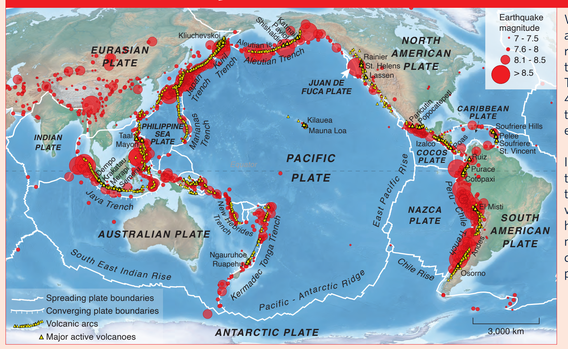
Planning for Earthquakes and Tsunamis: Lessons from Japan for British Columbia

By David W. Edgington, Emeritus Professor

In this research paper I consider how international experience in the management of catastrophic natural disasters might be transferable across jurisdictions by comparing two study areas, the Tōhoku coastal region of northeast Japan, and the coastal area of southwest British Columbia (BC), Canada. I present a conceptual framework recognizing that good practice from one jurisdiction can be useful in improving disaster management planning in another. This framework also underscores that disaster management experience from overseas should be interpreted carefully, taking into account national and local conditions. Empirically, I re-examine the 2011 Great East Japan Earthquake and the stricken Tōhoku region at the time of its tenth anniversary to see what lessons might be learned for disaster planning in southwest BC. Both study areas face exposure to hazards involving low probability/high impact mega-earthquakes and tsunami, and both have taken steps to reduce the vulnerability of coastal communities and infrastructure. In the case of the BC southwest coast this region is vulnerable to both a catastrophic magnitude 9 earthquake and tsunami (also known as 'the Really Big One') resulting from the rupture of the Cascadia Subduction Zone (CSZ). When compared to Japan, however, BC lacks a history of major seismic events close to population centers and has little direct experience of planning for large earthquakes and tsunami events along its coastline. To help discern which particular features of Japan's planning for (and response to) the Great East Japan Earthquake might yield policy implications for BC, I use the four pillars of disaster management as analytical tools: (1) the mitigation of risk, (2) disaster preparedness, (3) the emergency response, and (4) post-disaster recovery. The study methodology involved extensive site visits to both the Tohoku region of Japan and southwest BC, face-to-face interviews with disaster managers and first responders, a review of relevant policy documents and reports of the Great East Japan Earthquake, together with a review of current disaster management practice in BC.

Based on Edgington, D.W. 2021. "Planning for Earthquakes and Tsunamis: Lessons from Japan for British Columbia, Canada", Progress in Planning, 1-26 https://-doi.org/10.1016/j.progress.2021.100626.

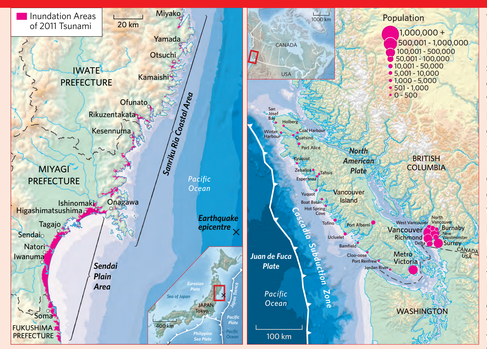
Tōhoku, Japan and British Columbia, Canada



Map source: based on material in Rinard Hinga (2015) Ring of Fire: An Encyclopedia of the Pacific Rim's Earthquakes, Tsunamis and Volcanos.

What is the nature of the 'Really Big One' and what is the likelihood of its occurrence? Both Japan and coastal BC lie in the seismically active Pacific Ring of Fire. This is a horseshoe-shaped belt about 40,000 kms around much of the rim of the Pacific Ocean where many volcanic eruptions and mega-earthquakes occur.

In Japan, many types of natural calamities occur - such as tsunamis, floods, typhoons, earthquakes, cyclones, and volcanic eruptions. Indeed, this country has gone through thousands of years of natural disasters, affecting its economy, development, and disaster prevention programs.



The coast of Vancouver Island is replete with capes and bays, and resembles the Pacific coastline of the stricken Tōhoku region, Japan. Moreover, as with northeast Japan, southwest BC is vulnerable to a Mw9.0 mega-earthquake due to the proximity of the Cascadia Subduction Zone (known as the 'Cascadia Fault'), which lies about 50 kms offshore from Vancouver Island. There is a risk of a powerful earthquake and tsunami similar to the calamity that affected the northeast Japanese coastline. In the BC Lower Mainland the 'Really Big One' would result from a rupture of the Cascadia fault and it would shake high-rise buildings in Vancouver. The ensuing tsunami would generate waves over 10 meters high and devastate Pacific coastal communities on Vancouver Island.

While it is not the only fault line that could produce a powerful earthquake in southwest BC, the off-shore Cascadia Subduction Zone (CSZ) stretches about 600 kms south to northern California. It is likely to produce a mega-earthquake and tsunami from just 50 kms away from the coast, allowing residents close to the sea on Vancouver Island only around 20 minutes to escape to higher ground. Oral histories from First Nations communities, records of 'orphan' (long-distance) tsunamis in Japan, together with paleo-seismic research, indicate that the last time this occurred was January, 1700, just over 300 years ago.
Image: Modified from U.S. Geological Survey (USGS)

'When Catfish Cause Earthquakes'. Image: Tokyo University Library.

Aspects of the 2011 Japanese Tragedy and Links with British Columbia

Photo: Miyako City Office.

The devastating Mw9.0 quake, which triggered a gigantic tsunami, left many of Japan's coastal towns in ruins and sparked an accident at the country's Fukushima Daiichi nuclear power plant. Around 90 per cent of the 21,200 missing or dead was as a result of the tsunami, which attacked fishing harbors and beaches along a 600 km shoreline. Over 400,000 buildings and houses were washed away or damaged, and roughly 400,000 survivors lived in emergency shelters, such has school gymnasiums, for several weeks. Many local municipalities lost their city offices, mayors and top officials in the disaster, which impeded relief and recovery efforts.

Photo: https://www.livingoceans.org/initiatives/clear-the-coast

The tsunami triggered by the Great East Japan Earthquake washed out houses, cars, shipping containers and as well as fishing vessels and fishing gear. All told, over 26 million tons of debris had to be removed from the coast and affected towns, recycled and burnt in furnaces before any rebuilding could commence. Some debris was pushed offshore by the waves. Driven by ocean currents and winds, fishing material such as floats, together with parts of timber boats and houses, have drifted eastward and were picked up on the coast of BC in 2012 and 2013.

International Comparisons

To compare BC disaster planning with Japanese experience in 2011, I used the 4 Pillars of Disaster Management to arrange the data I collected :

(1) Mitigation: proactive measures to understand and reduce the impact of hazards.

(2) Preparation: helping local communities practice what to do if a catastrophe occurs.

(3) Emergency Response: activities are taken directly after an emergency to save lives, minimize property damage, or improve recovery. Relief, a term commonly used in international disaster management, is one component of response.

(4) Recovery and Reconstruction: Returning survivors' lives back to a normal state following the impact of disaster consequences. Recovery involves the cleaning up of debris, the reconstruction of public infrastructure, housing and local businesses. The recovery phase generally begins after the immediate response has ended, and can persist for months or years thereafter.

Mitigation: Building Regulations and Seismic Retrofits

Photo: Professor Masahige Motoe, Faculty of Architecture, Tōhoku University.

Japan learned many lessons from the earlier 1995 Hanshin-Awaji (Kobe) earthquake. One was to invest in seismic upgrading of existing buildings and houses. By 2015 around 100 per cent of schools and 90 per cent of public important buildings had met the approved seismic resistance grade with funding provided by the national government.

In BC, retrofitting older buildings and infrastructure has been slow over the past 30 years or so. A major problem is the large number of older structures at risk, especially those located in the cities of Vancouver and Victoria. Current building regulations for new structures in BC are on a par with those in California and other jurisdictions that are exposed to earthquake risk. However, there are estimated to be thousands of buildings in Vancouver and Victoria built prior to the development of earthquake building codes put in place in the early 1970s.

Preparing Communities at Risk: Early Warning Systems

Map source: Modified from Ocean Networks Canada, https://www.oceannetworks.ca/sights-sounds/images/maps.

The 2011 Great East Japan Earthquake was the first catastrophic disaster where early warning systems played a role. The Japanese system safely stopped the express Shinkansen trains and automatically closed down city gas supply to stop fires breaking out.

In BC, a system of earthquake sensors both underwater and on Vancouver island track seismic activity in real time. The aim is to provide automatic shutdown alerts if a major earthquake is detected - for example, shutting off gas supplies to certain areas, alerting hospitals to pause surgeries and stopping the Skytrain from running.

Emergency Response: Who You're Going to Call?

Photo: 10th Division of the Ground Self-Defense Force

On March 11, 2011, the Japanese government established an Emergency Disaster Response Headquarters, headed by the prime minister, within 30 minutes. A national emergency was declared and the first teams of both active and reserved troops from the Self Defense Forces (SDF, or 'jietai') were deployed and reached the affected area within hours. Over the next days, more than 100,000 SDF officials were providing emergency rescue and relief, using helicopters.

Emergency response in BC, is focused mainly on the work of volunteers, together with local police, ambulance and firefighters. However, a catastrophic earthquake and tsunami attack would quickly overwhelm the capacity of local municipalities to provide an effective response, including rescue of and care for survivors. Where would outside assistance come from and how soon could it arrive?

Reconstruction: Temporary Housing and Modular Housing

Temporary housing, Natori, Miyagi Prefecture, 2016. Photo: D. Edgington

Temporary accommodation for survivors was provided in Japan during 2011 and provided mainly in the form of 2-room industrialized prefabricated housing units installed in barrack-like complexes. This type of modular housing could be supplied relatively speedily in a matter of months because of the national government's pre-arranged Memorandum of Understanding with prefabricated home manufacturers, based upon a standard design. However, delays occurred in implementing temporary housing complexes the rocky coast due primarily to the difficulty of finding appropriate space for sufficient housing units on high ground away from the devastated coast. After 2011, many evacuees had to live in cramped quarters for over 5 years, until land could be developed for private or public housing projects, usually located away from the coast and at a much higher elevation than before.

City of Vancouver Modular Housing, Cambie St., Vancouver. Source: City of Vancouver.

BC Housing (a unit of the provincial government) has already examined the likely need for modular and manufactured housing solutions to long-term dislodgment of communities from devastated areas. Accordingly, in 2019 it developed a `tool kit' for municipalities and First Nations governments, based on best-practice design principles for modular housing complexes. The approach behind this policy initiative is to develop well-designed temporary housing units as a step towards providing permanent housing. In other words, by providing modular housing of high standard that meet BC building code requirements and which has a building life expectancy of several years, local communities could contribute to more permanent housing expectations.

The 'tool kit' also encourages communities to reserve potential sites for transitional housing in advance. From a local municipality's perspective, high-standard modular housing built as part of a post-disaster reconstruction phase could be treated as community public rental accommodation for survivors while they establish their own personal recovery. To that end, there would also be a need for local governments in BC to assume the role of managing large numbers of rental units.

Conclusions

Tsunami warning sign, Tofino, 2016. Photo: D. Edgington.

British Columbia has not yet experienced a catastrophic earthquake and tsunami. There is merit in examining Japanese experience at the time of the 2011 disaster in Tōhoku and carefully selecting lessons on `what to do' and `what to avoid' in order to improve provincial and local government procedures here in BC – from pre-disaster mitigation programs to post-disaster recovery and reconstruction.

There is also a much wider implication - that no government disaster management system can fully prepare for such a nexus of devastation. Consequently, if we take the choice of living on the turbulent Pacific Ring of Fire we should also take individual responsibility and get ready for the forthcoming Cascadia Subduction Zone mega-earthquake and tsunami.

In this vein, `tsunami tendenko' is a phrase in the dialect of the Tōhoku coast that is used to encourage people to evacuate from the tsunami – and alone, without taking any belongings or waiting for other family members. This phrase can be translated as "you should protect your life by yourself". And in the local seafaring culture, it is acceptable not to blame people who did not help others after a tsunami disaster.