

MARCH 11, 2011 JAPAN EARTHQUAKE AND TSUNAMI

Updated: March, 2015

The 11 March 2011 magnitude 9.0 Honshu, Japan earthquake (38.297 N, 142.372 E, depth 30 km) generated a tsunami that was observed all over the Pacific region and caused tremendous devastation locally*. The National Police Agency of Japan reports that as of February 2015, there are 15,890 deaths and 2,590 missing and presumed deaths; and 6,152 injuries in 12 Japanese prefectures. The tsunami also caused one death in Papua, Indonesia and one death in Klamath River, California. The earthquake and tsunami caused \$220 billion damage in Japan and resulted in a nuclear disaster with an International Atomic Energy Agency (IAEA) rating of 7 at the Fukushima I (Daiichi) Nuclear Power station. The tsunami also caused \$30 million damage in Hawaii; \$55 million damage to marine facilities in California; and \$6 million in losses to the fishing industry in Tongoy, Chile over 16,000 km from the source. This was the first time observational evidence from satellites linked a tsunami to ice-shelf calving in Antarctica.

This is the fourth largest earthquake in the world and the largest in Japan since instrumental recordings began in 1900. The earthquake generated the deadliest tsunami since the 2004 magnitude 9.1 Northern Sumatra earthquake and tsunami caused nearly 230,000 deaths and \$10 billion in damage. This is the most devastating earthquake to occur in Japan since the 1995 Kobe earthquake caused over 5,500 deaths and the deadliest tsunami since the 1993 Hokkaido earthquake generated a tsunami which was responsible for over 200 deaths.

MARCH 11, 2011 EYEWITNESS AND INSTRUMENTAL RECORDINGS

Field survey results indicate the highest runup height was 38.9 meters (tide removed) in Iwate Prefecture (39.533757 N, 142.046279 E) (<http://www.coastal.jp/tsunami2011/>). Runup is the difference between the elevation of maximum tsunami penetration (inundation line) and the sea level at the time of the tsunami. Tide gauge recordings on 75 Japanese tide stations range from 1 to 9 meters. Two meter waves were observed at tide gauges in Russia, South America, Hawaii, and the west coast of the United States. The highest wave ever recorded by an ocean-bottom sensor was measured at 1.8 meters by DART® station 21418 located 450 nautical miles northeast of Tokyo (see display on p. 4). NGDC will continue to update the historic tsunami database as eyewitness and field survey reports are received.

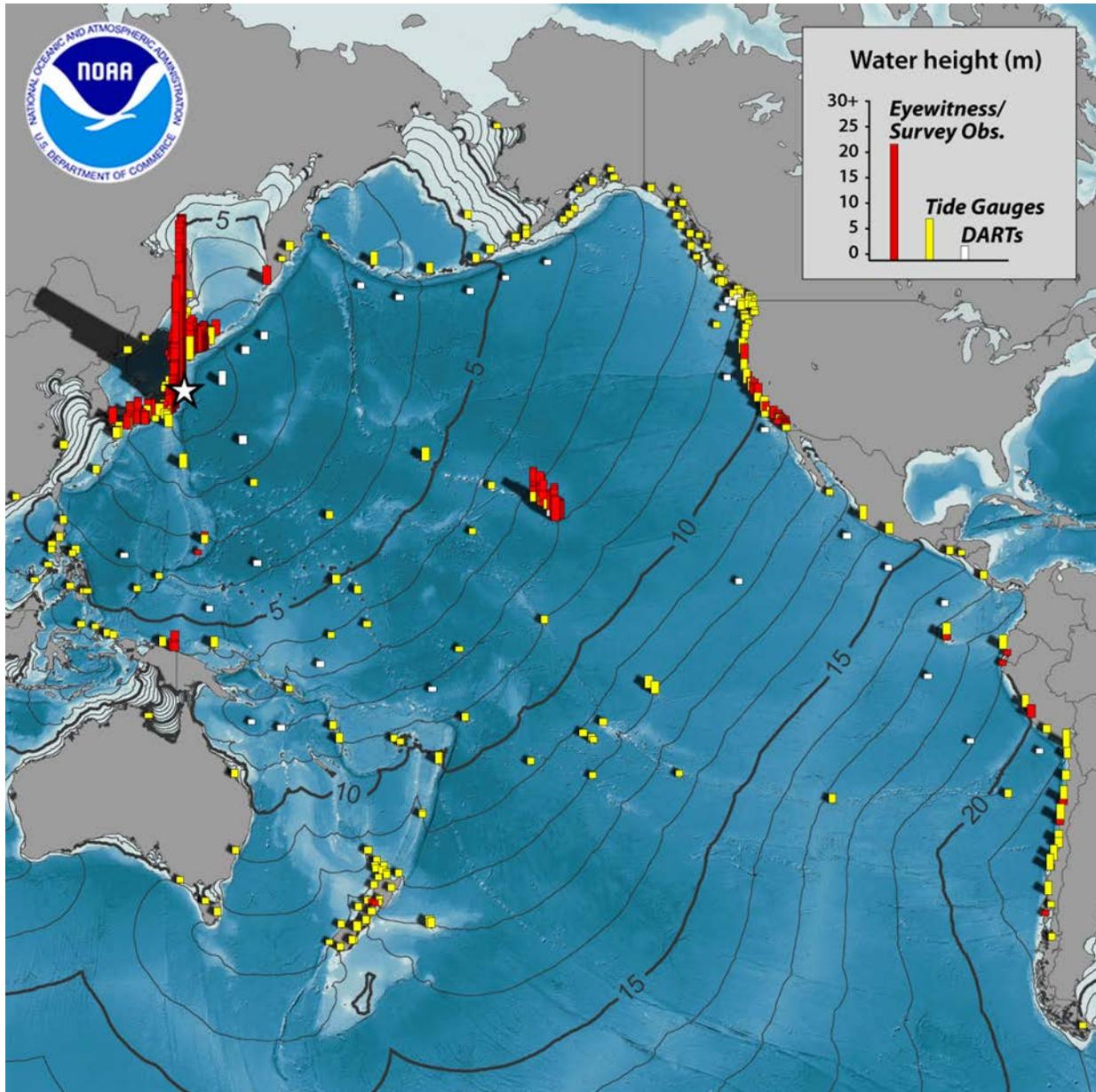
HISTORICAL EARTHQUAKES AND TSUNAMIS IN JAPAN

At the time of this event (March 3, 2011), according to the NOAA National Geophysical Data Center / World Data Service for Geophysics / (<http://ngdc.noaa.gov/hazard>) Global Historical Event databases, 2,111 tsunamis (validity $\geq 1^+$) had occurred in the world since 2000 B.C. and 281 (13%) of these tsunamis caused deaths. In the Japanese region, 304 tsunamis (validity $\geq 1^+$) had been observed since 684 A.D., and 78 (26%) of these events caused deaths. The majority of Japanese tsunamis were generated by earthquakes (87%), the remainder resulted from volcanic eruptions (5%) and unknown causes (8%). The most fatal Japanese earthquakes and tsunamis are listed below:

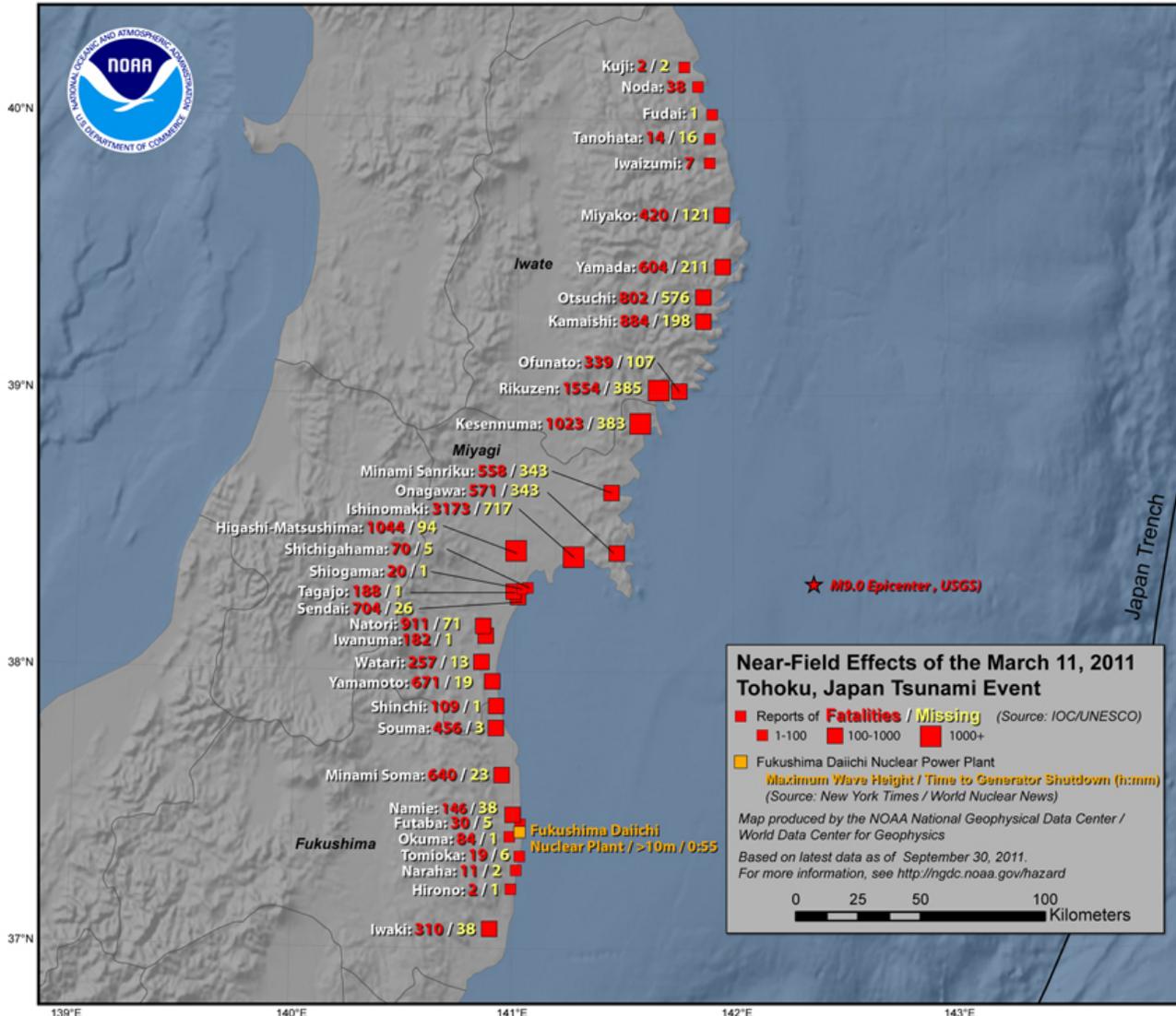
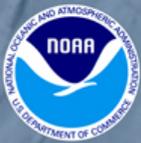
- 1293 Kamakura earthquake caused **23,024 deaths** and generated a small tsunami
- 1498 Enshunada Sea earthquake-generated tsunami caused **31,000 deaths**
- 1586 Ise Bay earthquake and tsunami caused over **8,000 deaths**
- 1771 Ryukyu Islands earthquake-generated tsunami caused over **13,000 deaths**
- 1792 Mt. Unzen eruption generated a tsunami. The eruption and tsunami caused over **15,000 deaths**
- 1847 Zenkoji earthquake caused **12,000 deaths**
- 1855 Tokyo earthquake caused **6,757 deaths** and generated a small tsunami
- 1891 Mino-Owari earthquake caused **7,273 deaths**
- 1896 Sanriku earthquake and tsunami caused over **27,000 deaths**
- 1923 Sagami Gulf earthquake caused over **99,000 deaths** and generated a tsunami that caused over **2,000 deaths**
- 1995 Kobe earthquake caused **5,502 deaths** and generated a small tsunami

*Data are collected from the US NOAA National Weather Service Tsunami Warning Centers, the US Geological Survey National Earthquake Information Center, the US NOAA National Data Buoy Center, IOC/UNESCO, International Tsunami Survey Teams, and news organizations. Refer to the NGDC event page for data and their sources (http://ngdc.noaa.gov/hazard/tsu_db.shtml). For more information on this event please see http://www.ngdc.noaa.gov/hazard/honshu_11mar2011.shtml.

†A validity score or confidence designation is assigned to each tsunami event ranging from -1 for erroneous entries to 4 for definite or confirmed tsunamis.



March 11, 2011 tsunami water heights from eyewitness accounts, field surveys, and tide gauges. Overlain are tsunami travel times plotted at 1-hour intervals (black lines) using the earthquake epicenter (star) as a point source. The maximum runup was 38.9 meters (tide removed) in Iwate Prefecture. (Credit: J. Varner, NGDC)



Kuji: 2 / 2 ■
 Noda: 38 ■
 Fudai: 1 ■
 Tanohata: 14 / 16 ■
 Iwaizumi: 7 ■
 Miyako: 420 / 121 ■
Iwate
 Yamada: 604 / 211 ■
 Otsuchi: 802 / 576 ■
 Kamafishi: 884 / 198 ■
 Ofunato: 339 / 107 ■
 Rikuzen: 1554 / 385 ■
 Kesenuma: 1023 / 383 ■
Miyagi
 Minami Sanriku: 558 / 343 ■
 Onagawa: 571 / 343 ■
 Ishinomaki: 3173 / 717 ■
 Higashi-Matsushima: 1044 / 94 ■
 Shichigahama: 70 / 5 ■
 Shiogama: 20 / 1 ■
 Tagajo: 188 / 1 ■
 Sendai: 704 / 26 ■
 Natori: 911 / 71 ■
 Iwanuma: 182 / 1 ■
 Watari: 257 / 13 ■
 Yamamoto: 671 / 19 ■
 Shinchi: 109 / 1 ■
 Souma: 456 / 3 ■
 Minami Soma: 640 / 23 ■
Fukushima
 Namie: 146 / 38 ■
 Futaba: 30 / 5 ■
 Okuma: 24 / 1 ■
 Tomioka: 19 / 6 ■
 Naraha: 11 / 2 ■
 Hirono: 2 / 1 ■
 Iwaki: 310 / 38 ■

★ M9.0 Epicenter, USGS

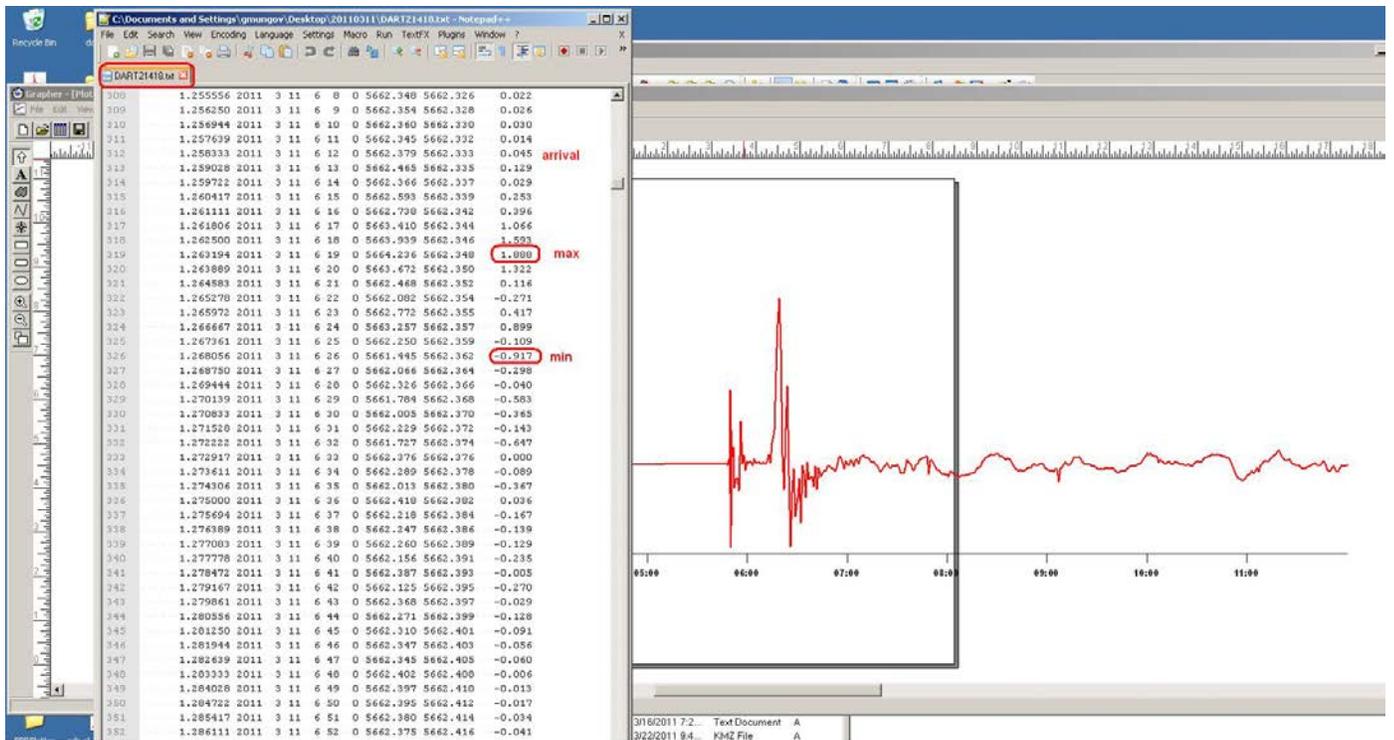
Near-Field Effects of the March 11, 2011 Tohoku, Japan Tsunami Event

- Reports of **Fatalities** / **Missing** (Source: IOC/UNESCO)
 - 1-100
 - 100-1000
 - 1000+
- Fukushima Daiichi Nuclear Power Plant
 - Maximum Wave Height / Time to Generator Shutdown (h:mm) (Source: New York Times / World Nuclear News)

Map produced by the NOAA National Geophysical Data Center / World Data Center for Geophysics
 Based on latest data as of September 30, 2011.
 For more information, see <http://ngdc.noaa.gov/hazard>

0 25 50 100 Kilometers

DART 21418 – 450 NM NE of Tokyo, Japan (38.711 N, 148.694 E) Processed data and plot
http://www.ngdc.noaa.gov/hazard/tsunami/pdf/21418_data.JPG



An aerial view of damage to Sukuiso, Japan, a week after a 9.0 magnitude earthquake and subsequent tsunami devastated the area. Credit: Dylan McCord. U.S. Navy (<http://ngdc.noaa.gov/hazardimages/event/show/256>)



Damaged roads in the affected regions have made access to communities in need all the more challenging. Taken outside Otsuchi in Iwate prefecture. Credit: Japanese Red Cross (<http://ngdc.noaa.gov/hazardimages/event/show/256>)

