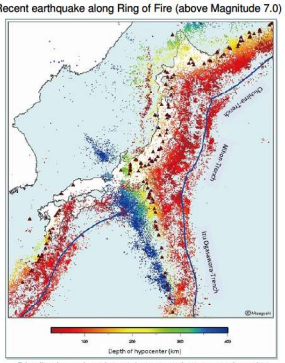
2011 Great East Japan Earthquake

Magnitude 9.0, Fourth Largest Earthquake in the World Since 1900

■ Earthquake and Tsunami Prone Area

Recent earthquake along Ring of Fire (above Magnitude 7.0)



Distribution of active volcano and past earthquake

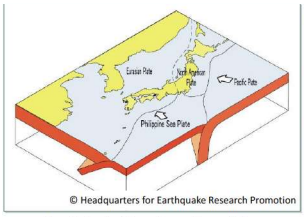
The Pacific Ring of Fire is an area where large numbers of earthquakes and volcanic eruptions occur in the basin of the Pacific Ocean. About 80% of the world's largest earthquakes occur along the Ring of Fire.

Japan sits atop section of the Ring of Fire where four tectonic plates are pressing and causes periodic occurrence of large earthquakes near the boundaries of those plates. The March 11 earthquake with a registered magnitude of 9.0 occurred near the boundary of the Japan Trench, where the pacific plate is subducting under the North American plate.

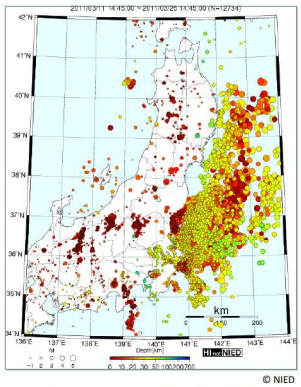
Large offshore earthquakes had occurred in the same subduction zone in 1611, 1896, and 1933, and each caused devastating tsunami on the coast. While the occurrence of earthquakes had been predicted in this region, the scale of the March 11 earthquake was much larger than predicted. Multiple hypocenters were linked resulting in 400 km long and 200 km wide range from source area. It is the 4th largest earthquake in the world since 1900. Some experts said that this scale of earthquake and entailing tsunami occurs with a one thousand year return period.

Earthquake	Date	Magnitude	Epicenter	People killed/missing	Maximum height of tsunami
Meiji-Sanriku	15 June 1896	8.2	Off Iwate	21,959 (Only people killed)	38.2 m (Ofunato city)
Showa-Sanriku	3 March 1933	8.1	Off iwate	3,064	29.3 m (Ofunato city)
Chile	22 May 1960	9.5	Off Chili in South America	142	5.6 m (Miyako city)

■ March 11 Earthquake



Four kinds of plate on the periphery of Tokyo



Distribution of earthquake from 11 to 25 March

Note: The image of flooded area before and after the earthquake shows that most of the plains along the coast, particularly from Miyagi Prefecture to Fukushima Prefecture, suffered massive damages.

Date and Time
11 March 2011 at 14:46 JST (5:46 GMT)

Type of Earthquake
Plate-boundary thrust-faulting earthquake on or near the Japan Trench subduction zone
Hypocenter
130km off the Pacific coast of Tohoku region (38°N, 142°E), 24km deep

Magnitude
9.0 (interim value, the largest in Japan and the 4th largest in the world)

Height of Tsunami Measured at Tidal Observatories
Miyako City, Iwate Pref.: above 8.5 m
Ofunato City, Iwate Pref.: above 8.0 m
Kamaishi City, Iwate Pref.: above 4.1 m
Ayukawa, Ishinomaki City, Miyagi Pref.: above 7.6 m
Souma City, Fukushima Pref. : above 9.3 m

Aftershocks
More than one thousand aftershocks above M 4.0 have occurred since March 11. The frequency of aftershocks has been gradually decreasing.

	M4.0 - M4.9	M5.0 - M5.9	M6.0 - M6.9	M7.0 - M7.9	M8.0 -	Total
Total	576	378	48	2	1	1005

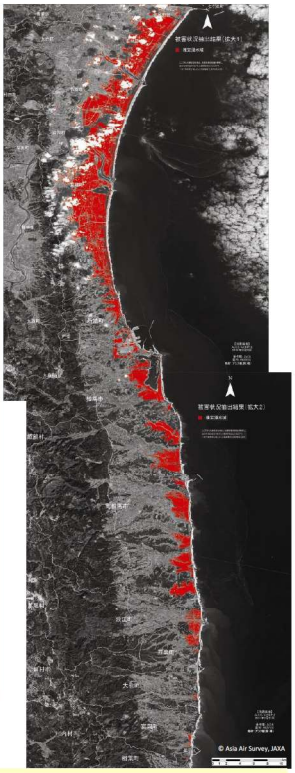
Source: TRC

The number of aftershock (as of 25 April)

■ Damages of the March 11 Earthquake and Tsunami

Iwate Prefecture

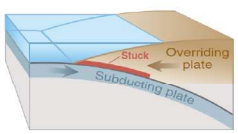
Miyagi Prefecture



Most areas under 10m Elevation level were washed away by the Tsunami along coast of Sendai and Natori-city, Miyagi Prefecture.
Note: Flooded area is extracted from the image before and after the earthquake. The Image shows most of plains along the coast particularly from Miyagi Prefecture to Fukushima Prefecture which suffered massive damages.

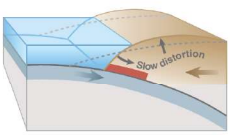
Fukushima Prefecture

■ Mechanism of Tsunami



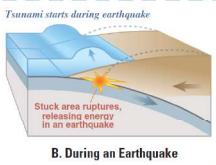
Vertical Slice Through a Subduction Zone

One of the many tectonic plates that make up Earth's outer shell descends, or "subducts," under an adjacent plate. This kind of boundary between plates is called a "subduction zone." When the plates move suddenly in an area where they are usually stuck, an earthquake happens.



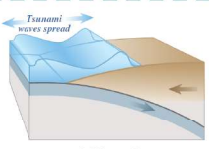
A. Between Earthquakes

Stuck to the sub ducting plate, the overriding plate gets squeezed. Its leading edge is dragged down, while an area behind bulges upward. This movement goes on for decades or centuries, slowly building up stress.



B. During an Earthquake

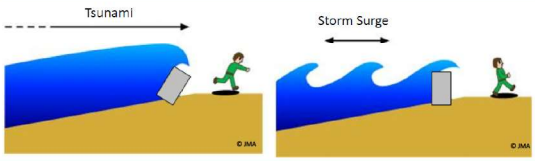
An earthquake along a subduction zone happens when the leading edge of the overriding plate breaks free and springs seaward, raising the sea floor and the water above it. This uplift starts a tsunami. Meanwhile, the bulge behind the leading edge collapses, thinning the plate and lowering coastal areas.



C. Minutes Later

Part of the tsunami races toward nearby land, growing taller as it comes in to shore. An other part heads across the ocean toward distant shores.

A tsunami occurs as a result of the movement of huge volume of seawater from the seabed to the sea surface, whereas ocean waves are caused by the movement of wind over the sea surface. On the other hand, a storm surge is an offshore rise of water associated with a low pressure weather system, typically tropical cyclones and strong extratropical cyclones.



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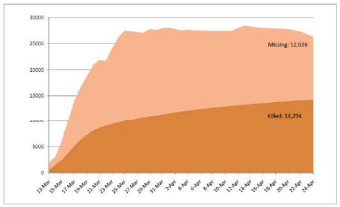
2011 Great East Japan Earthquake
Continuous Countermeasure and Activities

■ Why so devastating?



Total number of Missing/Killed (as of 24th April)

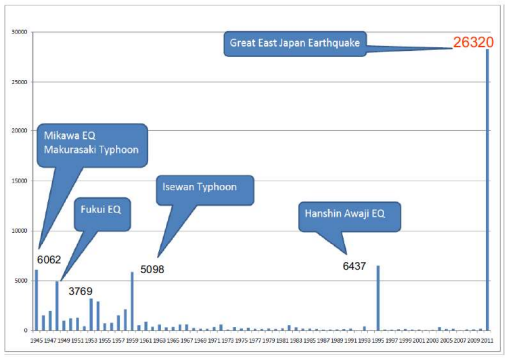
Total number of evacuees (as of 24th April)

After a series of large-scale earthquakes, multiple tsunami waves of unprecedented scales reached coastal areas wreaking enormous destruction. According to the field surveys, tsunami waves reached the heights of 14 - 15 meters in many coastal areas with maximum run-up of 38.9 meters high as so far measured. It reached as far as 5.5 kilometers inland of Sendai City, and resulting to 561 square kilometers of swamped areas as a whole.

The government has confirmed 26,320 killed or missing as of April 24. The number of casualties far exceeds that of the 1995 Great Hanshin Awaji (Kobe) earthquake. The National Policy Agency reported that based on all confirmed deaths, 90 percent were from drowning and more than 60 percent were over 60 years old.
Cost of damage, including destroyed houses, factories, and social infrastructure such as roads and bridges, is estimated between 16 and 25 trillion yen estimated by the Cabinet Office as released on March 23.

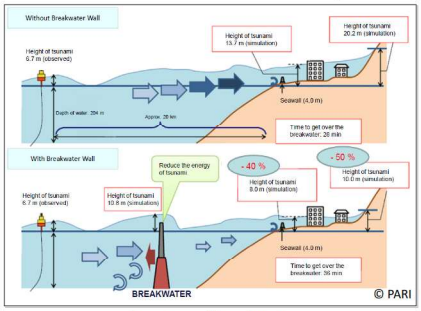
Source (left graph): TRC

Source (right graph): Cabinet Office, Government Of Japan



Natural disasters from the 1945 -Number of death/missing-

■ Structural Measures *-Reducing underlying risks-*

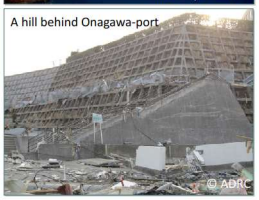


Structure of breakwater

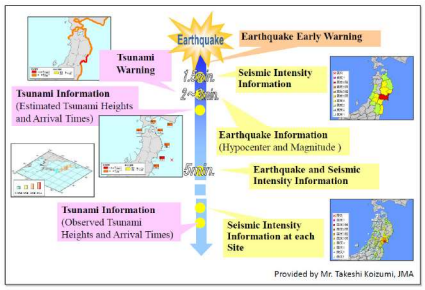
The most notable was the construction of 10m high and 2.5 km long dykes in Taro area of Miyako City, often called as "the Great Wall", and the world's biggest breakwater (8 meter high above sea which is 63 meter deep) in Kamaishi City.

The breakwater wall, which had been standing at the mouth of Kamaishi Bay, collapsed, and the tsunami reached 6.9m - 9m high at several points. Based on the simulation by Port and Airport Research Institute, the tsunami would have reached up to 13.7m high and would have caused damage to much wider areas without the wall. The breakwater wall was estimated to have impeded tsunami energy by 40%.

A hill behind the Onagawa port (right below) was designated as a evacuation area. There are traces of water inside the hospital building on the hill, indicating that tsunami had reached the top of the hill which is nearly 16 meters high, but this higher ground proved to be safe from tsunami.



■ Non-Structural Measures *-Tsunami warning, Tendenko, Tsunami Disaster Education-*



Tsunami warning

Tsunami Warning: Japan Meteorological Agency started issuing tsunami warning three minutes after the first main shock. Through media and other channels, tsunami warning messages including information on expected tsunami height and arrival time were disseminated. The local governments were also sending tsunami warning messages by sirens and by community wireless system. It helped people to escape from tsunami by evacuating to higher grounds or elevated building.

Tsunami Tendenko (right above): The word Tsunami Tendenko means "at time of tsunami: go uphill independently, care only for your own safety, and don't think of anyone else, even your family." This is a local wisdom known in the Tohoku Sanriku region.

Tsunami Disaster Education (right below): Kamaishi-city is one of the hardest hit areas. Pre-disaster education and various activities to raise people's awareness had been conducted in this city, which helped people take appropriate actions and saved their lives.

(right photo and map) © Prof. Toshitaka Katada, Gunma University

■ Activity of national government

Senior Vice Minister's Visit to a Depot (23 March)

Government's Initial Emergency Response within 24 Hours:
The government immediately responded to the disaster. Within an hour after the earthquake, the first Extreme Disaster Management Headquarters meeting was held at Prime Minister's Residence with all the cabinet members. The first field survey team, headed by Senior Vice Minister Shozo Azuma, was dispatched within 4 hours after the earthquake.

Government-led Emergency Relief during the First Few Weeks:
The devastating tsunami literally swept away coastal areas and some cities and towns completely lost their functions. Even the prefectures (second-tier local governments) were overwhelmed by the level of damage. The National Government established a dedicated headquarters to support the victims. For weeks, the national government conducted nationwide emergency relief efforts.

Delivery of Food and Water by the National Government (during the first week)

Emergency Meeting with Governor (12 March)

Government's Special Headquarters for Supporting Disaster Victims (23 March)

Rescue activity by the Emergency Fire Response Team at Kesennuma-City, Miyagi Prefecture (12 March)

Emergency Response

[11 March]
2:46pm Strike of the Earthquake (M9.0)
3:14pm Establishment of Extreme Disaster Management Headquarters (Headed by Prime Minister)
3:37pm 1st Meeting of DM Headquarters
6:42pm Dispatch of 1st Field Survey Team (Headed by Senior Vice Minister)
[12 March]
6:00am Establishment of National Field Office
9:00am Dispatch of 2nd and 3rd Field Survey Teams

[Source]

AAS, Asia Air Survey
ADRC, Asian Disaster Reduction Center
Cabinet Office, Government Of Japan
ERI, Earthquake research Institute, The University of Tokyo
FDMA, Fire and Disaster Management Agency (photo taken by Tokyo Fire Department)
Gunma University, Prof. Toshitaka Katada, Gunma University (photo taken by a local resident in Kamaishi City, Iwate Prefecture)
Headquarters for Earthquake Research Promotion
ITIC, International Tsunami Information Center
JAXA, Japan Aerospace Exploration Agency
JMA, Japan Meteorological Agency
NIED, National Research Institute for Earthquake Science and Disaster Prevention
PARI, Port and Airport research Institute
TRC. Tokio Marine & Nichido Risk Consulting

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