Example of why did the earthquake and tsunami occur report

Environment, Electricity

2011 Tohoku Earthquake and Tsunami

Introduction

The Tohoku earthquake that occurred in the Pacific Ocean on 11th March, 2011 at a shallow depth of 32 kilometers is by far the largest earthquake ever recorded in the Japanese history and the fifth largest in the world. The earthquake was of 9. 0 magnitude with its epicenter located 130 kilometers off Sendai, Honshu, the largest city in the Tohoku region. This earthquake set off devastating tsunami waves travelling like a jet plane at the speed of 700 kilometers an hour (Sorkhabi, 2011). The waves that reached the altitude of 40. 5 meters travelled up to 10 kilometers inland, destroying towns and villages that came its way. The powerful tsunami waves also swept along the Pacific, wreaking havoc in California, Hawaii, Washington, Oregon, and British Columbia. This paper would discuss in detail the reasons for the Tohoku earthquake and tsunami to take place, the foreshocks to the event and the likelihood of reoccurrence, and its impacts, and would investigate if any measure was taken or not to minimize the effect.

Japan has a long history of earthquakes. In fact, the area is so prone to earthquakes that minor tremors are almost a daily affair. About 1, 500 earthquakes take place in Japan every year. It is because Japan sits in the 'Ring of Fire', the area stretching along the basin of the Pacific Ocean in which 90% of the world's earthquakes and over 75% of the world's volcanic eruptions take place. The island nation sits atop or near the boundary of four tectonic plates; the Pacific, Eurasian, North American, and Filipino plates (Marder, 2011). These four huge slabs of the earth's crust constantly brush

against each other, slip under, lock up and jolt again, and as these plates rub against each other, the pressure builds up and sometimes quite unpredictably, the pressure releases. The release of this pressure triggers earthquakes, and the sudden thrust of the seabed forces the ocean water upward, triggering tsunami (Marder, 2011).

In the case of the Tohoku earthquake, the collision of two tectonic plates, the North American plate, which is a continental plate, and the Pacific plate, which is an oceanic plate, was involved. The earthquake occurred in the subduction zone, which is a boundary between two tectonic plates in which one plate is moving beneath the other (USGS, 2011). The Pacific plate is the largest and fastest-moving tectonic plate of the earth subducting at a rate of 80 to 100 mm a year beneath the North American plate (Marder, 2011). In 2011, the process of subduction created a friction that made the Pacific plate to stick, building a huge pressure of energy, and when that pressure released, an earthquake broke out. According to David Wald, a seismologist at the National Earthquake Information Center at USGS, the earthquake of Tohoku generated approximately the same amount of energy as is consumed by the whole of the country of the USA in a year (Marder, 2011). About 10 miles of the earth’s crust ruptured along the Japan Trench where the tectonic plates meet (Sample, 2011). The earthquake took place at the shallow depth of only 20 miles below the surface of the Pacific Ocean, releasing much of its energy at the seabed, and that release of energy moved the ocean water upward, triggering a series of waves of high magnitude called tsunami.

The Foreshocks and the Likelihood of Reoccurrence

Before the main earthquake took place on 11th March, 2011, an earthquake of 7. 3 magnitudes took place on 9th March in the offshore eastern Honshu, followed by a series of aftershocks some of which were greater than 6. 0 magnitudes (Sorkhabi, 2011). This earthquake of 7. 3 magnitude, however, did not attract much attention as it took place at the seafloor more than 130 kilometers away from the shore. Though this earthquake comes under the category of strong earthquake because of its magnitude, it did not cause any severe destruction. It triggered a tsunami of 60 centimeters high that struck the coast an hour later the earthquake took place. The occurrence of this earthquake followed by the aftershocks fooled everyone because the seismologists thought that the subsequent earthquakes, three of which were over 6. 0 magnitudes and 5 of which were stronger than 5. 0 magnitudes, were aftershocks of the 7. 3 magnitude earthquake (Liu and Zhou, 2012). It is only after the Tohoku earthquake surfaced that it became clear that the 7. 3 magnitude earthquake and the subsequent earthquakes were the foreshock sequence of an earthquake of greater magnitude as the Tohoku was.

Temporal distribution of foreshocks, main shock, and aftershocks (Liu and Zhou, 2012)

The principal earthquake of 9. 0 magnitude was followed by three aftershocks of more than 7. 0 magnitude, and till date, more than 800 aftershocks of 4. 5 magnitude or greater have taken place (Birmingham, 2013). There is a much speculation about one big earthquake to hit the capital city of Japan soon. Though making a prediction about when and

where an earthquake will take place is difficult, scientists, however, using the concepts of the earthquake cycle and seismic gaps try to determine when a major earthquake becomes more imminent. Besides, they also monitor the geochemical signs at critical fault zones in order to forecast an earthquake. However, scientific development in terms of predicting an earthquake is not so advanced, and therefore, the earthquake forecasts are not as precise as that of cyclones or tornadoes (Sorkhabi, 2011). However, taking into account a sharp increase in the seismic activity across the northeast Japan in recent times, it is believed that all these may be a forewarning for an imminent big earthquake. As per the prediction made by a group of researchers of the Earthquake Research Institute at the University of Tokyo, there is a 70% chance of an earthquake of 7. 0 magnitude or higher to take place in Japan's capital Tokyo by 2016. If this prediction becomes true, then a death toll of up to 11, 000 people and damages worth $1 trillion will be incurred by the third largest economy of the world (Birmingham, 2013).

Impacts

Primary Impacts

The extent of damage caused by the massive earthquake and the devastating tsunami were enormous. However, most of the damage was caused by the tsunami, which engulfed every town and village that came its way and reduced them into heaps of rubble. As per the report of Japan's National Police Agency, the number of buildings completely destroyed with almost no structure standing by the earthquake and tsunami was 45, 700, and the number of buildings heavily damaged was 144, 300. As estimated,

altogether the earthquake coupled with tsunami created 24-25 million tons of debris and rubble in the country. 300 hospitals were devastated by the disaster, with 11 of them being completely destroyed. 15, 889 people died, of which the majority died by drowning, 6, 152 people were injured, and 2, 601 people went missing (NPA, 2014). Scores of children lost their parents and were separated from families. About 230, 000 automobiles and trucks were estimated to be either damaged or completely destroyed in the disaster. Cosmo Oil Company's oil refinery, which produced 220, 000 barrels per day, was caught on fire by the earthquake at Ichihara, east of Tokyo. Another oil refinery located in Sendai, owned by JX Nippon Oil & Energy, with the production capacity of 145, 000 barrels per day, also caught fire due to the earthquake (Inajima and Okada, 2011).

Secondary and Short-Term Impacts

In the immediate aftermath of the disaster, about 1. 5 million households lost access to water supplies. The reactors at the Fukushima Dai-ni, Tōkai nuclear power stations, Fukushima Daiichi, and Onagawa Nuclear Power Plant sustained considerable damage in the disaster as a result of which about 4. 4 million households, which were served by the Tohoku Electric Power, were left without electricity (Inajima and Okada, 2011). The power generation capacity of the Tokyo Electric Power Company (TEPCO) was affected due to the shutdown of the nuclear power plant reactors and several other conventional power plants, and therefore, rotational blackouts of approximately three hours began to take place owing to power shortages. An emergency state was declared by the Japanese government when the

cooling system of Fukushima Daiichi Nuclear Power Plant experienced a failure, and the residents living nearby the reactor were told to evacuate their homes (Inajima and Okada, 2011).

Long Term Impacts

The long term impact of the 2011 Tohoku earthquake and tsunami involves both economic as well as humanitarian crises. The tsunami gave rise to 300, 000 refugees overnight in the affected areas of Japan and caused shortages of water, food, shelter, fuel, and medicine. Though three years have passed, 267, 000 people are still living as refugees in shelters, makeshift housings, and asylums. Of these refugees, about 70, 000 people are those who were evacuated when the Fukushima Nuclear Power Plant broke down. The majority of the tsunami-affected communities suffer from a slow rate of reconstruction as a result of which the number of people leaving the areas has been ever-increasing (Chen, 2014). There are people who do not have the affordability or the means to rebuild their homes inland. Many of these people have lost their near and dear ones to the tsunami. Many of these people suffer from a growing sense of frustration and show the signs of post-disaster suicides.

Economically, Japan is suffering from a long term impact of the tsunami. The total cost of rebuilding is estimated to be $122 billion. The earthquake and tsunami also resulted in suspended business activities across the affected areas. About 644 companies, hit by the disaster, declared bankruptcy, and these companies, which included 150 manufacturing firms, 157 service providers, and 113 wholesalers, left behind liabilities worth ¥925. 4 billion

(Chen, 2014). Another serious impact of the tsunami was the damage incurred by the Fukushima Daiichi Nuclear Power Plant, which spilled radiation-contaminated water into the Pacific. Researchers fear that there is a chance of long-term environmental as well as health hazard as a result of this.

The Efforts undertaken to minimize the Effects

Earthquake and tsunami are not uncommon in Japan, which experiences 20% of the earthquakes of the world. Therefore, Japanese people are quite well-prepared for earthquakes and tsunamis. Children are taught to go under the desk or hang on to their legs until the quake is over to shelter themselves from falling objects. If anyone is out in the open, then they know that they are to rush to the center of that open space to avoid being hit by falling objects. Drills happen in offices, schools, and other institutions almost every month. The fire department also organizes quake simulation sessions for children and adult groups. Buildings with more than two stories have evacuation suites for use to slide down safely. Most of the buildings have massive shock absorbers to absorb seismic energy. Modern buildings also have bases that can move semi independently from the superstructure, making them less vulnerable to massive earthquakes (Foster, 2011). Almost 40% of the total coastline in Japan has sea walls to reduce the effects of the tsunami. Thus, Japan is the most well-prepared country in the world when it comes to earthquakes and tsunami. However, if an earthquake and tsunami of such magnitude happens, it is difficult to prepare for that.

Earthquake measures in Japan are comprehensive and modern. Even the

earthquake detection system is also highly sophisticated. However, Tsunami protection system can still be improved. Currently, Japan has sea walls built and tsunami bunkers created at highlands to minimize the effect of the tsunami. They can further create natural barriers like growing shrubs and coastal vegetation along the coastline to reduce the effect of the tsunami. Also, there is a ‘ dual barrier’ system that has been developed in Netherland and found to be useful against the giant tsunami waves (Steiner-Dicks, 2011). Furthermore, Hitachi Zosen Corporation has developed and is currently constructing a ‘ flap gate’ real-time tsunami protection structure. This modern sea water barrier deploys automatically when a tsunami wave approaches. These devices can be employed to withstand the tsunami.

Conclusion

The Tohoku earthquake of 2011 is the largest earthquake experienced by Japan in its history. This earthquake of 9. 0 magnitude, which occurred due to the tension created by the shift of the Pacific plate beneath the North American plate, created a devastating tsunami that wreaked havoc in the Hotoku region, killing thousands of people, leaving hundreds of thousands others homeless, and ruining several buildings and structures that came its way. Since Japan's location is in the 'Ring of Fire', it is very prone to earthquakes, and taking into account the increasing number of earthquakes in the recent times after the Hotoku earthquake of 2011, it is expected that a big megaquake is due in Japan by 2016. Japan, still reeling under the shock of the Hotoku earthquake, is one of the countries best prepared for earthquakes. However, given the fact that the earthquake prediction is not

as precise as that of cyclones or tornadoes, it is difficult to predict about an imminent earthquake accurately, but Japan is gearing itself up for another megaquake, taking enough protection to safeguard itself against a disaster. Hopefully, Japan will not be as affected by the future earthquakes as it had been by the Hotoku one.

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