

Mattie plates slide
beneath each other
into the

[Economics](#), [Budget](#)



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Earthquake At 2: 46 P. M. on March 11, 2011, one of the most powerful earthquakes ever recorded in history hit northeastern Japan. An earthquake so powerful it triggered a series of large tsunamis that destroyed many coastal areas of the country and instigated a major nuclear accident at a power station along the coast. This earthquake was referred to as the Great Sendai Earthquake. The Great Sendai Earthquake, also referred to as the Great Tohoku Earthquake, was a magnitude-9.

The earthquake occurred in northeastern Japan, off the country's main island, Honshu (Pletcher). The epicenter, or the middle of the earthquake, was located 130 kilometers east of the city of Sendai. The focus happened at a depth of thirty kilometers below the bottom of the Pacific Ocean (Pletcher). It was felt as far away as Russia, Taiwan, and China (Pletcher). The natural disaster was preceded by several foreshocks. This included an event that happened by weeks after the main quake that had a magnitude-7.2 event that centered roughly forty kilometers away from epicenter.

(Pletcher). The disaster took the public by surprise as few scientists predicted the country would experience an earthquake as large as that, as the original forecast was a lot smaller and in a different area (Oskin). However, a decade before, Japanese geologist predicted the large earthquake, but the warnings went unheeded by officials as it was predicted based on past events that included earthquakes and tsunamis (Oskin).

Although, today, Japanese scientists are researching these past events to better predict future disasters (Oskin). However, geologists suggest

that thenatural disaster relieved stress that the tectonic plates had collected overcenturies (“ In”). Because of this, scientist are predicting that the Faultline isunlikely to create a large earthquake anytime soon (“ In”). The earthquakewas caused by a rupture of the subduction zone, where plates slide beneath eachother into the hotter later beneath the crust, the mantle (Oskin).

This certainsubduction zone was associated with the Japanese Trench, which separates the Eurasianplate from the Pacific plate (Pletcher). These plates collided and released theenergy that cuild up over centuries of collecting energy from sticking to otherplates (Oskin). This caused these two particular plates to displace water thatsat above it which created a series of highly destructive tsunami waves thatmeasured approximately over thirty feet tall and reached as far as tenkilometers inland (Pletcher). Sendai wasn’t the only city affected by thetsunami waves; other communities, including Kamaisha and Miyako in Iwate; Ishinomaki, Kensenuma, and Shiogama in Miyagi; and Hitachinaka and Kitaibarakiin Ibaraki were also devastated (Pletcher). Tsunami warnings were triggered bythe main quake throughout the Pacific basin (Pletcher).

The natural oceanicdisaster raced from the epicenter towards the land at about 800 kilometers perhour, generating waves that affected many other areas of the world, includingthe Hawaiian Islands chain, Aleutian Islands chain, and the west coast of NorthAmerica (Pletcher). Eighteen hours after, waves also reached Antarctica andcaused the outer-shell of the Sulzberger Shelf to break (Pletcher). There was a warning of the seismicdisaster

one-minute prior from the Japan early warning system that monitor stringent seismic building codes to predict when an earthquake is about to begin (Oskin). This helped save many lives as this one minute warning shut down many (possible high-casualty) facilities, for example trains (Oskin). Within two weeks of the disaster, the Japanese government's official count of deaths surpassed 10, 000; more than one and a half times that were still listed as missing and presumed dead (Pletcher).

The numbers dramatically increased in the following days which sprung multiple rescue operations along the Japanese coast (Pletcher). The official count rose to approximately 28, 500, but by the end of 2011, the number reduced to 19, 300 (Pletcher). More than half the victims were age 65 years or older (Pletcher). Out of all the prefectures in Japan that were in the effected area, Miyagi suffered the greatest of losses as 10, 800 were officially pronounced dead or missing and another 4, 100 were injured (Pletcher).

Although nearly all the human casualties were caused by the large tsunami waves along the coast, the earthquake was responsible for a considerable amount of damage over a wider area (Pletcher). Fires took place in many cities such as a petrochemical plant in Sendai, a portion of the city of Kensennuma, and an oil refinery at Ichihara (Pletcher). Infrastructure throughout eastern T? hoku was heavily affected with roads and rail lines damaged, water and sewage systems disrupted, and electric power knocked out (Pletcher). A dam, near the prefectural capital, Fukushima city, burst due to the earthquake causing the destruction of thousands of homes in Fukushima, Ibaraki, and Chiba prefectures (Pletcher). The tsunami also

caused a considerable amount of oceanic litter to become a considerable concern among habitants near the Pacific Ocean. The National Oceanic and Atmospheric Agency reported that the tsunami carried out five million tons of debris and trash out to the sea (Oskin). Within weeks following the disaster, much of the debris from the coast of Japan showed up along the North American west coast (Oskin). Another result from the natural disaster included the significant concern of the status of several nuclear power stations in the Tohoku region (Pletcher).

Three nuclear power plants shut down their reactors as they were closest to the epicenter (Pletcher). The aftershocks from the earthquake cut the main power and the tsunami waves damaged the back up generators at some of the plants, most notably the Fukushima Daiichi plant, also known as “Number One” plant, a plant situated in the northeastern Fukushima prefecture about 100 kilometers south of Sendai (Pletcher). With the power gone, the cooling systems failed and a few days after the disaster, the cores overheated which led to partial meltdowns of the fuel rods (Pletcher).

The melted material fell and burned sizable holes in the bottom of the containment vessels in reactors one and two, exposing nuclear materials in the cores (Pletcher). Pressurized hydrogen gas in the outer containment buildings enclosing the reactors caused multiple explosions to erupt (Pletcher). Fuel rods stored in reactor four were touched off by the fire resulting from the explosions in the first three reactors (Pletcher). The facility released significant levels of radiation in the weeks following the earthquake; workers sought to stabilize the damaged reactors by cooling them with

seawater and boric acid (Pletcher). Japanese officials were afraid of possible radiation exposure, so they established a thirty kilometer no-fly zone and created an area of twenty kilometers around the Fukushima Daiichi plant (Pletcher).

There was a spike in levels of radiation found in the local food and water supplies that prompted officials in Japan and overseas to issue warnings about their consumption (Pletcher). Towards the end of March 2011, seawater near the Daiichi facility was discovered to have been contaminated with high levels of iodine-131, cesium-134, and cesium-137, and other radioactive isotopes which stemmed from the exposure of pumped-in seawater that workers used to cool the fuel coils (Pletcher). The water later had leaked in water-filled trenches and tunnels between the facility and the ocean (Pletcher). Japanese nuclear regulators, in mid-April, elevated the security level of the nuclear emergency at the Fukushima Daiichi from five to seven—the highest level on the scale created by the International Atomic Energy Agency (Pletcher).

This placed the Fukushima accident in the same category as the Chernobyl accident, which happened in the Soviet Union in 1986). Evaluation zones were thought to be uninhabitable for decades, due to radiation levels remaining high for many weeks after the accident (Pletcher). However, several months after the accident, government officials announced radiation levels in five towns just beyond the twenty kilometer radius had declined enough to allow residents to reenter their homes, but some former residents stayed away, concerned about the amount of radiation in the soil

(Pletcher). In December 2011, Japanese Prime Minister Noda Yoshihiko declared the Fukushima Daiichi facility stable, but numerous leaks followed the accident (Pletcher). Years later, a significant leak happened in August 2013, which was severe enough to prompt Japan's Nuclear Regulation Authority to classify it as a level-3 nuclear incident (Pletcher).

In the first hours of the earthquake, the Japanese Prime Minister Kan Naoto moved to set up an emergency command center to be located in Tokyo (Pletcher). In result, many rescue workers and approximately 100,000 members of the Japanese Self-Defense Force were mobilized quickly to deal with the disaster (Pletcher). Many Japanese citizens criticized Japan's meteorological Agency for underestimating the size of the tsunami wave (Oskin). Japanese officials upgraded and installed a new tsunami warning system because of the criticism (Oskin). However, the warnings the system issued were unheeded by citizens as people underestimated their personal risk, assuming that the tsunami wouldn't reach their area (Oskin).

In a study done over the Miyagi and Fukushima prefectures, officials found that only 58% of people headed for higher ground after the earthquake (Oskin). The country also requested U. S. military personnel stationed in the country to be a part of the relief efforts, and in turn a U.

S. Navy aircraft was dispatched to the area (Pletcher). Several other countries, such as Australia, China, India, New Zealand, South Korea, and U. S., helped by sending teams for search-and-rescue, while dozens of other countries and major international relief organizations helped with financial and material support (Pletcher). Private and other

nongovernmental organizations from all over the world established relief funds to aid in the rescue and recovery efforts (Pletcher). Scientists, from all over the world, also swarmed the country to study the Faultline that caused the earthquake (Oskin).

They dropped sensors in the ocean, along the Faultline to measure the forces that caused the seismic disaster (Oskin). Initially, the rescue work was essentially difficult as it was hard to get personnel, supplies, and equipment to the devastation zone, and periods of inclement weather hindered with air operations (Pletcher). Once workers did reach the devastation zone, they dealt with the widespread area of destruction of entire cities that were washed away or covered by great piles of mud and debris (Pletcher). Even though many people were rescued in the first several days of the natural disaster, much of the relief work consisted of the recovery of bodies (Pletcher). Hundreds of bodies were washed ashore in several areas after they had been swept out towards the open sea (Pletcher).

Shelters were limited in their food and supplies as several hundred-thousand people swept into them, while tens and thousands more remained isolated in worse conditions, waiting for relief efforts to reach them (Pletcher). These numbers only grew with the Fukushima accident (Pletcher).

Two weeks after the earthquake, a quarter million survivors were housed in relief shelters (Pletcher). Over two years later, a small number remains housed in shelters as the effects of the land were devastating (Pletcher). More than 300,000 residents were displaced and lived in temporary homes, such as hotels, public housing units, or private homes (Pletcher). Four years

later, 230, 000 people were still displaced, however a large number was due to the continuation of the Fukushima accident(Pletcher).

The country worked to repair theinfrastructure of public services and wouldn't stop until they were fullyoperational again (Pletcher). The region's power supply continued to beaffected with the ongoing nuclear accident in Fukushima, which caused many temporarypower outages and rolling blackouts (Pletcher). The economy also took a hit in themonths following the disaster as it caused a severe reduction in the region'smanufacturing output (Pletcher). The earthquake and tsunami combined causeddamage and loss of business and factories, but by late summer, the economyrepaired itself and grew briskly (Pletcher).

In early 2012, industrial output reachedthe level it was before the disaster (Pletcher). The government sought to push supplementbudgets through the legislature, managing to push three different ones through(Pletcher). In early November, the largest budget, the third one, was approvedand provided roughly \$155 billion (Pletcher). A bulk of the money raised forrelief efforts went towards the reconstruction of the devastated areas (Pletcher). In February 2012, the government alsoestablished a cabinet-level reconstruction agency to help coordinate efforts inthe coastal area (Pletcher). The government planned for the agency to last theprojected estimate it would take the Japanese northeastern coast to be repaired; the estimate was roughly ten years (Pletcher).

The agency worked to attempt todetermine if the buildings they rebuild could be made to withstand earthquakesand tsunamis (Oskin). In late 2015,

the agency reported that the disaster was almost cleaned up as nearly all the debris from each devastated area has been removed (Pletcher).

WorksCited “ In Japan, small shakes presage bigquakes.

” Nature News, NaturePublishing Group, [www. nature. com/news/in-japan-small-shakes-presage-big-quakes-1. 19252](http://www.nature.com/news/in-japan-small-shakes-presage-big-quakes-1.19252). Oskin, Becky.

“ Japan Earthquake & Tsunami of 2011: Facts and Information.” LiveScience, Purch, 13 Sept. 2017, [www. livescience.](http://www.livescience.com/39110-japan-2011-earthquake-tsunami-facts.html)

[com/39110-japan-2011-earthquake-tsunami-facts. html](http://www.livescience.com/39110-japan-2011-earthquake-tsunami-facts.html). Pletcher, Kenneth, and John P.

Rafferty. “ Japan earthquake and tsunami of 2011.” Encyclopædia Britannica, Encyclopædia Britannica, inc. 22 Nov.

2016, [www. britannica. com/event/Japan-earthquake-and-tsunami-of-2011](http://www.britannica.com/event/Japan-earthquake-and-tsunami-of-2011).