

Postseismic crustal movement of the 2011 Tohoku Earthquake and its impacts on hydrographic surveys and charts

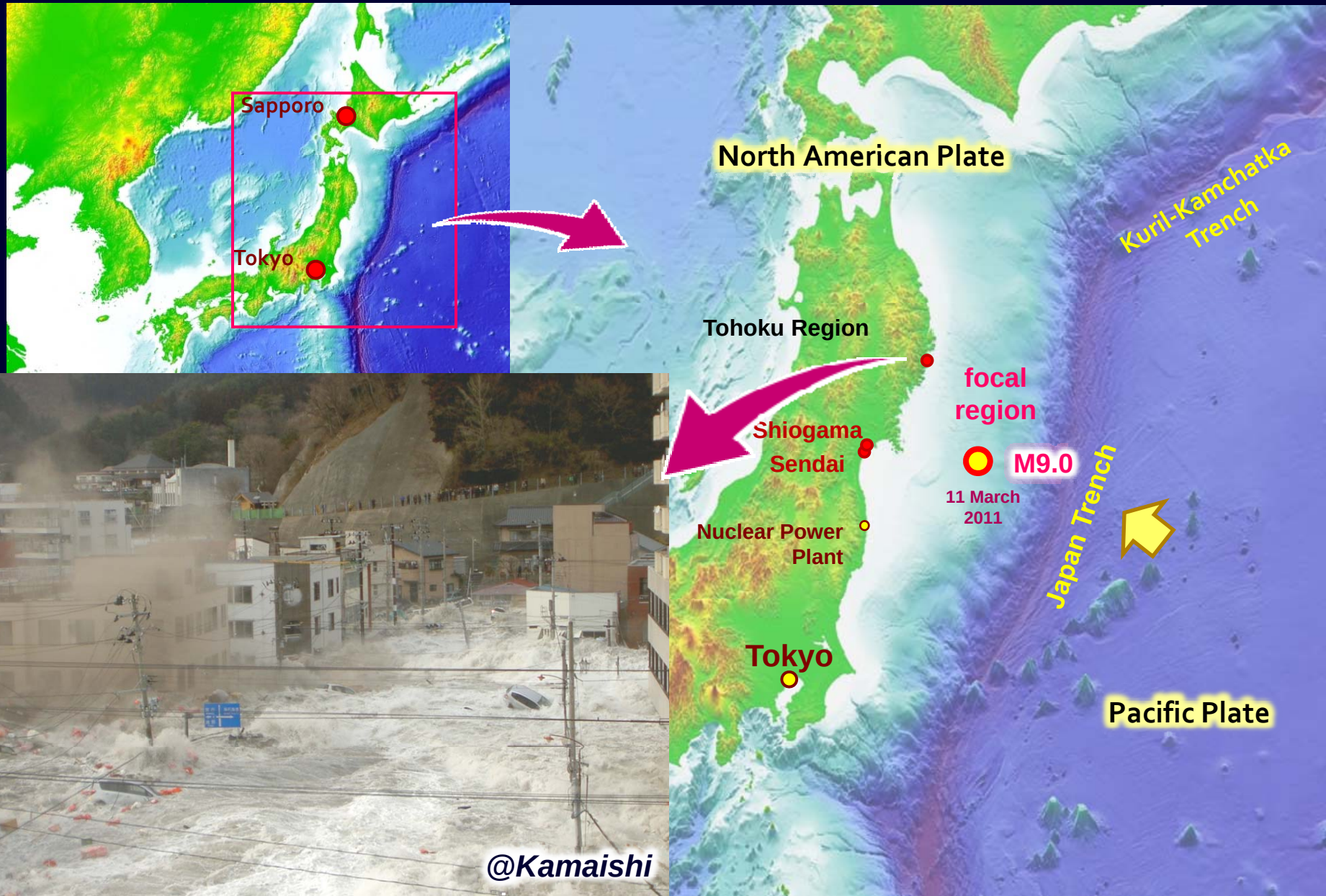
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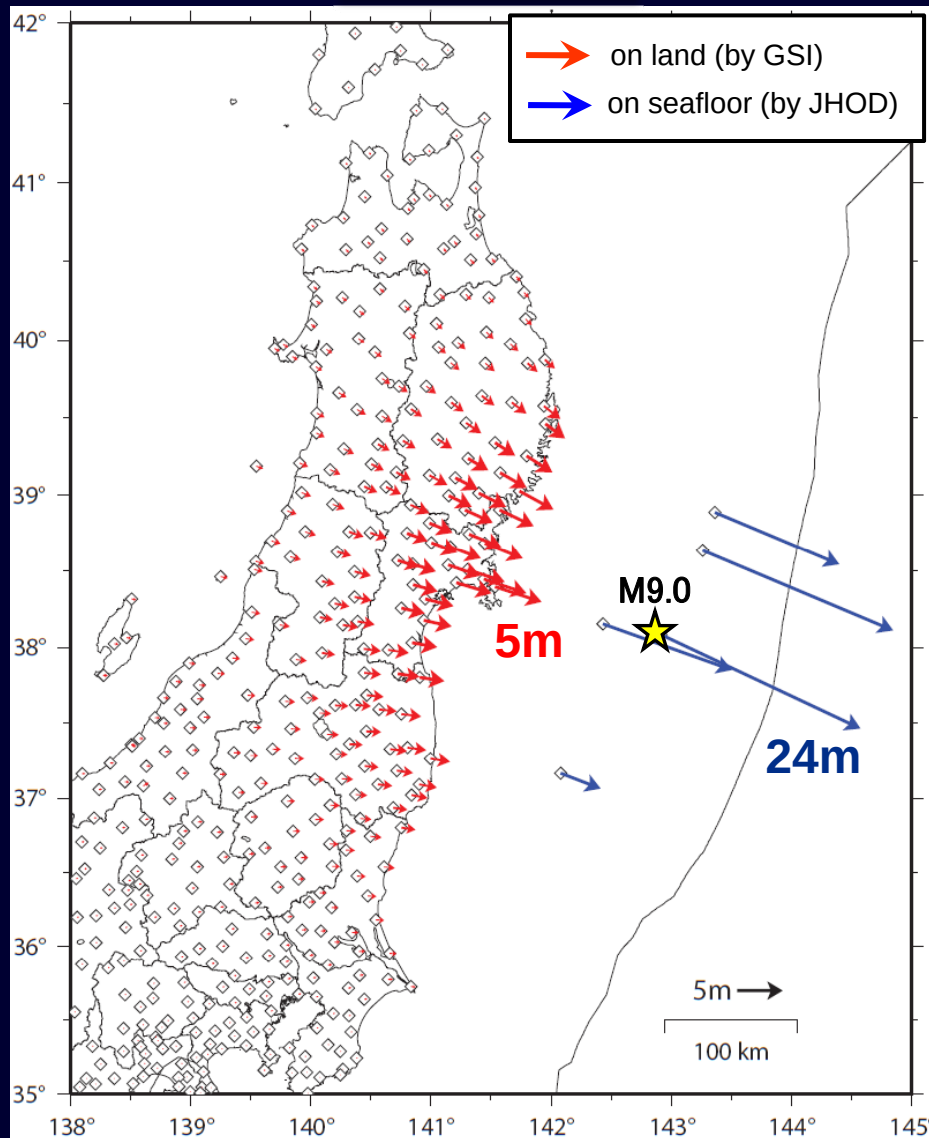
1. 2011 Tohoku Earthquake and JHOD's responses to the disaster
2. Issues related to postseismic crustal movement and JHOD's actions

2011 Tohoku Earthquake

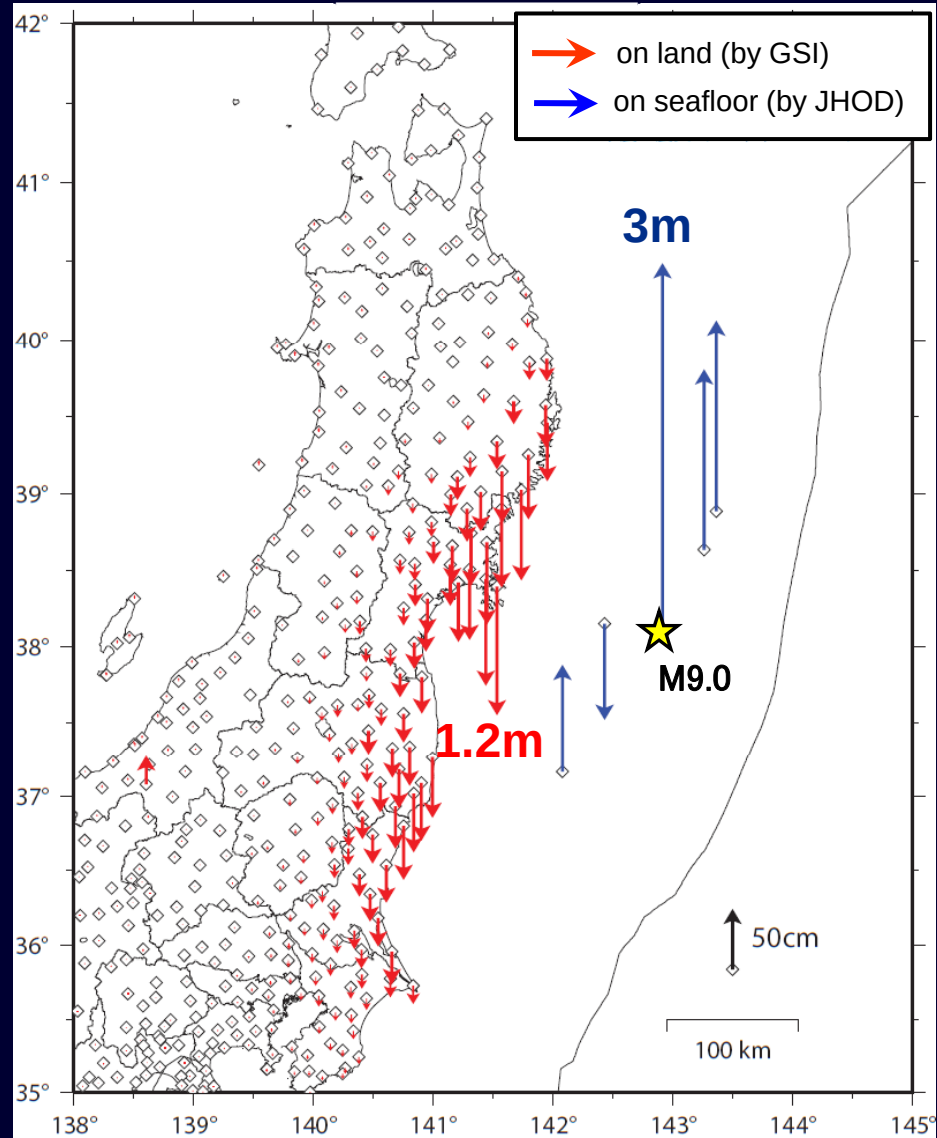


Coseismic movement

Horizontal



Vertical

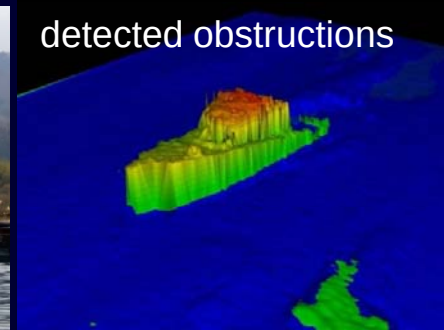


JHOD's Responses



1. Phase 1 (March - April 2011)

Obstruction surveys for re-opening damaged ports



All the ports were re-opened within 15 days after the earthquake.

2. Phase 2 (May 2011 -)

Hydrographic surveys for chart revision

1st stage : high-priority areas in a port

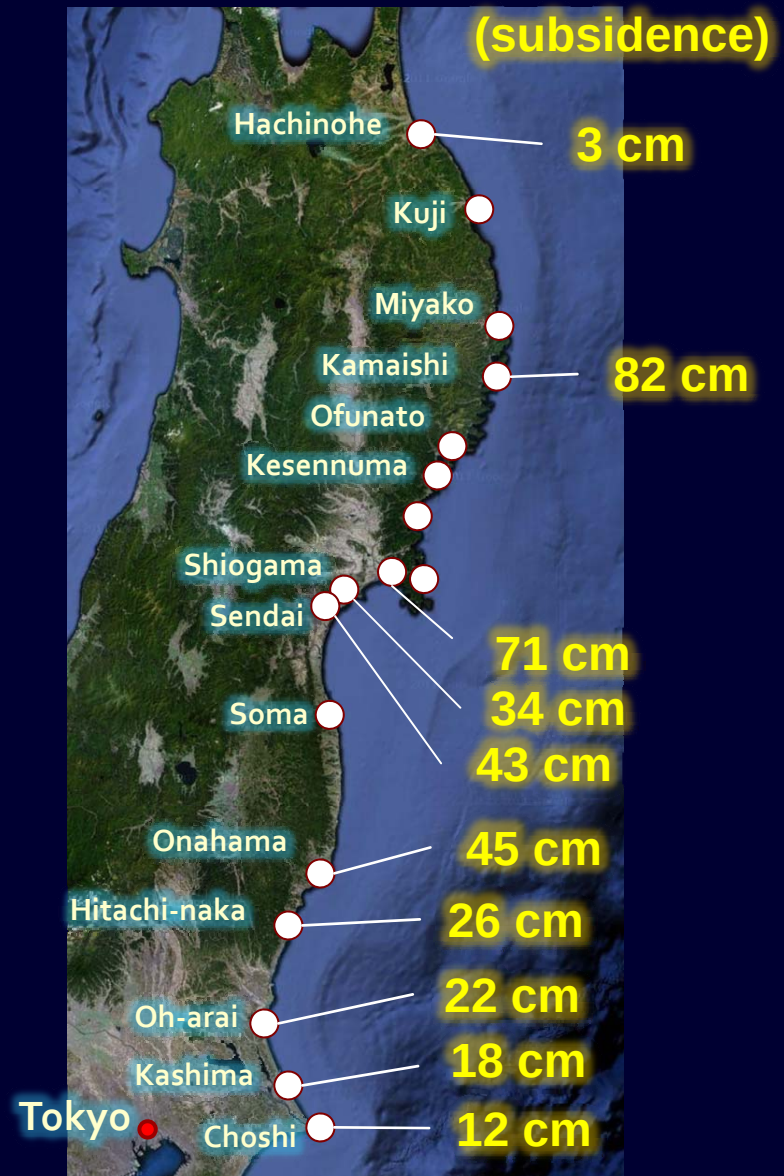
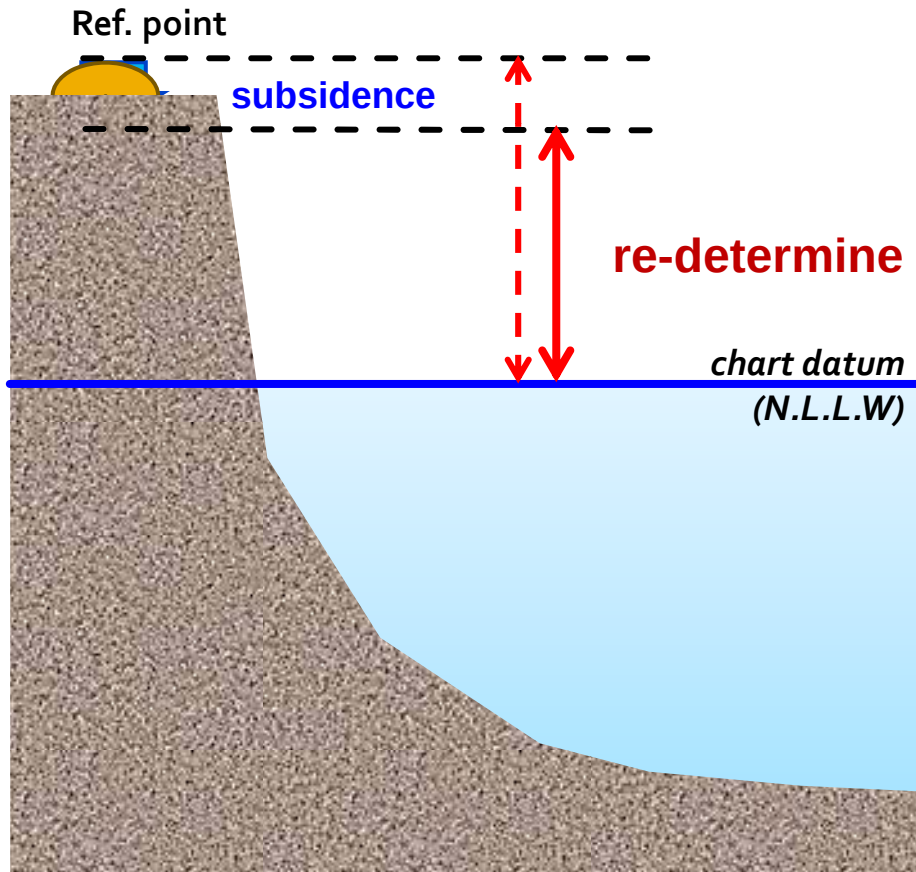
2nd stage: other areas in a port

Re-determination of chart datum levels

“CDL-11”

**= postseismic chart datum level
determined in 2011**

After the earthquake



(May-June 2011)

HL04 *Tenyo*



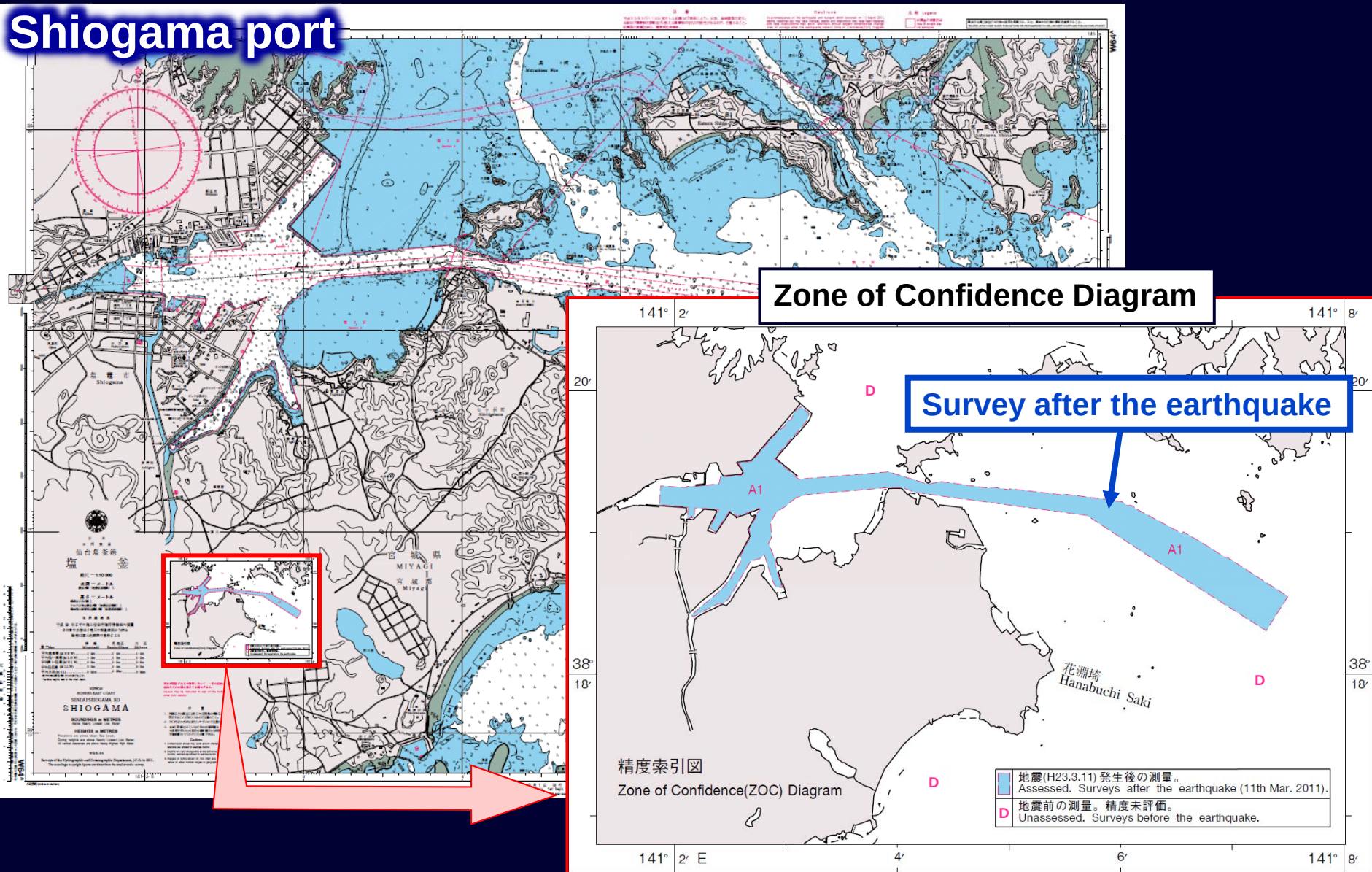
survey boat

A white survey boat with the hull number 'H04-M1' is shown on the water. Two crew members wearing orange safety gear are visible on deck. The boat is moving towards the right, leaving a small wake. In the background, an industrial port with various structures and cranes is visible under a clear sky.

SEABAT 8125

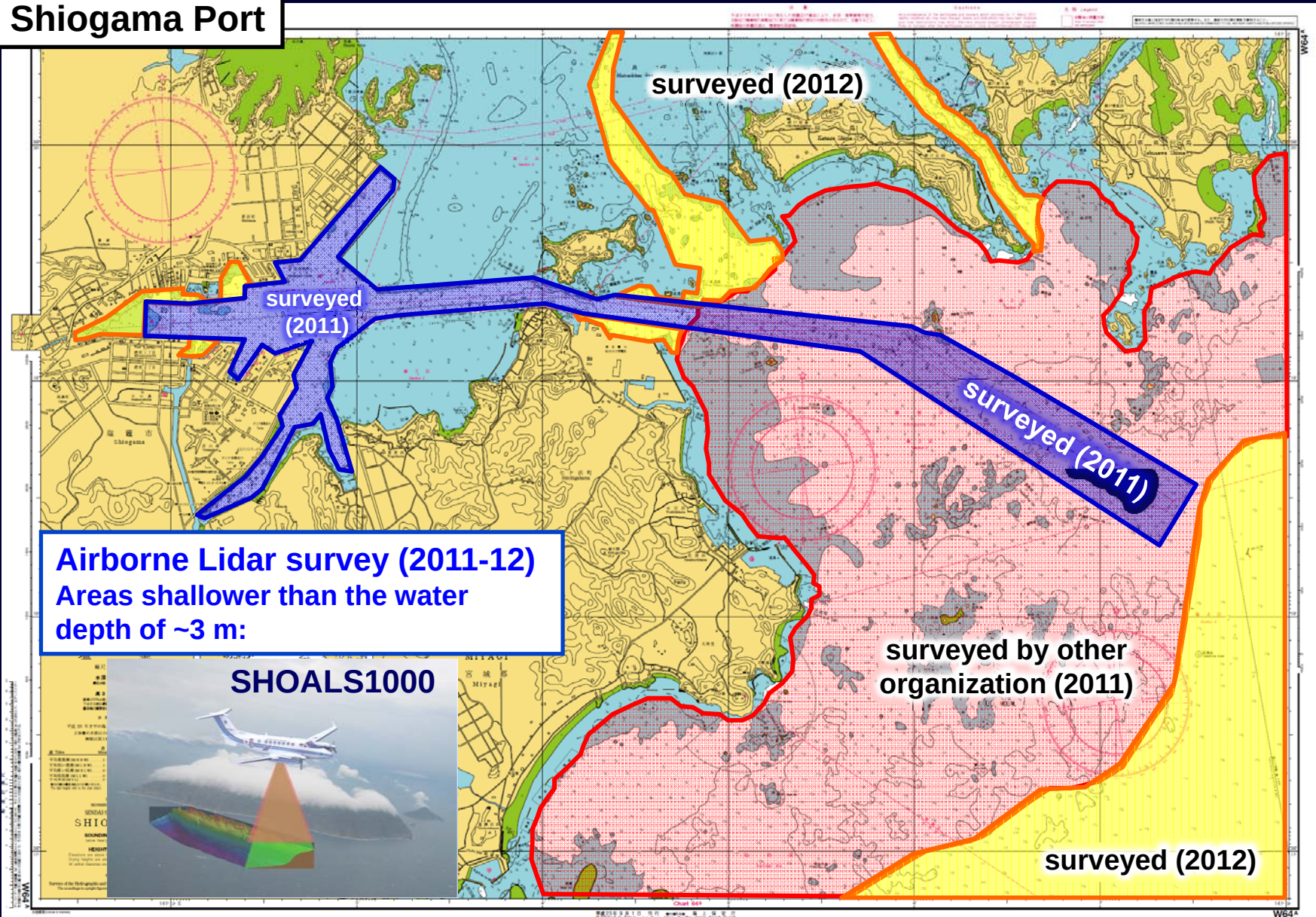
New edition chart (Sep. 2011)

Shiogama port



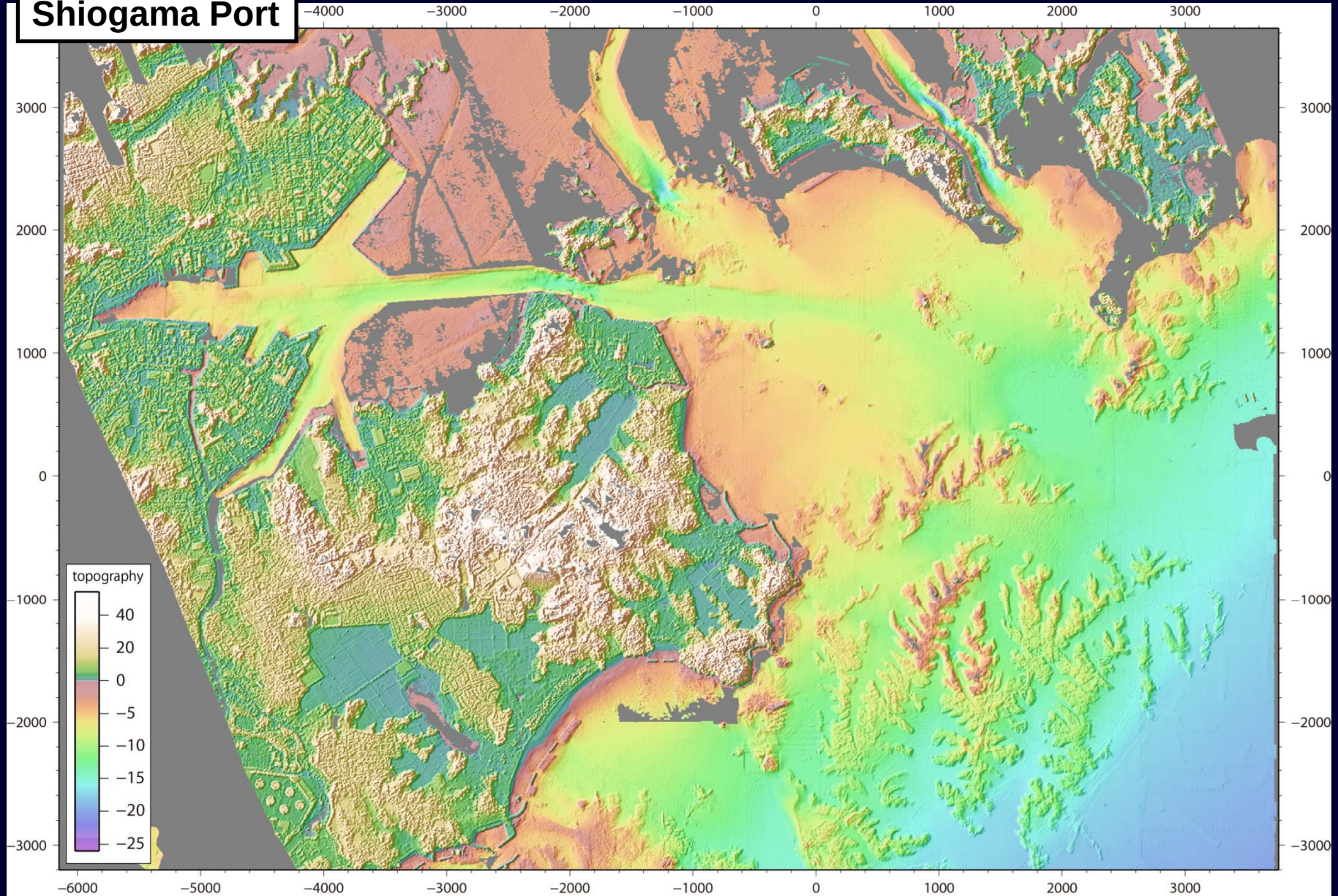
2nd-stage survey: other areas in a port

Shiogama Port

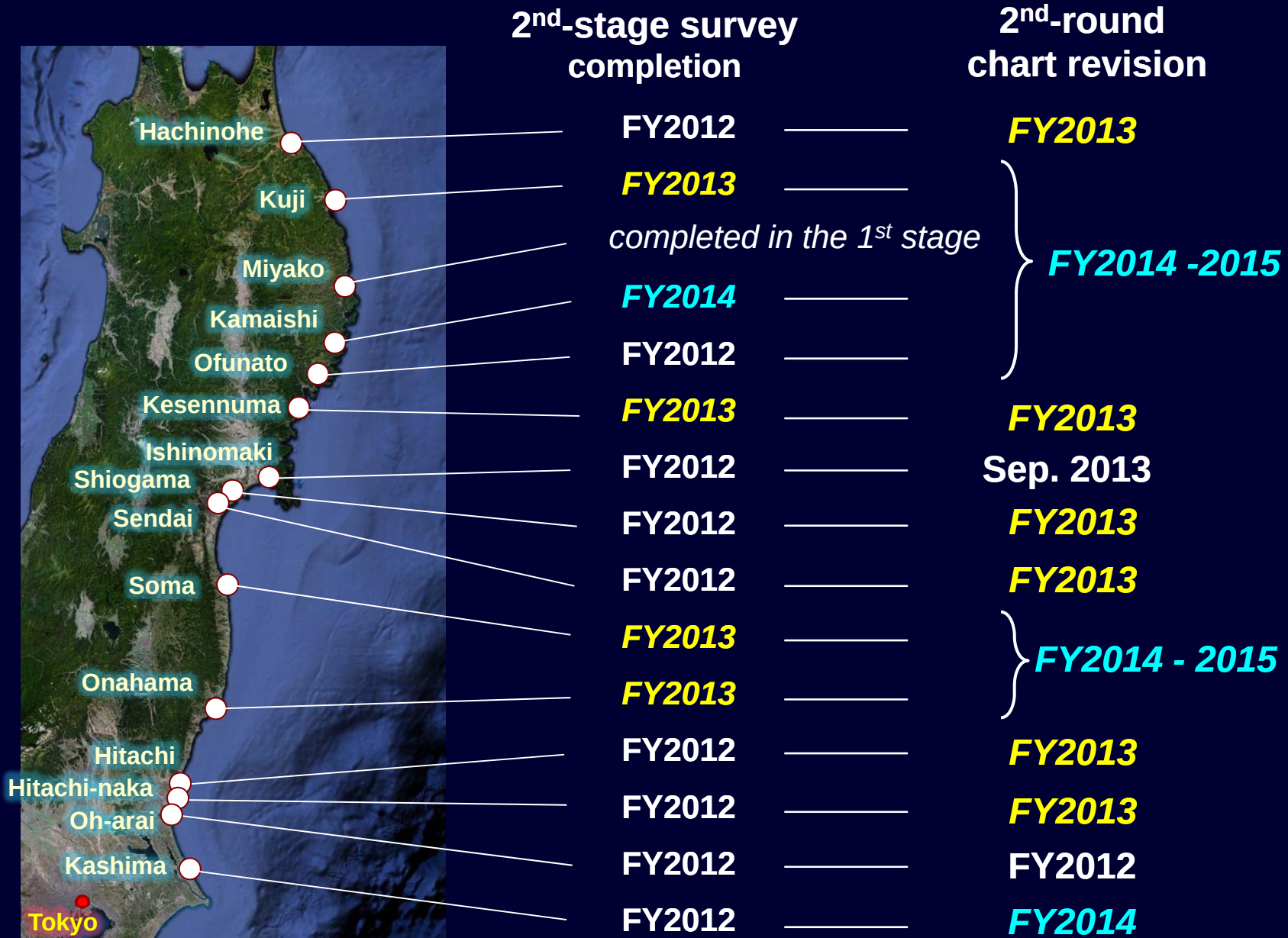


All data merged (June 2012)

Shiogama Port



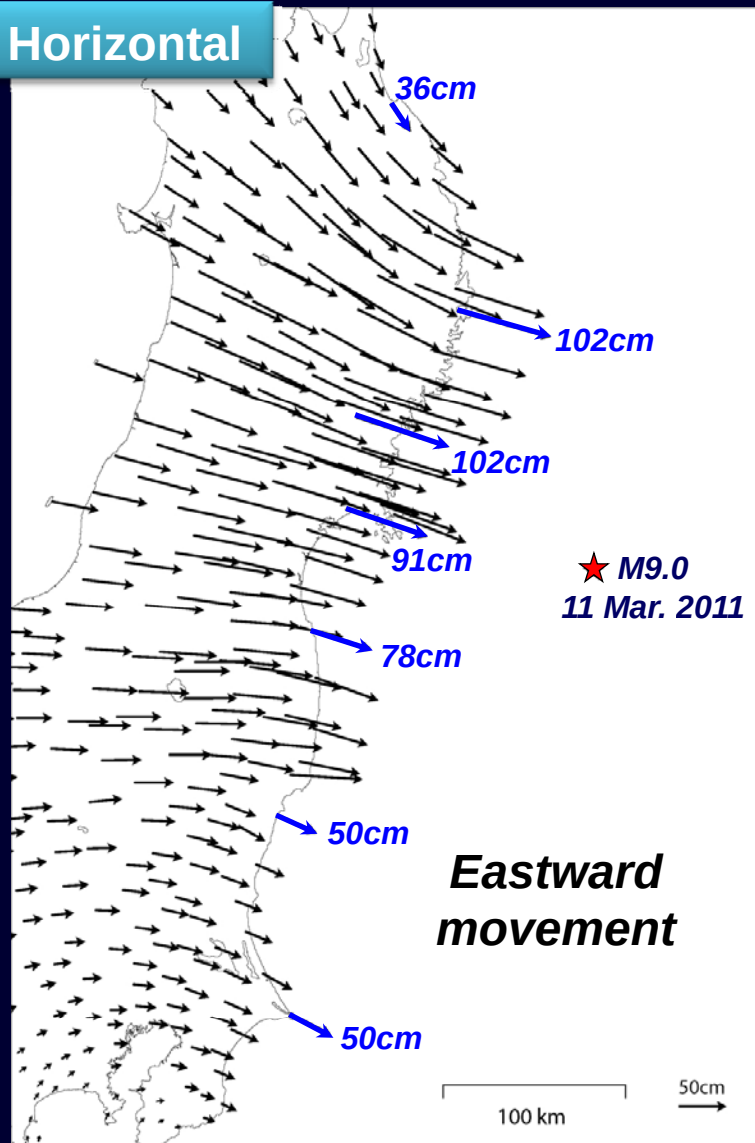
Progress as of Oct. 2013



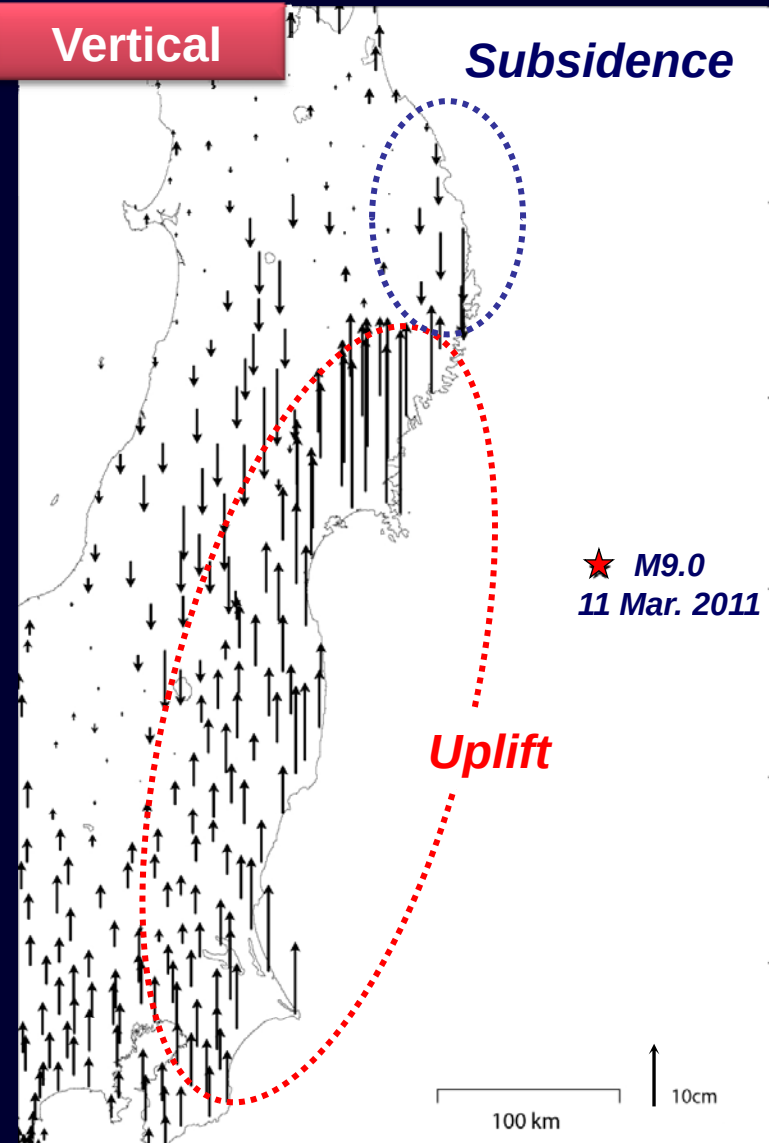
Postseismic movement (GEONET)

total displacement from 12 Mar. 2011 to Aug. 2013

Horizontal



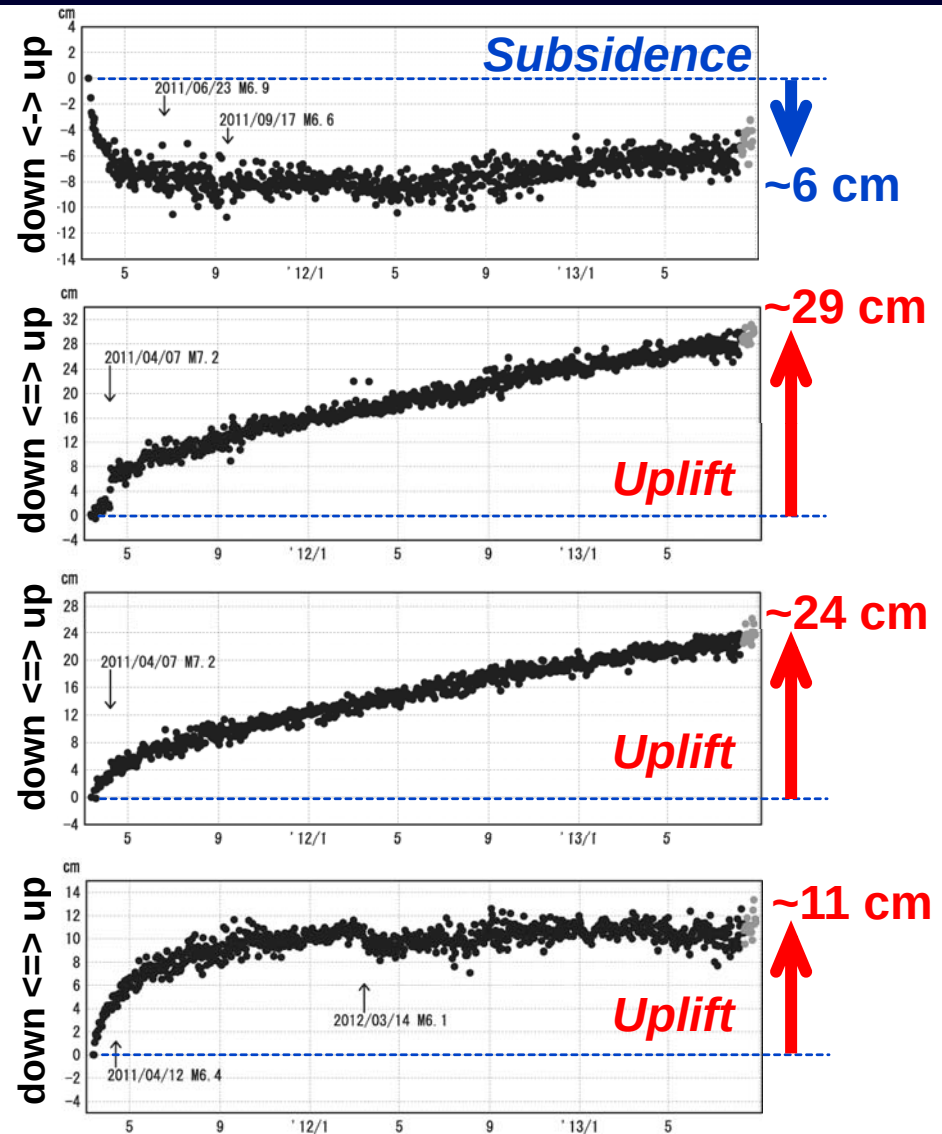
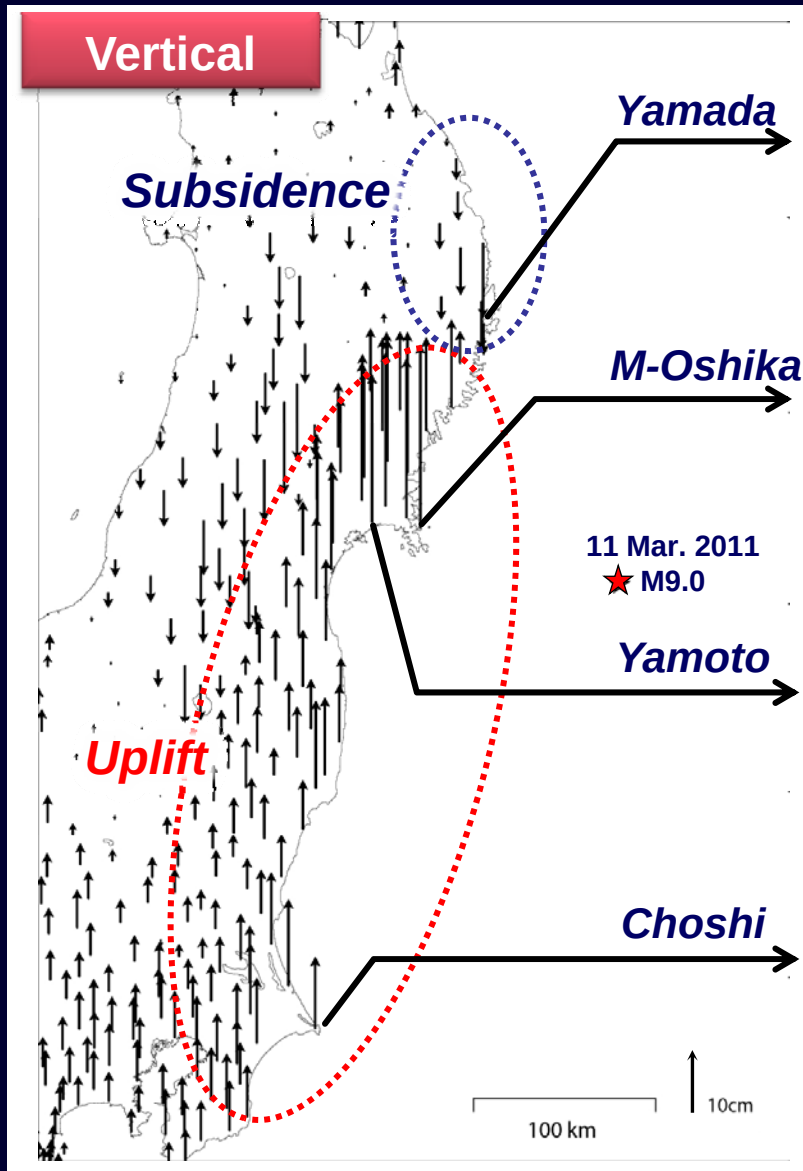
Vertical



Data: GPS network "GEONET" (by GSI)

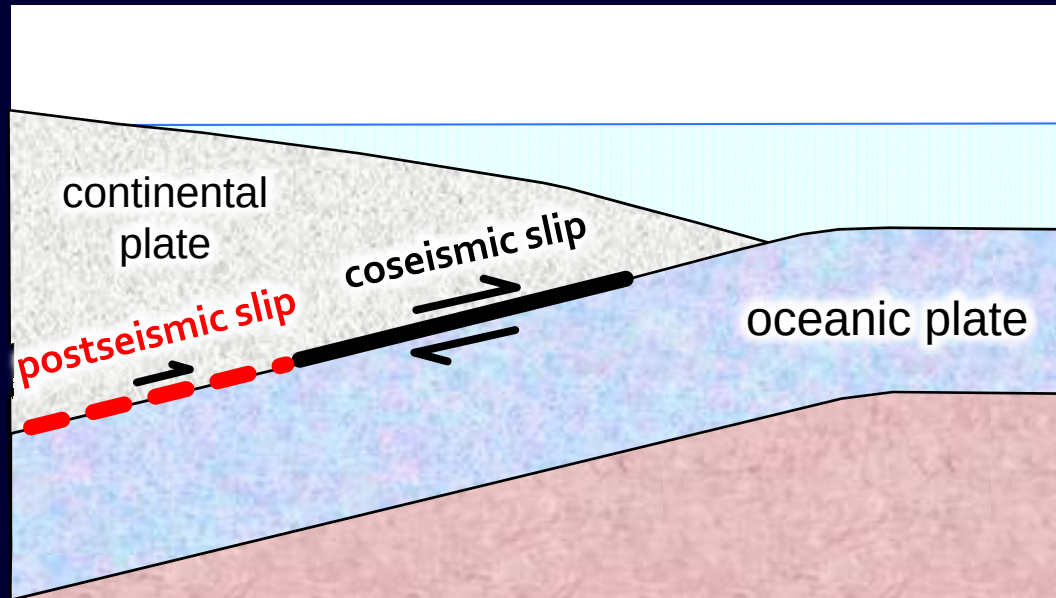
Time series of displacement

Period: 12 March 2011 to August 2013



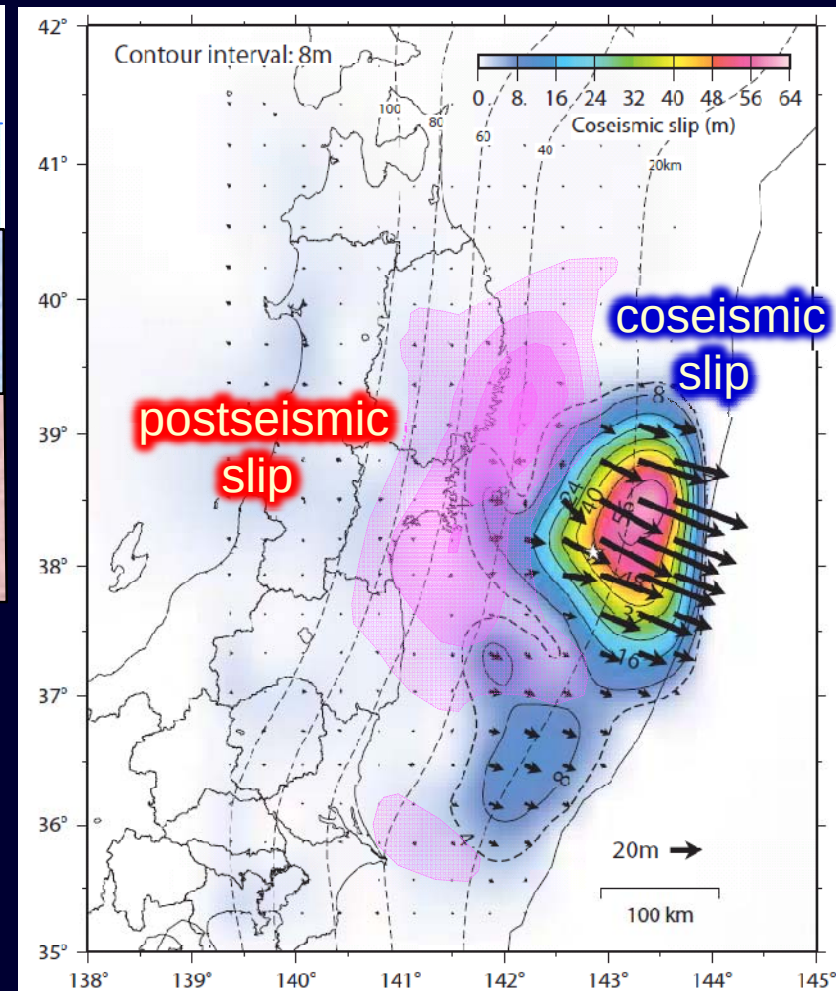
Data: GPS network "GEONET" (by GSI)

Mechanism of postseismic movement



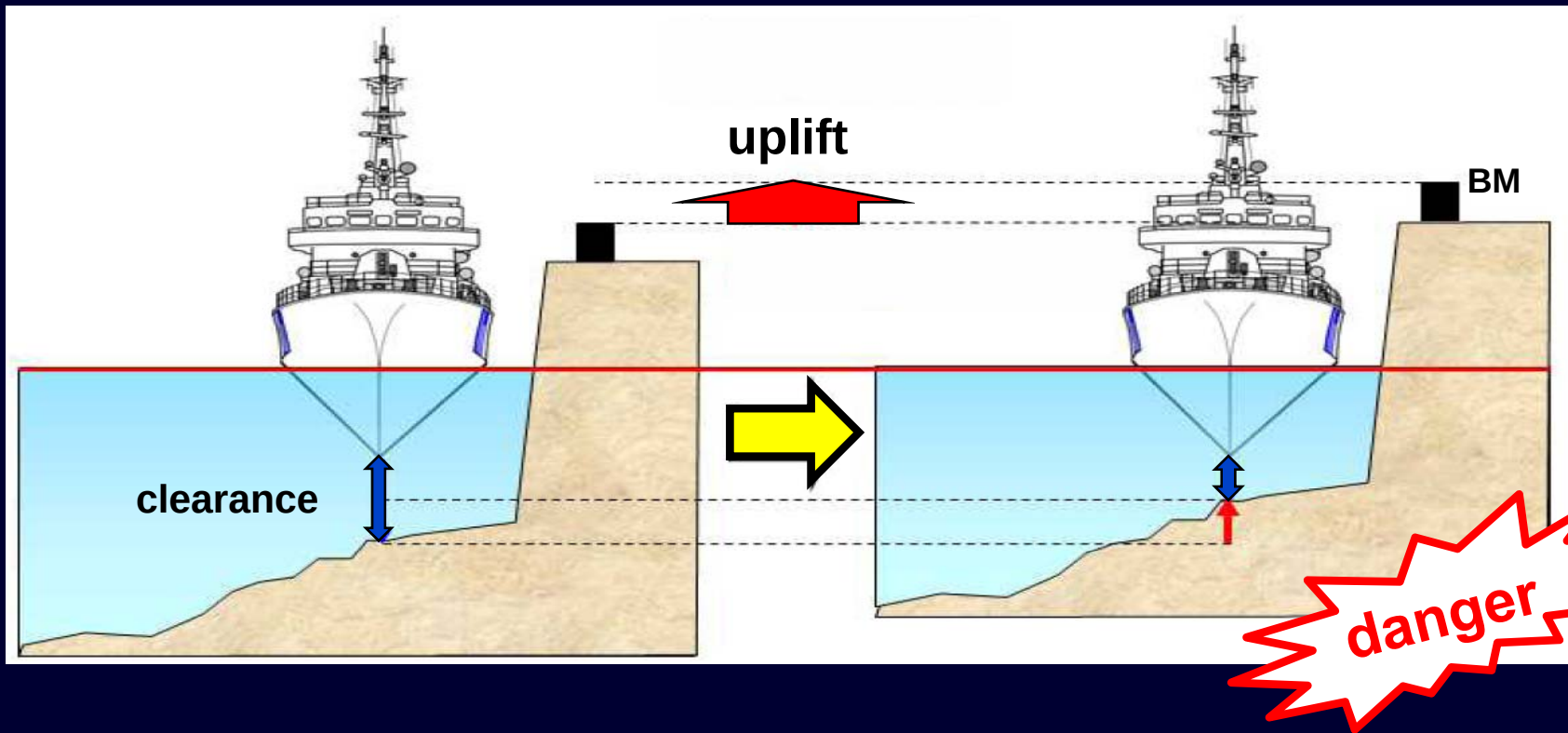
Postseismic movement

- Phenomenon common to major earthquakes
- Due to a slow slip in an adjacent region to a coseismic slip region



Estimated by terrestrial GPS data
and seafloor GPS/Acoustic data

Significant uplift will leads ...



Real depth $\ll$ Chart depth

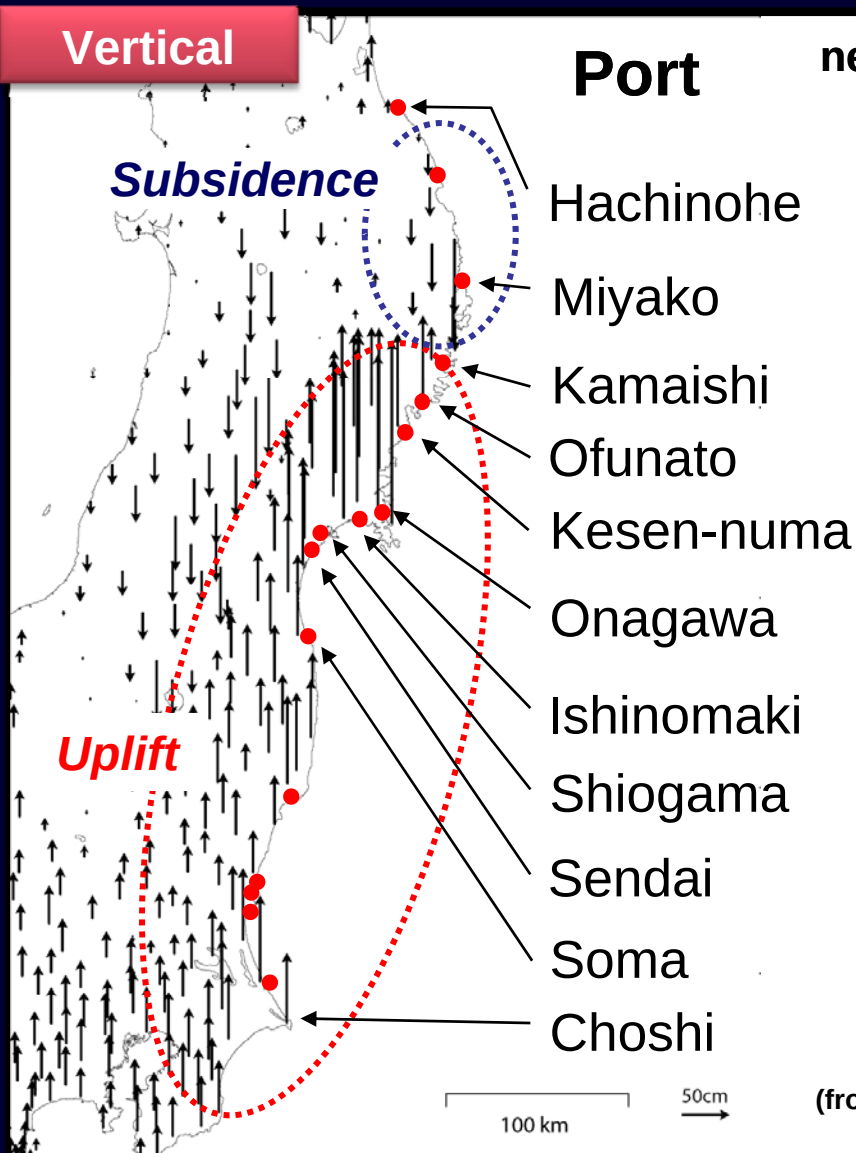


Risk to safety
navigation

“Re”-revision of chart datum levels (May 2013)

Period: 12 Mar. 2011 to Apr. 2013

Vertical



Port

nearest GEONET
station (land)

Tide observation

**re-determined for
4 ports in May 2013**

||

“CDL-13”

= postseismic chart datum level
determined in 2013

Hachinohe

+2 cm

Miyako

-6 cm

Kamaishi

+6 cm

Ofunato

+10 cm

Kesen-numa

+13 cm

Onagawa

+14 cm

+13 cm (from June 2011)

Ishinomaki

+22 cm

+15 cm (from June 2011)

Shiogama

+14 cm

+13 cm (from June 2011)

Sendai

+14 cm

+14 cm (from June 2011)

Soma

+12 cm

Choshi

+11 cm

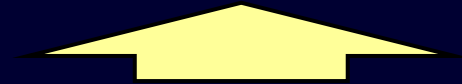
100 km

50cm

(from 12 March 2011)

Impact on survey data/charts

- a huge amount of existing sounding data collected after the earthquake, based on old chart datum levels
- soundings of nautical charts published after the earthquake



How should we deal with?

- to throw them away and do re-survey?
- to leave them as they are?

Approaches we took

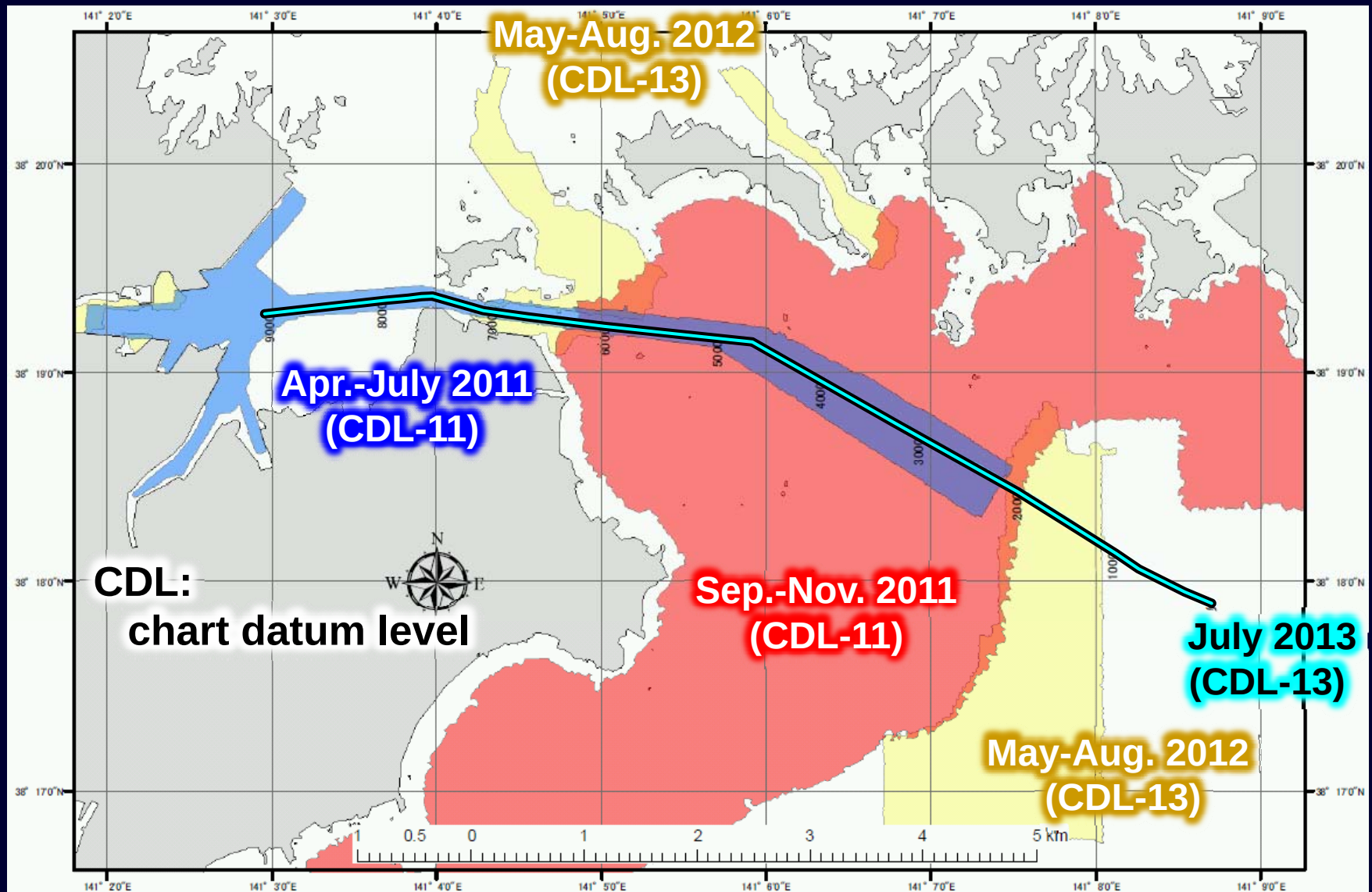
To do test surveys for checking if water depth change due to postseismic uplift has occurred over a chart area.



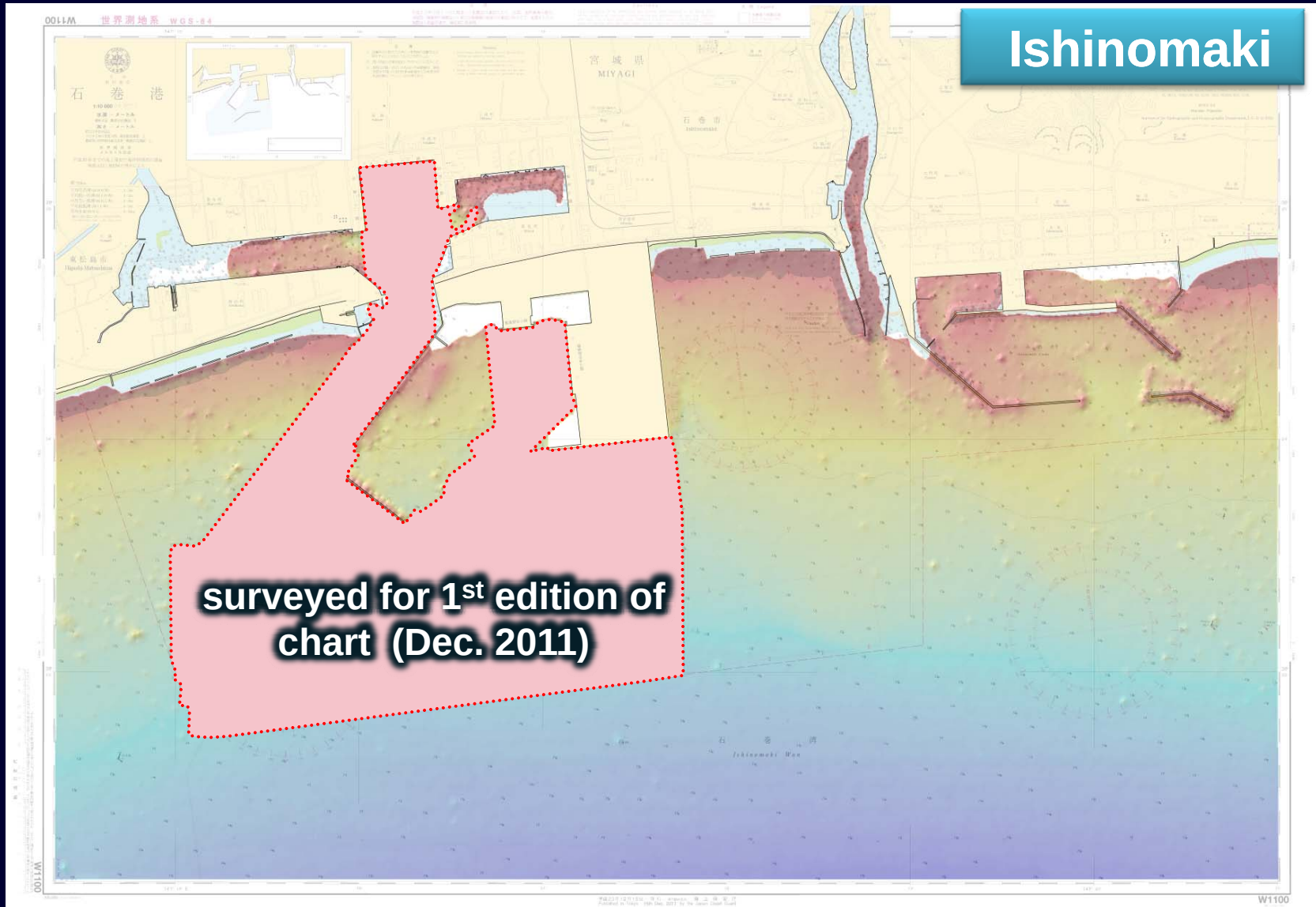
3 ports

- Large uplift has been observed
- New edition chart is to be published soon.

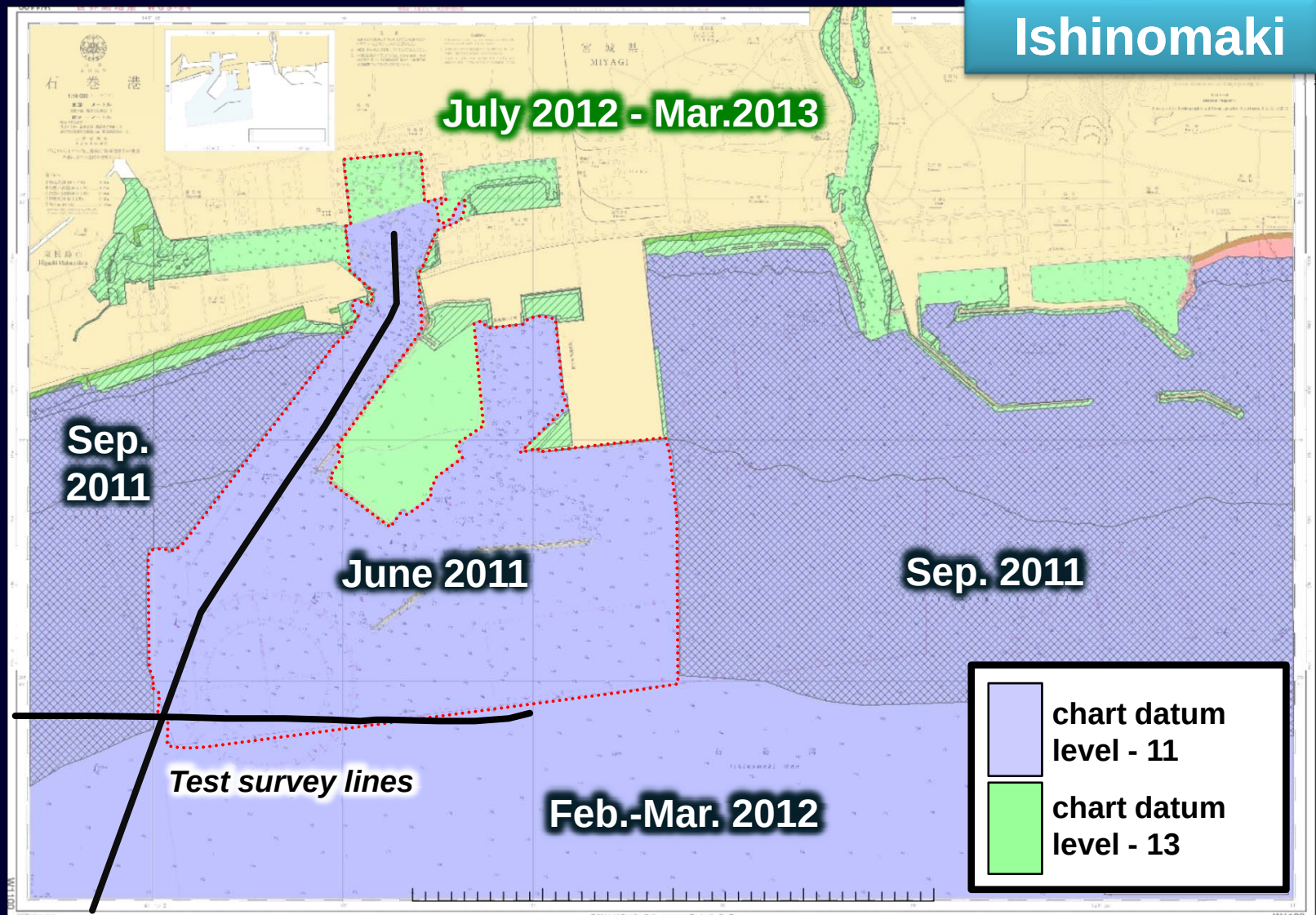
Test survey (Shiogama port, July 2013)



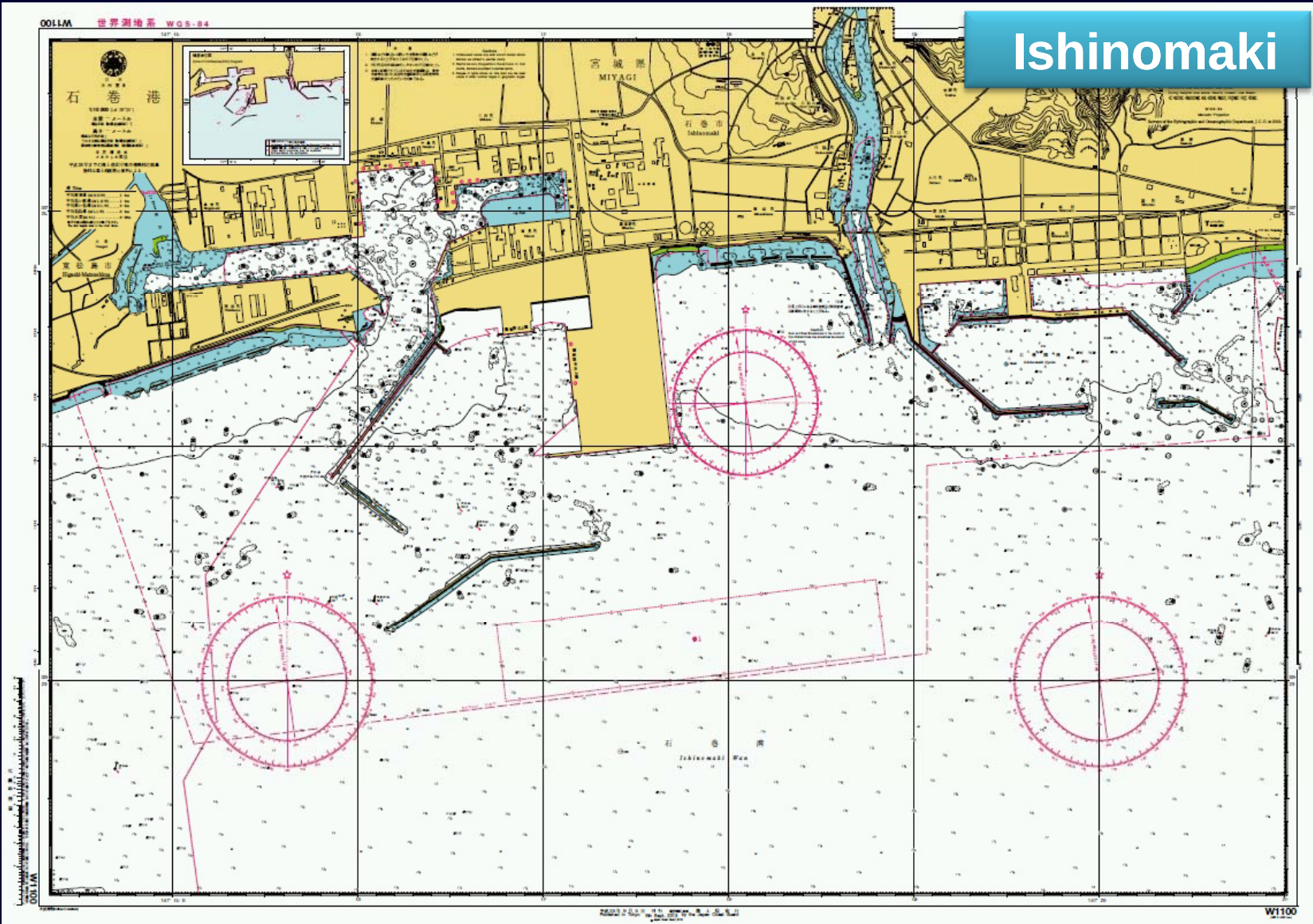
Another example of fully-surveyed port



Another example of fully-surveyed port



Ishinomaki



Concluding remarks

- For the three ports, depth correction was applied to existing older survey data across the board, using values of chart-datum-level change.
- Postseismic movement is anticipated to continue for further several years.
- In near future, similar depth correction may be needed for other ports and/or the above-mentioned three ports.



Thank you for your kind attention!

