Eurasian Journal of Applied Engineering and Technology (EJAET)

Review *https://doi.org/10.32523/3136-3385-2026-155-2-7-26*

Earthquake disasters and countermeasures-the case of Japan, Hachinohe

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Abstract. On December 8, 2025, a major earthquake struck off the eastern coast of Aomori Prefecture, causing severe damage in Hachinohe City and surrounding areas. The event highlighted the vulnerability of regional infrastructure, economic activities, and local communities to seismic and tsunami hazards. This study examines the impacts of the earthquake on transportation facilities, communication networks, residential districts, public utilities, and social systems. Using Hachinohe as a representative case study, the paper reviews historical experiences with earthquakes and tsunamis in Japan, the geophysical mechanisms responsible for their occurrence, and the strategies implemented to reduce disaster-related losses. Particular attention is given to the resilience of critical infrastructure, emergency response operations, evacuation procedures, and post-disaster recovery processes. The research also evaluates the effectiveness of existing disaster management policies and community-based preparedness programs. Furthermore, the study discusses potential challenges associated with future environmental and socio-economic changes, including population decline and climate-related risks. Based on the findings, recommendations are proposed for strengthening disaster preparedness, improving risk mitigation measures, enhancing infrastructure resilience, and supporting sustainable regional development in earthquake-prone coastal regions.

Keywords: earthquake disaster, tsunami, Hachinohe, seismic resilience, disaster mitigation, infrastructure damage, emergency response, regional sustainability, Pacific Plate subduction, disaster recovery.

Received 16.01.2026. Revised 15.06.2026. Accepted 18.06.2026. Available online 30.06.2026

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Introduction

On December 8, 2025, shortly after 11 PM, I felt a strong tremor. I was in bed in my bedroom, waiting for the shaking to subside, as I feared my house might collapse. Fortunately, there was no power outage, so I immediately turned on the television. Within minutes, an earthquake alert was broadcast. The epicenter was off the coast east of Aomori Prefecture, and the maximum seismic intensity in Hachinohe was recorded as higher 6. A tsunami warning was issued, and evacuation orders were given to move away from the sea. Many residents living near the coast evacuated to higher ground on a cold winter night.

Fig.1 shows the damage to the top of the viaduct piers of the Hachinohe Line railway. Due to this damage, the Hachinohe Line was unusable, but it was restored and operations resumed three weeks after the disaster. Fig.2 shows a communication tower with a fractured vertical member. Because there was a risk of collapse, and concerns about the tower's collapse after the earthquake, surrounding residents evacuated, and surrounding roads became impassable. Repairs were completed 18 days later, the evacuation of surrounding residents ended, and life returned to normal. In the city center and some residential areas, buildings have been damaged and repairs are underway.

Off the coast of Hachinohe, the Pacific Plate is subducting beneath the continental plate at a rate of several centimeters per year. * The strain energy generated at this plate boundary is the cause of major earthquakes occurring every few decades. The mechanism of these earthquakes has already been elucidated, and improvements are being made, albeit slowly, to mitigate the damage caused by earthquakes and tsunamis resulting from this activity.

Japan, including Hachinohe, has repeatedly suffered from earthquakes and tsunamis. Using Hachinohe, where the author lives, as an example, this study examines how society has responded to these earthquakes and tsunamis, protecting livelihoods and industries, and considers what challenges should be faced and how they should be resolved in the face of future regional environmental changes.

Figure 1. Viaduct pier of Railway in Hachinohe Figure.2. Tower with a broken vertical member

Japan Meteorological Agency: The mechanism of earthquake occurrence
https://www.jma.go.jp/jma/kishou/know/jishin/jishin/about_eq.html

The earthquake that occurred on December 8, 2025, had a seismic intensity of higher 6 as the maximum seismic intensity and occurred off the coast of eastern Aomori Prefecture. This area off the coast of eastern Aomori Prefecture is located at the boundary between the Pacific Plate and the continental plate, and the phenomenon of the Pacific Plate subducting beneath the continental plate continues. "Around Japan, the oceanic plates, the Pacific Plate and the Philippine Sea Plate, are moving towards the continental plates (North American Plate and Eurasian Plate) at a speed of several centimeters per year, subducting beneath the continental plates." * Fig.3 is a distribution map of earthquakes that occurred near Japan in 50 years (1960-2011). It shows that many earthquakes have occurred along the boundaries of each plate.

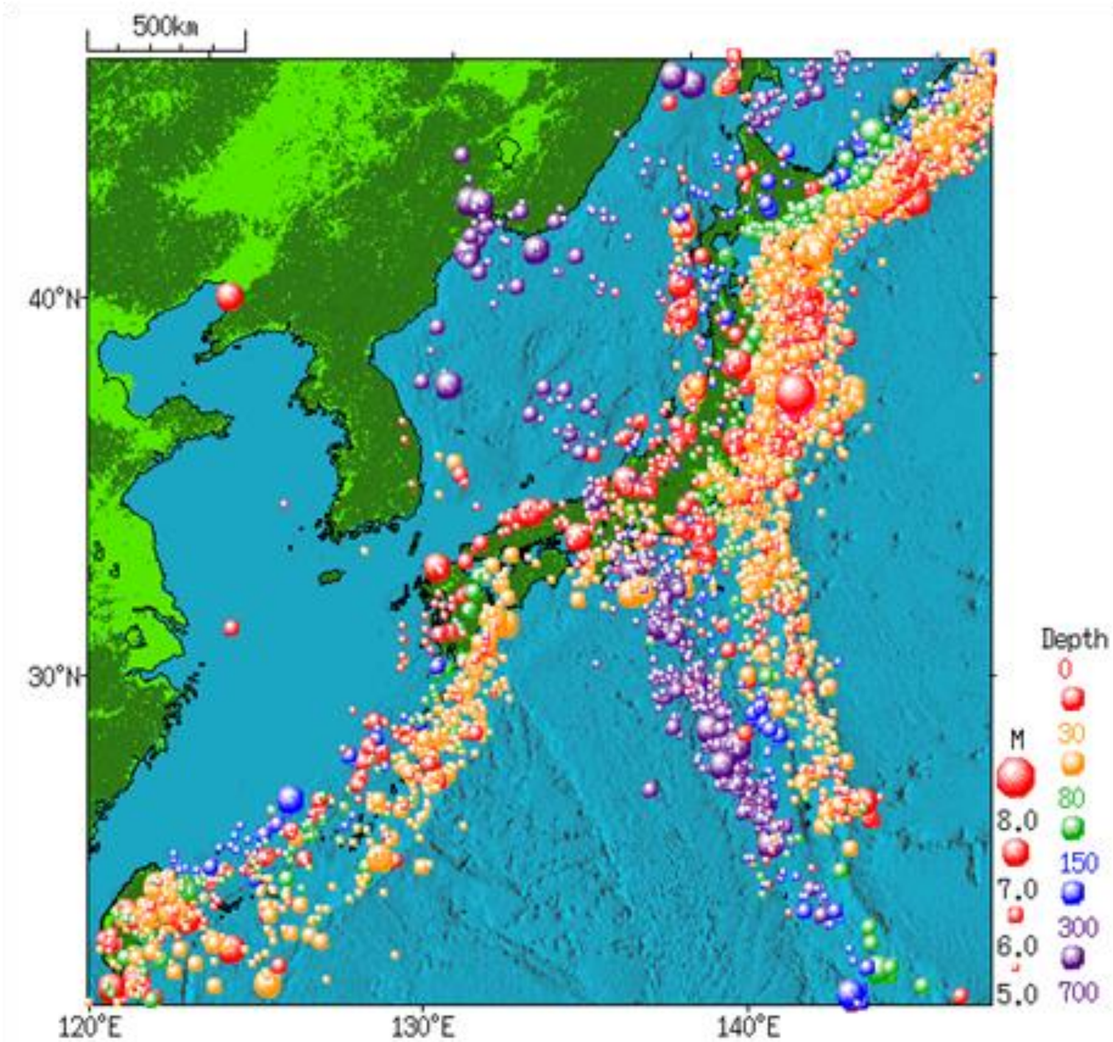


Figure 3. A distribution map of earthquakes that occurred near Japan in 50 years (1960-2011)
From Japan Meteorological Agency(JMA)
*Japan Meteorological Agency: The mechanism of earthquake occurrence
https://www.jma.go.jp/jma/kishou/know/jishin/jishin/about_eq.html

Therefore, the area around Japan is subjected to complex forces from multiple tectonic plates, making it one of the most earthquake-prone regions in the world. This generates significant strain energy at the boundary, and the release of this energy frequently causes earthquakes. Between 2011 and 2024, 1971 earthquakes of magnitude 6.0 or greater occurred worldwide, of which 328 (16.6%) occurred in Japan*.

Figure 4 shows earthquake information published in real time on the Japan Meteorological Agency website. It shows earthquakes that occurred around Japan within 24 hours from 11:00 AM on March 1, 2026. While it shows that many earthquakes occurred, many of them occurred near the plate boundary.

The epicenter of the earthquake that occurred on the Pacific side of eastern Japan on March 11, 2011, was located south of the current location. Because a large amount of energy was released simultaneously at multiple locations, it became a massive earthquake with a magnitude of 9.0 (Mw) and a maximum seismic intensity of 7, generating a large tsunami. This earthquake resulted in over 20,000 deaths, and even 15 years later, recovery, including damage to nuclear power plants, is still ongoing.

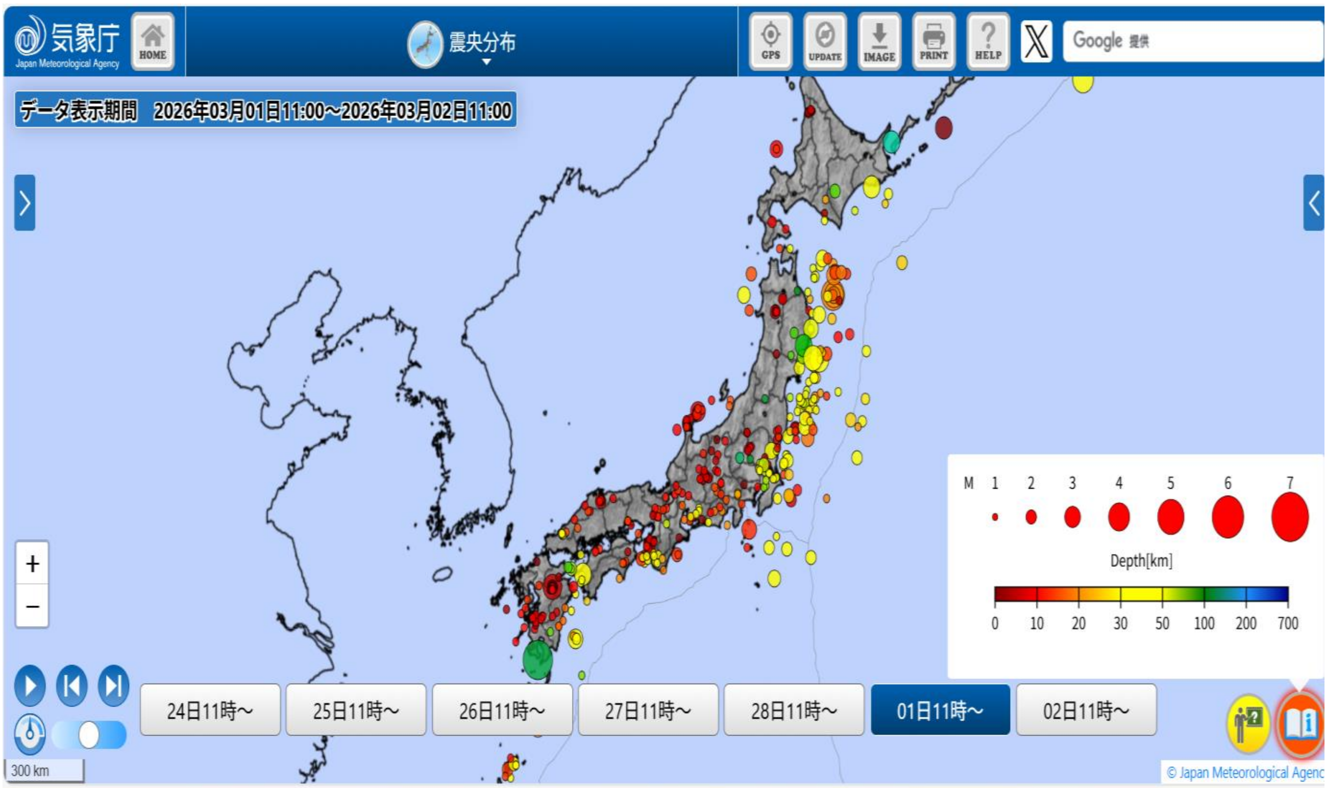


Figure 4. Earthquakes that occurred within 24 hours of 11:00 AM on March 1, 2026
From Japan Meteorological Agency
*Ministry of Land, Infrastructure, Transport and Tourism
https://www.mlit.go.jp/river/toukei_chousa/kasen_db/pdf/2025/2-2-3.pdf

https://www.jma.go.jp/bosai/map.html#5/37.079/136.084/&contents=hypo

While magnitude, an indicator of earthquake energy, is used globally, seismic intensity, which represents the strength of shaking in various locations caused by an earthquake, is expressed differently from country to country. In Japan, the Japan Meteorological Agency uses a 10-level seismic intensity scale shown in Table 1. Each level of seismic intensity corresponds to a corresponding level of human experience and corresponding actions. Seismic intensity 1 represents the lowest level of seismic intensity felt by humans, and seismic intensity 7 represents the highest level. Instrumental seismic intensity is calculated from the three components of the acceleration waveform recorded by seismometers at installation points using a predetermined procedure including a Fourier transform. It is measured approximately a few minutes after the earthquake occurs and communicated to the public through television, radio, and the website.

Figure 5 shows earthquakes with a maximum seismic intensity of 1 or higher that occurred during the week from February 21st, plotted with the magnitude as the diameter. 45 earthquakes occurred during this period. This kind of information can be found on the Japan Meteorological Agency's website. The area around Hachinohe City experiences approximately one earthquake per day.

Table 1 Seismic intensity scale、Measured seismic intensity、and Human Experiences and Behavior in Japan *The author translated the Japan Meteorological Agency's materials

Seismic intensity scale	Measured seismic intensity I	Human Experiences and Behavior
0	I<0.5	People do not feel the shaking, but it is recorded on seismographs.
1	0.5<I <1.5	Some people who stay quiet indoors may feel a slight vibration.
2	1.5<I<2.5	Most people who stay quiet indoors feel the vibration. Some sleeping people may wake up.
3	2.5<I<3.5	Most people who stay quiet indoors feel the vibration. Some people who are walking may feel the vibration. Most sleeping people wake up.
4	3.5<I<4.5	Most people are startled. Most walking people feel the vibration. Most sleeping people wake up.
lower 5 (5L)	4.5<I<5.0	Most people feel fear and want to hold on to things.
upper 5(5U)	5.0<I<5.5	Most people have difficulty walking without holding on to things, or experience other problems with their movements.
Lower6(6L)	5.5<I<6.0	Standing becomes difficult.
Upper6 (6U)	6.0<I<6.5	Standing becomes impossible, and people can only move by crawling. People are thrown into disarray by the shaking, unable to move, and may even be blown away.
7	6.5<I	

Figure 6 shows the number of earthquakes with seismic intensity of 1 or higher that occurred in Japan during the 10-year period from 1996 and the 10-year period from 2016 (20 years later). Hereafter, the former data will be referred to as the 1996 data, and the latter as the 2016 data. The horizontal axis represents the number of earthquakes from seismic intensity 1 to 7, and the vertical axis represents the number of earthquakes on a logarithmic scale. The two curves are similar, but the 2016 data shows more earthquakes with seismic intensity 6U and 7, which cause significant damage. For the maximum seismic intensity of 7, there was one in the 1996 data, but four in the 2016 data.

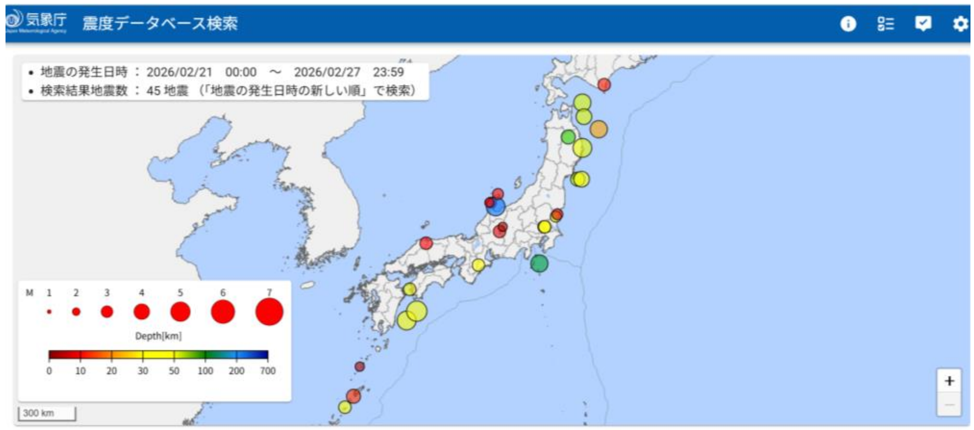


Figure 5. Earthquakes with a seismic intensity of 1 or higher in 24 hours (from Feb. 21, 2026, to Feb. 27, 2026) in Japan. By Japan Meteorological Agency: https://www.data.jma.go.jp/eqdb/data/shindo/index.html

When approximation lines showing the relationship between maximum seismic intensity and the number of earthquakes are inserted, it is shown that the slope of the 2016 data is gentler, indicating that higher intensity earthquakes occurred in the 2016 data. The number of earthquakes in each 10-year period was 33,659 in the 1996 data and 24,376 in the 2016 data, with the total number of earthquakes in the 2016 data decreasing by 72.4%. The average daily occurrence rate was 9.2 times in 1996 and 6.7 times in 2016.

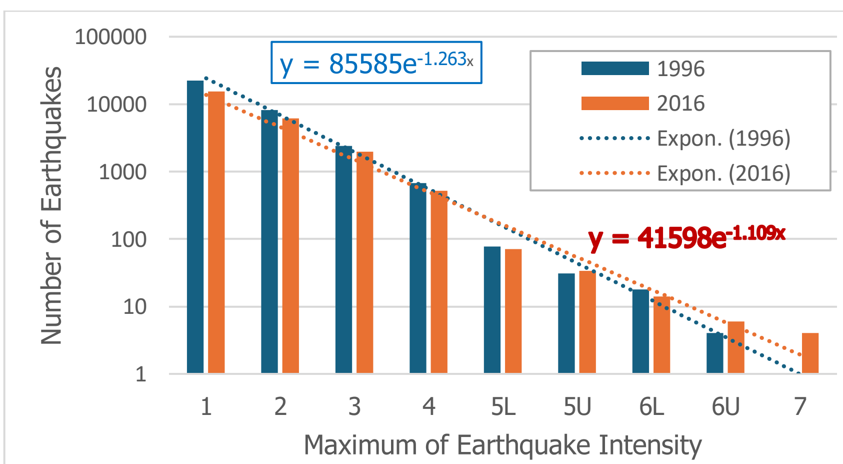


Figure 6. Maximum seismic intensity and number of earthquakes: 10-year period from 1996 and 2016

Figure 7 shows the maximum seismic intensity and number of occurrences of earthquakes that caused human casualties in Japan over the past 10 years, from 2016. There were 49 earthquakes that caused human casualties, which averages out to 4.9 per year. Over the 10 years, there were 17 earthquakes with a maximum seismic intensity of 6L or higher, averaging out to 1.7 per year.

Comparing the maximum seismic intensity and the number of fatalities, there were 9 occurrences of 6L with 4 deaths, 4 occurrences of 6U with 4 deaths, and 4 occurrences of 7 with 962 deaths. It can be seen that earthquakes with a maximum seismic intensity of 7 caused many deaths in a single earthquake, resulting in significantly different damage compared to earthquakes with a seismic intensity of 6U.

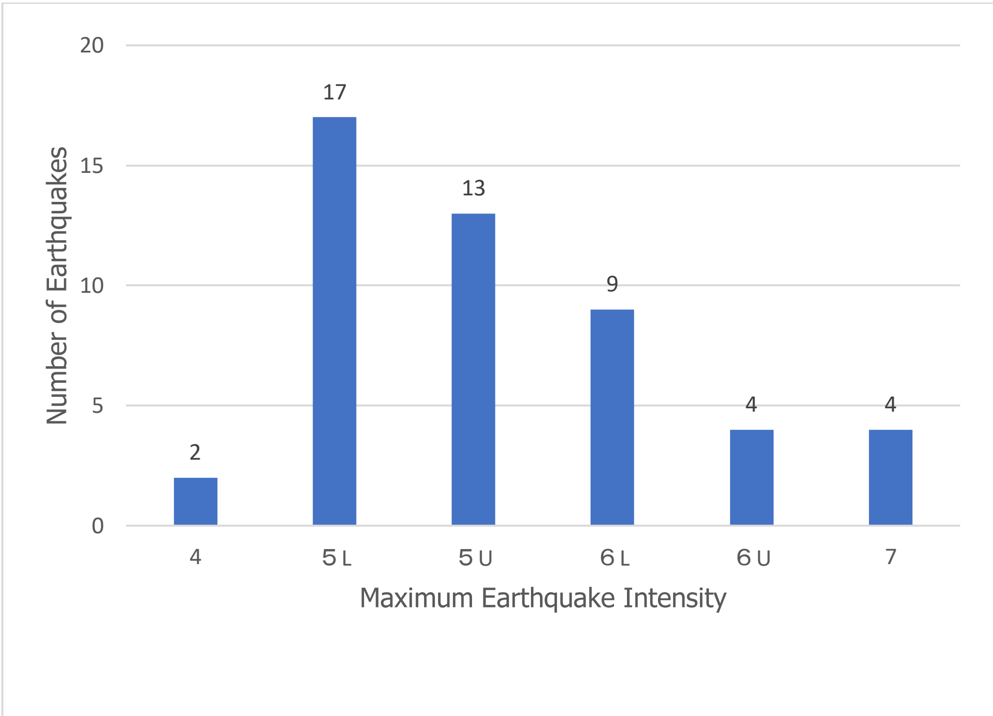


Figure 7. Maximum Earthquake Intensity and Number of Earthquakes from 2016 to 2025
The numbers are from https://www.data.jma.go.jp/eqev/data/higai/higai1996-new.html#higai2006

Figure 8 compares the number of earthquakes resulting in human casualties, categorized by maximum seismic intensity, over a 10-year period from 1996 to 2016. Here, human casualties refer to people injured or killed by the earthquake. While the number of earthquakes with a maximum seismic intensity of 5L or higher remains roughly the same, the number of earthquakes with a maximum seismic intensity of 4 differs significantly. This requires verification of the number of earthquakes with a maximum seismic intensity of 4, but assuming similar earthquake patterns in the two periods, it suggests that earthquakes resulting in human casualties in 1996 were able to decrease in 2016.

Figure 9 is a figure that adds the percentage (line graph) of earthquakes causing human casualties to the total number of earthquakes (including those without human casualties), to Figure 7, which shows the number of earthquakes that caused human casualties. Both the 1996 and 2016 data show that the rate of human casualties increases with increasing maximum seismic intensity, reaching 100% at seismic intensity 7. Comparing the 1996 and 2016 data, the rates are similar for each category: 6U (50% and 67%), 6L (56% and 64%), 5U (36% and 38%), and 5L (22% and 24%). However, the 2016 data shows higher rates in all categories. On the other hand, for seismic intensity 4, the rates are 4.4% and 0.38%, a decrease of approximately 1/10 compared to the 2016 data. This suggests an improvement in disaster prevention capabilities against earthquakes with a maximum seismic intensity of 4, but it is necessary to acknowledge that improving disaster prevention capabilities against earthquakes with a maximum seismic intensity of 5 or higher remains a challenge.

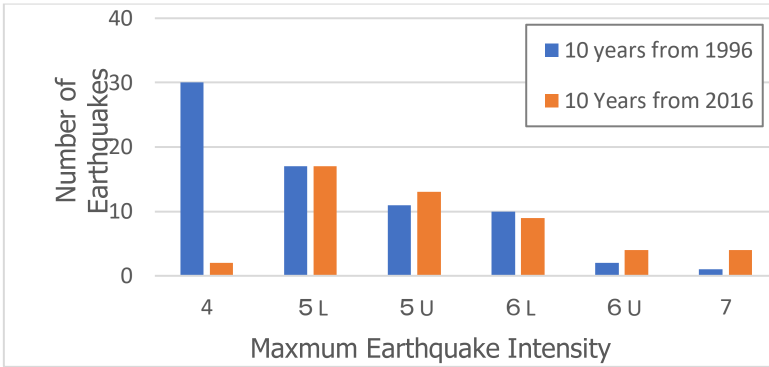


Figure 8. Maximum Earthquake Intensity and Number of Earthquakes 10 years from 1996 and 2016

Regarding damage to houses, between 1996 and 2010 there were 5,238 completely destroyed and 24,780 partially destroyed or slightly damaged, while between 2015 and 2010 there were 16,054 completely destroyed and 409,608 partially destroyed or slightly damaged, with the damage between 2015 and 2010 being overwhelmingly greater. It is necessary to understand that this is due to the difference in the number of earthquakes with a maximum seismic intensity of 6U and 7, and that even earthquakes with the same maximum seismic intensity of 7 can be of different magnitudes.

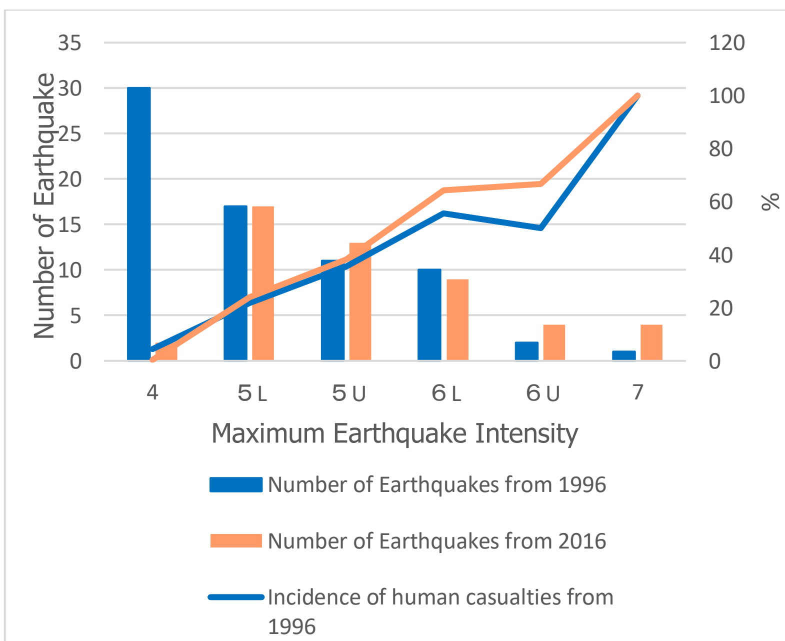


Figure 9. Maximum Earthquake Intensity and Number of Earthquakes

Percentage of earthquakes that resulted in human casualties in 1996 and 2016 (%)

In Japan, throughout history, numerous disasters have repeatedly occurred, causing significant damage to the lives of citizens and communities.

Rikuzentakata city in Iwate Pref.

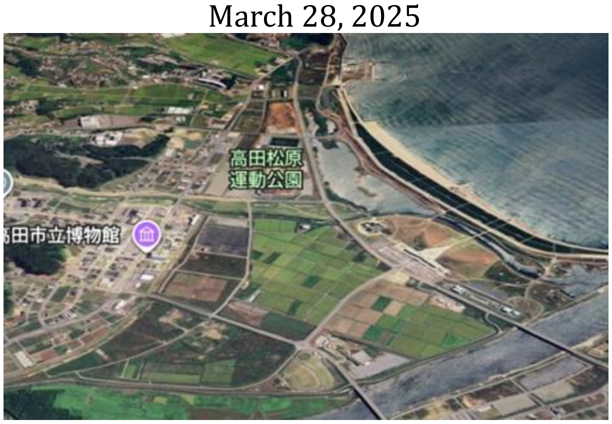
Otsuchi Town in Iwate Pref.

May 2007

March 2010

March 28, 2025

March28, 2025



Sep. 2025 Google Earth

Sep. 2025 Google Earth

Figure10. Damage by the 2011 Tohoku Region Pacific Ocean offshore Earthquake Earth

*Ministry of Internal Affairs and Communications, Document I: Number of Deaths and Housing Damage by Prefecture in the Great East Japan Earthquake (as of March 1, 2025)
https://www.fdma.go.jp/publication/hakusho/r7/items/part7_section2.pdf

Among these, earthquakes have been devastating lives and property, destroying houses and infrastructure, and wiping out people's livelihoods and industries. Each time, people have strived to protect themselves from earthquakes by implementing earthquake-resistant urban planning and evacuation plans.

However, the 2011 Tohoku Region Pacific Ocean offshore Earthquake (magnitude Mw9.0 on March 11, 2011) not only caused damage from the earthquake itself, but also resulted in the subsequent massive tsunami, which claimed many lives, homes, factories, fishing boats, and entire communities. Furthermore, in Fukushima Prefecture, the radiation damage from the nuclear power plant meant that even after the threat of earthquakes and tsunamis subsided, the surrounding areas remained uninhabitable for a long period. Looking at the recovery of disaster-stricken areas excluding those around nuclear power plants, much of the social infrastructure, such as seawalls, roads, and elevated ground, which were planned to be completed within 10 years of the disaster, has already been completed. However, 15 years have passed, and the original population has not returned.

Figure 10 shows aerial photographs of Rikuzentakata City and Otsuchi Town, which face the Pacific Ocean and suffered significant damage from the tsunami, before the disaster, immediately after the disaster, and 15 years later. In Rikuzentakata City, the population decreased by 23% in 10 years after the disaster, and in Otsuchi Town, it decreased by 29%. Considering that the population decrease in Hachinohe City during the same period was 6%, this represents a significant population decline. This means that even if social infrastructure is prepared, people's hearts and communities do not recover in the same way as things are rebuilt. Recovery takes a long time. Also, as can be seen in Fig.10, although ground elevation was carried out in coastal areas after the disaster, the land use situation is different compared to the situation before the disaster. This situation highlights the importance of earthquake preparedness and minimizing damage, which are crucial social issues.

The Ministry of Internal Affairs and Communications has reported the following damage from this earthquake: 19,782 deaths, 2,550 missing persons, 6,242 injured, 122,053 houses completely destroyed, and 284,074 houses partially destroyed. *

Furthermore, it has been reported that high-rise buildings in areas far from the epicenter shook significantly during this earthquake. This is thought to be due to the long-period components of seismic waves transmitting over hundreds of kilometers, causing resonance with high-rise buildings that have long natural periods. Currently, information regarding long-period ground motion that causes such phenomena is also being provided to the public.

1. Before 2011 (Top), March 2011 immediately after the disaster (middle, and Sep.2025, 15 years after the disaster (Lower).
2. The left side is Rikuzentakata city, the right side is Otsuchi town. The tsunami run-up height was 40m at Rikuzentakata, and it was 21m at Otsuchi
3. The photos before and immediately after the disaster are from Tohoku Construction Association materials, and the photo 15 years after the disaster is from Google Earth.

The methodology

Table 2 summarizes the date, time, name, and damage overview of major earthquakes that occurred around Hachinohe in the last 50 years. The four earthquakes that caused significant damage to the Hachinohe region in the last 50 years are the 1968 Tokachi offshore earthquake, the 1994 Sanriku far offshore earthquake, the 2011 Tohoku Region Pacific Ocean offshore earthquake, and the 2025 Aomori Prefecture Eastern offshore earthquake. Fig.11 shows the location of each epicenter. The following can be understood from these tables and figures;

1. Frequency of major earthquakes: Major earthquakes with epicenters off the coast of Hachinohe occurred in 1968, 1994, and 2025, with intervals of 26 and 31 years. This

suggests that strain energy accumulating near plate boundaries leads to rupture after approximately 30 years.

2. In contrast, the 2011 earthquake occurred in a wider area south of Hachinohe. The possibility of such an earthquake occurring over a wide area is considered extremely rare compared to localized earthquakes like those off the coast of Hachinohe. The maximum seismic intensity is greater than that of the 1968 earthquake. This is thought to be due to the larger magnitude of the earthquake.
3. Comparing the 1994 and 2025 earthquakes, which have similar magnitudes and maximum seismic intensity, the 1994 earthquake had a magnitude of 0.1 greater, resulting in greater damage and a wider area of impact. However, the damage from the 2025 earthquake seems to be less than in the past. This may be because we have experienced many earthquakes, and each time we have considered disaster prevention, leading to improved building strength and successful results in evacuation drills and other measures. In the case of structural damage, the natural frequencies of the ground and structures can be related to the magnitude of the damage, so it is necessary to evaluate them in conjunction with the characteristics of each seismic wave.

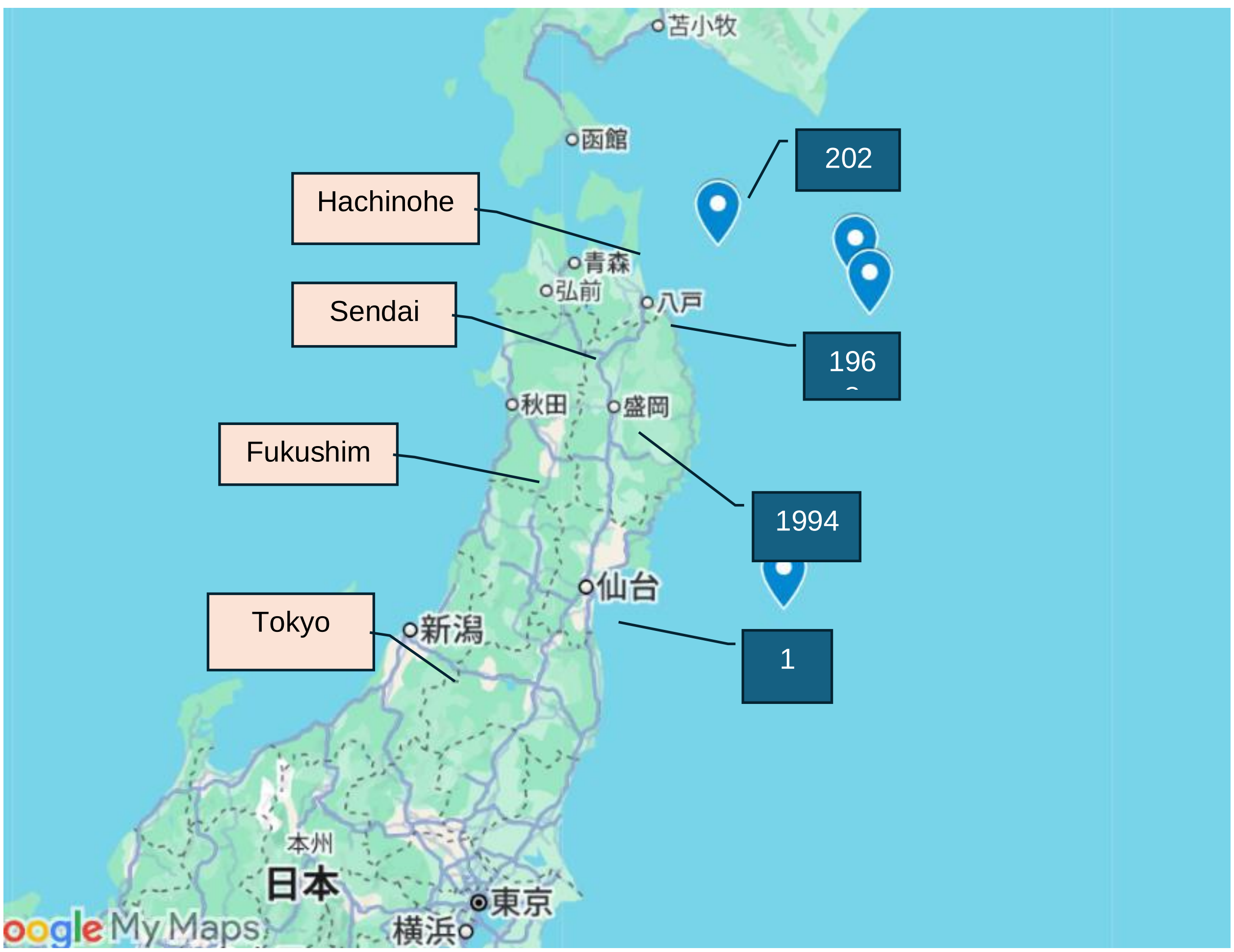


Figure11. Epicenters of Big Earthquakes near Hachinohe

Figure 12, 13, and 14 show the damage caused by earthquakes and tsunamis in Hachinohe City in 1968, 1994, and 2011, respectively.

Table 2 Major earthquakes that occurred around Hachinohe in the last 50 years

	The 1968 Tokachi offshore earthquake, May 16,1968, Magnitude Mw8.2	
	Seismic Intensity	5 at Hachinohe, Hakodate, Morioka, etc.
	Main damage	Tsunami of 5m, 52 dead or missing, 330 injured, landslides (heavy rain the day before), railway damage and closure
	The 1994 Sanriku far offshore earthquake, Dec. 28, 1994, Mj7.6	
	Seismic Intensity	6 at Hachinohe, Tsunami 55cm at Miyako
	Main damage	3 dead due to building destruction, 788 injured, 72 buildings completely destroyed, deaths
	The 2011 Tohoku Region Pacific Ocean offshore Earthquake, Mar. 11, 2011, Mw9.0, the largest M in Japanese history	
	Seismic Intensity	7 at Miyagi Pref., 5U at Hachinohe. Tsunami (Maximum height 9.3 m or more at Soma, Maximum run-up height 40.1 m at Ryori Bay
	Main damage	The largest earthquake disaster in Japanese history: 22,318 dead, 2,553 missing, 6,242 injured, nuclear power plant damaged.
	The 2025 Aomori Prefecture Eastern offshore earthquake, Dec. 8, 2025, Mj 7.5	
	Seismic Intensity	6U at Hachinohe
	Main damage	0 deaths, 61 injured, buildings, overpass, and tower damaged.

Mw: Moment magnitude scale, Mj: Magnitude scale by Japan Meteorological Agency

Figure 12 shows the 1968 earthquake, which, due to heavy rainfall in the days leading up to it, resulted in numerous ground-related disasters.

Figure 12. Damage by the 1968 Tokachi offshore Earthquake (Hachinohe City)
Left-Road collapse (Provided by Hachinohe City)
Center-Road collapse (Provided by Disaster Prevention Specialist Library)
Right-Damage to buildings (Provided by Disaster Prevention Specialist Library)

This suggests that earthquake damage can be compounded by other disasters. As mentioned earlier, this earthquake caused significant damage to water pipes, which contributed to Hachinohe

City becoming the birthplace of earthquake-resistant pipes.

Figure 13 shows the 1994 earthquake, which caused extensive damage to buildings such as the city hall and schools in Hachinohe City. In January of the following year, 1995, the Great Hanshin Earthquake caused significant damage to structures, leading to major changes in earthquake-resistant building standards.

Figure 14 shows the 2011 earthquake, which brought a large tsunami to Hachinohe City. Breakwaters designed to maintain harbor tranquility were destroyed, fishing boats moored in the harbor were washed ashore, and beachfront restaurants were damaged. The height of the tsunami that hit Hachinohe City was lower than that of Iwate and Miyagi prefectures to the south.

Figure 13. Damage by the 1994 Sanriku far offshore Earthquake (Hachinohe City) Left Slope collapse (from Morioka Meteorological Observatory website), Center) Damage to buildings (ibid.) Right Damage to buildings

Figure 14. Damage by the 2011 Tohoku Region Pacific Ocean offshore Earthquake and Tsunami

(Hachinohe City) Left) Bottom of a fishing boat washed ashore in Hachinohe Port by the tsunami (by author) Center) Overturned car. Offshore breakwater was destroyed in Hachinohe Port. (Ibid.) Right) Damage to a restaurant near the coast (Ibid.)

Following the major earthquake, seismic reinforcement efforts have been underway. This section describes the seismic reinforcement of social infrastructure implemented in the Hachinohe area.

(1) Seismic Reinforcement of Water Supply Facilities:

In Hachinohe City, the water supply system suffered significant damage in the 1968 earthquake. The main cause was that water pipe joints came loose due to ground deformation, leading to leaks. As a result, the seismic resistance of water pipe joints was strengthened. The developed joints are based on a seismic isolation concept and are designed with large expansion and bending margins to accommodate major earthquakes and poor ground conditions. Under normal circumstances, the pipe body is not subjected to excessive force, and the joints can adapt to ground fluctuations. * In addition, loop main lines of water pipes have been installed around the city, and main water pipes have been installed so that even if some water treatment plants are damaged, the impact on the water supply will be minimal. As a result, in subsequent major earthquakes, even if localized water outages occur, a stable water supply to citizens has been possible. Furthermore, the development and installation of earthquake-resistant water pipes in Hachinohe City began immediately after the 1968 earthquake, making them the first earthquake-resistant water pipes in Japan, and Hachinohe City is considered the birthplace of earthquake-resistant water pipes.

In addition, following the 1994 Sanriku far offshore earthquake, in order to prevent large-scale structural damage in the 1995 Hyogo Prefecture Southern Earthquake that occurred the following month in January 1995, mainly in Kobe City, seismic regulations for various structures were revised and seismic reinforcement work was carried out. For bridges, in addition to seismic reinforcement of bridge piers, the installation of bridge girder collapse prevention devices has been carried out in various places. In Hachinohe City, as shown in Fig.15, seismic reinforcement of bridge piers has also been carried out mainly on important routes.

Figure 15 Seismic reinforcement of bridge piers by PC panels
(2012, Yanagibashi Bridge, Hachinohe City)

Findings/Discussion

This section introduces some of the earthquake disaster prevention measures implemented in Japan. While raising seawalls and strengthening structures are important, providing information on earthquakes and tsunamis, as well as responding to disasters from the time of the event onward, are also crucial activities.

Many citizens receive information through the Earthquake Early Warning system. Earthquake waves consist of fast P-waves (approximately 7 km/s) and slow S-waves (approximately 4 km/s), and this system utilizes the difference in their speeds. Since the strong waves that cause damage are S-waves, the Earthquake Early Warning system detects P-waves and warns of an impending earthquake before the S-waves arrive. For example, if detected 60 km away, it can provide 20 seconds of early warning. Because processing time for notification takes several seconds, if an earthquake occurs nearby, the Earthquake Early Warning may only be issued after the earthquake has arrived.

This warning is transmitted to citizens by the Japan Meteorological Agency via the internet (mobile phones), television, radio, etc. Although it's only for a short time, this allows us to have information about the epicenter and magnitude of an earthquake, enabling us to prepare ourselves physically and mentally. This observation is conducted at approximately 1,700 points nationwide. The Earthquake Early Warning system is also working to quickly and accurately estimate the epicenter and magnitude from data from a limited number of observation points.

Fig. 16 is a distribution map of locations where sea level fluctuations are observed to monitor tsunamis. Information regarding tsunamis and storm surges is provided based on the data observed here. When an earthquake occurs, the Japan Meteorological Agency immediately estimates the magnitude and location of the earthquake, and based on this, determines the expected tsunami height along the coast. Within minutes of the earthquake, a major tsunami warning (expected maximum wave height of 3m or more), a tsunami warning (expected maximum wave height of 1m to 3m), or a tsunami advisory (expected maximum wave height of 0.2m to 1m) is issued for each region. The information provided includes the expected arrival time of the first tsunami and the expected tsunami height.

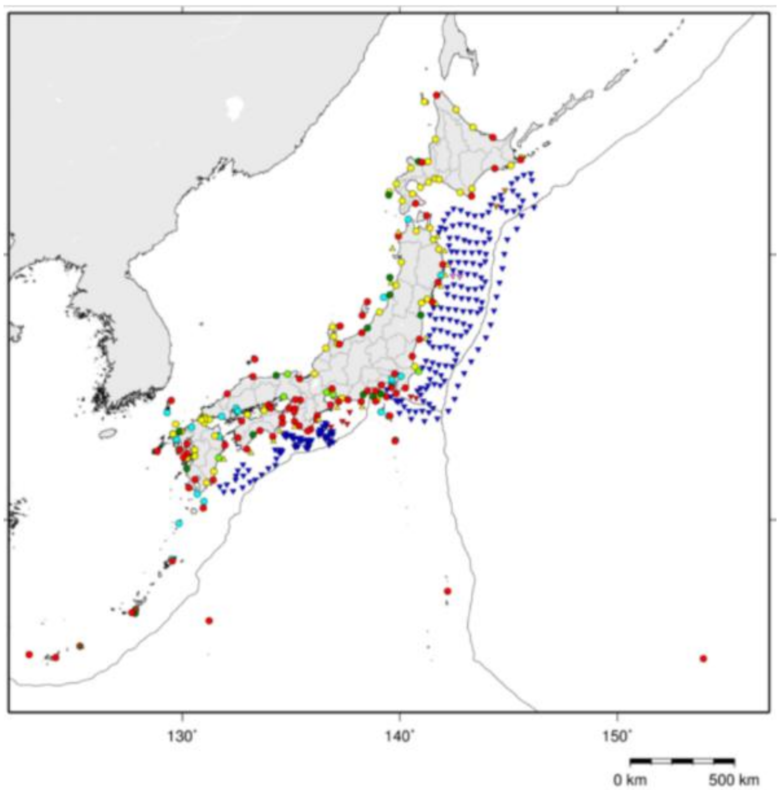


Figure 16 Tsunami observation points by JMA

Along with this basic information about tsunamis, information about expected damage and actions to take will also be conveyed. For example, in the case of a major tsunami warning, citizens will be informed via television, radio, and the internet that "A massive tsunami will strike, completely destroying or washing away wooden houses, and people will be swept away by the tsunami's current. People in coastal areas or along rivers should immediately evacuate to higher ground or safe places such as evacuation buildings." Evacuation sites and routes will be prepared and communicated to citizens by each municipality.

Fig.17 is a tsunami inundation forecast map, also known as a tsunami hazard map, provided to citizens by Hachinohe City. It shows the inundation depth from past and future tsunamis, providing preliminary information for evacuation.

In a tsunami disaster, 27 tsunami evacuation buildings have been designated as emergency and temporary shelters for situations where evacuation to areas outside the predicted inundation zone is not possible in time.

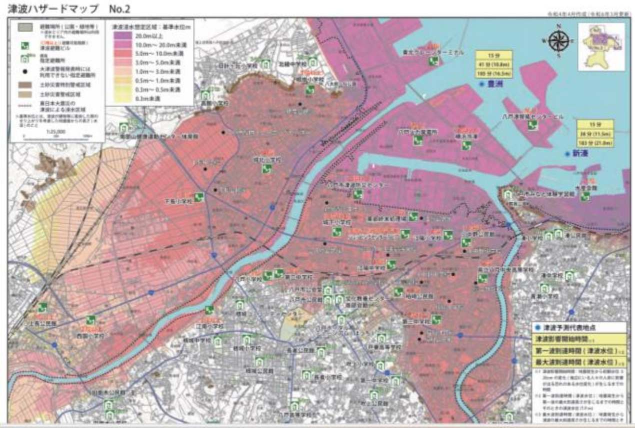


Figure 17 Tsunami Hazard Map (Central Hachinohe City, 2025)
Differences in color indicate differences in tsunami water depth.

These include tall buildings such as elementary and junior high schools, shopping centers, and factories in coastal areas, with cooperation from both public and private facilities. Additionally, these include evacuation towers constructed specifically for tsunami evacuation in low-lying areas without nearby higher ground. Fig. 18 shows one of the tsunami evacuation buildings constructed in response to the tsunami damage caused by the 2011 Tohoku earthquake and tsunami. It is equipped with necessary supplies for evacuation, such as drinking water, food, and heating equipment. It is also sometimes used for disaster prevention meetings.

Figure 18 Tsunami Disaster Prevention Center in Hacinohe
Constructed for tsunami evacuation purposes in a low-lying area with no nearby elevated ground.

Evacuation drills are conducted to teach people how to respond during an evacuation. In Japan, September 1st is designated as Disaster Prevention Day, and evacuation drills are conducted around this time as part of disaster prevention training. These drills are organized by schools, companies, and neighborhood associations, with support from local governments. The reason for choosing September 1st is that this is when Japan enters its windy season, and the country has experienced severe flooding in the past. Fig.19 shows a disaster prevention drill conducted by students of Hachinohe Institute of Technology in collaboration with the local community. It is expected that experiencing these drills will enable people to respond more smoothly in the event of a disaster, thereby reducing damage.

Figure 19. Disaster Prevention Drill (Joint Drill between HIT Students and the Local Community)

- Left Water Discharge Training Conducted Under the Guidance of Firefighters
- Center Training in Evacuation Support for People with Disabilities, Experiencing Evacuation Under Different Conditions (Wheelchair, Slope, Gravel Road)
- Right: Earthquake Experience on a Vibration Table: Earthquake Simulation Vehicle mounted on a Car

In an earthquake or tsunami that is expected to cause damage, evacuation information will be disseminated by each municipality via television, radio, and the internet. At home, lifelines may be cut off, resulting in water outages, power outages, and other inconveniences. Evacuation centers are typically local schools and community centers. While drinking water, food, and bedding are provided, living in an evacuation center presents challenges regarding toilets and privacy. To address these issues, mobile toilets (vehicles equipped with multiple toilets) and indoor tents may be used. Fig.20 shows the locations of evacuation shelters in Hachinohe City. 80 locations have been designated to suit the actual needs of the residents.

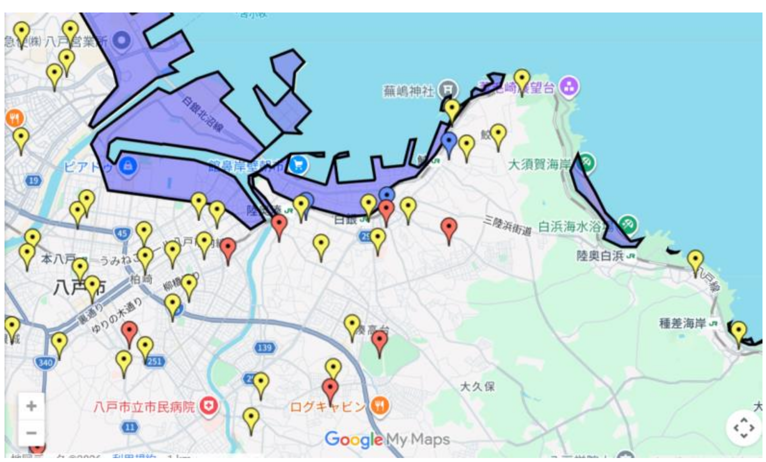


Figure 20. Google Maps showing 80 evacuation shelters in Hachinohe City during the 2011 Tohoku Region Pacific Ocean offshore Earthquake and tsunami. Schools and community centers were among the facilities used as evacuation shelters.

Life in evacuation centers is often inconvenient, and if the scale of damage is large and expected to be prolonged, temporary housing may be prepared. While the average area per unit is a very small 30 square meters, it provides access to water, sewage, electricity, gas, and heating, and allows for a certain degree of privacy. Rent is generally free, and the period of stay is typically several years. Fig.21 shows an example of temporary housing.

Afterward, some residents move out of emergency temporary housing as their homes are repaired or they find new residences. For citizens who cannot find housing, local governments sometimes provide permanent housing called "reconstruction housing." Reconstruction housing is public housing developed by local governments with the aim of providing long-term housing for people who have lost their homes in a disaster. The rent for this reconstruction housing is set lower than that for regular housing. Because it is difficult for the elderly to find new housing, reconstruction in aging areas is challenging.

In Japanese disaster prevention, there is a concept called "self-help, mutual aid, and public assistance." Self-help means protecting oneself, public assistance means that public institutions will protect oneself, and mutual aid means that oneself and public institutions cooperate to protect oneself.

Figure 21. Example of temporary housing

To protect oneself from disaster, first and foremost, each individual must take action to protect themselves. Based on the pre-disaster prevention measures promoted by the government, the author's recommended approach to personal disaster prevention is as follows:

1. Measures to arrange furniture: First, earthquake resistance of the home, prevention of furniture tipping over, prevention of ceiling-hanging objects falling, and prevention of glass products such as cups and bottles tipping over.
2. Stockpiling of food and beverages: Stockpiling three days' worth of food and water, storing used bathwater.
3. Preparation of an emergency survival kit: Valuables, identification, cash, etc.
4. Method of checking on the safety of family members: Dedicated phone number for checking on safety.
5. Confirmation of evacuation locations and routes: Community center.

In addition, I have taken other preventative measures such as placing slippers, a flashlight, and a radio around my bed, and preparing a portable toilet.

Conclusion

On December 8, 2025, I experienced an earthquake at my home in Hachinohe City. While the damage was not significant compared to the reported seismic intensity, considering the continued possibility of large earthquakes in the future, I have compiled my knowledge of earthquakes and tsunamis to date. Currently in Japan, there is concern about massive earthquakes and tsunamis in areas that have not experienced major earthquakes for some time, such as the Tokyo metropolitan area and the Tonankai earthquake, and disaster prevention plans are being developed accordingly. There are fears that earthquakes similar to the 2011 Tohoku earthquake could occur in other parts of Japan. Currently, long-term scientific earthquake prediction is not possible. It is hoped that it will become possible to scientifically evaluate whether the plate boundaries around Japan are in a period of concentrated activity with earthquakes occurring at intervals ranging from several decades to several centuries.

As discussed in this text, each time a major earthquake occurs, various disaster prevention measures are modified or added. Regarding the seismic resistance of structures, damage from major earthquakes is investigated, design standards are revised, and improvements are made to existing structures as seismic reinforcement work. However, it has been reported that the frequency of record-high or record-low occurrences is high not only for earthquakes and tsunamis, but also for other disasters such as floods and heavy snowfalls. By accumulating records of natural disasters, it is necessary to consider how future countermeasures should be developed. Furthermore, there are challenges such as how much seismic resistance should be increased and how high seawalls need to be built.

I hope this article will be useful as information regarding earthquakes and tsunamis in Japan, particularly in Hachinohe City.

Acknowledgments

In writing this article, I utilized materials from the Japan Meteorological Agency, the Morioka Local Meteorological Observatory, Hachinohe City, and the Disaster Prevention Specialist Library. When considering natural disasters, I believe that the preservation and availability of past data is extremely useful in reflecting on the past and considering future countermeasures. I predict that the accumulation of data will lead to a reduction in future disasters. I would like to express my gratitude to everyone who provided the materials.

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