

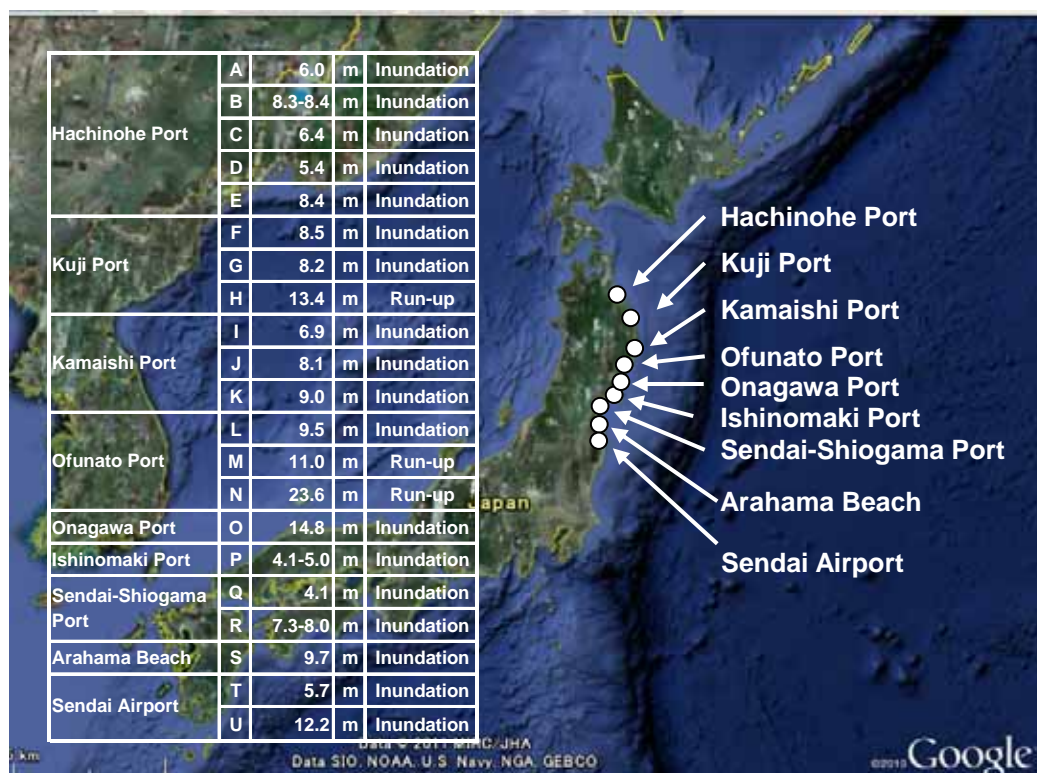
March 25, 2011

Executive Summary of Urgent Field Survey of Earthquake and Tsunami Disasters by the 2011 off the Pacific coast of Tohoku Earthquake

Port and Airport Research Institute (PARI) has accomplished urgent field survey of devastating multiple disasters of earthquake and tsunami by the 2011 off the Pacific coast of Tohoku Earthquake which occurred in March 11, 2011, at 14:46 local time, rating a magnitude of 9.0.

PARI dispatched three survey teams separately to the following major devastated ports and airports: 1) Hachinohe port, 2) Kuji Port, 3) Kamaishi Port, 4) Ofunato Port, 5) Onagawa Port, 6) Ishinomaki Port, 7) Sendai-Shiogama Port, 8) Arahama Beach, and 9) Sendai Airport through March 15-19, soon after the earthquake.

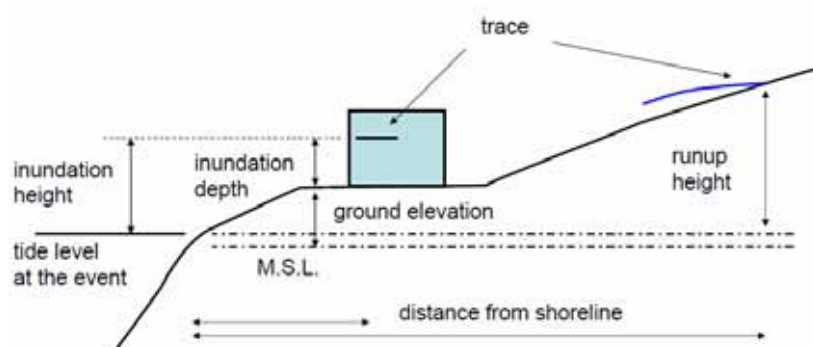
Major surveyed items are 1) inundation height, 2) run-up height, and 3) seismic damages of port structures.



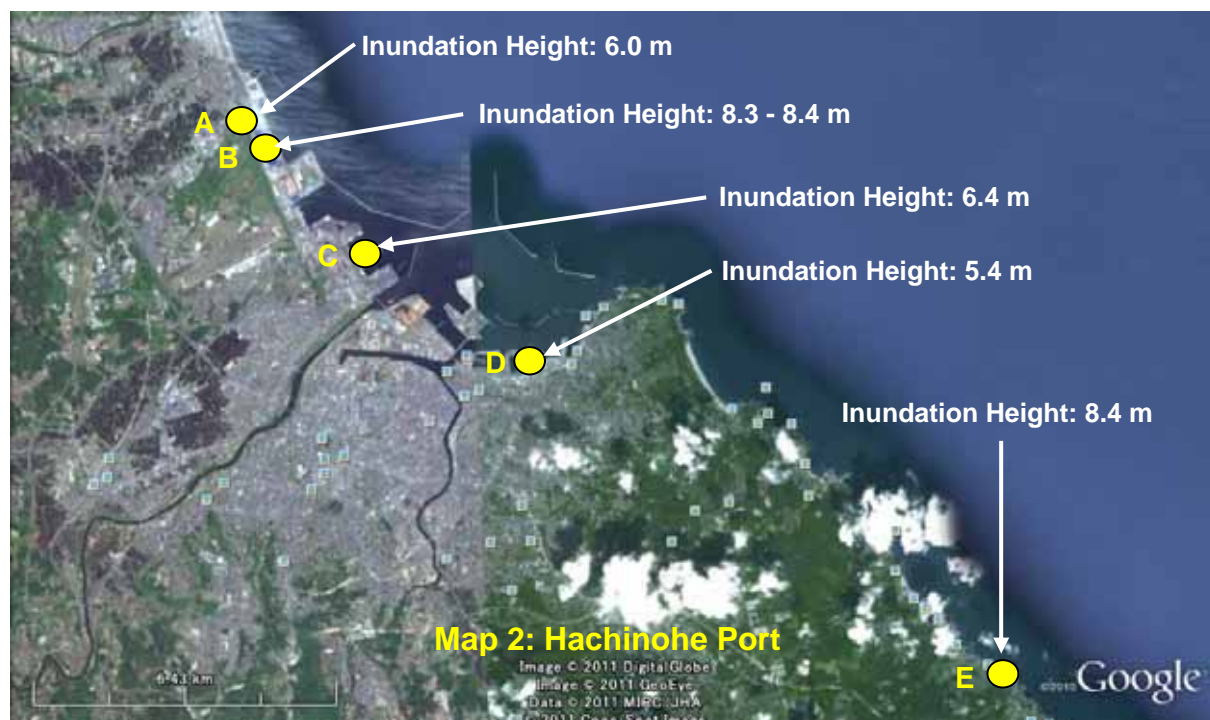
Map 1: Location of Surveyed Ports

1. Hachinohe Port

Inundation heights of 5.4 to 6.4 m were observed at the points **C** and **D** in the port area protected by breakwater. At the points **B** and **E** directly facing the Pacific Ocean, the inundation height was 8.3 to 8.4 m.



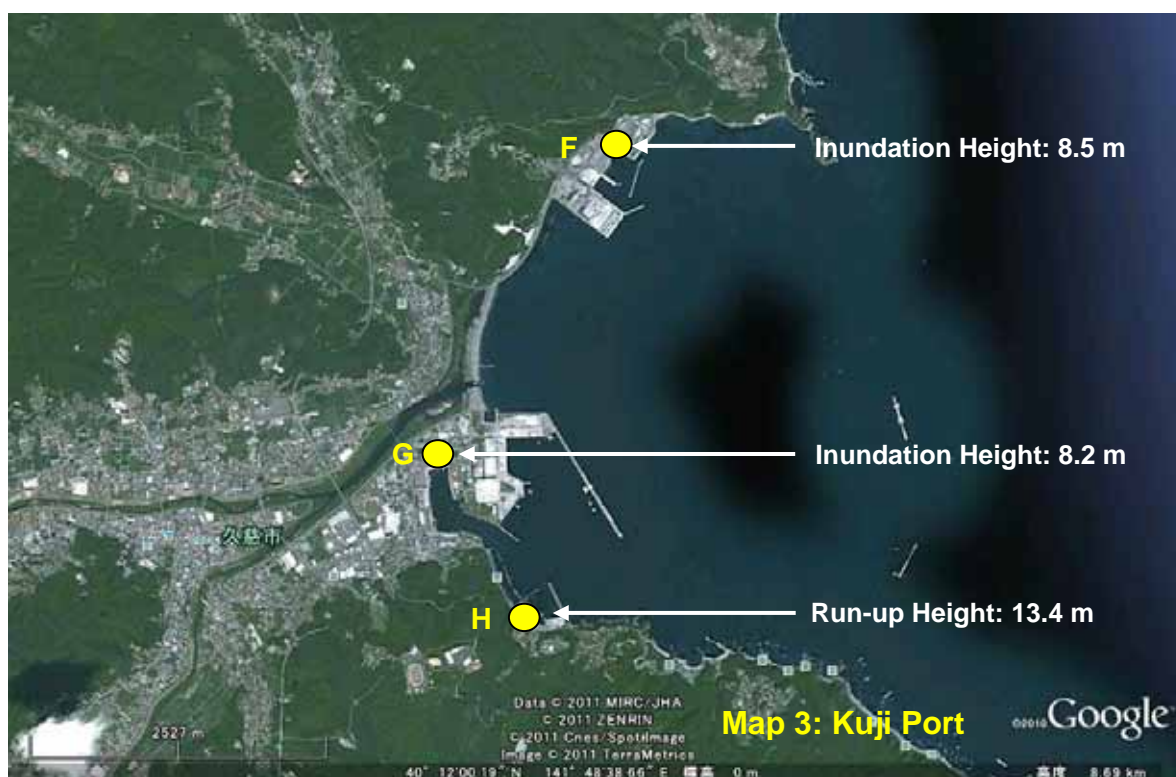
North breakwater caissons of 1,870 m out of the total length of 3,500 m were slipped out and submerged, being affected by tsunami. Significant seabed scours were observed at the mouths of the breakwaters as well as along with the reclaimed island quay.



2. Kuji Port

Inundation heights of 8.2 to 8.5 m were observed at the points **F** and **G** in the port area, and run-up height of 13 m was observed at the point **H**.

Outer breakwaters were visibly observed un-damaged. Floating dock was half-sunken, which was moored near the point **G** in the harbor. Upper concrete walls of caissons temporarily placed behind the breakwater were damaged.



3. Kamaishi Port

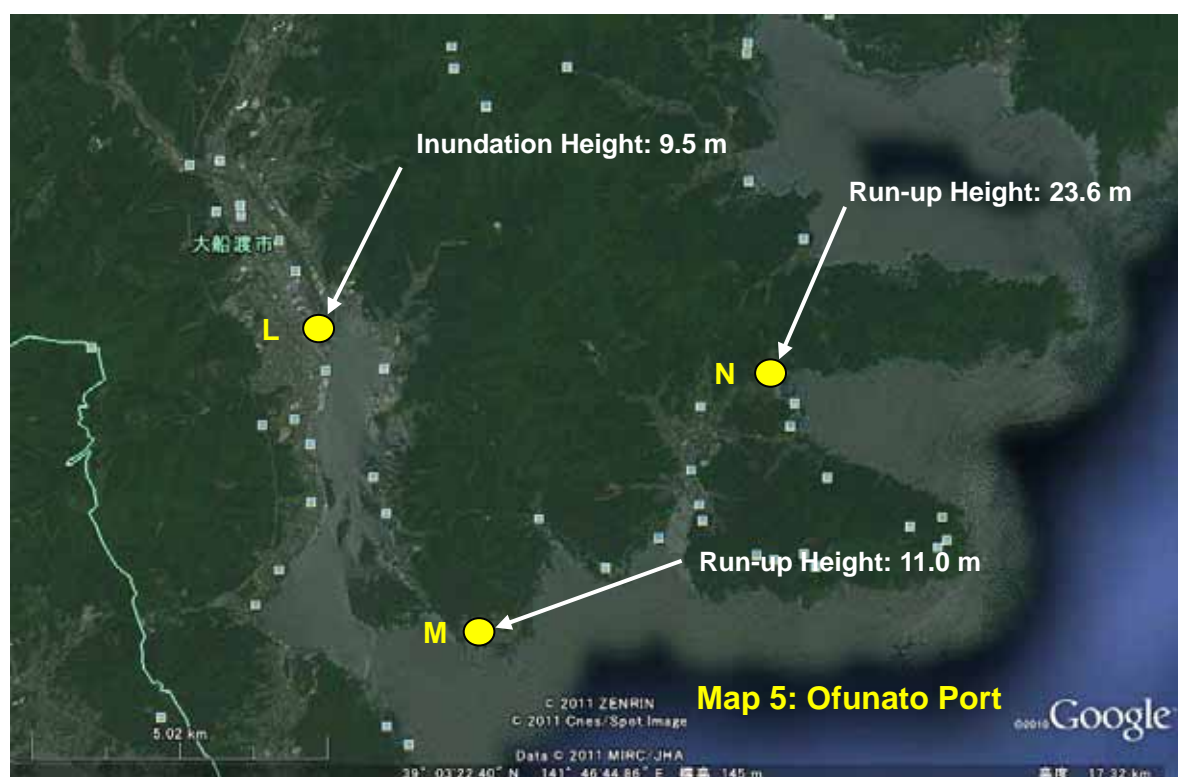
Inundation heights of 6.9 to 9.0 m were observed at the points **I**, **J**, and **K** in the inner port area. Most wooden houses were floated out completely. Reinforced concrete (RC) buildings and large-scale grain silos were damaged but not collapsed. A number of vehicles together with destroyed houses were observed floated out on the road.



4. Ofunato Port

Inundation height of 9.5 m was observed at the point **L** in the inner port area. Many RC buildings were observed inundated up to the second floor, having many logs stuck in windows, while most wooden houses were completely destroyed.

Run-up height of 11.0 meters was observed at the point **M** directly facing the Pacific Ocean. Furthermore, extremely high run-up height of 23.6 m was observed at the point **N**.

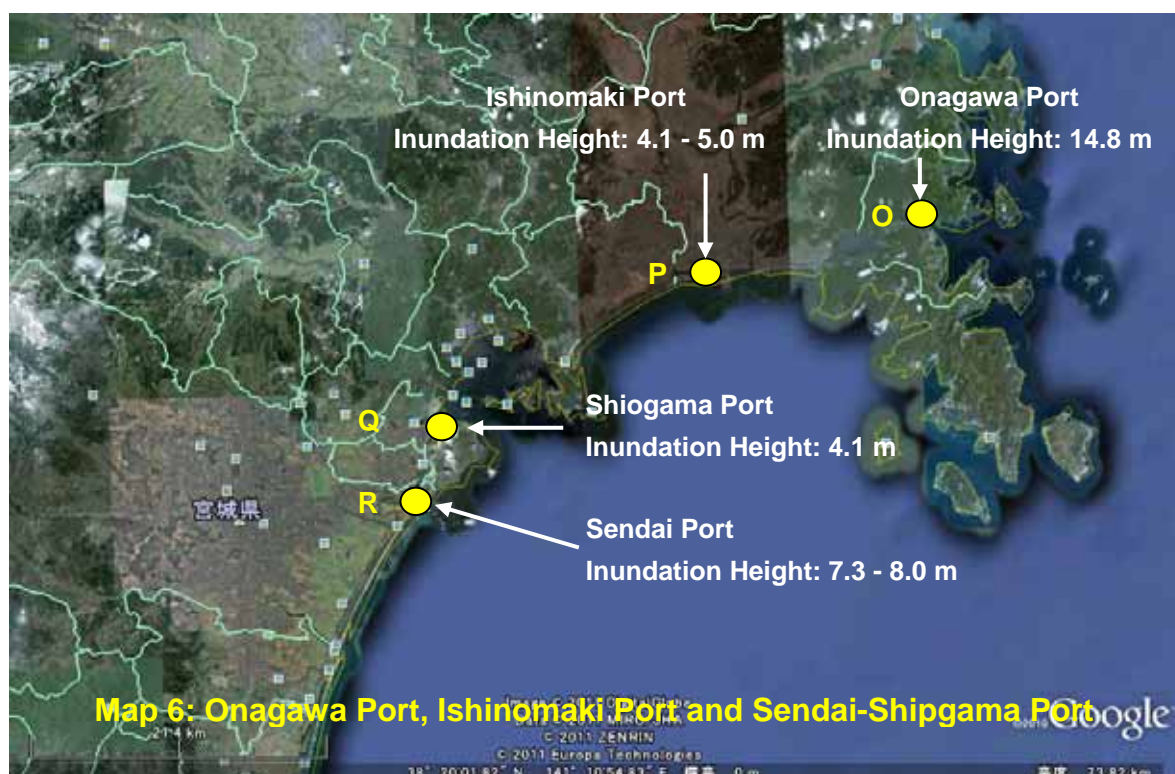


5. Onagawa Port, Ishinomaki Port and Sendai-Shiogama Port

Inundation height of 14.8 m was observed at the point **O** in Onagawa port area. Almost all the wooden houses were completely destroyed on the flat area. RC buildings were severely damaged but stayed at the original position. However, some steel-frame buildings were over-turned.

The inundation height was 4.1 to 5.0 m at the point **P** in Ishinomaki port area. Warehouses and RC buildings were damaged but not collapsed. On the other hand, some wooden houses were floated out several hundreds meters inland.

Inundation height of 4.1 m was observed at the point **Q** in Shiogama port area. At the point **R** in Sendai port area, the inundation height was 7.3 to 8.0 m. Significant numbers of tank trucks, vehicles and containers were floated out on the roads, having resulted in some damages on the many buildings.



6. Arahama Beach and Sendai Airport

Inundation height of 9.7 m was observed at the point **S** on the Arahama beach and no significant scours were observed behind the coastal dike. However, at the point **U** on the front beach of Sendai airport, where the inundation height was 12.2 m, significant scours were observed behind the coastal dike resulting in its collapse. Inundation height of 5.7 m was observed at the point **T** in the Sendai airport building.

