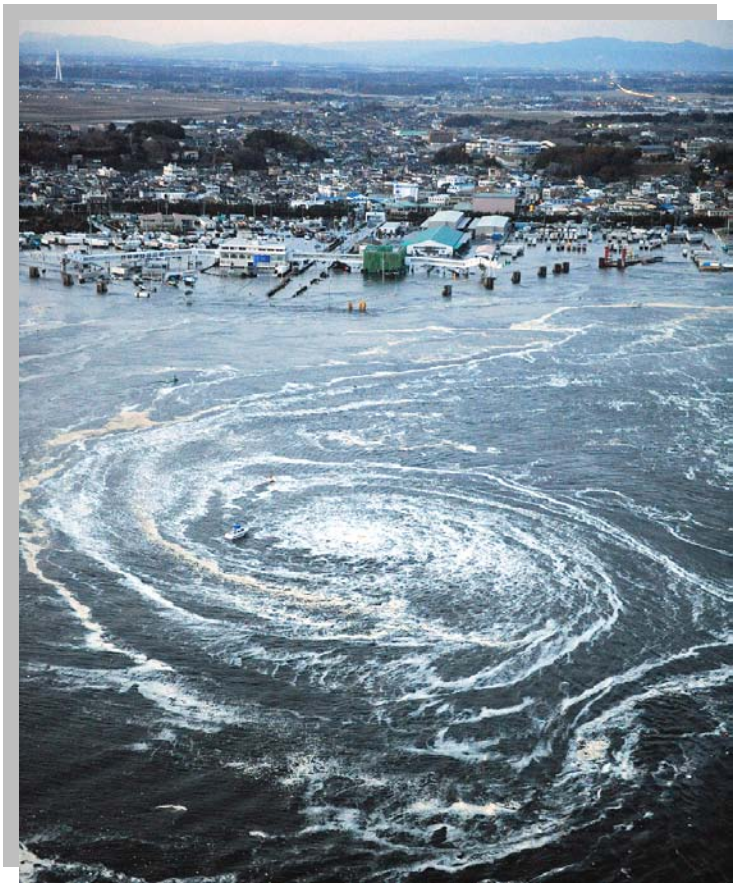
MEGA DISASTER IN A RESILIENT SOCIETY

The Great East Japan (Tohoku Kanto) Earthquake and Tsunami of 11th March 2011



SYNTHESIS AND INITIAL OBSERVATIONS

International Environment and Disaster Management
Graduate School of Global Environmental Studies
Kyoto University
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About this Report

This report is published on 25th of March 2011, two weeks after the Great East Japan [Tohoku-Kanto] Earthquake and Tsunami. The aim of the report is to synthesize certain existing data with basic situation analysis. The disaster has posed a major challenge to the disaster risk reduction community, which needs to be discussed in future over the course of time. Assistance of Yukiko Takeuchi for providing information, and Kumiko Fujita and Yuta suda in translating parts of the Japanese information is acknowledged. Support from Kyoto University Global COE Program "Global Center for Education and Research on Human Security Engineering for Asian Megacities" (http://hse.gcoe.kyoto-u.ac.jp) is highly acknowledged.

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1. Event Information

1.1 Earthquake

On 11th March 2011, at 14:46, the northeastern part of Japan was triggered by a major earthquake of magnitude 9. The distance of the epicenter was 130 km off the Pacific coast of Tohoku region, and the depth was 24 km. As per the Japan Meteorological Agency (JMA), the seismic intensity of 7 [in the Japanese scale of 1 to 7] was recorded in Kurihara city of Miyagi prefecture (Figure 1). Moreover, the intensity of 6+ was recorded in 28 cities and towns in Miyagi, Fukushima, Ibaraki, and Tochigi Prefecture. It also included Wakuya town, Tome City, and Osaki city. Intensity of 6- or weaker was observed in different parts of the country.

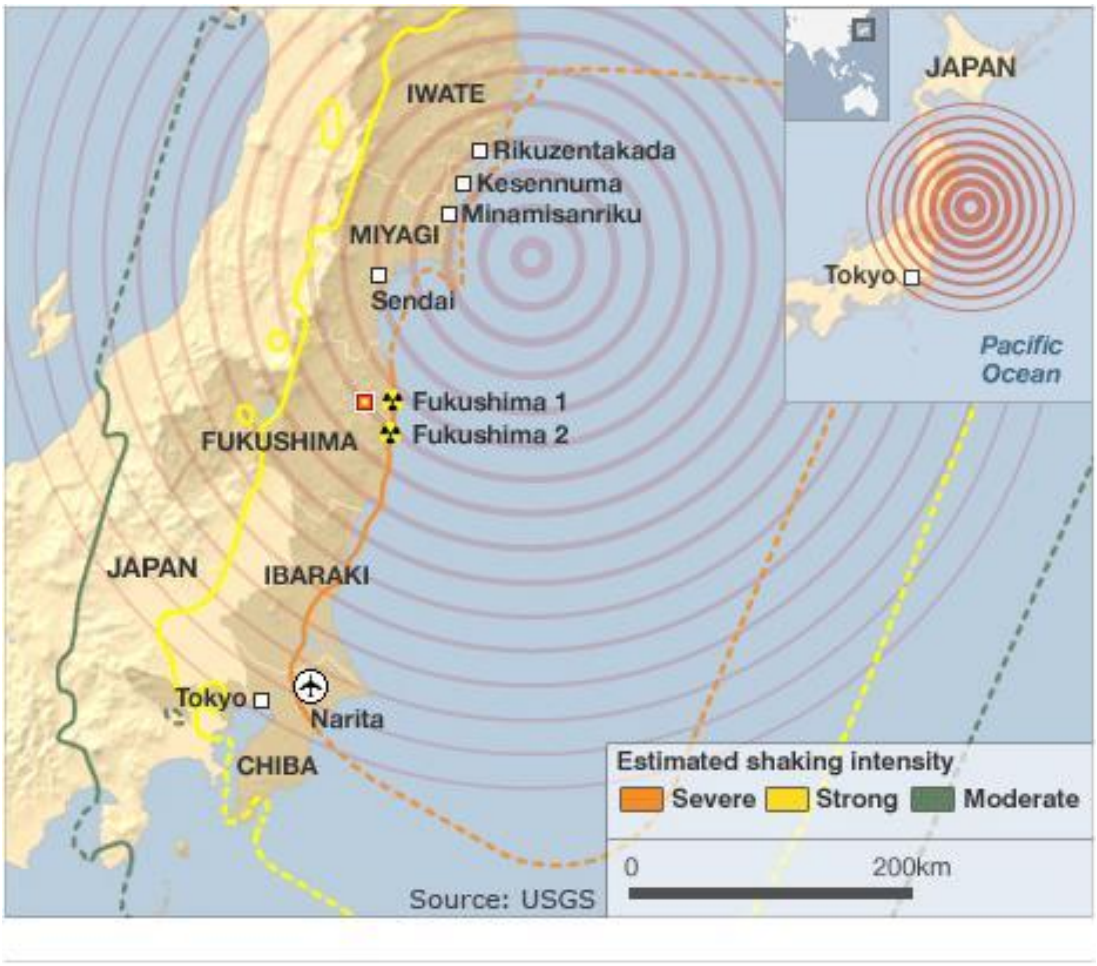

Figure. 1. Map of affected areas
Source: USGS

Table. 1. Earthquake Summary

Date and Time:	11 March 2011 14:46 JST (05:46 UTC)	
Magnitude:	9.0 (interim value; the largest earthquake recorded in Japan)	
Hypocenter:	130km off the Pacific coast of Tohoku region, from Iwate to Ibaraki Prefectures, 24km depth	
Mechanism:	Reverse fault type with WNW-ESE compressional axis (by CMT analysis)	
JMA Seismic Intensity:	7 (Max)	Kurihara City of Miyagi Prefecture
	6+	28 cities and towns (including Wakuya Town, Tome City, Osaki City, Natori City) in Miyagi, Fukushima, Ibaraki, and Tochigi Prefectures
	6- or weaker	Observed nationwide from Hokkaido to Kyushu
Tsunami Warnings	Issued at 14:50 JST 11 March 2011	

Source: Japan Meteorological Agency (JMA)

Soon after the earthquake, aftershocks of very high intensity were recorded by Japan Meteorological Agencies (JMA) (Figure 2). Around 3 aftershocks of 7 and 7+ magnitudes were triggered within 1 to 2 hours in the prefecture of Sanriku Oki, and Ibaraki-Ken Oki. The largest aftershock of 7.4m was recorded around 15:15 JST in Ibaraki-Ken Oki. There were 49 aftershocks of magnitude 6 or greater recorded on the same day in the larger areas of the coast of Iwate, Miyagi, Fukushima, and Ibaraki prefectures.

Table. 2. Aftershock Summary

Date	**Aftershock magnitude***	**Occur Time**	**Region/Prefecture**
11th March	7.0	15:06 JST	Sanriku Oki
	7.4	**15:15 JST**	**Ibaraki-ken Oki**
	7.2	15:26 JST	Sanriku Oki
	6.1	15:57 JST	Ibaraki-ken Oki
	6.8	16:15 JST	Fukushima-ken Oki
	6.6	16:29 JST	Sanriku Oki
	6.7	17:19 JST	Ibaraki-ken Oki
	6.0	17:47 JST	Fukushima-ken Oki
	6.4	20:37 JST	Iwate-ken Oki
	6.1	21:13 JST	Miyagi-ken Oki
	6.0	21:16 JST	Iwate-ken Oki

*** Magnitude 6 or greater**

Source: Japan Meteorological Agency (JMA)

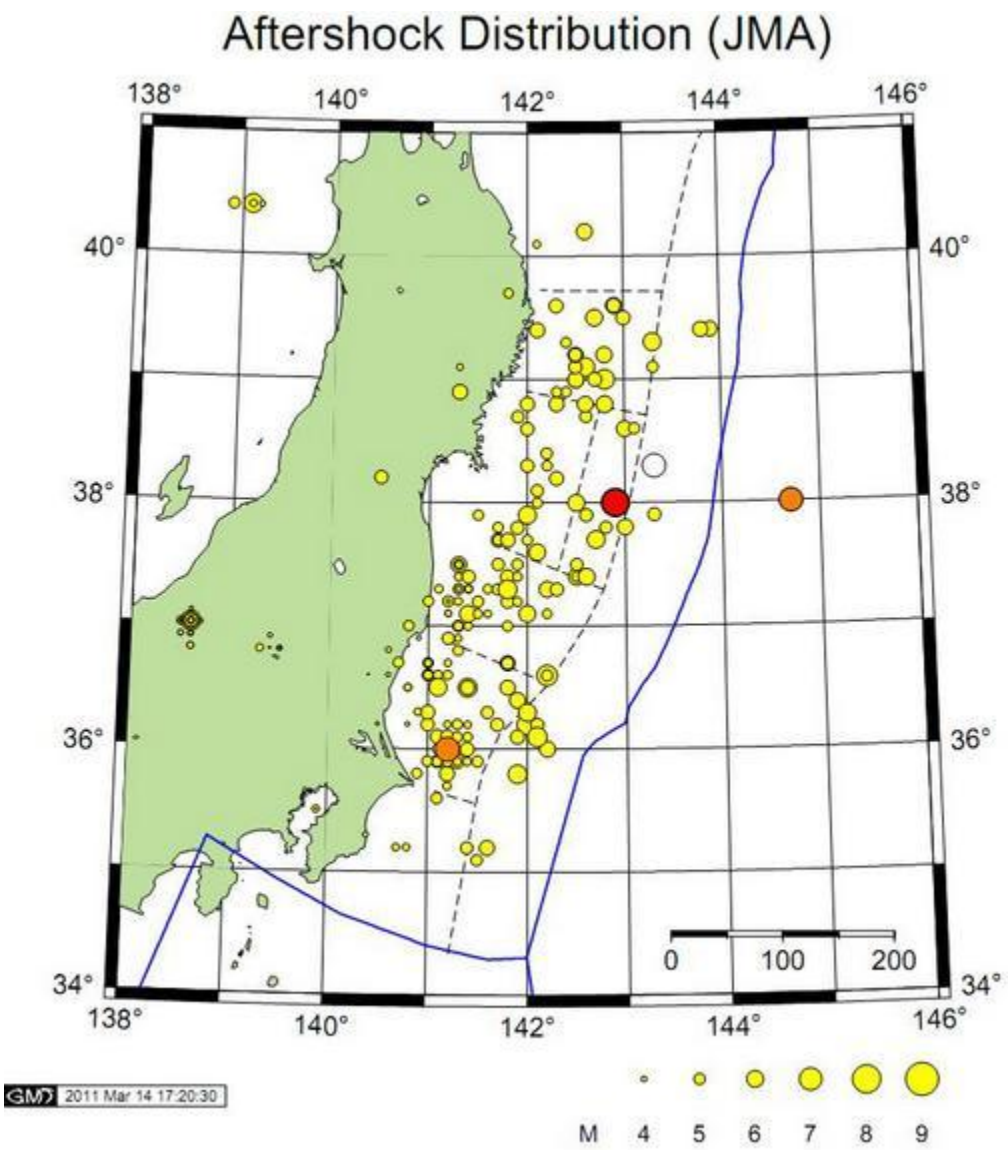

Figure 2. Map showing aftershock distribution
Source: Japan Meteorological Agency (JMA)

1.2 Tsunami

The earthquake was followed by a major tsunami, with maximum height of 11.87 meter was recorded near the coast of Akamae. At 15:31 JST,11 March 2011, major tsunami of more than 3 m or more arrived in northern part of Japan: eastern, central, western part of pacific coast of Hokkaido, pacific coast of Aomori, Iwate, Miyagi, Fukushima, Ibaraki, Chiba prefecture, Kujukuri & Sotobo area, and Izu islands. However, major Tsunami landed within 30 minutes in Iwate, Miyagi, and Fukushima and pacific coast of Aomori prefecture. Moreover, many aftershocks were recorded. For example, aftershock of 8.4m, 8.8m at 16:09 JST, 11 March 2011, 16:09 JST,11 March 2011 respectively. The cities that are affected by the Tsunami are show in annex. The earthquake in Japan also triggered warning in other countries, such as Taiwan, Indonesia, Russia, Philippines, the

Pacific Islands, and as far away as Hawaii, Mexico, and Colombia. One important point in this regard is that the earthquake happened in 14:46, and the tsunami warning was issues at 14:49, and it was on the JMA website on 14:49.

Figure 3. Tsunami affected areas Source: OCHA, 2011

Table. 3. Overview of the forecast by Japan Meteorological Agency (JMA) - magnitude and tsunami wave estimates for the main shock over time

Date & time of issue	*Magnitude*	*Depth*	*Major Tsunami Forecast region*	*Estimated Tsunami arrival time*	*Estimated Tsunami Height*
14:50 JST, 11 March 2011	7.9	10 km	Iwate pref.	already arrived	3m
			Miyagi pref.	15:00	6m
			Fukushima pref.	15:10	3m
15:14 JST, 11 March 2011	7.9	10 km	Pacific coast of aomori pref.	already arrived	3m
			Iwate pref.	already arrived	6m
			Miyagi pref.	already arrived	10m or more
			Fukushima pref.	already arrived	6m
			Ibaraki pref.	15:30	4m
			Kujukuri and Sotobo area, Chiba pref.	15:20	3m
15:31 JST,11 March 2011	7.9	10km	Eastern part of pacific coast of hokkaido	already arrived	3m
			Central part of pacific coast of hokkaido	already arrived	6m
			Western part of pacific coast of hokkaido	15:40	4m
			Pacific coast of aomori pref.	already arrived	8m
			Iwate pref.	already arrived	10 or more
			Miyagi pref.	already arrived	10 or more
			Fukushima pref.	already arrived	10 or more
			Ibaraki pref.	already arrived	10 or more
			kujukuri and sotobo area, chiba pref.	already arrived	10 or more
			Izu islands	already arrived	4m
16:09 JST,11 March 2011	8.4	20km	Eastern part of pacific coast of hokkaido	already arrived	6m
			Central part of pacific coast of hokkaido	already arrived	8m
			Western part of pacific coast of hokkaido	already arrived	6m
			Pacific coast of aomori	already arrived	3m

			pref.		
			Iwate pref.	already arrived	10 or more
			Miyagi pref.	already arrived	10 or more
			Fukushima pref.	already arrived	10 or more
			Ibaraki pref.	already arrived	10 or more
			kujukuri and sotobo area, chiba pref.	already arrived	10 or more
			Izu islands	already arrived	6m
			Ogasawara islands	already arrived	4m
			Sagami bay and miura peninsula	already arrived	3m
			Wakayama pref.	already arrived	3m
			Tokushima pref.	16:40	3m
			Shizuoka pref.	already arrived	3m
18:47JST, 11 March 2011	8.8	20km	Eastern part of pacific coast of hokkaido	already arrived	6m
			Central part of pacific coast of hokkaido	already arrived	8m
			Western part of pacific coast of hokkaido	already arrived	6m
			Pacific coast of aomori pref.	already arrived	3m
			Iwate pref.	already arrived	10 or more
			Miyagi pref.	already arrived	10 or more
			Fukushima pref.	already arrived	10 or more
			Ibaraki pref.	already arrived	10 or more
			kujukuri and sotobo area, chiba pref.	already arrived	10 or more
			Izu islands	already arrived	6m
			Ogasawara islands	already arrived	4m
			Sagami bay and miura peninsula	already arrived	3m
			Wakayama pref.	already arrived	3m
			Tokushima pref.	16:40	3m
			Shizuoka pref.	already arrived	3m

Source: Japan Meteorological Agency (JMA)

The hypo-central region of this earthquake extends from offshore Iwate prefecture to offshore Ibaraki prefecture so that the most effected area were Iwate prefecture, Myagi prefecture, Fukushima prefecture and Ibaraki prefecture (Table 6). It is counted that the number of authorities (local towns and cities) worst affected by the quake and tsunami

is 54 in total 174 towns/cities of these four prefectures (Table 6 and Figure 4a). Figure 4b shows Tsunami level (m) and arrival time (hour/minute) after the quake. The Japanese Meteorological Agency said that the earthquake may have ruptured the fault zone from Iwate to Ibaraki with a length of 500 km and a width of 200 km. The Joint Research Centre (European Commission) identified 88 (towns and villages) affected by the tsunami. They are listed in the appendix.

Table 4: The number of local authorities effected by tsunami

Name of Prefecture	*Total number of cities*	*Cities Affected by tsunami*
Iwate Prefecture	35	14
Miyagi Prefecture	36	17
Fukushima Prefecture	58	12
Ibaraki prefecture	45	11
Total	174	54

Source: Collected from the various agency of Japan Government

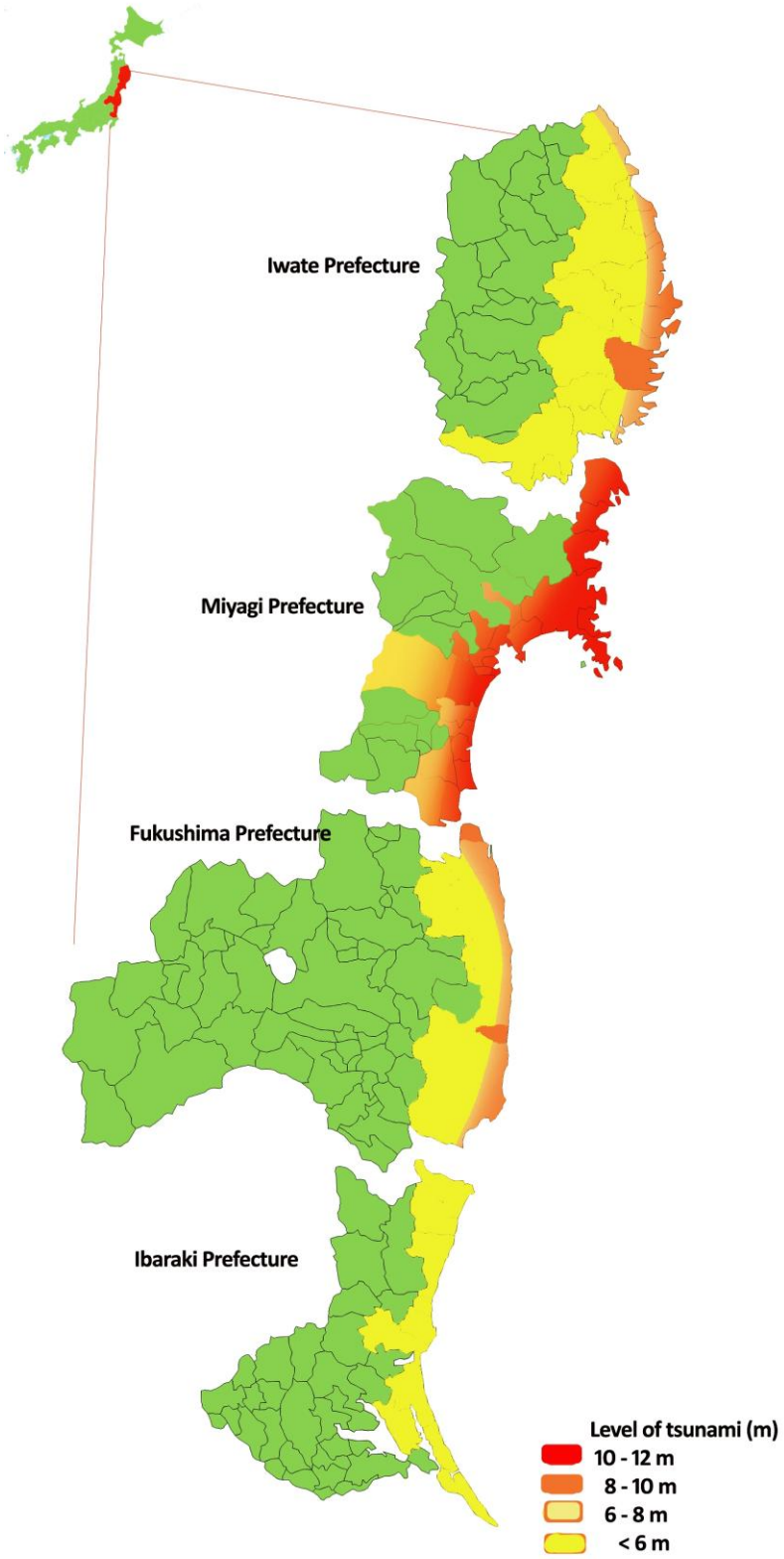

Figure 4a. Map of local authorities affected by Tsunami (analyzed by IEDM, Kyoto University)

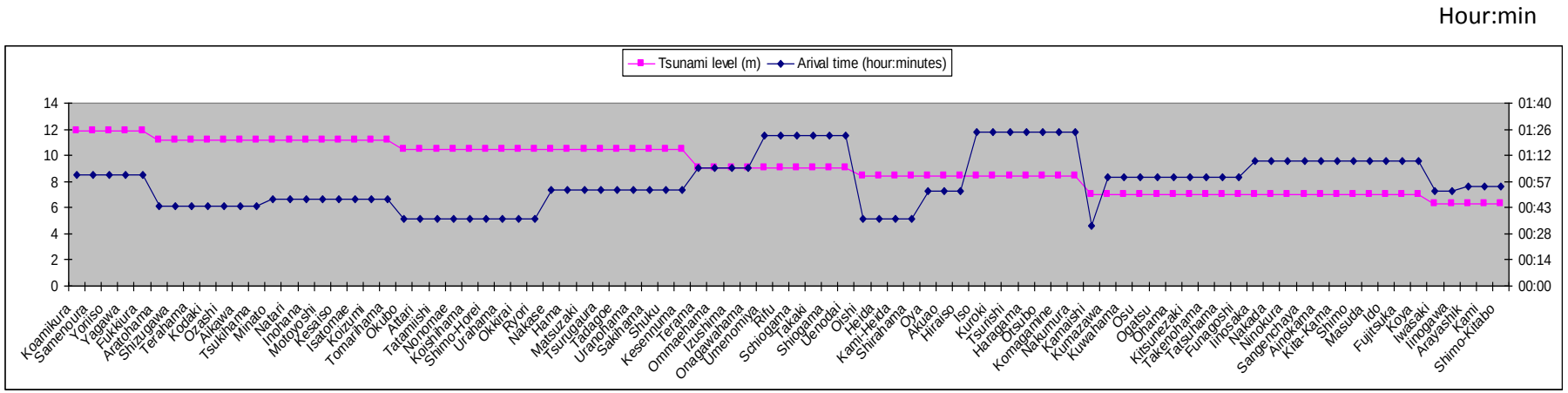

Figure 4b: Tsunami level (m) and arrival time (hour/minute) after the quake
(analyzed by IEDM, Kyoto University)

1.3 Nuclear Emergency (still ongoing)

On 11th March at 20:30 CET (04:30 JST), a nuclear emergency situation at the Fukushima Daiichi (number one) nuclear power plant was declared and reported to the International Atomic Energy Agency (IAEA)(Figure 5). Because of the intense earthquake all the three operating (out of six) reactors automatically began the process to be shut down. However, the back-up diesel generators which were supposed to supply the water pumps with energy to cool down the fuel rods inside the reactors failed (Chandler, 2011). Due to the tsunami, with waves of up to 14m, the back-up diesel generators were damaged. As a result, pressure levels inside the reactors number one and three began to rise because the fuel rods were not sufficiently cooled anymore and the water available began to evaporate.

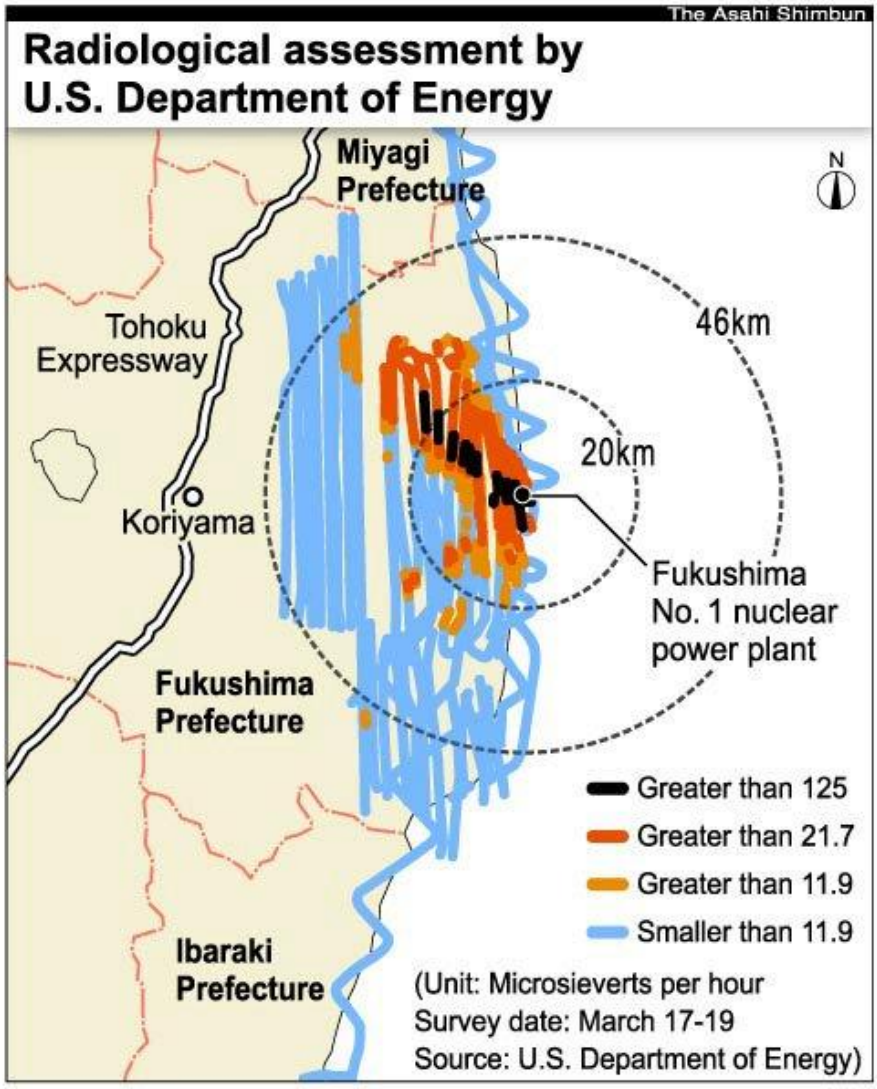

Figure 5. Map showing the radiological assessment. Source: Asahi Shimbun March 24, 2011

At 15:30 JST on March 12 a first hydrogen explosion took place at the number one reactor and led the Japanese government to evacuate people within a 20km radius around the Fukushima Daiichi power plant. The Japanese government then classified the situation at the Fukushima Daiichi nuclear power plant as a number 4 “Accident with Local Consequences” on the International Nuclear and Radiological Event Scale (INES).
At 11:01 JST on March 14, another explosion took place in reactor number 3 at the Fukushima Daiichi nuclear power plant.

At 06:14 JST on March 15, another explosion took place in the number 2 reactor at the Fukushima Daiichi nuclear power plant. And a fire broke out in the number 4 reactor where spent fuel rods were stored to undergo their cooling process, soon after the fire was extinguished. These incidents led to further increase of emission of radiation with levels up to 400 millisievert per hour near the site. A person is supposed not to be exposed to more than 2.4 millisivert per year! Subsequently, the Japanese Government established a 30km radius “No Fly Zone” around the Fukhushima Daiichi nuclear power plant.

On March 16, the Japanese Government decided to begin dousing the overheating reactors by using helicopters which had a carrying capacity of up to 7.5t to spray water into the damaged reactors. Four times this spraying took place.

On March 17, the helicopters’ water spraying was supported by further units of the Self Defense Force (SDF) to shoot water from the ground, using heavy water cannon trucks, into the most troubled number 3 reactor. These operations continued the following days, meanwhile new power cables were installed to provide the reactors number 1 and 2 with energy to start-up again the cooling mechanisms. However, power is, at the time of writing this report, not yet restored due to new heightened smoke in the number 3 and 4 reactors. Reactors number 1 and 2 are having electricity.

Increased radiation levels have been reported in spinach, milk and tap water outside the demarcated 30km evacuation zone. Farmers are advised to voluntarily avoid distributing contaminated food into the markets.

1.4 Fire Events

On 11th March, several fires resulted due to powerful earthquake triggered near the east coast of Honshu, the largest and main island of Japan. The same day fire broke out at Cosmo Oil Company refinery in Ichihara city. The fire was continued till 14th March. The following (Figure 6) shows the number of fire events occurred since 11th March, after the earthquakes. It shows how the number of events increased after the first day of earthquake, where only 44 cases were recorded and increased to 325 cases on 19th March. These events were regularly monitored and updated by Japan Police Agency (JPA).

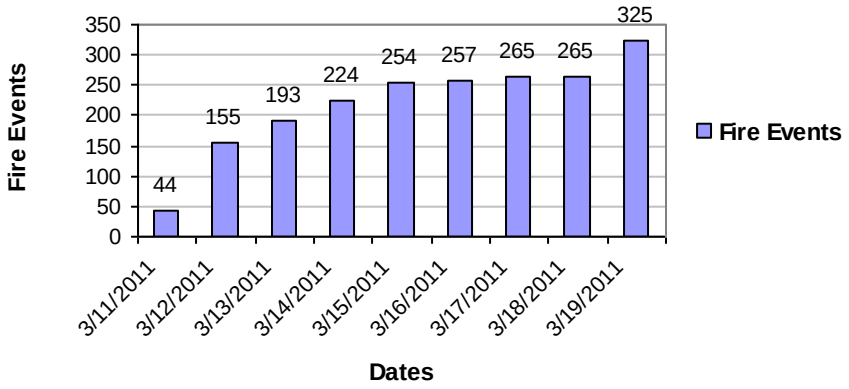

Figure 6. Number of fire events
Sources: Japan Police Agency (JPA)

2. Damage Information

As of 23th March, the resulted death was nearly 9,079, and 12,782 missing. The disaster also damaged 126,000 buildings. Moreover, serious damage is recorded for infrastructure, such as bridges, transportation system, electricity, gas supplies, and communication services.

Figure 7. Number of persons killed, missing, and injured
Sources: Asian Disaster Preparedness Center (ADRC); National Police Agency of Japan (JPA)

2.1 Human Life

The number of persons killed, injured and missing can still increase due to ongoing search and rescue operation. Therefore, it is early to speculate on number of total persons killed, injured and missing. The Figure 8 shows, number of people recorded killed, injured and missing since 11th March after the earthquake.

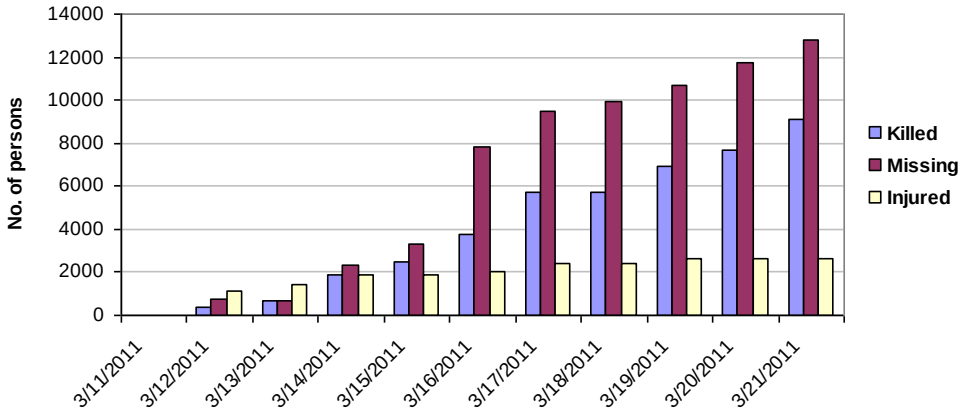

Figure 8. Number of persons killed, missing, and injured
Sources: Asian Disaster Preparedness Center (ADRC); National Police Agency of Japan (JPA)

Table 5. Prefecture wise number of persons killed, missing and injured (as of March 22, 2011)

Prefecture	Killed	Missing	Injured
Hokkaido	1		3
Aomori	3	1	66
Iwate	2,773	5,018	108
Miyagi	5,507	3,487	955
Akita			8
Yamagata	1		21
Fukushima	743	4,272	220
Tokyo	7		77
Ibaraki	19	1	636
Tochigi	4		133
Gunma	1		35
Saitama			42
Chiba	16	3	194
Kanagawa	4		127
Niigata			2
Yamanashi			1
Shizuoka			4
Tokushima			
Kochi			1
Total	**9,079**	**12,782**	**2,633**

Sources: National Police Agency of Japan (NPA)

2.2 Infrastructure

Infrastructure refers to the important facilities and systems that support a society, such as highways, streets, roads, and bridges; mass transit; airports and airways; water supply and water resources; solid-waste treatment and disposal; electric power generation and transmission; telecommunications; and so forth. The term may also include basic social facilities such as schools and hospitals. The March 11 earthquake and tsunami had caused unprecedented damage to infrastructure affecting utilities and public and private services. Citigroup expects 5-10 trillion yen in damage to housing and infrastructure, while Barclays Capital estimates economic losses of 15 trillion yen ($183.7 billion) or 3 percent of Japan's GDP.

Following the 9.0 magnitude earthquake, massive waves of debris-filled water swept away buildings, cars, and ships. Fires occurred in several cities and nuclear power plants, refineries, airports, and parts of the transport networks were shut down. Japan's north east, the epicenter of the disaster, is home to ports, steel mills, oil refineries, nuclear power plants, and manufacturers of car and electronics components. Many of those facilities have been destroyed. The extensive damage to Japan's infrastructure in the

north and east of the country are expected to dampen its economic growth. The damage to roads, rail lines, ports, and power plants is inevitably affecting economic activity. Global companies from semiconductor makers to shipbuilders face disruptions to operations after the quake destroyed vital infrastructure, damaged ports, and knocked out factories supplying everything from high-tech components to steel. The World Bank report states that it would take Japan about five years to rebuild.

Massive cleanup efforts are underway. Vital infrastructure is gradually being restored in areas hit by the March 11 mega earthquake, but the fate of tens of thousands of people remain uncertain. Aftershocks are still continually being felt and the crisis at the Fukushima Daiichi nuclear power plant has not been fully under control.

2.2.1 Transportation

In the aftermath of the massive earthquake and ensuing tsunami, train services were suspended, stranding millions of commuters. People in Tokyo waited in long lines for taxi cabs and buses while thousands of others booked hotel rooms. Tens of thousands began walking home while others tried to buy bicycles. Bike shops sold off their entire inventory, including high end bikes that cost 300,000 yen. In Tokyo many people spent the night in their offices.

It was reported by the government that the quake and ensuing tsunamis damaged 1,232 points of roads. The impact on roads however was quite localized, covering about 4% of Japan's geographical area. Ports, roads, and other infrastructure were ravaged by tsunamis, with manufacturers suspending operations in affected areas. It became a struggle for responders to deliver aid supplies to victims.

Four trains were missing along the coast and a ship carrying 100 people was swept away. At least six Japanese seaports have seen major damage. The biggest port in the north-east, Sendai, has been destroyed and will not be operational for months. The impact of this on the global supply chain and international trade is considerable. Factories have been closed because of delays in the shipments of parts. The closure of the ports is estimated to be costing Japan USD 3.4B in lost sea-borne trade each day. In addition, the airport in Sendai has suffered extensive damage, but other major airports have not been directly affected by the natural disaster.

The damaged roads, airports, and seaports have been gradually repaired, with the Tohoku expressway and the submerged Sendai airport opened to emergency vehicles, airplanes, and helicopters. But delivery of relief goods contributed from around the nation to evacuees and survivors still remains difficult due to shortages of fuel and transport vehicles. Across the region, almost all train lines are running more frequently than at the start of the week. However, regular deliveries to stores are reportedly patchy. Many areas have near-normal supplies of the essentials while others appear close to depletion. Many train services remain affected, but most are gradually improving. Airports open, but reported very busy.

2.2.2 Energy

The troubles at the Fukushima Daiichi nuclear plant have left its operator Tokyo Electric Power Co. unable to provide sufficient electricity to Tokyo and surrounding prefectures and forced to implement power rationing for the first time in its history. In the Kanto region, centering on Tokyo, a power shortage of some 25 percent is being observed and this could become a large bottleneck in the economy. Areas served by TEPCO account for some 40 percent of Japan's economic output. The power outages, however, have not been as regular or as widespread as anticipated. Power-conservation measures appear to be helping, with many shops and businesses either closed or reducing electricity consumption.

Power shortage after the quake forced companies such as Sony Corp. and Toyota Motor Corp. to halt production. South Korean firms are facing higher prices for memory chips, in part because Japan accounts for up to 36 percent of global production and that production is now disrupted, while Thai exporters of cars report that current supplies of components imported from Japan will last through April.

Japan is in urgent need to import coal, LNG, and oil products to restore energy consumption, but damaged storage tanks, ports and refineries render the country incapable of absorbing all the fuel and raw materials foreign suppliers might want to rush in. Japan is struggling to restore power supplies as electricity blackouts affect five million houses and to ramp up availability of gasoline to end queues of cars at fuel stations. Japan's trade minister said the government has asked refiners located in the west to boost run rates to 95 percent or more to help stabilize demand and supply in the quake-hit areas of the east.

To help Japan cope, countries such as South Korea, Russia and Indonesia have already pledged to supply the country with extra cargoes of oil, coal, and LNG. Yet, a lack of sufficient handling capacity may mean that these supplies will take a while to reach consumers. The earthquake that struck the world's third-largest oil consumer caused the loss of around 9,700 megawatts (MW) of nuclear and 10,831 MW of thermal power generation. Similarly, crude consumption in Japan has declined as more than 30 percent of the country's refinery capacity, or 1.4 million bpd, has been shut because of the quake even as some get ready to restart operations.

As of March 20, a total of 242,927 households in the north were without electricity, Tohuku Electric Power Co. says. Many regional train lines were suspended or operating on a limited schedule to help reduce the power load. Fuel scarcity forced the Miyagi prefectural government to allow burial of victims without cremation.

2.2.3 Water management

The earthquake that affected the east coast of Japan has caused huge disruption to the country's water supply. Around 1.4 million households are without running water, but there has been some improvement in the provision of electricity and water services. Eleven prefectures are without water, compared to 17 right after the earthquake happened. The most affected prefectures from water shortages include: Miyagi, Fukushima, Yamagata, Ibaraki, Tochigi, Chiba, Akita and Aomori. As part of a national emergency committee, led by the prime minister, over 250,000 bottles of water have been distributed, with beer tankers being used to transport water and 5,000 mobile latrines have also been deployed. Water supply in some parts of Tokyo has also stopped, the metropolitan government's Bureau of Waterworks said. The water supply went out after the earthquake damaged the municipal water pipes. For example, most of the areas in Tsukuba city are out of water so the municipal office set up a few spots for drinking water. People need to go to those spots at certain times to get water. At least 1.04 million households in 11 prefectures were without running water as of Saturday, the Health Ministry said on March 19. The supply of water is critical in the aftermath of a disaster because of risk of epidemics as displaced people gather in shelters, the World Health Organization said on its website.

2.2.4 Communications

The earthquake in Japan has had surprisingly limited impacts on the structure and routing dynamics of the regional Internet. Of roughly 6,000 Japanese network prefixes in the global routing table, only about 100 were temporarily withdrawn from service. Other carriers around the region have reported congestion and drops in traffic due to follow-on effects of the quake, but most websites are up and operational, and the Internet is available to support critical communications. Compared to the 2006 Taiwan earthquake, which resulted in a larger number of major cable breaks, it appears that the majority of the region's submarine cables have escaped the worst damage, and diverse capacity remains to carry traffic around the points of damage.

Nationwide, Japan is home to a large data center industry, and a cloud services industry pegged at about 10 percent of world cloud revenue in 2010. According to continual updates from Japan’s Ministry of Internal Affairs and Communication and the Japanese office of news outlet ZDNet, about one dozen major data centers and cloud facilities had reported back with varying degrees of problems, though no loss of life.

2.2.5 Solid Waste Management

The earthquake and tsunami generated so much debris that it is going to take weeks if not months to clean-up. Two days after the catastrophic earthquake and tsunami devastated coastal towns only did the scale of the devastation sank in. Houses and cars were overturned everywhere. Residents returning to their houses and apartments to collect and clean their belongings were greeted by a much changed landscape. Several neighborhoods were completely swept away, leaving vast wastelands of mud and debris.

The rubbles were searched for dead bodies before the cleanup. The painstaking task must be completed before heavy machinery can be called in en masse to begin the next phase: clearing away the oceans of debris that are all that is left of much of northeastern Japan's coast. However, fuel shortages have hampered the use of heavy machinery.

2.2.6 Social Infrastructure

Initial estimates put the number of schools damaged or destroyed at some 4,000, meaning that there will be major interruptions in children's education and return to a sense of normalcy that school provides. There are 554 schools currently being used as evacuation centers (OCHA, March 21). According to United Nation, to allow affected children get primary education, Ministry of Education, Culture, Sports, Science and Technology (MEXT) is allowing transfer with necessary documents. Many local governments have offered to host school children. For example, Osaka has offered to receive 3,000 students of high schools hosted by families. Similarly, Kagawa Prefecture will going to take 200 elementary school children and 40 students from high school. As far the damage to the public schools is concerned, the Miyagi Prefectural Board of Education (MPBE) recorded 548 damaged schools out of the total 884 public schools in Miyagi prefecture. The table is listed in the appendix.

3. After Event

This section particularly focuses on after the event, especially on the search and rescue operation, followed by shelters.

3.1 Search and Rescue

11 March 2011: Immediately following the disaster the Government established an Emergency Response Team, headed by Prime Minister Naoto Kan. The Government has mobilized thousands of troops for the rescue effort. More than 300 planes and 40 ships conducted airlifts and boat rescues. Continued aftershocks and tsunami hampered rescue efforts (OCHAa).

12 March 2011: Following a direct appeal from the Government of Japan, several international search and rescue teams began to be deployed. The U.S. Agency for International Development (USAID) sent Urban Search and Rescue (USAR) teams from Fairfax County and Los Angeles County to assist in the rescue efforts. The U.S. rescue teams comprised of approximately 150 personnel made up of doctors, firefighters, engineers and 12 canine teams trained to search for victims traveled with over 74,000 thousand pounds of state-of-the-art gear that can find bodies under collapsed buildings using heat sensors and telescoping cameras.

Britain dispatched a team of 59 fire service search and rescue specialists, two rescue dogs and four medical staff to join the international relief effort. The team brought 11 tons of specialist rescue equipment, including heavy lifting and cutting equipment (AFP).

In its initial response, the Republic of Korea sent a team consisting of two rescue dogs and five relevant personnel (two dog handlers and three rescue assistants).

Switzerland deployed a search and humanitarian assessment team, comprising 25 Swiss experts and nine sniffer dogs. One group will use sniffer dogs and tracking devices to locate victims buried underneath the debris in the tsunami-hit region. A second group will assess the most urgent humanitarian and environmental needs, to coordinate efforts on the ground with the authorities, and to provide initial emergency relief. In addition, two specialists from the Swiss Humanitarian Aid Unit (SHA), who were deployed in Beijing, were expected to arrive (Government of Switzerland).

Figure 9. A military helicopter flies over a sunken town on March 12, 2011 following a massive tsunami triggered by one of strongest earthquakes ever recorded in Sendai, northern Japan. (AP)

13 March 2011: International rescue teams started to arrive in Japan (Table 8). The two rescue teams sent by the USAID arrived at Misawa airport on a chartered aircraft. The rescue teams proceeded to Ohunato in Iwate Prefecture and will be engaged in search and rescue activities under the direction of the Tokyo Fire Department which was already in operation there. (Government of Japan)

On board a chartered Air China plane, the Chinese 15-member rescue team arrived at Haneda Airport. The Chinese International Search and Rescue Team (CISAR) brought with them four tons of materials and equipment for search and rescue, power supply and telecommunication (Xinhua News Agency).

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Figure 10. Members of the Chinese rescue team prepare to depart to aid Japan, after the earthquake and tsunami, at the airport in Beijing on March 13, 2011. (Stringer/AFP/Getty Images)

Rescue teams from Germany, Switzerland and Singapore arrived at Narita Airport. The German rescue team consisted of three rescue dogs and 43 relevant personnel. The Swiss rescue team consisted of nine rescue dogs and 27 relevant personnel. Lastly, the Singaporean rescue team consisted of five rescue dogs and five relevant personnel (Government of Japan).

The offer for operational support made by France and Monaco were accepted by the Government of Japan. Consequently, the Monegasque Rescue and Clearing Unit, the French RIISC n° 7 detachment in Brignoles and fire-fighters from the Paris, Seine and Marne Fire Departments were mobilized. The 11 Monegasque fire-fighters specialized in search operations for individuals buried beneath the debris and trained for working in a "radiological environment" (i.e. in the event of contamination or radio-active source).

Among them was also a non-commissioned officer qualified in managing radiological operations. The Monegasque fire-fighters will be equipped with special suits, respirators as well as individual and collective detecting equipment to ensure their protection. Each of them will also carry an individual device (dosimeter) that measures the level of radiation exposure upon their return (Government of Monaco).

The Government of Japan has ordered 100,000 Self Defense Force troops to assist emergency operations with the aid of 190 planes and 45 boats. The Red Cross has 62 teams also providing assistance and there are 178 Disaster Medical Teams deployed, with another 111 teams on the way. However, rescue and relief operations are being hampered by continuous aftershocks, tsunami alerts, and fires. Many areas along the northeast coast remain isolated and unreachable by emergency services. To date, 3000 people have been rescued (OCHA b).

Table 6. USAR Teams received by the Government of Japan as of 13 March 2011

USAR Team	Personnel	Rescue Dogs	Date of Arrival for Initial Teams
Republic of Korea	5	2	12 March
Singapore	5	5	12 March
USA-Hungary Baptist Aid Rescue24	4	-	12 March
Australia	72	2	13 March
Germany	41	3	13 March
Mexico	9	6	13 March
New Zealand	65	-	13 March
People's Republic of China	15	-	13 March
United Kingdom	63	2	13 March
USA	144	12	13 March

Source: OCHA b

Figure 11. March 13: A Japanese home is visually inspected by a helicopter-based Search and Rescue (SAR) team from the aircraft carrier USS Ronald Reagan (CVN 76), as the home floats adrift miles from the coast of Japan two days after the 9.0 magnitude earthquake and subsequent tsunami. (U.S. Navy photo by Mass Communication Specialist 3rd Class Dylan McCord/Released).

Figure 12. March 13: A joint team from the U.S. Air Force and Marines conduct a search and rescue flight over Sendai airport. Source: REUTERS / US Air Force/Staff Sgt. Samuel Morse/Handout

Figure 13. March 13: Rescue workers checking the remains of a destroyed house in Miyagi prefecture. AFP/ Mike Clarke

Figure 14. March 13: Fire-department personnel rescue a woman from the devastated city of Natori. Source: www.time.com

14 March 2011: The emergency rescue and relief operation underway continued to be hampered by high magnitude aftershocks and tsunamis. There have been more than 100 aftershocks since Friday's 9.0 magnitude earthquake. Relief efforts are concentrated on extensive search and rescue, as well as re-establishing essential services in Miyagi, Fukushima and Iwate prefectures, in liaison with government bodies and local governments. More than 3,660 police personnel from prefectures across the

country have been deployed to support transportation, security and life-saving operations (OCHA c).

A total of 1,146 teams from the Ground Self-Defense Force and 40 teams from the Air Self-Defense Force are engaged in emergency response operations. The Ministry of National Defense has so far deployed 66,000 personnel of the 100,000 the Japanese Prime Minister has ordered to be deployed as well as 96 helicopters, seven fixed wing aircraft and 58 naval vessels, which are employed in search and rescue and related tasks. Local authorities in the affected areas are leading the local response with their own considerable capacities (ibid.).

The UK Search and Rescue team deployed by DFID have now arrived at their base, 20 km outside Ofunato in the north east of Japan. The British team will be working alongside US search and rescue colleagues and dogs in Ofunato and Kaimaishi - where tens of thousands were missing.
Some 2,000 bodies have been found on two shores in Miyagi Prefecture and about 1,000 bodies were found coming ashore on hardest-hit Miyagi's Ojika Peninsula. Another 1,000 have been spotted in the town of Minamisanriku, where the prefectural government has been unable to contact about 10,000 people, or over half the local population. About 200 to 300 bodies have yet to be recovered by the police in Sendai due to the difficulty of reaching them amid the devastation and rubble (Australian Broadcasting Corporation (ABC).

Additional support team from the Republic of Korea (ROK) which was offered in the Japan- ROK Summit telephone conversation on March 13 arrived at Narita Airport at 10:40 on three C-130H transport aircrafts. This consisted of 102 personnel including rescue workers and two officials of the Ministry of Foreign Affairs and Trade. The team is expected to operate in Sendai (Government of Japan).
A group of EMERCOM rescuers, who have arrived in Tokyo on the instructions of the President of the Russian Federation, have proceeded to the city of Sendai. There were 54 people in the group on three rescue motor vehicles carrying search equipment, hydraulic tools, tools for breaking down the concrete, and all that is needed for autonomous operation within two weeks - inflatable modules, generators, and communication facilities.

More are expected to join the Russian Federation group. 25 specialists of the Far Eastern regional search and rescue team are expected to arrive aboard Mi-26 helicopter from Khabarovsk. EMERCOM airplane IL-76 departure from Moscow airport Ramenskoye to Tokyo will take aboard a team of approximately 50 rescuers and special rescue equipment. Expert group of "Rosatom" corporation is planned to depart together with specialists from EMERCOM of Russia. It will also take aboard 25 rescuers of the Siberian regional center in Krasnoyarsk. An airplane AN-74 with 25 rescuers on board is also planned to take off from the airport of Khabarovsk. Thus, the overall number of

Russian EMERCOM forces in Japan will be about 180 people. (Government of the Russian Federation). The USAR teams with their area of work are shown in Table 7.

Table 7. Specialized International USAR Teams received as of 14 March 2011

USAR Team	Personnel	Rescue Dogs	Area of Action
Australia	74	2	Miyagi (Minamisanriku-cho)
Germany	41	3	Miyagi (Minamisanriku-cho)
France	134	-	Miyagi (Sendai City)
Mexico	9	6	Miyagi
New Zealand	65	-	Miyagi (Minamisanriku-cho)
People's Republic of China	15	-	Iwate (Ofunato-cho)
Taiwan Province of China	30	-	Miyagi (Sendai City)
Republic of Korea	105	2	Miyagi (Sendai City)
Russian Federation	54	3 vehicles	Miyagi (Sendai City)
Singapore	5	5	Fukushima (Soma City)
Switzerland	27	9	Miyagi (Minamisanriku-cho)
United Kingdom	64	2	Iwate (Ofunato-cho)
USA (2 teams from LA and Fairfax	148	12	Iwate (Ofunato-cho)
USA-Hungary Baptist Aid Rescue 24	4	-	
International Rescue Dogs	12	9	

Source: OCHA c

Figure 14. March 14: Soldiers of Japan Self-Defense Force and firefighters search for the victims in the rubbles in Matsushima, Miyagi Prefecture, Japan. Source: www.foxnews.com

Figure 15. March 14: Soldiers of Japan Self-Defense Force and firefighters search for the victims in the rubbles in Matsushima, Miyagi Prefecture, Japan. Source: www.foxnews.com

Figure 16. March 14: Rescue workers carry an elderly man found alive by tsunami survivors buried under rubble along a slope of a hill in Minamisanrikucho in Iwate Prefecture three days after a powerful earthquake-triggered tsunami hit the country's east coast. Source: www.foxnews.com

Figure 17. March 14: Rescuers conduct search operation amidst smoldering debris in Kesennuma, northern Japan following Friday's massive earthquake and the ensuing tsunami. Source: www.foxnews.com

Figure 18.March 14: Firefighters work during a search operation in the rubble of buildings in Ofunato, Iwate Prefecture, northern Japan. Source: www.foxnews.com

Figure 19. March 14: A survivor of the tsunami that swept through his village of Saito, in northeastern Japan, retells the story to a rescue team that arrived to search the area. (AP Photo/David Guttenfelder)

Figure 20. March 14: Firefighters search for victims in Soma city, Fukushima prefecture, Japan. (AP Photo/Wally Santana)

Figure 21. March 14: A Japan Self-Defense Force member reacts after rescuing a four-month-old baby girl in Ishinomaki, northern Japan. (AP Photo/The Yomiuri Shimbun, Hiroto Sekiguchi)

Figure 22. March 14: Japanese rescue workers carry the body of a tsunami victim in devastated town of Otsuchi. In the town of Otsuchi in Iwate prefecture, 12,000 out of a population of 15,000 have disappeared following Friday's massive earthquake and tsunami. (REUTERS/Damir Sagolj)

Figure 23. March 14: Rescue workers move the body of a patient through the halls of a hospital in Minamisanriku town. (REUTERS/Adrees Latif)

Figure 24. March 14: Japanese emergency crews work to free a body as it sits pinned among concrete sea barriers in Toyoma, Japan.(AP Photo/Mark Baker)

Figure 25. March 14: Rescue workers search for victims in the rubble in Rikuzentakata, northern. Source: REUTERS / Toru Hanai

15 March 2011: The threat of continued aftershocks and tsunami continues to affect emergency operations in northeast Japan. Snow and rain is also forecast from the evening of 15 March until 17 March in the earthquake and tsunami affected areas and is likely to impact road conditions and affect humanitarian access to the disaster hit areas. USAR teams on the ground are summarized in Table 8.

The Government of Japan decided to accept an emergency rescue team from Mongolia composed of 12 members from the National Emergency Management Agency of Mongolia (Government of Japan).

With the help of 9,500 fire-fighters and 920 police, Self Defense forces have together rescued 22,184 people to date. In Miyagi, one of the most affected prefectures, which sustained the largest number of casualties and the largest number of evacuees, the National Police Agency and Japan Self-Defense Force have rescued more than 2,200 people to date. It has rescued stranded people and sick patients. In addition, the Japan Coast Guard, and Fire and Disaster Management Agency have rescued nearly 3,000 people, including about 970 affected people stranded in isolated villages. Various national agencies have provided personnel mobilized from prefectures mostly outside of

the Tohoku region for this relief operation. The National Police Agency has mobilized 1,115 police officers and 7 helicopters. The Fire and Disaster Management Agency has provided 2,588 personnel including 19 air units. 31 Disaster Medical Assistance Teams (DMAT) have been operating at the Sendai Medical Centre (OCHA d).

Notwithstanding these efforts, Prime Minister Naoto Kan today ordered a shift of focus in humanitarian operations from rescue activities to provision of essential items to the affected areas.

Figure 26. March 15: British search and rescue workers search under a roof removed from a house for survivors of the tsunami in Ofunato, Japan. (AP Photo/Matt Dunham)

Figure 27. March 15: Los Angeles County Fire Dept. rescue team members search for survivors in a damaged house in Ofunato, Iwate Prefecture, northern Japan, four days after a powerful earthquake-triggered tsunami hit Japan's east coast. (AP Photo/Shizuo Kambayashi)

Table 8. Specialized International USAR Teams as of 14 March 2011

USAR Team	Personnel	Rescue Dogs	Area of Action
Australia	72	2	Miyagi (Minami-Sanriku-cho)
Germany	43	3	Miyagi (Minami-Sanriku-cho)
France	134	-	Miyagi (Sendai City)
Mexico	9	6	Miyagi
New Zealand	65	-	Miyagi (Minami-Sanriku-cho)
People's Republic of China	15	-	Iwate (Ofunato-cho)
Taiwan Province of China	30	-	Miyagi (Sendai City)
Republic of Korea	105	2	Miyagi (Sendai City)
Russian Federation	54	3 vehicles	Miyagi (Sendai City)
Singapore	5	5	Fukushima (Soma City)
Switzerland	27 + 2	9	Miyagi (Minami-Sanriku-cho)
United Kingdom	64	2	Iwate (Ofunato-cho)
USA (2 teams from LA and Fairfax)	148	12	Iwate (Ofunato-cho)
USA-Hungary Baptist Aid Rescue24	4	-	
International Rescue Dogs	12	9	
Turkey	8		
International Medical Corp	14		

Source: OCHA d

Figure 28. March 15: Members of a Fairfax County, Virginia, search and rescue team from the U.S. walk through a damaged area as they search for tsunami survivors in Ofunato, Japan. (AP Photo/Matt Dunham)

Figure 29. March 15: Members of a British search and rescue team search a smoldering industrial facility damaged by Friday's earthquake and tsunami in Ofunato, Japan. (AP Photo/Matt Dunham)

Figure 30. March 15: A convoy of Japan Ground Self-Defense Force arrives in the tsunami-hit area for recovery operations in Minamisanriku, Miyagi Prefecture. (AP Photo/Shuji Kajiyama)

Figure 31. March 15: Los Angeles County Fire Dept. members and a dog search for survivors at Ofunato, Iwate Prefecture, northern Japan. (AP Photo/Shizuo Kambayashi)

Figure 32. March 15: Members of a Los Angeles County in the U.S. search and rescue team walk past an upside ship washed ashore by the tsunami in Ofunato, Japan. (AP Photo/Matt Dunham)

Figure 33. March 15: members of USS Tortuga (LSD 46) check vehicles and equipment on the flight deck before the ship gets underway to complete the Japan Ground Self-Defense Force onload. Tortuga loaded more than 50 vehicles on their flight deck Tuesday from the Tomakomai Port pier in Hokkaido, northern Japan. (AP Photo/US Navy, K.Madison Carter)

Figure 34. March 15: Firefighters inspect the damage on a building ruined by Friday's earthquake and tsunami in Minamisanriku, Miyagi Prefecture, Japan. Source: www.foxnews.com

Figure 35. March 15: Rescue workers carry the body of a victim in Kesennuma. Source: www.time.com

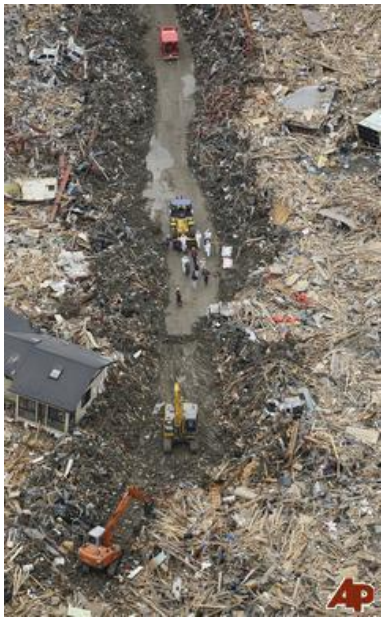


Figure 36.March 15: Heavy machines make the way in the rubble at the earthquake and tsunami devastated area in Rikuzentakata, Iwate Prefecture, Japan, four days after the disaster. (AP Photo/Kyodo News)

Figure 37. March 15: Japanese soldiers search for the bodies of victims at a village destroyed by earthquake and tsunami in Rikuzentakata in Iwate prefecture, northeast Japan. Source: REUTERS / Toru Hanai

Figure 38. March 15: Rescue workers carry the body of a victim at a village destroyed by the earthquake and tsunami in Rikuzentakata in Iwate prefecture, northeast Japan. Source: REUTERS / Lee Jae-Won

Figure 39. March 15: Rescue workers arrive to the devastated residential area of tsunami hit Otsuchi as the forest burns above the town. Source: REUTERS / Aly Song

Figure 40. March 15: Firefighters continues search under the rain at the earthquake and tsunami devastated area Tuesday night in Kesennuma, Miyagi Prefecture, Japan, four days after the disaster. (AP Photo/Kyodo News)

16 March 2011: There are now 689 International Search and Rescue Specialists currently deployed with 32 search dogs. Three teams (Germany, Switzerland and International Rescue Corps) are withdrawing. Some teams are still to arrive from Russia and Indonesia. The snow is complicating ongoing emergency relief operations which are already challenged by continued aftershocks. Emergency teams have still not been able to reach all the affected areas due to logistical challenges. Search and Rescue teams say conditions are becoming increasingly difficult not only due to weather conditions but also a lack of supplies including fuel and vehicles. Currently, there are 80,000 troops on the ground along with police, fire service and the Japanese coast guard (OCHA e).

Weather conditions on the ground deteriorating, with low temperatures and heavy snow falling, the British and US search and rescue teams returned to Ofunato at 0530 local time to clear the final sector which had not been cleared yesterday. The teams then travelled 30 km north to Kamaishi, where 1,000 people are reported missing. In heavy snow, the team immediately started to search the central industrial and residential areas which had been badly affected by the earthquake and the tsunami. Three bodies were detected in the debris, but no survivors were found.

Fourteen U.S. Navy ships and their aircraft and 17,000 sailors and Marines are now involved in the humanitarian assistance and disaster relief efforts in Japan. The military effort has included 113 helicopter sorties and 125 fixed-wing sorties, moving people and supplies, helping in search and rescue efforts, and delivering 129,000 gallons of water and 4,200 pounds of food. The USS Tortuga, with heavy-lift MH-53 helicopters aboard, has completed loading 273 Japanese Ground Self-Defense Force troops, 93 vehicles and equipment for delivery in Onimato (American Forces Press Service).

9 Russian rescuers began search and rescue operations in the northeastern part of Sendai with 3 vehicles and search and rescue equipment. During the first day of operation they found eight dead bodies but no survivors. The second dispatch of the rescue team from Russia which consists of about 80 personnel, arrived at Narita Airport around 3:30 p.m. on two aircrafts of the Ministry of Russian Federation for Civil Defence, Emergencies and Elimination of Consequences of Natural Disasters. There are now 161 Russian rescuers in Japan, the largest foreign group of rescuers at the moment. The Russian teams are scheduled to work in Sendai and the surrounding area (Government of Japan and Government of the Russian Federation).

Figure 41. March 16: Heavy snow falls on rubble and rescue workers at a devastated factory area in Sendai, northern Japan. (REUTERS/Kim Kyung-Hoon)

Figure 42. March 16: Firefighters operate heavy machinery in the snow while seeking survivors beneath an overpass in Otsuchi, northern Japan. (AP Photo/The Yomiuri Shimbun, Yoichi Hayashi)

Figure 43. March 16: Firefighters search for survivors in the snow in Minamisanriku, northern Japan. (AP Photo/The Yomiuri Shimbun, Hiroaki Ono)

Figure 44. March 16: Braving snow, rescue workers search for survivors in the rubble of tsunami-stricken town of Minamisanriku in Miyagi Prefecture. (AP Photo/The Yomiuri Shimbun, Hiroaki Ohno)

Figure 45. March 16: Heavy snow falls as members of the Japan Self-Defense Force arrive at the devastated residential area in Otsuchi.(REUTERS/Damir Sagolj)

Figure 46. March 16: A member of a British search and rescue team climbs on the roof of a building damaged by the tsunami, whilst searching for trapped people as snow falls in Kamaishi, Japan. (AP Photo/Matt Dunham)

Figure 47. March 16: Rescue workers carry a charred body from the rubble onto a truck from a village destroyed by the devastating earthquake, fires and tsunami in Kesennuma, Miyagi province, Japan. (Paula Bronstein/Getty Images)

Figure 48. March 16: Policemen gather around the covered bodies of victims retrieved from the debris in Rikuzentakata, Iwate Prefecture. (REUTERS/Adrees Latif)

Figure 49. March 16: Self-Defense Force members put a tarp over bodies in Minamisanriku, northern Japan. (AP Photo/The Yomiuri Shimbun, Tsuyoshi Matsumoto)

Figure 50. March 16: Rescue workers cover a body from the rubble of a village destroyed by the devastating earthquake, fires and tsunami in Kesennuma, Miyagi province, Japan. (Paula Bronstein /Getty Images)

Figure 51. March 16: Japan Ground Self-Defense Force personnel conduct a search operation following the March 11 huge earthquake triggered tsunami at Natori, Miyagi Prefecture, Japan. (AP Photo/Mark Baker)

Figure 52. March 16: Japan Self-Defense Force's members clear debris in Ofunato, Miyagi, northern Japan. (AP Photo/Kyodo News)

Figure 53. March 16: Rescue workers from Japan's Self-Defense Forces dig though the debris of houses that were destroyed in Minamisanriku, in Miyagi prefecture. Source: www.time.com

17 March 2011: Search and rescue teams are continuing their activities in cooperation with their Japanese counterparts with the focus now on recovery and the access to those areas is strictly limited to rescue workers. Four teams have now completed their mission in Japan bringing the number of International Search and Rescue specialists down to 637 (14 teams) with 29 search dogs. The teams report that bad weather conditions continue to hamper operations along with poor telecommunications, debris on roads and fuel shortages. The teams are monitoring radiation levels for safety (OCHA f). A rescue team of the Republic of South Africa consisting of 49 personnel has been dispatched (Government of Japan).

Currently nearly 5,300 U.S. service man and women are supporting the disaster relief effort in Japan. The military operation includes eight ships, including the aircraft carrier USS Ronald Reagan, transport aircraft and more than 100 military helicopters which are being repositioned to northern Japan to best assist ongoing humanitarian efforts. The U.S. military has flown reconnaissance flights and provided the Japanese government with images of the areas affected by the earthquake and tsunami. Search and rescue flights and missions along the coast continue, relief operations including the delivery of food, water and other relief supplies also continue (OCHA f).

Figure 54. March 17: Chinese rescue team members search for survivors in Ofunato, Iwate Prefecture, northern Japan. (AP Photo/Shizuo Kambayashi)

Figure 55. March 17: Taiwan rescue team members search for survivors in Ofunato, Iwate Prefecture, northern Japan. (AP Photo/Shizuo Kambayashi)

Figure 56. March 17: Members of a British search and rescue team works at a devastated area in the aftermath of Friday's tsunami that struck Kamaishi, Japan. (AP Photo/Matt Dunham)

Figure 57. March 17: Rescuers from Australia conduct search operation in Minamisanriku, northern Japan. (AP Photo/Yomiuri Shimbun, Tsuyoshi Matsumoto)

Figure 58. March 17: Members of a U.S. search and rescue team from Los Angeles County stand in snow while on a recovery operation in the aftermath of Friday's tsunami that struck Kamaishi, Japan. (AP Photo/Matt Dunham)

Figure 59. March 17: Self Defense Force members walk through debris at a devastated area in Minamisanriku, northern Japan. (AP Photo/The Yomiuri Shimbun, Tsuyoshi Matsumoto)

Figure 60. March 17: Members of a British search and rescue team carry away the covered body of an unidentified woman to place her remains near a road to be driven away shortly afterwards by Japanese emergency services after removing her from a destroyed house on their recovery operation in the aftermath of Friday's tsunami in Kamaishi, Japan. (AP Photo/Matt Dunham)

Figure 61. March 17: Japan Ground Self Defense Force personnel conduct a search operation following the March 11 earthquake triggered tsunami at the port in Sendai, Japan. (AP Photo/Mark Baker)

Figure 62. March 17: Firefighters continues search operation in Kesennuma, northern Japan following Friday's massive earthquake and tsunami. (AP Photo/Kyodo News)

Figure 63. March 17: Japan Ground Self-Defense Force members search though the rubble in the snow in Ishinomaki, Miyagi Prefecture, northern Japan. (AP Photo/Kyodo News)

18 March 2011: The weather conditions show no sign of improvement but rescue operations continue and another 154 people have been found in the last 24 hours. There are 543 International Search and Rescue specialists (14 teams) from 12 countries currently working. The Government says more than 16,500 people remain stranded (10,000 in Iwate and 6,500 in Miyagi) but more than 100 helicopters have been mobilized by the Self Defense Force and police and the coast guard for search and rescue missions. To date 26,000 survivors have been found (OCHA g).

Russian rescuers continue their work in areas of Japan. They have examined an area of about 100 sq km and pulled 112 bodies from under the rubble. Unfortunately, they could not find any survivors yet. Although food, water, and fuel are running short in many parts of Japan, the team did not encounter problems with fuel, as well as water and food supplies. The rescuers have reserve fuel. In addition, extra fuel has been purchased from the Japanese side (Government of the Russian Federation).
The USAR teams from Fairfax Country, Virginia and Los Angeles County, California concluded their last search and rescue assignment on March 17. Today, the US USAR teams transferred $145,000 in equipment to the Ofunato fire department to assist with local efforts. The equipment include 4 zodiac boat kits-containing boats, motor, fuel tanks and paddles- 16 kerosene heaters, 160 cots and 160 sleeping bags (USAID g).

Figure 64. March 18: Japanese soldiers observe a moment of silence at the time when the massive earthquake struck in the town of Yamamoto, northeastern Japan just one week after the earthquake and resulting tsunami. Photo: AP

Figure 65. March 18: A Chinese search and rescue team observes a moment of silence at the devastated city of Ofunato, northeastern Japan just one week after a massive earthquake and resulting tsunami. (AP Photo/ Yomiuri Shimbun, Takashi Ozaki)

Figure 66. March 18: Japanese soldiers walk past tsunami-smashed vehicles and debris on a search mission at Sendai airport, northeastern Japan. (AP Photo/Kyodo News)

Figure 67. March 18: A firefighter conducts search operations amid rubble in Minamisanriku, northern Japan. (AP Photo/Kyodo News)

Figure 68. March 18: Firefighters march toward the assigned areas for search for victims in Rikuzentakata, Iwate Prefecture. (AP Photo/Kyodo News)

Figure 69. March 18: Firefighters and rescuers continue search operation in Onagawa, northern Japan. (AP Photo/Kyodo News)

19 March 2011: In the last two days there has been a concerted effort by Japan's emergency services to rescue the last groups of people still stranded as a result of the earthquake and tsunami that devastated the northeast coast on 11 March. More than 16,000 stranded people in Iwate, Miyagi and Fukushima who were in areas cut-off due to damaged roads and communications have been brought to evacuation centers. The Emergency Disaster Response Headquarters says there are now just over 20 people still to be reached in Miyagi and Fukushima. With almost all people in the earthquake and tsunami affected areas now accessible, the focus of the response is shifting from search and rescue operations to caring for those who have been evacuated (OCHA h).

A 47-member South African Search and Rescue team and a 33-member team from Turkey have deployed to assist while another six international search and rescue teams have completed their activities and are going home. There are currently 333 rescuers working with Japanese counterparts on the recovery of bodies (ibid.).

Figure 70. March 19: Japanese firemen carry away a body they found where it had been washed into a ravine in Onagawa, northeastern Japan. (AP Photo/David Guttenfelder)

Figure 71. March 19: A Japan Ground Self-Defense Force officer conducts a search of the debris at Sendai Airport in Sendai, Miyagi Prefecture, Japan. (AP Photo/Mark Baker)

Figure 72. March 19: Police officers work on recovery operations in Otsuchi, northern Japan. (AP Photo/The Yomiuri Shimbun, Yoichi Hayashia)

Figure 73. March 19: Japanese soldiers what appears to be the body of a victim at the devastated city of Ishinomaki, northeastern Japan. (AP Photo/Kyodo News)

Figure 74. March 19: Firemen search for remains in the river in Kesennuma, Miyagi Prefecture, northern Japan. (AP Photo/Shizuo Kambayashi)

Figure 75. March 19: Firefighters carry the wrapped body of Kuniko Kitamura, 69, out of the ruins of her home in Onagawa, northeastern Japan. (AP Photo/Shuji Kajiyama)

20 March 2011: The Government of Japan has received offers of assistance from a total of 123 countries and regions, and 33 international organizations. To date, 11 International Search and Rescue teams have completed their assignment and another four teams remain doing debris removal and recovery activities (Table 9). It is expected that all teams will finish their missions early next week.

Table 9. International USAR Operations as of 20 March 2011

International USAR Teams			
Country	**Personnel**	**Dogs**	**Area of Operation**
Australia	72 Rescuers	2	Minami-Sanriku(Miyagi)
China 1	15 Rescuers		Ofunato(Iwata)
China 2 (Taiwan)	28 Rescuers		Ofunato(Iwata)
Germany	43 Rescuers	3	Minami-Sanriku(Miyagi)
Korea	107 Rescuers	2	Sendai(Miyagi)
Mexico	12 Rescuers	6	Natori (Miyagi)
Singapore	5 Handlers	5	Soma(Fukushima)
Switzerland	27 Rescuers	5	Minami-Sanriku(Miyagi)
UK	63 Rescuers	2	Ofunato(Iwata)
US-1 (Fairfax)	72 Rescuers	6	Ofunato(Iwata)
NZ	45 Rescuers		Minami-Sanriku(Miyagi)
Russia (EMERCOM 3)	54 Rescuers		Sendai(Miyagi)
Russia (EMERCOM 2)	28 Rescuers		Sendai(Miyagi)
Russia (EMERCOM 1)	54 Rescuers		Sendai(Miyagi)
Russia (EMERCOM 4)	28 Rescuers		Sendai(Miyagi)
US-2 (LA)	72 Rescuers	6	Ofunato(Iwata)
South Africa	49 Rescuers		Ishinomaki ((Miyagi)
France	74 Rescuers		Sendai(Miyagi)
Mongolia	12 Rescuers		
Turkey	33 Rescuers		Rifu (Miyagi)
Total: 890 Rescuers + 37 Rescue dogs from 20 teams representing 15 countries			

International USAR Teams in rescue operation 20th March 2011			
Country	**Personnel**	**Dogs**	**Area of Operation**
China 1	15 Rescuers		Ofunato(Iwata)
South Africa	49 Rescuers		Ishinomaki ((Miyagi)
Mongolia	12 Rescuers		
Turkey	33 Rescuers		Rifu (Miyagi)
Total: 109 Rescuers 4 teams representing 4 countries			

Source: OCHA i

An 80-year-old woman and her 16-year-old grandson were rescued from their damaged home today in the city of Ishinomaki, nine days after the massive earthquake and tsunami. The two had been trapped in their kitchen and survived by eating yoghurt and other food in the refrigerator. (REUTERS)

Figure 76. March 20: Sumi Abe, 80, is carried on a stretcher out of her destroyed house in Ishinomaki, Miyagi Prefecture, Japan. Sumi Abe and her grandson Jin, 16, were rescued in northeastern Japan when the teenager is able to pull himself out of their flattened two-story house Sunday, nine days after the devastating earthquake and tsunami. (AP Photo/Kahoku Shimpo via Kyodo News)

Figure 77. March 20: Urban Search and Rescue officers from South Africa walk through the remains of a suburb in Natori, Miyagi Prefecture, Japan. (AP Photo/Mark Baker)

Figure 78. March 20: Police officers search through debris in a residential area destroyed by the March 11 earthquake and tsunami in Rikuzentakata, Iwate Prefecture, Japan. (AP Photo/Matt Dunham)

Figure 79. March 20: Rescuers sift through the remains of a property in the suburb of Natori, Miyagi Prefecture, Japan. (AP Photo/Mark Baker)

3.2 Shelter Issue

On 16th March, the Government announced a plan for managing and delivering food and relief items to evacuation centers in the affected areas. Evacuation centers will send requests to municipalities, and the prefecture will consolidate these requests and liaise with the national government. The national government will then request relief items and food from the private sector and other municipalities. These will be consolidated at Japan Self-Defense Force (JSDF) sites (there are 50 sites nationwide) and the JSDF will transport these relief items to the affected areas. Distribution of relief items will be conducted by the Municipalities and/or JSDF. According to the Emergency Disaster Response Headquarters in the Office of the Prime Minister, 1.5 million meals have been delivered in total to evacuation centers and hospitals in the affected areas. This is a significant increase from the number of meals delivered as of March 15. (483,550 meals).

The six most affected prefectures have a total population of about 16.9 million people. To date, approximately 492,355 have been evacuated from these areas and are currently living in temporary shelters across seven prefectures. Other prefectures not affected by the emergency are offering to take some of the evacuees. Currently, there are approx. 2400 shelters for earthquake and tsunami affected areas. As reported on 15th March, the Ministry of Land, Infrastructure, Transport and Tourism has ordered the construction of 600 temporary shelters to be built within two weeks 4,200 shelters in four weeks and 30,000 shelters in two months.

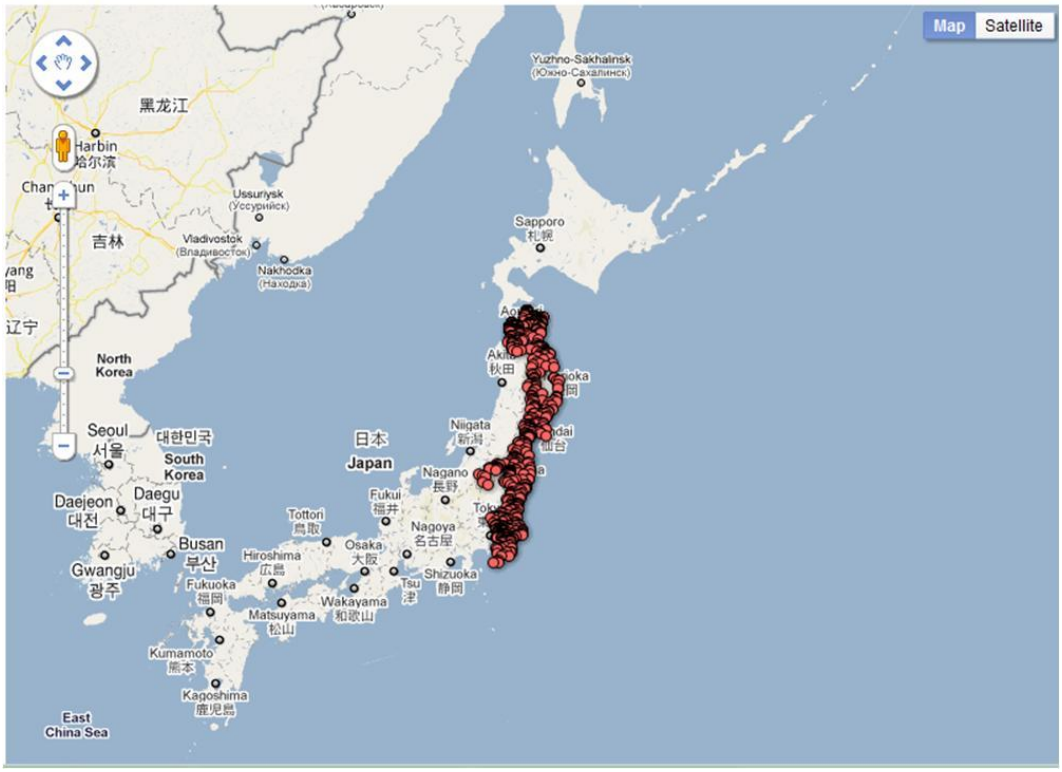


Figure 80. Locations of Reported Shelters in Affected Areas
Source: Google Crisis Response Shelter Information

The interactive site, provided by Google enable persons in Japan to seek and update any information related to shelter issues. Important issues are listed below within the above link that can be updated anytime by anyone within the affected areas:
https://spreadsheets2.google.com/pub?hl=ja&hl=ja&key=0An_bfTU7s7XHdGxhazkyeExVTDV2TmZfM28tdHRUcVE&output=html&ndplr=1

- List of water point/water
- List of medical hospital
- List of where to get food and daily necessities/No. of daily meal
- List of where to get gasoline supply/Fuel gas
- List of functioning ATM-Bank
- List of designated emergency shelter
- List of pay phones with mobile charge
- List of toilets/restrooms
- List of tentative garbage yard
- List of open bath facility

Additionally, according to Cabinet Secretariat Civil Protection Portal Site, in order to accurately and promptly carried out rescue and evacuation of residents and evacuees, the National Protection Law (Article 148), the governor, Civil Protection and Enforcement Act (Article 35) and with the consent of the administrator of the facility to meet the criteria specified institutions, pre-determined shelter has been established. As a result, the prefectural governor of the area population, urbanization status, based on local circumstances and conditions specified for emergency, shelters have been built in cooperation with the municipalities.

The number of individuals residing in evacuation centers is decreasing as road repairs enable displaced individuals to travel to relatives' and friends' houses in unaffected areas or return to their houses as electricity is restored, according to OCHA. On March 20, OCHA reported that the number of people living in evacuation centers had decreased by more than 15,700 people—or 5 percent—since March 18.

As of March 20, more than 21,000 residents of affected areas had relocated to other parts of Japan, according to OCHA. The GoJ Ministry of Land, Infrastructure, Transport, and Tourism has requested Japan's housing industry build 30,000 transitional shelters—including two rooms, a kitchen, toilet, and washroom—in the next two months and has deployed specialist teams to the affected areas to select suitable locations for shelter placement. Construction has begun in Iwate Prefecture, where workers had completed approximately 200 shelters as of March 20, according to OCHA. In addition, all of Japan's prefectures are making plans to provide more sustainable housing for the displaced population in evacuation centers.

Figure 81. American Red Cross Shelter Location in Sendai

Figure 82. American Red Cross Shelter Location in Tokyo

Figure 83. Pictures around Shelter Issues

People wait to receive medical treatment at a shelter for earthquake and tsunami evacuees in Rikuzentakata.

Evacuees take shelter at an evacuation centre after an earthquake and tsunami in Sendai.

Survivors stay at a shelter in Rikuzentakata, Iwate prefecture in northeast Japan after the magnitude 8.9 earthquake and tsunami struck the area.

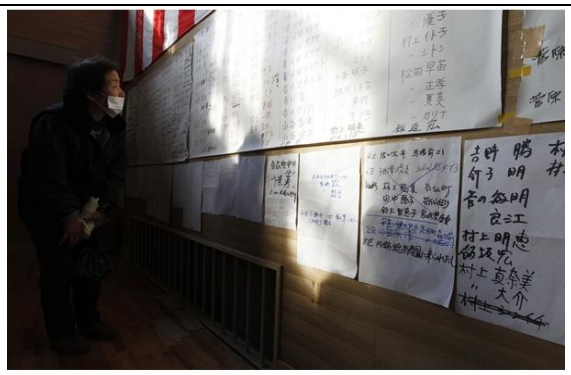
Mother and children: situation in evacuation centre.

Source: http://www.allvoices.com/contributed-news/8483558-japan-more-than-500000-people-sleep-in-shelters

Survivors shelter at an evacuation center after a quake-tsunami disaster in Japan

People rest at a shelter for earthquake and tsunami evacuees in Miyako city

A woman greets a baby as she reunites with her relatives at a shelter for the first time after an earthquake and tsunami in Rikuzentakata in Iwate prefecture, northeast Japan



Listed name of evacuees

Survivors cry at a shelter in a village ruined by an earthquake and tsunami in Rikuzentakata in Iwate prefecture, northeast Japan

A survivor looks at a board showing names of other survivors at a shelter in a village ruined by an 8.9 magnitude earthquake and tsunami, in Rikuzentakata in Iwate prefecture, northeast Japan

3.3 Economic Impact

The Earthquake triggered on March 11 in Japan is recorded as fourth most severe in the world. It is too early to estimate the economic cost of disaster. However, World Bank estimated around $122 to $ 235 billion, which will be 2.5 to 4 percent of country's Gross Domestic Product (Table 10). The table shows comparison of damage, death toll, cost to private insurer, and national budget for reconstruction between the Kobe earthquake and March 11, 2011 northeast earthquake and Tsunami (World Bank, 2011).

Table 10. Comparisons between Kobe earthquake and March 11, 2011 northeast earthquake and Tsunami.

	March 11, 2011 northeast earthquake and tsunami – estimates	**The 1995 Kobe earthquake**
Damage	Estimates range from $122 to 235 billion (2.5 to 4 percent of GDP)	$100 billion (around 2 percent of GDP)
Death toll	15,214 (dead and missing)	6,434
Cost to private insurance	$14–33 billion*	$783 million
National budget for reconstruction	$12 billion from current budget. Much more in FY2011	$38 billion over 2 fiscal years

Sources: Government of Japan and private estimates and projections as of March 17, 2011. * AIR World estimate.

The aftermath of 11, 2011 northeast earthquake and Tsunami affected trade, industries, insurance market and livelihoods of affected people. The following section briefly shows some of the impact in these areas.

Impact on Industries: Three largest auto makers – Toyota, Honda, and Nissan stopped their production in almost all of their domestic assembly plants due safety of their workers and deaths, as reason for taking this decision. Similarly, Sony has also shutdown its production. The temporary closure of industries, oil refineries, ports, power stations are likely to affect the output throughout the country, said Wolfgang Leim of Commerzbank **(**March 12, Daily Telegraph).

Impact on Insurance Market: The insurance industry may have to pay about $10 billion in claims, said James Shuck, (a London-based insurance analyst at Jefferies International Ltd.). Risk Management Solution (RMS) and its rivals haven't published estimates of insured losses yet, but analysts who track insurance companies said insurance claims could be $10 billion to $25 billion. One analyst said it could be as high as $50 billion. However, the insurance penetration and density is very low in Japan when compared to leading western markets. According to RMS data, commercial and industrial lines are significantly under-insured, with many large corporations insuring their properties on an

indemnity basis only, with no loss of profits or earthquake insurance. Moreover, many small businesses and households in Japan are completely uninsured (March 11, Networking News). It is too early to speculate on the impact on the insurance market.

Impact on Trade: In the last five years, Japan has accounted for around 9% of the region's total external trade in developing East Asia (World Bank, 2011). Assuming the real GDP of the country slow by 0.25% to 0.5% by mid 2011, exports from developing East Asia may also slow down by 0.75% to 1.5% (World Bank, 2011). This time more disruption will be faced by the production networks, especially in automotive and electronics industries. Japan is a major producer of parts, components, and capital goods, supply to East Asia production chain (World Bank, 2011). In Thailand, exporters of cars report that current supplies of components imported from Japan will last through April. In Thailand, exporters of cars report that current supplies of components imported from Japan will last through April. Prices have already risen by more than 20 percent in some categories.

Impact on livelihoods and future employment opportunities: The impact can also be seen on the agricultural production. The agriculture account for 1.1 percent of country's GDP, with 3.9 percent of labor force is engaged in farming. The serious damage is recorded on the East side of Honshu, the main island. The Hokkaido agricultural part has much less damage. The same is true for west of Honshu. People's livelihoods has seriously affected by loss in income, and will further increase with expenditure in the recovery process.

The northeastern part is badly affected and many companies are facing loss in terms of material, human, and financial capital. The recovery process may create employment opportunities due loss in human capital. However, the impact of meltdown, many experts from the industries say, will result in further complications. Due to huge infrastructural damages, the repair cost may have to be born by companies who are dominating countries economy. This may increase pressure of these companies. As such employment opportunities may shift. Thus, it is too early forecast the employment opportunities for people who lost their livelihood due to disasters.

3.4 Volunteers

After the disaster, many individuals and organizations have been trying to contribute to search and rescue, relief, and other efforts in a variety of ways. A group of boys aged around 13 years old in Taro spearheaded relief efforts for quake and tsunami victims. The boys took it upon themselves to scavenge for food and supplies among the debris where their village once stood. They have been able to provide some relief to hundreds of survivors sheltered at a nearby Buddhist temple.

In another story, a volunteer group is set to send more than 300 Japanese-speaking interpreters to help foreigners in the areas of northeastern and eastern Japan that were stricken by the devastating earthquake. The Japan Guide Consortium Volunteer Interpreters Bureau based in Tokyo keeps on standby interpreters, both in and outside Japan, in more than 10 languages including English, Chinese, Korean, Russian, and French. The interpreters will work for relief teams and volunteers from overseas as well as quake-affected foreigners at places such as hospitals and evacuation centers. Another sociolinguistic study group at Hirosaki University in quake-hit Aomori Prefecture is posting online many sample signs and instructions relating to post-disaster information for foreigners written in easy-to-understand Japanese. Finally, in Iwate, the International Association there is providing information online on the whereabouts of foreigners with Iwate prefectural residency. The list, updated daily, offers data on the missing person's nationality, place of residence, age, and the name of the person seeking the information.

Contributing enormously to the relief efforts is the Japanese Red Cross. Local Red Cross volunteers are distributing relief items, hot meals, and deployed nearly 171 medical teams, as well as 2,400 nurses trained to provide emotional support and counseling for those affect by the disasters. Emotional support will be one of the greatest needs in the weeks and months ahead given thousands of people have been traumatized and are in a state of shock. Evacuations from the exclusion zone around the nuclear power plant are also being supported by the organization. Lastly, the Japanese Red Cross specialist helicopter team is helping evacuate people from affected areas, and is transporting medicine and food to hospitals.

As the humanitarian crisis in Japan continues to unfold, volunteer technologists from around the globe are also coming together to offer help. Since March 11, Crisis Commons volunteers from around the world have been collecting information and data sets in support of a UN OCHA information-gathering request. NetHope, a unique collaboration of 32 of the world's leading international humanitarian organizations, has been working with volunteer technology groups, including Crisis Commons, working on information and data sharing activities, providing guidance on what kind of information will be useful for the response teams.

Kobe earthquake on 1995 experienced unprecedented influx of volunteers from all over the country. There were chaos, mis-communication, resource constrain etc. Based on this experience, a nation-wide volunteer coordination system was developed, where the volunteers can register themselves about their expertise and available time. In this disaster also, there were significant number of volunteers, who were registered, however, the dispatch was limited due to lack of needs expressed by the local villages. This does not mean that there is no need of volunteer, but it is purely the information blockage, and in many cases, the needs are yet to reach to the volunteer coordination centers. In the weeks and months ahead, volunteer activities are likely to increase as cleanup and reconstruction efforts intensify.

4. Initial Observations

Japan is known for its resilience to disasters. In spite of several past disasters, Japan overcome difficult situation with the help of strong community linkages, social capital, leadership of local communities and a strong governance support system. Following is a brief analysis at this early stage of response and recovery. This is divided into two parts: highlights of disaster situation, which will characterize the key points of the current disaster. The second part summarizes some of the issues, which needs attention at short, medium and long term recovery.

4.1 Highlights of the Disaster Situation

A few characteristics features of the disaster include the following:

4.1.1 Co-occurrences of Different Hazards

In the current context, there was a massive earthquake of magnitude 9.0, followed by a gigantic tsunami [in some cases, the height may be more than 15 m, and in some case inland water more than 4 km]. This was followed by the nuclear meltdown, which posed another threat to the already existing grooming situation. Also, there was a cold spell [with snow fall in several parts of the worst affected areas] which also affected the relief and rescue operation. The aftershocks continued for a long time with larger magnitude than the usual one, which shows stronger activity in the fault regions. In the disaster management, we often talk about the worst case scenario, and the disaster preparedness needs to target the worst case scenario. The current multi-disaster situation shows the actual worst case scenario with multiple occurrences of different hazards at the same time. This situation is also one on the rare case of natural disaster causing industrial disasters.

4.1.2 Severity of Damages

The damage level was extremely high, where the tsunami washed away most of the built environment close to the coastal areas, includes vital infrastructures [water, electricity], roads, railways, airports, schools, hospitals, government buildings [in some cases village office], houses etc. The damage was possibly beyond any imagination and expectation. Most of the designated evacuation centers were destroyed.

4.1.3 Perception-Action Gaps

There were some cases where people were trapped under the debris of the collapsed buildings due to earthquake. This was a major barrier for them to evacuate when the tsunami warning was heard. The area affected by the current disaster is well known for its high hazard and vulnerability. There are significant amount of research which simulated the trigger of earthquake and tsunami of the regions. Evacuation drills have been practiced for years with different group of people through initiatives of multi-

stakeholders. On 27th of February 2010, there was a major earthquake in Chile, which posed a tsunami threat to Japan east coast [the current earthquake and tsunami affected areas] almost after 18 hours of the occurrence of the earthquake. A tsunami warning and evacuation order was issued in the Japanese east coast after 50 years [after the Valdivia, Chile earthquake of 1960 which caused a tsunami and killed more than 142 people in Sanriku coast of east Japan]. When the tsunami warning was issued on 1st of March, only a few % of the coastal communities [somewhere between 6-7%] actually evacuated, and many people went to the coastal areas to look at the condition of the sea and then take a judgment whether to evacuate or not. People in the coastal areas have their hazard maps and often the earthquake and tsunami issues are discussed in the media. Thus, there is a very high level of perception, but with limited actions at individual and community level.

4.1.4 The Last Mile Communication

At the aftermath of the disaster, a survey was conducted by the Weather News of Chiba city [ref: asahi.com[1]] about the people's reaction [target: 37,000 responders with 7,900 responders from the five worst affected provinces of Aomori, Iwate, Miyagi, Fukushima and Ibaraki]. In the five mostly affected prefectures, the survey [ref: asahi.com] showed that only 8% of the responders mentioned that they took shelters in the higher land. It was found that on an average it took 23 minutes for the residents to know about the tsunami, although the warning was issued almost simultaneously when the earthquake was recorded [the earthquake happened at 14:46, the tsunami warning was issues at 14:49, and the tsunami expected time and height was declared at 14:50]. In Iwate prefecture, the lead time was too short. However, in Miyagi it was an average of 10 minutes, in Fukushima an average of 20 minutes, in Hokkaido, Aomori and Ibaraki an average of 40 minutes. While for the Iwate residents possibly people got entrapped in tsunami while evacuating, however the high casualty in Miyagi and Fukushima, it surely shows the failure of the last mile communication.

4.1.5 Massive Numbers of Evacuees

In the current disaster [earthquake and tsunami], there was an unexpected number of evacuees due to the devastating nature of the event. The nuclear meltdown incidence also added another level of seriousness to the current threat. An evacuation order was made for the people living within 20 km of the nuclear reactor. Thus, the number of evacuees raised to almost more than 350,000 people, which was totally unprecedented.

4.1.6 Evacuation Centers outside the City/ town/ villages

Usually in Japan, the evacuation centers are the schools or the public buildings in the community. However, in the current disaster, due to the extensive damage and nuclear emergency, people need to evacuate outside their town, city or village. The total number of evacuation center is more than 2300 places all over Japan. In some cases,

[1] http://www.asahi.com/national/update/0319/TKY201103190101.html [in Japanese]

the whole village or town with the village and /or town government made long distant evacuation. It has s serious consequence in terms of physical, psychological, institutional and socio-economic issues of the recovery process[2].

4.1.7 Aged Population

Many parts of Japan, as well as the affected areas have aged population and a significant part of the population needs regular medical care. Since the time lapse between the earthquake and the tsunami was very short, the evacuation of the aged population was a major challenge. At the aftermath, due to failure of the vital lifelines, the medical care of this group was population was seriously affected, in addition to the patients from the disasters.

4.1.8 Environmental Issues

The tsunami has brought huge about of debris including housing materials, broken boats, cars, trees etc, and will have severe environmental consequence. Clearing of rubbles is a major task, and needs to be done with utmost care. The tsunami also made severe impacts to the agriculture land, which will need long term recovery, at least in next 2-3 years. The nuclear meltdown has started its effects, although minor in the first 10 days, due to its contamination to the ground and effectively to the food chain. The earthquake largely sank the ground level of the Pacific coast of Tohoku region and northern part of Kanto region. The risk of the submergence and flood in these regions has become larger than before the earthquake[3]. Therefore, it is necessary to pay special attention to the tide level and to prepare for the submergence and flood in these regions, especially during the spring tide, when the flood tide level becomes higher than usual.

4.2 Future Issues and Challenges

There will be several issues in the short, medium and long term recovery process at the aftermath of the disaster. There will be several future issues, which need to be addresses at different stages of the recovery process. These are as follow:

4.2.1 Coordination

The key word at the aftermath of any major disaster is the coordination and proper management. The coordination is not restricted among the government departments, it has also a significant implication to the non-government organizations and other relief based organizations. A total coordination center needs to be set up at the prefecture level, which should be connected to the central coordination center in the upper level,

[2] In Futaba-cho of Fukushima prefecture, the whole village was evacuated. This is the same situation as that of Miyake-mura during Miyakejima volcanic eruptions. The other example is Kawaguchi-mura where the local government also moved along with the local residents. 70% of the 3,000 people village were affected, and rest 30%, a number of 525 people evacuated along with the local government.

[3] Source: JMA: http://www.jma.go.jp/jma/en/News/2011_spring_tide.html

and city or town coordination point, as the lower governance structure. The one-point coordination is of extreme importance to avoid confusion and mis-management. Sector based approach is preferred based on the past experiences, like shelter, health, education, livelihood etc.

4.2.2 Information

The related issue is sharing right information at the right time. Due to natural reason, there exist panic and mis-perception on different levels of information. Media plays an important role in reducing the panic, and sharing proper information to the people and communities. Due to evacuation in the far distant area, the proper information flow and information linkage is of utmost importance.

4.2.3 Collaboration

Many of the local governments [town, village level governments] have lost their personnel as well as people. This will have a severe impact on the recovery process, since several of the expertise in the local government was lost. In this junction, collaboration with non-government actors [like professional NGOs, academics, professional societies, private entities] will be required in these local governments. Also, support from other neighboring and non-affected local governments [earlier experiences of disaster recovery] will be helpful.

4.2.4 Volunteer Management

At the aftermath, there are flows of volunteers from different parts of the country. This disaster is also no exception. Volunteer coordination centers are already set-up at different locations to make proper coordination. Volunteer coordination needs to be properly linked to the two above points, linkages to government coordination system, and information flow [linkage to media]. Two related issues need to be kept in mind: first, the roles and types of volunteer changes over time, and often past experiences provide important information. The second point is that there are often different intensity of volunteer initiatives in the same affected areas, which needs to be distributed evenly.

4.2.5 Temporary Shelter

The temporary shelter construction is already started, with an initial estimate of 32,800. This would be spread in different parts of the five most affected provinces. The allocation of people in the temporary shelter is an important issue. This is to be noted that people may live there for 3-5 years, and the neighborhood relationship is of utmost importance. Therefore, proper attention needs to be made when allocation of temporary shelter is done. The location of the temporary shelter is also of importance, keeping in mind the high level of seismic activities in the region.

4.2.6 Relocation versus In-situ Reconstruction

At the aftermath of several disasters, especially in case of coastal hazards, there is always a challenge to choose between in-situ reconstruction [which is desirable and preferred by the residents] versus relocation [which cannot be avoided due to new policy and regulation and thinking of longer term safety and security]. If relocation is decided, proper strategy and policy needs to be incorporated for sustainable and adaptive relocation. Some of the examples from 2004 Indian Ocean Tsunami will be useful in this regard.

4.2.7 Adoption of Village or Town

Keeping in mind the vastness of the damages in the current disaster, integrated and consolidated approach is required from all parts of Japan. Adoption of a village or town or a neighborhood can be a good approach, which is practiced in different parts of the world after major disasters. Here also, proper coordination is required in the adoption process. This means that when a city X adopts a village or town Y, it takes care of different aspects of the recovery process. Based on the available resources, the adoption process can be coordinated based on sectors, like health, education, shelter, food, livelihood support etc.

4.2.8 One Village One Shelter Policy

As a long term sustainable recovery, a “one village one shelter policy” can be adopted widely, or at least in some critical parts of the coastal prefecture. This means that a shelter needs to be built in the close vicinity of the coastal areas to reduce the time of evacuation. It will be have a significant cost implication, however, this needs to be properly designed and planned based on the available simulations of the existing fault system and expected tsunami arrival time.

4.2.9 People’s Resilience

Finally, the whole recovery process depends on the people’s power, its networking, neighborhood tie, and resilience. People of Japan are known for its resilience and to cope with the natural disasters. This disaster recovery will also show people’s power through strengthening the resilience among the affected people. A total recovery needs time, people are strong, and we should be chase with time. A Proper well coordinated, planned and decisive recovery policy with well-thought participation of different stakeholders will be useful and efficient.

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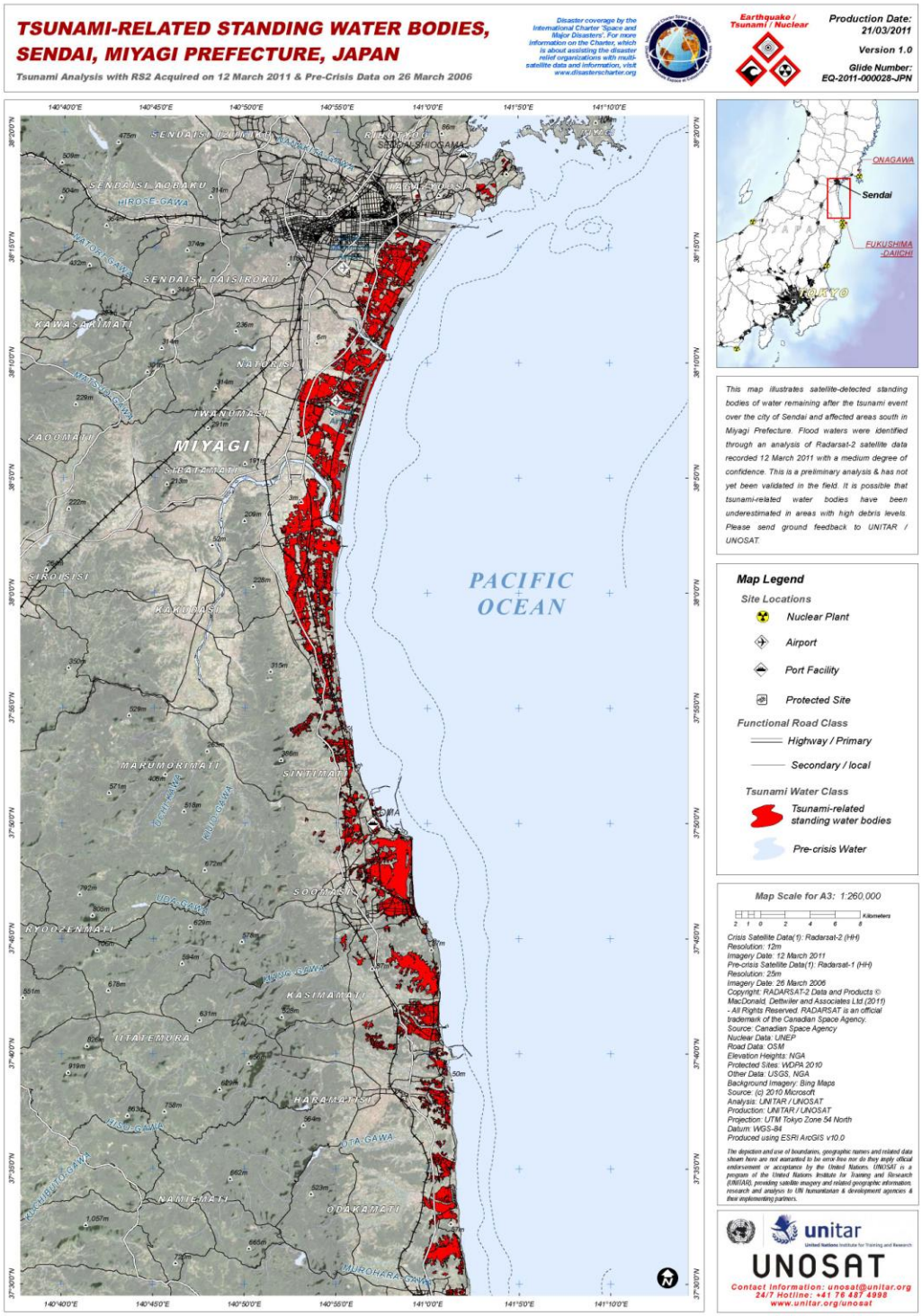
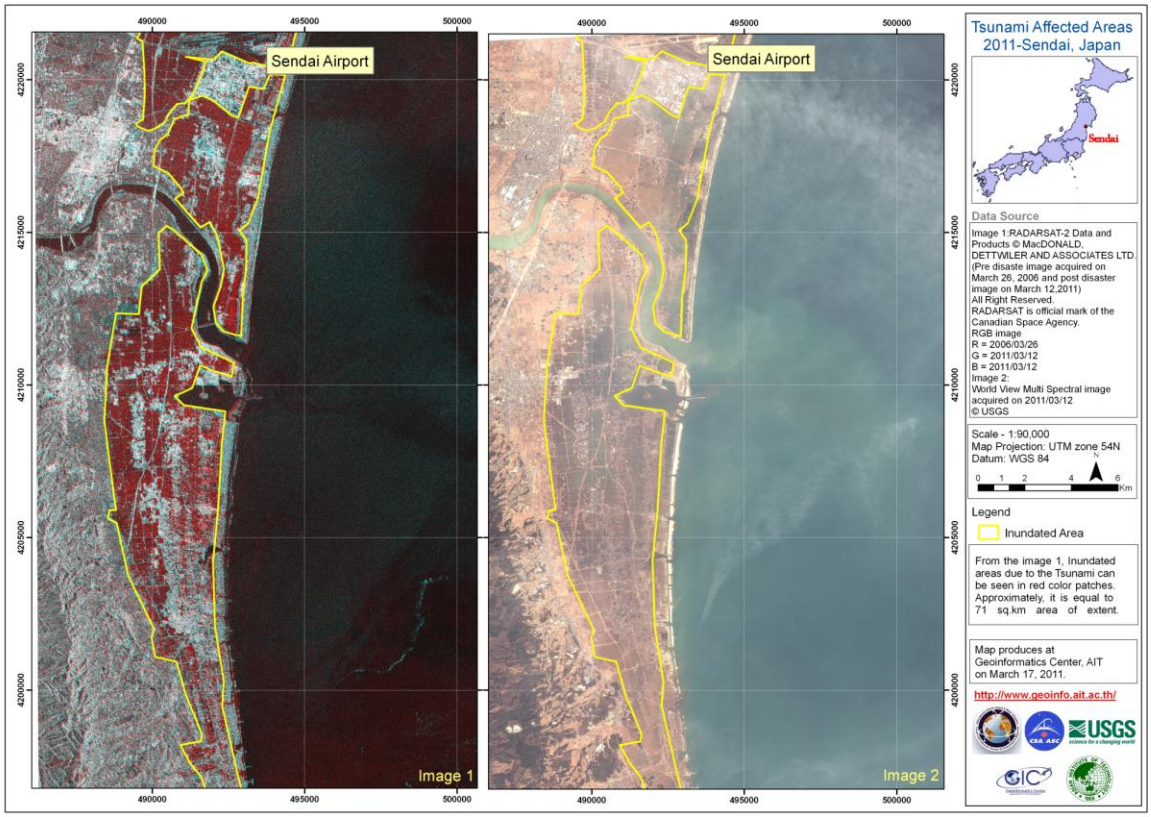
6. Appendix

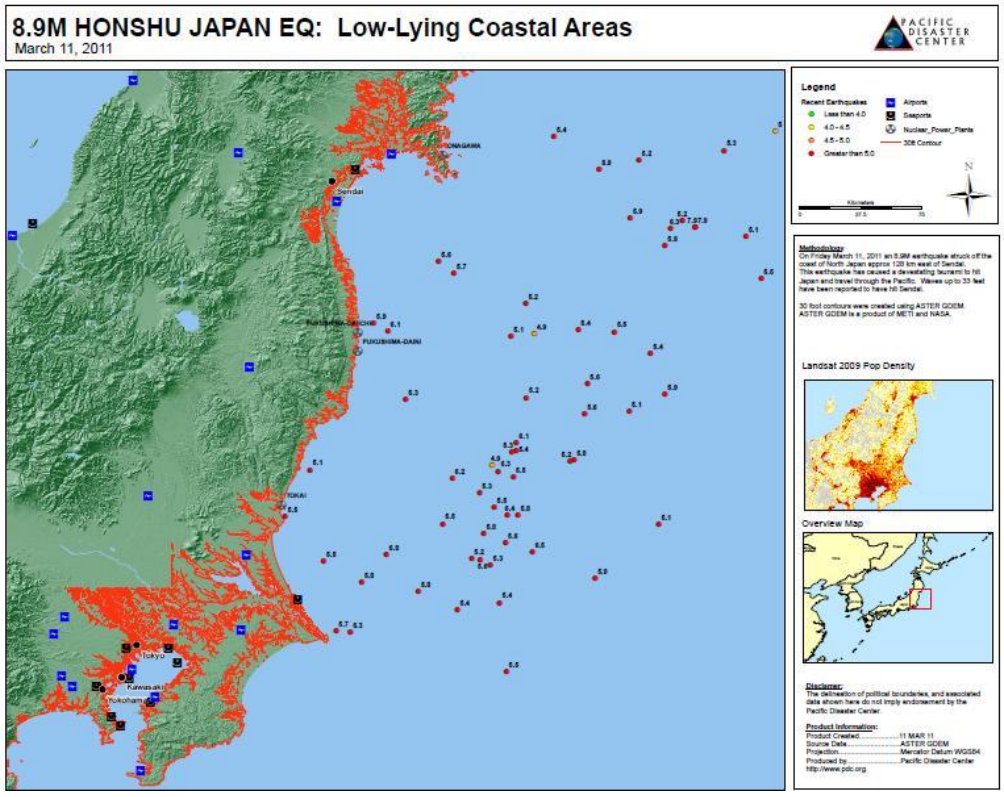
6.1 Maps and Satellite Images



Sources: Canadian Space Agency

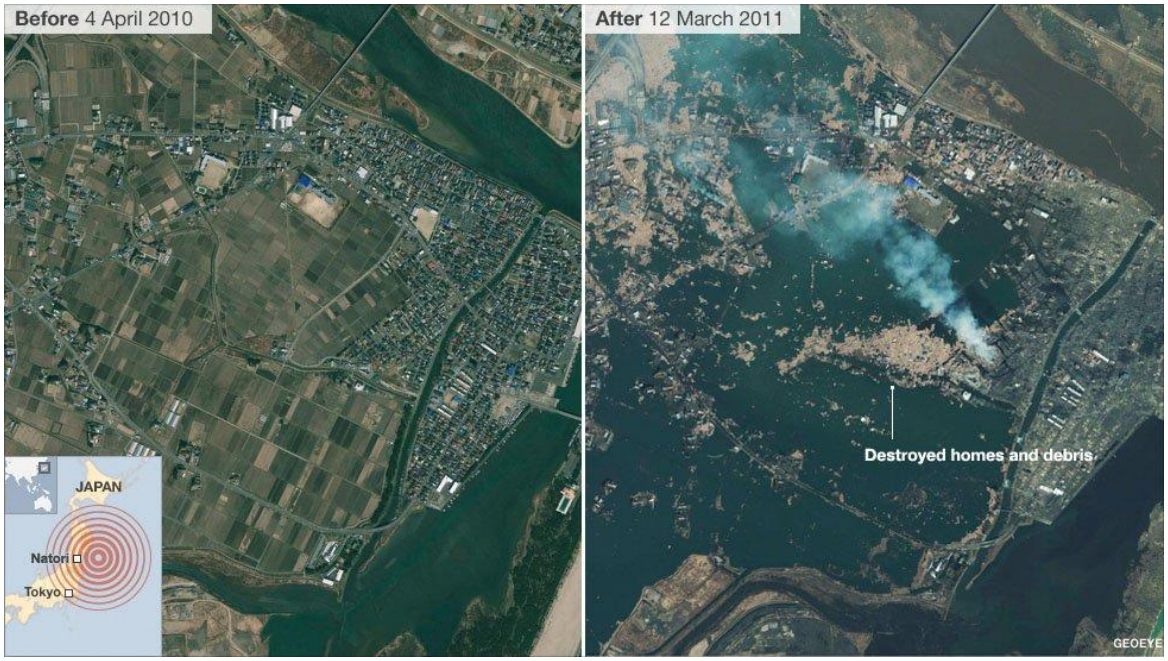


Source: USGS



Source: Pacific Disaster Center

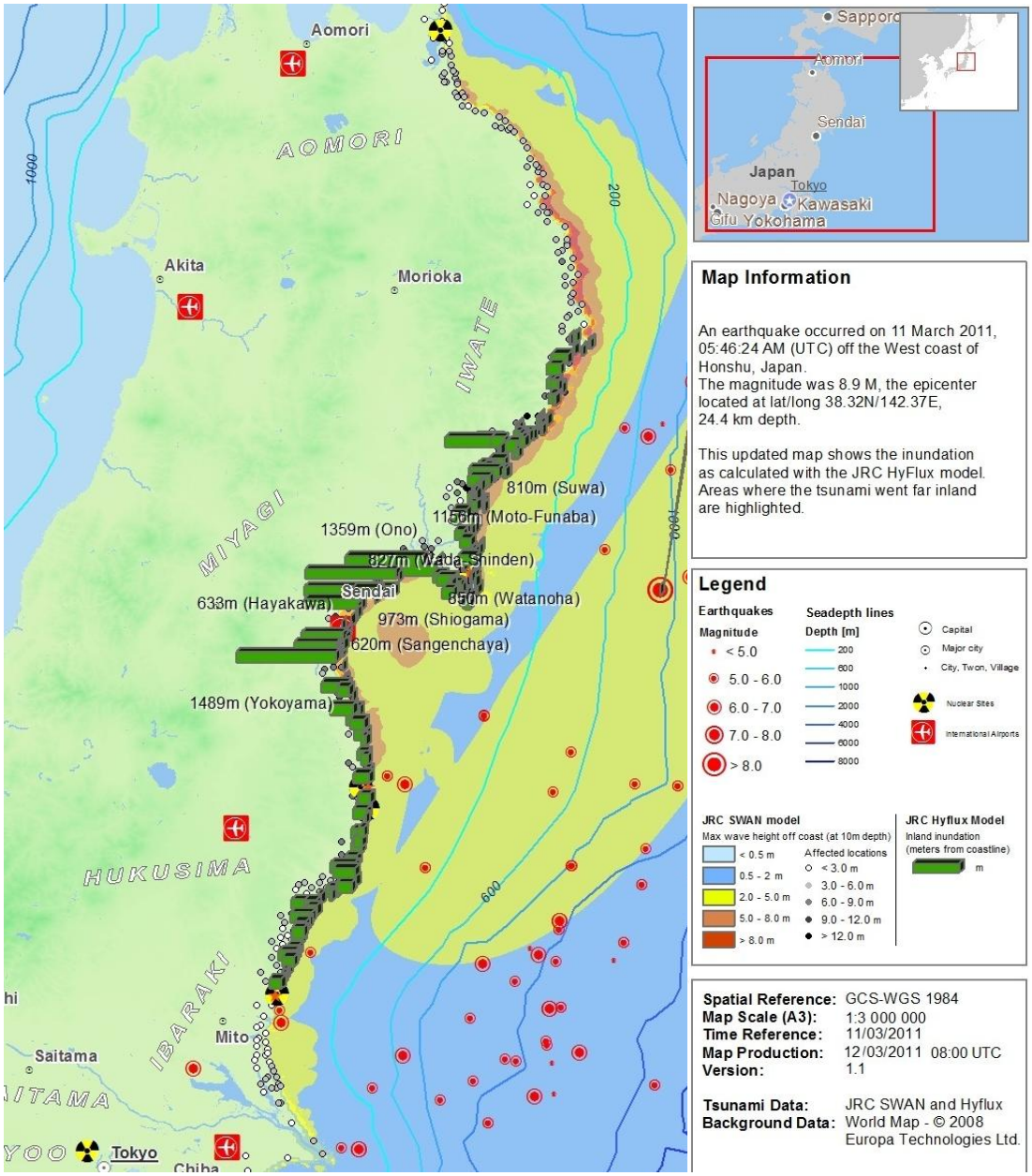
Source: GeoEye



Source: GeoEye

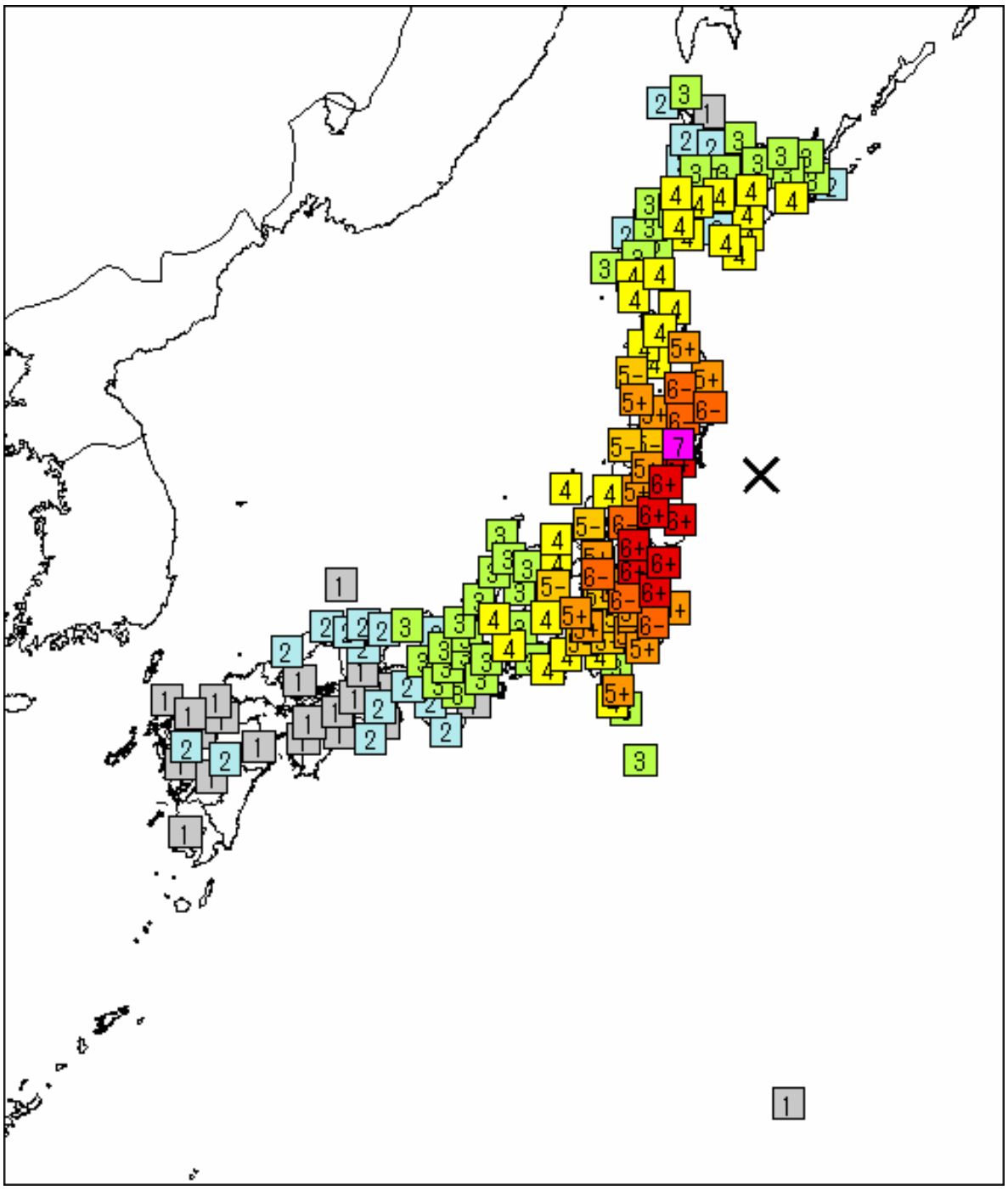
Source: GeoEye

Source: GeoEye



Map showing the level of water hit to the inland by tsunami
Source: European Commission and GDACS

Intensity Map [source: JMA]



6.2 List of Cities affected by Tsunami in Japan

City	*Wave height (meter)*	*Arrival time relative to earthquake*
Koamikura	11.87	1:01
Samenoura	11.87	1:01
Yoriiso	11.87	1:01
Yagawa	11.87	1:01
Fukkiura	11.87	1:01
Aratohama	11.17	0:44
Shizugawa	11.17	0:44
Terahama	11.17	0:44
Kodaki	11.17	0:44
Ozashi	11.17	0:44
Aikawa	11.17	0:44
Tsukihama	11.17	0:44
Minato	11.17	0:48
Natari	11.17	0:48
Inohana	11.17	0:48
Motoyoshi	11.17	0:48
Kesaiso	11.17	0:48
Isatomae	11.17	0:48
Koizumi	11.17	0:48
Tomarihama	11.17	0:48
Okubo	10.48	0:37
Attari	10.48	0:37
Tatamiishi	10.48	0:37
Nonomae	10.48	0:37
Koishihama	10.48	0:37
Shimo-Horei	10.48	0:37
Urahama	10.48	0:37
Okkirai	10.48	0:37
Ryori	10.48	0:37
Nakase	10.48	0:53
Hama	10.48	0:53
Matsuzaki	10.48	0:53
Tsurugaura	10.48	0:53
Tadagoe	10.48	0:53
Uranohama	10.48	0:53
Sakihama	10.48	0:53
Shuku	10.48	0:53

Kesennuma	10.48	0:53
Terama	9.08	1:05
City	*Wave height (meter)*	*Arrival time relative to earthquake*
Ommaehama	9.08	1:05
Izushima	9.08	1:05
Onagawahama	9.08	1:05
Umenomiya-Jutaku	9.08	1:23
Rifu	9.08	1:23
Schiogama	9.08	1:23
Takaki	9.08	1:23
Shiogama	9.08	1:23
Uenodai	9.08	1:23
Oishi	8.38	0:37
Heida	8.38	0:37
Kami-Heida	8.38	0:37
Shirahama	8.38	0:37
Oya	8.38	0:52
Akuao	8.38	0:52
Hiraiso	8.38	0:52
Iso	8.38	1:25
Kuroki	8.38	1:25
Tsurishi	8.38	1:25
Haragama	8.38	1:25
Otsubo	8.38	1:25
Komagamine	8.38	1:25
Nakumura	8.38	1:25
Kamaishi	6.99	0:33
Kumazawa	6.99	1:00
Kuwahama	6.99	1:00
Osu	6.99	1:00
Ogatsu	6.99	1:00
Ohama	6.99	1:00
Kitsunezaki	6.99	1:00
Takenohama	6.99	1:00
Tatsuhama	6.99	1:00
Funagoshi	6.99	1:00
Iinosaka	6.99	1:09
Nakada	6.99	1:09
Ninokura	6.99	1:09
Sangenchaya	6.99	1:09
Ainokama	6.99	1:09
Kita-Kama	6.99	1:09
Shimo-Masuda	6.99	1:09
Masuda	6.99	1:09

Ido	6.99	1:09
Fujitsuka	6.99	1:09
City	*Wave height (meter)*	*Arrival time relative to earthquake*
Koya	6.99	1:09
Iwasaki	6.28	0:52
Iinogawa	6.28	0:52
Arayashik	6.28	0:55
Kami-Asamigawa	6.28	0:55
Shimo-Kitabo	6.28	0:55
Yotsukura	6.28	0:55
Maeyachi	6.28	0:57
Shinden	6.28	0:57
Wabuchi	6.28	0:57
Naka-Komatsu	6.28	0:57
Sunaoshi	6.28	0:57
Hirobuchi	6.28	0:57
Yamane	6.28	0:57
Moto-Funaba	6.28	1:03
Higashi-Fukuda	6.28	1:03
Kanomata	6.28	1:03
Ishinomaki	6.28	1:03
Kamata	6.28	1:03
Sugaya	6.28	1:25
Sakamoto	6.28	1:25
Ryoishi	5.58	0:37
Hakozaki	5.58	0:37
Kirikiri	5.58	0:37
Unozumai	5.58	0:37
Anto	5.58	0:37
Toyoma	5.58	0:48
Ena	5.58	0:48
Hongo	5.58	0:50
Kojirahama	5.58	0:50
Takatsudo	5.58	0:52
Oragahama	5.58	0:52
Futaba	5.58	0:52
Watanoha	5.58	0:53
Minami-Ibi	5.58	0:53
Tachiya	5.58	0:53
Isobe	5.58	0:53
Umekawa	5.58	0:53
Kashima	5.58	0:53
Inai	5.58	0:53
Mizunuma	5.58	0:53

Kiyohashi	5.58	1:03
Onoda	5.58	1:03
City	*Wave height (meter)*	*Arrival time relative to earthquake*
Namie	5.58	1:03
Koharagi	5.58	1:05
Imaizumi	5.58	1:05
Tsuya	5.58	1:07
Shimo-Tsuyakawa	5.58	1:07
Magome	5.58	1:07
Oyama	5.58	1:11
Kasano	5.58	1:18
Yamashita	5.58	1:18
Hanagama	5.58	1:18
Jumonji	5.58	1:31
Wada-Shinden	5.58	1:31
Shinhama	5.58	1:31
Fukanuma	5.58	1:31
Gamo	5.58	1:31
Tago	5.58	1:31
Iwakiri	5.58	1:31
Umenomiya-Jutaku Sugaya	5.58	1:31
Niida	5.58	1:31
Ogawara	4.88	0:46
Okuma	4.88	0:46
Bogoya	4.88	0:46
Tomioka	4.88	0:46
Koyatori	4.88	0:50
Omori	4.88	0:50
Aratame	4.88	0:50
Nakayama	4.88	0:50
Yamada	4.88	0:50
Osawa	4.88	0:50
Taira	4.88	0:50
Funakoshi	4.88	0:50
Dozan	4.88	0:52
Odaka	4.88	1:01
Nakanouchi	4.88	1:01
Rikuzen-Takata	4.88	1:03
Hosaura	4.88	1:03
Wakinosawa	4.88	1:03
Shimo-Funato	4.88	1:03
Sakari	4.88	1:03

Ofunato	4.88	1:03
Nakasato	4.88	1:03
City	*Wave height (meter)*	*Arrival time relative to earthquake*
Onaba	4.88	1:03
Hayakawa	4.88	1:12
Kabasaki	4.88	1:12
Arahama	4.88	1:12
Uenomachi	4.88	1:12
Kaikomba	4.88	1:12
Warabi	4.88	1:12
Yokoyama	4.88	1:12
Watari	4.88	1:12
Shibamachi	4.88	1:12
Hirawata	4.88	1:18
Nigo	4.88	1:18
Taketani	4.88	1:18
Shimanokoshi	4.18	0:39
Omoto	4.18	0:39
Kiriushi	4.18	0:39
Hamaiwaizumi	4.18	0:39
Sukinosawa	4.18	0:41
Ko-Tashiro	4.18	0:41
Settai	4.18	0:41
Sakiyama	4.18	0:42
Aonotaki	4.18	0:42
Taro	4.18	0:42
Sakikuwagasaki	4.18	0:42
Fudai	4.18	0:44
Kita-Nagano	4.18	0:52
Honnami	4.18	0:52
Omoe	4.18	0:52
Minami-Samuraihama	4.18	0:52
Ojiri	4.18	0:52
Takahira	4.18	0:52
Kayahama	4.18	0:52
Sasasawa	4.18	0:52
Kosode	4.18	0:52
Yagi	4.18	0:55
Taneichi	4.18	0:55
Uge	4.18	0:55
Ide	4.18	0:57

Kami-Shigeoka	4.18	0:57
Naraha	4.18	0:57
City	*Wave height (meter)*	*Arrival time relative to earthquake*
Shimo-Yata	4.18	0:59
Shiromae	4.18	0:59
Shimo-Takaku	4.18	0:59
Kita-Samuraihama	4.18	0:59
Choshi	4.18	1:01
Kitame	4.18	1:22
Sangatsuden	4.18	1:22
Motogi	4.18	1:37
Sendai	4.18	1:39
Miyako	3.49	0:44
Shimanokoe	3.49	0:44
Hirananamisawa	3.49	0:44
Otsuchi	3.49	0:50
Mizuki	3.49	0:52
Kitanosawa	3.49	0:52
Narusawa	3.49	0:52
Moto-Kawarago	3.49	0:52
Kisara	3.49	0:53
Idekura	3.49	0:53
Yunami	3.49	0:53
Koshigoe	3.49	0:53
Isohara	3.49	0:53
Hirakata	3.49	0:53
Uchino	3.49	0:53
Hamatsuga	3.49	0:55
Omi	3.49	0:55
Narage	3.49	0:55
Yoshikawa	3.49	0:55
Aotsuka	3.49	0:55
Satonomiya	3.49	0:55
Kuji	3.49	0:57
Shirane	3.49	0:57
Mayumi	3.49	0:57
Toyooka	3.49	0:57
Tamagawa	3.49	1:01
Torii	3.49	1:01
Horinai	3.49	1:01
Noda-Tamagawa	3.49	1:01

Kawajiri	3.49	1:01
Kawasiri	3.49	1:01
City	*Wave height (meter)*	*Arrival time relative to earthquake*
Denkiani	3.49	1:01
Kadonohama	3.49	1:01
Sunasawa	3.49	1:07
Hachinohe	3.49	1:11
Tsubonosawa	3.49	1:16
Suwa	3.49	1:16
Uchikoshi	3.49	1:16
Furumagi	3.49	1:18
Kinoshita	3.49	1:18
Kariyado	3.49	1:22
Shimonomachi	3.49	1:42
O-Basama	3.49	1:42

Source: Joint Research Centre, European Commission

6.3 Damage to public schools

March 23, 2011 (Wednesday) at 9:00

Office	*Municipality*	*Number of Schools (Public Kindergarten Park School)*	*Facility damage, etc.(number of schools)*
	Prefectural School	97	56
	Sendai City	202	134
Ogawara	Shiroishi	24	11
	Kakuda City	14	12
	Zaou Town	13	7
	Shichigashuku Town	3	3
	Ogawara Town	5	2
	Murata Town	9	8
	Shibata Town	10	9
	Kawasaki Town	12	3
	Marumori Town	13	6
	Total	103	61
Sendai	Shiogama City	12	9
	Natori City	20	2
	Watari Town	10	5
	Yamamoto Town	7	2

	Iwanuma City	8	8
	Matsushima Town	7	2
	Tagajyo City	10	2
	Shichigahama Town	5	1
	Rifu Town	9	9
	Iaiwa Town	9	3
	Osato Town	6	
	Tomiya Town	14	14
	Ohiramura Village	3	
	Total	120	57
Northern	Ohsaki City	62	54
	Kami Town	17	
	Shikama Town	5	
	Wakuya Town	12	
	Misato Town	14	
	Total	110	60
Kurihara	Kurihara City	64	47
Eastern	Ishinomaki City	71	48
	Higashi Matsushima City	16	1
	Onagawa Town	5	5
	Total	92	54
Tome	Tome City	48	37
South Sanriku	Kensen Numa City	40	34
	Minami-Sanriku Town	8	8
	Total	48	42

Source: Miyagi Prefectural Board of Education

About International Environment and Disaster Management (IEDM) Laboratory

The IEDM Laboratory of Kyoto University Graduate School of Global Environmental Studies targets to reduce the gap between knowledge and practice through proactive field-level, community-based project implementation. Apart from Japan, the research areas are mainly in the developing countries in Asia, which have the highest population growth, and high vulnerability, due to different types of natural and man-made disasters. The focus of this research field is to learn lessons from the field experiences through effective environment and disaster related project management.

Disaster issues are directly related to environmental degradation, and global climate change. The key of environment and disaster management is the end-user's (community and people) participation. Added to this, is education and learning through formal/non-formal education, and community/ family interactions. Working closely with the governments, NGO/NPO, United Nations, bilateral and multilateral development agencies and regional bodies, this research field is developing a unique process-oriented participatory approach of environment and disaster management through direct involvement and ownership of the community.

Cover page photo: A huge whirlpool caused by the earthquake and tsunami in Japan on 11th March 2011 (source NHK news)

Back page photo: Soldiers of Japan Self-Defense Force and firefighters search for the victims in the rubbles Monday, March 14, 2011 in Matsushima, Miyagi Prefecture, Japan, three days after northeastern coastal towns were devastated by an earthquake and tsunami. (Source: Kyodo News)

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