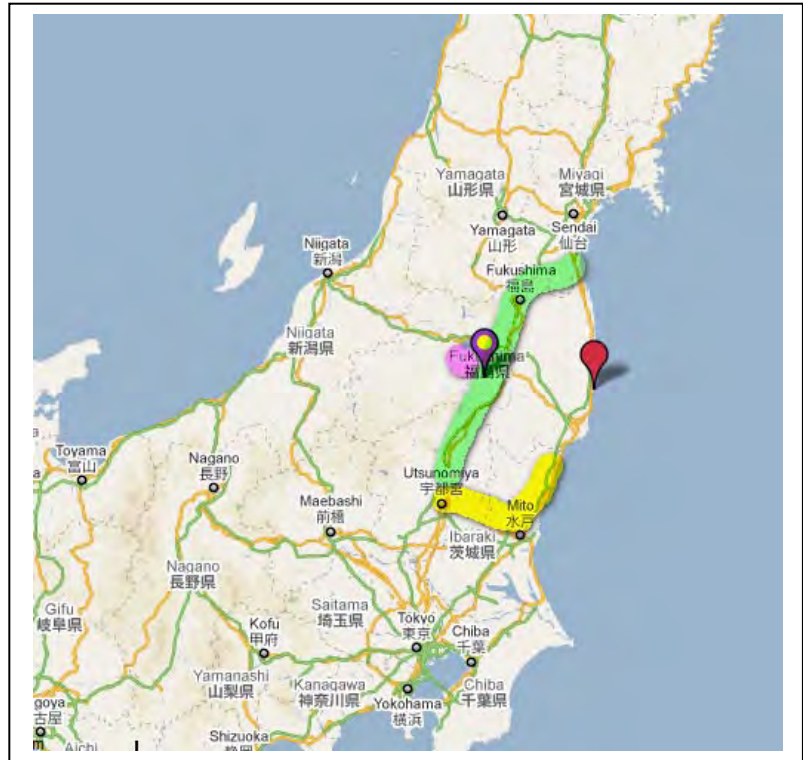


Re: Initial Survey, 11 March 2011 Tohoku Earthquake and Tsunami**31 Mar 2011**

C. Scawthorn (SPA Risk), J. Kiyono (Kyoto University), H. Sakai (Hiroshima Inst. Tech.)

This memo is written for non-Japanese investigators planning field surveys, and is based on a field survey 28-30 March. The map at right shows areas surveyed – for reference, the red pointer is Fukushima NPP, and our base was Utsunomiya. The locations visited are shown in the map below: March 28 (yellow) was over to the coast at the southern limit of significant runup, surveying liquefaction and tsunami runup at Oarai port, Hitachi City and further north. March 29 (green) was north to Fukushima City and then east to the coast at Soma and Shinchii (latter had about 2.5 km inland runup). March 30 was to Naganuma, site of the failure of an approximately 15 m high earthen dam, location shown by purple pointer with yellow dot.



Logistics: We traveled without a special pass and rented a hybrid car in Tokyo (Honda Fit) which allowed about 700 km on a full tank of gas. Our base was a hotel in Utsunomiya about an hour north of Tokyo, where conditions are quite normal. Gasoline north of Utsunomiya is generally unavailable at this time, so the radius for investigation is about as shown by the tracks. Travel is generally unimpeded except where roads are closed (ie, near the nuclear power plants, and at damaged roads).

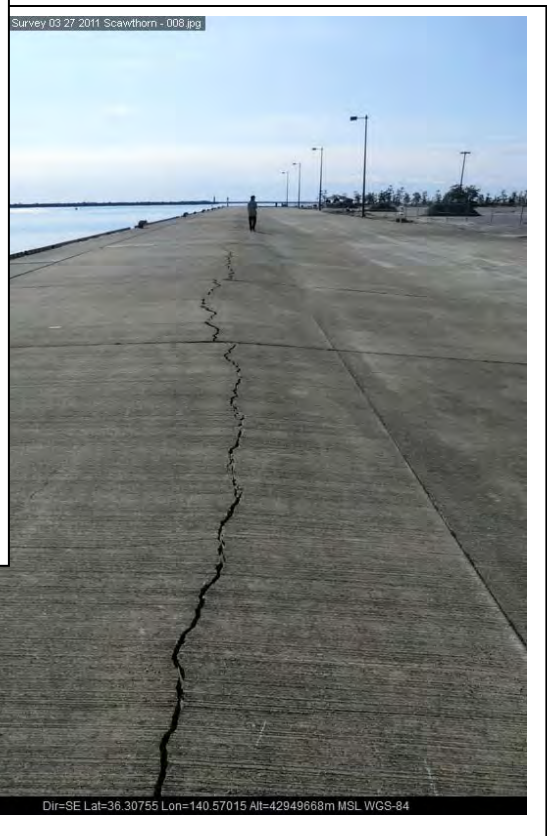
Summary Findings: As already observed by many, tsunami was the overwhelming cause of damage, - in the runup areas depths of 1 meter caused major damage to ordinary construction and runup of 2 meters near total destruction. Runup of 7 meters was not uncommon, with a reported maximum of 17m. Outside the tsunami runup, sporadic liquefaction, slope failures and minor structural damage was observed, as follows:

- **Geotechnical** effects outside the tsunami area appear limited – there are few slope failures relative to other earthquakes in Japan, and widespread liquefaction was not observed except in port areas.
- **Buildings** immediately beyond the runup area, and almost everywhere, were remarkable for lack of major damage. There is reportedly major shaking building damage at the Tohoku University campus in Sendai, but we didn't get that far.
- **Infrastructure:**
 - **Roads:** some slope failures, and disrupted pavements.
 - **Bridges:** some damage, but mostly undamaged. Did observe some coastal bridges washed away by tsunami (only abutments remained) at Shinchii. Usual settlement at abutments.
 - **Railroads:** There are two main N-S lines: the coast line, which is destroyed at several locations by tsunami, and will be out of service for months, and the inland main line

(including Shinkansen – approximately the green line in the map) which reportedly had structural damage to viaducts near Sendai. We observed the viaducts all along its route as far as Fukushima City, and didn't observe significant structural damage.

- **Electric Power:** beyond the nuclear plants, there are eight major fossil fuel power plants out of service, constituting 11% of Japan's entire installed capacity. This is a major disruption. See discussion below at Ports.
- **Telecom:** Cell towers and service OK as of the time of our visit.
- **Water and Wastewater:** appeared generally restored, with few excavations for pipe replacement. Observed a number of undamaged at grade water tanks.
- **Oil Tanks:** a number of large (50,000 kt) oil tanks were observed at several locations, with no apparent signs of sloshing or other damage.
- **Ports:** Ports are heavily impacted by tsunami, but also have quay damage due to liquefaction, reminiscent of Kobe. Soma is a significant deepwater port – a coal pier there serves the 2000 MW Soma Kyodo electric generating station and had its coal conveyor destroyed by the tsunami, as well as collapse of two of four major coal bucket cranes.
- **Shipping:** Nine major vessels totaling about 540,000 dwt were grounded or more seriously damaged.
- **Fisheries:** large numbers of fishing boats have been destroyed.

Selected photos follow (all georeferenced – the orange stamped locations are only approximate – use the lat/long at bottom), which should be self-explanatory from above text. The first author will be posting about 1,000 such photos to www.sparisk.com as soon as possible, and can be reached at cscawthorn@sparisk.com. Also attached is a scan of a page from Asahi newspaper showing areas of runup (pink) and still standing water (red) as well as tsunami wave heights, with key locations in English.



Japan Tohoku EQ Survey 03 28 2011 Scawthorn - 224.jpg



Location: IKANIKEISAIGANAIBAAI, IBARAKIKEN - Object: MURAMATSU
Dir=N Lat=36.45557 Lon=140.59578 Alt=16m MSL WGS-84

Japan Tohoku EQ Survey 03 28 2011 Scawthorn - 364.jpg



Location: HISANOHAMAMACHIHISANOHAMA, FUKUSHIMAKEN - Object: HISANOHAMA
Dir=WNW Lat=37.14256 Lon=141.00046 Alt=3m MSL WGS-84

Japan Tohoku EQ Survey 03 28 2011 Scawthorn - 358.jpg

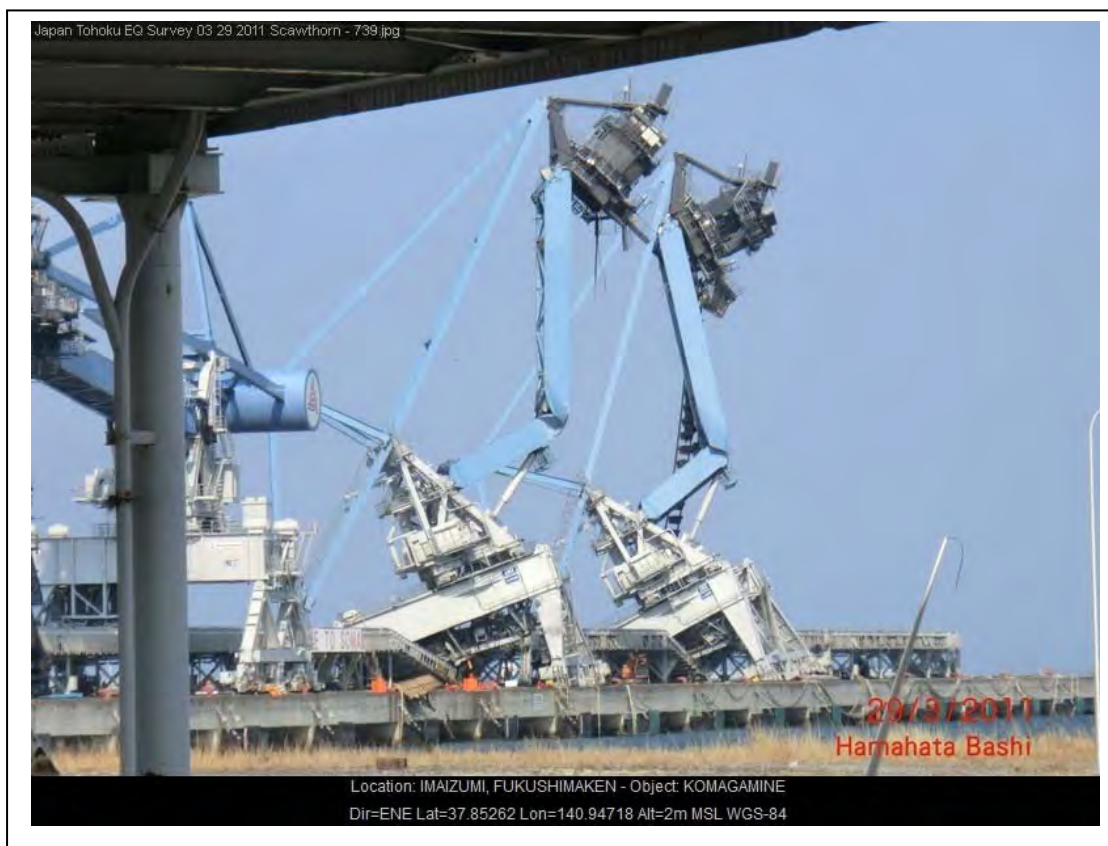


Japan Tohoku EQ Survey 03 29 2011 Scawthorn - 552.jpg





↑
RUNUP HEIGHT 5~7 m
↓







Japan Tohoku EQ Survey 03 29 2011 Scawthorn - 876.jpg



Location: OGAWA, FUKUSHIMAKEN - Object: KOMAGAMINE
Dir=NE Lat=37.8667 Lon=140.91998 Alt=28m MSL WGS-84

Japan Tohoku EQ Survey 03 30 2011 Scawthorn - 911.jpg



Location: TAKI, FUKUSHIMAKEN - Object: NAGANUMA
Dir=W Lat=37.30242 Lon=140.19464 Alt=417m MSL WGS-84

Japan Tohoku EQ Survey 03 30 2011 Scawthorn - 886.jpg



Location: TAKI, FUKUSHIMAKEN - Object: NAGANUMA
Dir=NE Lat=37.30242 Lon=140.19464 Alt=417m MSL WGS-84



津波による浸水範囲

市町村名は最新ではありません。国土地理院の「浸水範囲概況図」にパスコの推定浸水域を重ねた

石巻市～山元町で浸水が続いている地域
3月24日時点。パスコのデータから

1 仙台湾岸

仙台湾岸の広い地域に、海岸から内陸へ数kmの範囲に津波が襲った。木造家屋が数多く倒壊。いまだに海水が引かない水田も多い



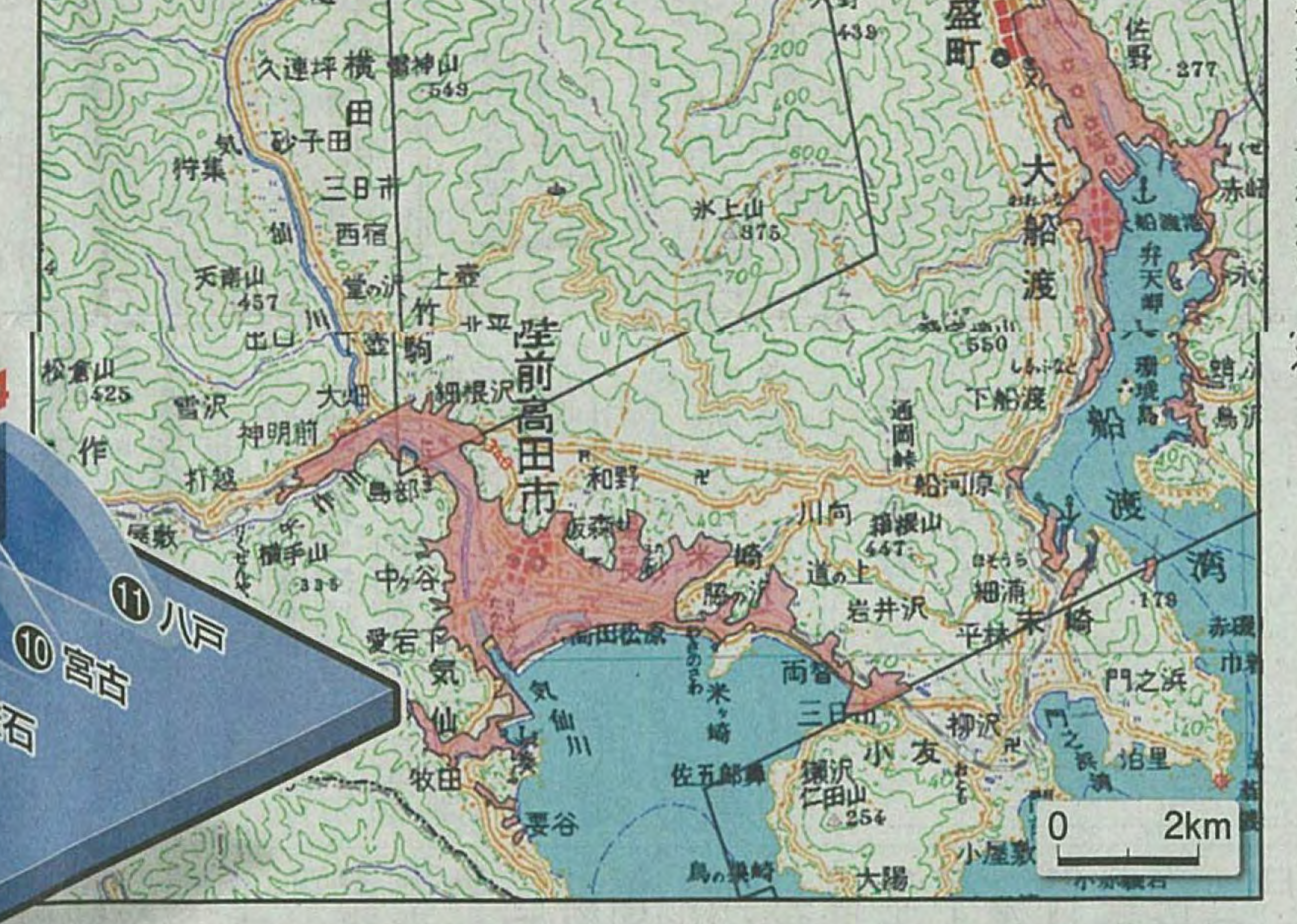
2 大槌町・釜石市周辺

釜石市中心部では、高さ10m前後の津波が来たとみられている。大槌町の市街地はほぼ壊滅状態で、町長の死亡も確認された



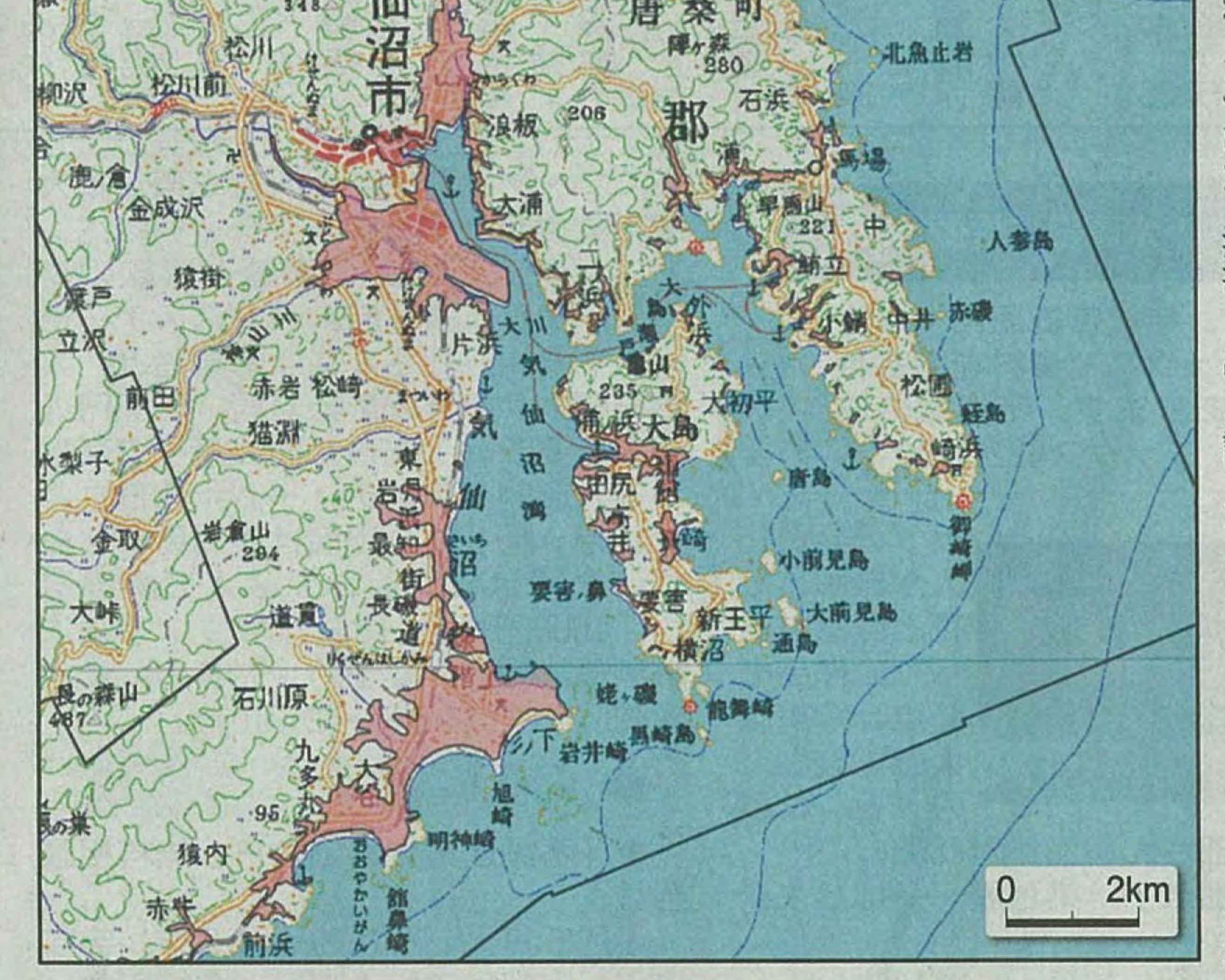
3 大船渡市・陸前高田市周辺

人口2万人を超す陸前高田市を津波が襲い、壊滅状態に。中心部は15m前後の津波が押し寄せ、平地に破損したビルがぼつぼつと残る景観になった。木造家屋に加え、鉄骨造りのビルも多く壊れた



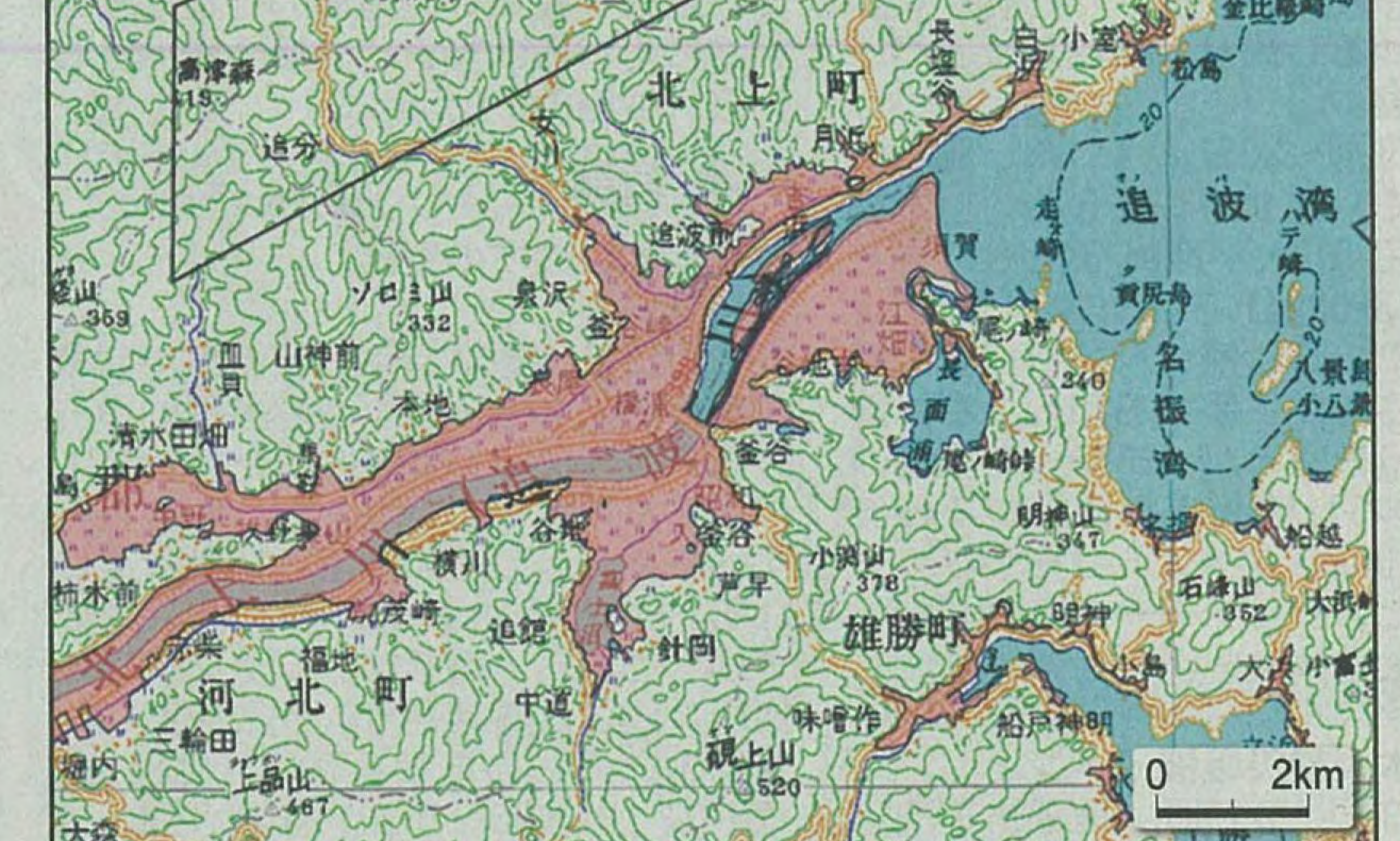
4 気仙沼市周辺

気仙沼市の中央部の津波の高さは、10m前後。湾奥から内陸に5隻以上の大型漁船が入り込んで漂流し、多くの建物をなぎ倒した



5 北上川（追波湾）周辺

追波湾を襲った津波は、河口から北上川をさかのぼった。途中にあった約3kmの堰（せき）を乗り越えて、少なくとも河口から約50kmの地点に達した



津波被害を受けた気仙沼市



各地の津波の高さ

数字はm。相馬は7.3m以上、宮古は8.5m以上と推定。大洗・相馬・宮古は気象庁、福島第一原発は東京電力、仙台新港・石巻・大船渡・釜石・八戸は港湾空港技術研究所、女川・南三陸は早稲田大の調べ

津波に襲われ水浸しになった仙台市若林区