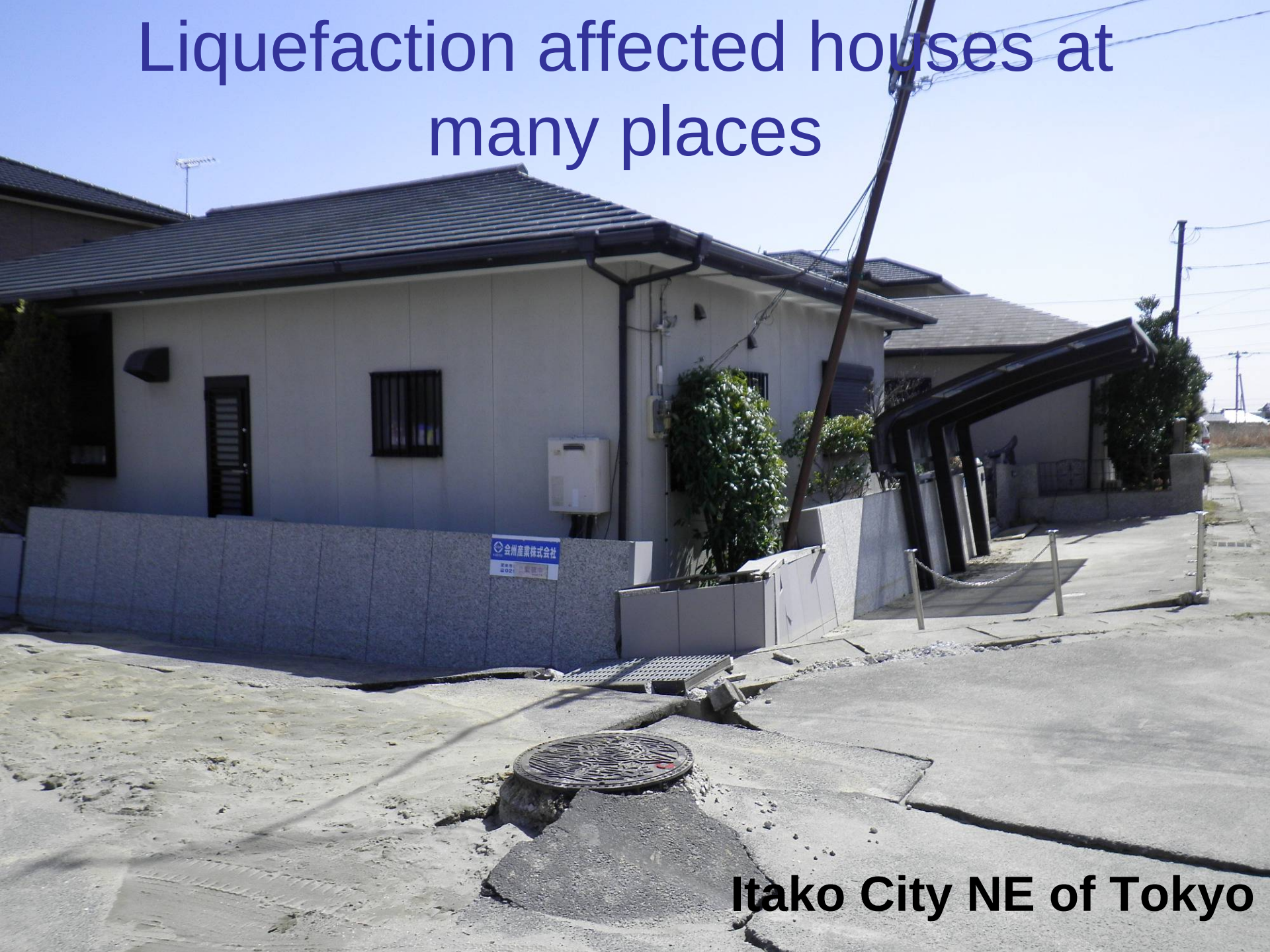


Liquefaction in residential area (Urayasu City)

Financial support is desperately needed for restoration

House tilting in Chiba City

Liquefaction affected houses at many places

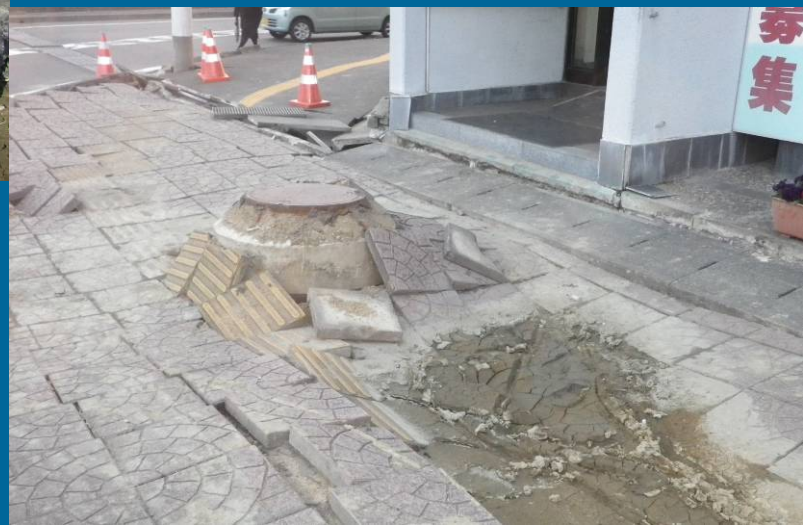


Itako City NE of Tokyo

Differential subsidence around pile-supported building and disconnection of lifeline (Urayasu City)

Successful soil improvement; Sand compaction piles and gravel drains

Sewage pipelines were destroyed at extremely many places



Problems of river levees
Nearly 2000 sites of damage

Liquefaction in foundation, subsidence, and lateral spread

Sand boiling on river side

Liquefaction in foundation

Repeated liquefaction; 4th time

1978 main and after-shocks, 2003 and 2011

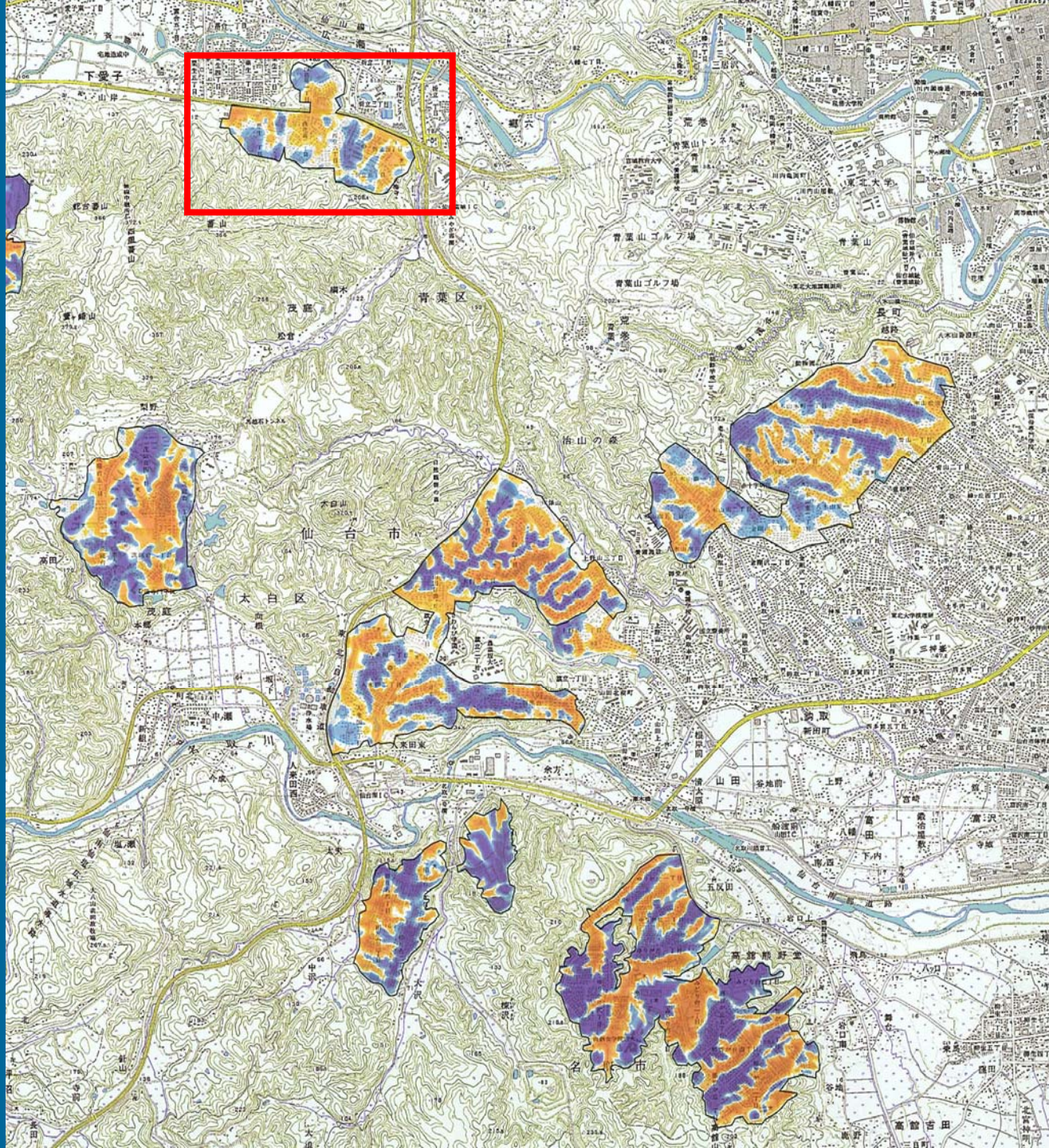
Most damages in river levees were associated with liquefaction in foundation or inside the levee.

Liquefaction is repeatable.

Damage in residential development in hilly area: cut and fill construction

Site of previous slope failure in 1978

In Sendai City, there are many residential developments in hill areas:



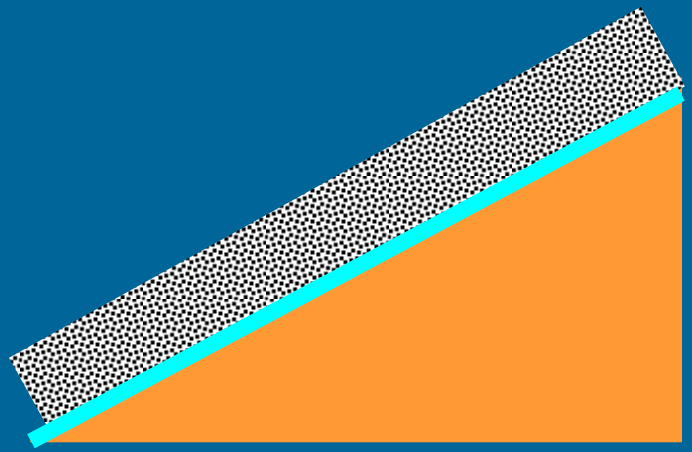

栗生五丁目
栗生四丁目
栗生三丁目
栗生二丁目
栗生一丁目
148.0
折立二丁目
81.0
浄化センター
折立三丁目
折立一丁目
112
208.4
薬師山

In Sendai City: On Fill,

On cut part, *in contrast, damage is much less*

Problems in residential fills

- Requirement for cutting cost
- Original surface (soft) soil remaining at the bottom
- Soil filling without removing vegetation
- Consequently, formation of soft layer between original ground and fill



Breaching of Fujinuma (irrigation) Dam

First dam was eroded and 150万m^3 of water attacked a downstream village

Flooded channel

Motion picture taken by eyewitness **Mr. S. Kobari**
by using his mother's mobile phone

Summary

- Vast area was affected and many damage occurred.
- Liquefaction affected private houses
- Residential development was damaged
- People need help from geotechnical discipline
- Individual damage is not so serious but number is significant.
- Should we revise design codes?