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Estimating Insured Losses from the 2011 Tohoku, Japan Earthquake and Tsunami

RMS Special Report

RMS

INTRODUCTION

At 2:46 p.m. local time, on Friday, March 11, 2011, a powerful M9.0 earthquake occurred offshore of the east coast of the Tohoku region on the Island of Honshu, Japan. Ground shaking duration lasted for over five minutes in many areas, including Tokyo. Sea floor deformation associated with the subsea fault movement generated a devastating tsunami, impacting the eastern coast of the Tohoku region (see Figure 1).

The earthquake was located on the subduction interface plate boundary where the Pacific Plate is driven underneath Japan along the Japan Trench. A roughly 400-km segment of the plate boundary ruptured as a cascade of several adjacent earthquake sources that had historically only generated independent smaller-sized earthquakes. Fault displacement in the earthquake is estimated at 30 to 40 m, which is quite large and explains the strong ground motions that radiated from the fault. The 450-year historical earthquake record of the Japan Trench does not contain any earthquakes of the size of the 2011 event; and the "maximum credible earthquake" along this section of the Japan Trench was previously considered to be M8.3.[1]

The M9.0 earthquake followed a series of strong earthquakes that had occurred offshore of Tohoku over the preceding few days. Two days previous, the largest of these foreshocks, measuring M7.2, occurred approximately 40 km from epicenter of the M9.0 event. The M9 mainshock was followed by a vigorous aftershock sequence, with nearly 300 M5.0 or larger events occurring in the region of the fault rupture within a week. The largest aftershock to date, involving the rupture along a section of the subduction zone to the south of the main fault rupture has a M7.9 and occurred within 40 minutes of the mainshock. While the large majority of aftershocks were located in the region of the main fault rupture, a few earthquakes were triggered far to the west outside this region, most notably in the Nagano (M6.7) and Shizuoka (M6.4) prefectures.

The vertical displacement of the sea floor associated with the underlying fault movement triggered tsunami waves that propagated westward toward the Japan coastline and eastward across the Pacific Ocean. The first tsunami wave reached the Japan coastline within 10 to 40 minutes after the earthquake. Coastal areas within Iwate, Miyagi, and Fukushima prefectures experienced waves of over 5 m, with some areas above 10 m (e.g., Miyako District in Iwate Prefecture), and in localized areas more than 15 m (e.g., Ofunato District in Iwate Prefecture). The locations with the highest inundation depths were typically associated with deep, funnel-shaped embayments that focused the tsunami waves.

[1] However, scientific research published in 2007, but not yet incorporated into the Japan National Seismic Hazard Maps, indicates that a major tsunamigenic earthquake occurred 869 AD. Based on the similarity of the tsunami inundation extent with the 2011 event, the 869 AD event may also have reached M9.

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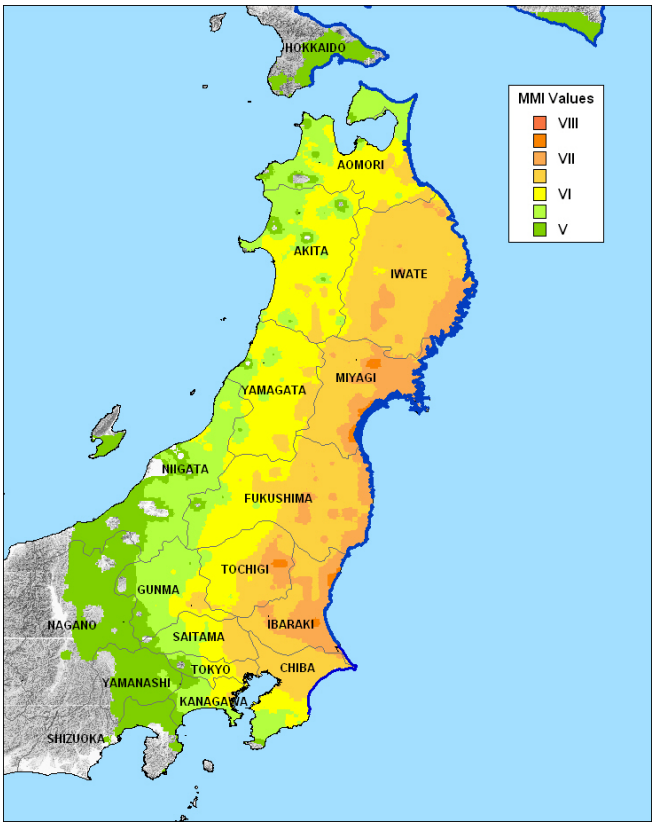

Figure 1: The impact zone of the 2011 Tohoku Earthquake and Tsunami, showing the ground shaking (red to green shading) felt across Honshu, and northeastern coastal areas affected by the tsunami (dark blue)

The 2011 earthquake is a major humanitarian disaster. As of April 10, there are over 13,000 confirmed deaths, with approximately 14,600 people missing. Over 440,000 people have been displaced from their homes by the earthquake, tsunami, and radiation alert. For the local and international insurance and reinsurance communities, the earthquake and tsunami will also reflect the largest insurance loss in more than five years, affecting many different lines of coverage in both the local and international markets. Since the earthquake's occurrence, RMS has provided clients with analytics and guidance on the event and been working to characterize the insurance implications from the event.

This paper briefly outlines the scope of damage as a result of the 2011 Tohoku Earthquake and Tsunami (informed by RMS reconnaissance efforts), followed by a discussion of the magnitude of insured losses to the main lines of business, highlighting the key drivers and uncertainties of these insured loss estimates.

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GROUND SHAKING AND TSUNAMI IMPACTS

Detailed damage assessments for the 2011 Tohoku Earthquake and Tsunami are just beginning, following the completion of work by the search and rescue teams. While the numbers of buildings with severe damage or collapse have already been collected, the detailed insurance damage costs will take weeks to months to delineate. From the level of ground shaking and the observations of damages, it is clear that while the prefectures of Kanagawa, Tokyo, and Chiba sustained primarily ground shaking related damage, in Fukushima, Miyagi, Iwate, Aomori, and Hokkaido, the principal source of loss overall is from tsunami inundation. In Ibaraki, Miyagi, and Fukushima prefectures, there were a number of industrial properties along the coastline that were severely damaged by the tsunami waves. Property damage in Tokyo can be classified as non-structural and contents damage due to ground shaking. Some fire following earthquake loss occurred, such as in Kesennuma, where a fire broke out due to oil leakage and burned several square kilometers of the town overnight. On Tokyo Bay in Chiba Prefecture, an explosion at the Cosmo Oil refinery caused a fire that burned for two days.

Ground Shaking

Strong ground shaking damage from the 2011 event was over a very large area, extending more than 500 km from north to south, with ground motions recorded at over 380 seismic stations across Japan. Within 100 km of the rupture, ground motions measurements were higher than expected, particularly at the high frequencies. However, this trend was reversed beyond 100 km, where ground motions were lower than predicted, particularly for the mid- and longer periods. The coastal plains closest to the fault rupture were the hardest hit by the high ground motions, but since many of these areas were then devastated by the tsunami, understanding the ground shaking impacts alone (i.e., separate from tsunami) is not easy.

Early reconnaissance indicates that ground shaking damage was minimized due to the strict building code requirements in Japan. Overall, modern commercial concrete structures generally performed well, while closer to the earthquake's rupture, the older concrete buildings (e.g., built prior to the 1981 building code enhancements) often sustained significant damage, as shown in Figure 2. Traditional (older) homes with heavy tile roofs experienced more damage than more modern residential structures. In addition, the most vulnerable industrial facilities were those with "clean rooms" because of their susceptibility to contamination and the difficulties associated with replacing or re-aligning unique high-tech manufacturing equipment.

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Figure 2: Collapsed building due to ground shaking in Sendai in Miyagi Prefecture (Source: RMS reconnaissance)

Localized ground deformation associated with liquefaction and landsliding was widely reported across the impacted region. While such ground deformation is not a major contributor to the insured losses, it did have significant impacts on lifelines and infrastructure. Liquefaction occurred in areas underlain by thick sediments and subject to strong to moderate ground shaking, including in reclaimed land around Tokyo Bay. Over 125 significant landslides occurred on steep slopes near the eastern coast. There was also tectonic ground deformation associated with the underlying fault rupture involving more than 50 cm of tectonic subsidence along the coastlines of Miyagi and Fukushima prefectures, while even closer to the concentration of underlying fault rupture, as at Oshika in Miyagi Prefecture, the tectonic subsidence was more than 1 m. Coastal subsidence can be a feature of the largest M9 subduction interface events.[2] Within the affected communities, the lowest-lying areas may now be below sea level. Tectonic subsidence will be a particular problem for infrastructure such as ports, urban drainage systems, and even the coastal railway, which may require raising and relocating to keep it out of reach of storm waves.

Tsunami

The prefectures most significantly impacted by the tsunami were Miyagi, Fukushima, and Iwate, with additional tsunami damage reported in Ibaraki, Chiba, and Hokkaido. Communities identified as “very significantly impacted” include (from north to south): Kamaishi, Otsuchi, Ofunato, Sumida, Rikuzen Takata, Kesennuma, Minamisanriku, Onagawa, Sendai, Watari, and Soma. In the Sendai region, the tsunami inundation extended inland 10 km from the coast, transporting huge floating debris fields of buildings, boats, cars, and trucks. The port facilities that service Hitachi, Daikin, and other leading manufacturers were badly affected, and the four key ports of Sendai, Hachinohe, Ishinomake, and Onahama will not be fully operational for months. The biggest of the affected ports at Sendai, ranking 13th for container traffic in Japan, is a key export hub for companies operating in northeast Japan.

Most of the low-rise structures in the regions inundated by a 3-m or higher tsunami were completely destroyed and washed away, as buildings were floated by the water, with walls giving way to the hydraulic pressures of the advancing water front and accumulated debris. The sill plate and anchor foundations of typical residential wood frame structures were completely inadequate to withstand the lateral and buoyancy forces exerted by the tsunami. Taller steel and concrete frame buildings lost walls on lower floors, but generally withstood the surge in water levels, remaining connected to foundations. In some cases, where the tsunami reached heights of 10 m or more, even 2- to 4-story structures were completely washed away, potentially from impacts with floating debris, or even structural weaknesses

[2] This tectonic subsidence is expected to rebound over the centuries prior to a repeat of this fault rupture.

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resulting from ground shaking damage (Figure 3). Infrastructure such as bridges, elevated roads, and railways sustained more damage where constructed parallel to the coastline than those running perpendicular.

Figure 3: Damage (and debris) due to tsunami waves along the coastline near Sendai in Miyagi Prefecture (Source: RMS reconnaissance)

Far-field Tsunami Damage

The tsunami waves also propagated away from Japan across the Pacific Ocean, reducing in amplitude (but still subject to local coastal amplification) and causing minor damage to boat marinas and port facilities in Hawaii, California, and Oregon. In Hawaii, there was localized flooding on the west coast of the Big Island, including minor damage to a number of shops and restaurants and major damage to two homes. Along the Pacific coast of North America, approximately 35 boats and most of the harbor docks were damaged in the harbor at Crescent City, California, and docks and vessels also sustained significant damage at Santa Cruz, California, and Brookings-Harbor, Oregon. This was the largest tsunami in the Pacific Ocean since that generated by the 1964 Alaska Earthquake.

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AFFECTED LINES OF BUSINESS

Insured exposure in Japan is a complex landscape of coverage, varying considerably by class of exposure and line of business. Residential earthquake insurance is subject to the provisions of the Japan Earthquake Reinsurance Company (J.E.R.). Domestic commercial and industrial coverage varies significantly by prefecture, and often does not include coverage for time element losses. There are a number of co-operative insurers for various sectors of the economy, including agriculture and fishing, which have their own coverage provisions. And, there is a significant amount of international business written in Japan, including facultative business and marine hull and cargo lines impacted by the tsunami.

Residential or household earthquake coverage in Japan can be purchased through either a commercial or co-operative insurer.

Residential

The Japanese non-life insurance market has undergone severe consolidation over the past decade, with 3 of the 29 domestic companies registered with the General Insurance Association of Japan (GIAJ) currently covering 90% of the market: Tokio Marine Holdings, MS&AD Insurance Group Holdings (Mitsui Sumitomo, Aioi, and Nissay Dowa), and NKSJ Holdings (NIPPONKOA and Sompo Japan). Earthquake coverage purchased through a commercial insurer is offered as an endorsement to the standard fire policy—and covers earthquake and tsunami damage to structures and contents under one endorsement. Of homeowners purchasing a fire policy, approximately 45% purchase this additional coverage (equating to close to 25% of Japanese households). Coverage is limited under the Earthquake Insurance Law, where payouts are based on classifications of “partial,” “half,” or “full” damage. Specifically, there is a 5% payout for partial damage (3-20% of structure value), 50% payout for half damage (20-50% of structure value), and 100% for full damage (>50% of structure value).

The insured residential risk is ceded to the Japan Earthquake Reinsurance Company (J.E.R.) and, in the event of a loss-causing earthquake, liabilities are allocated between J.E.R., the participating non-life companies, and the Japanese government, depending on the size of the loss. For example, the J.E.R. is 100% liable for losses under JPY115 billion (USD$1.4 billion). For losses between JPY115 billion and 1.12 trillion (USD$1.4 and 13.5 billion), the government covers 50% of the loss and participating insurers cover 50%. As losses increase, government participation increases, with J.E.R. and non-life insurers sharing less of the burden. Above JPY5.5 trillion (USD$66 billion), payouts to policyholders are prorated.

All household and most commercial fire polices are automatically extended to include earthquake fire expenses insurance (EFEI). The EFEI extension pays an additional 5% of the sum insured in the event that 50% or more of the property is destroyed by fire following earthquake or volcanic eruption, a policy coverage distinct from the fire following protection cover provided within earthquake policies.

Co-operatives (Kyosai)

Co-operatives or Kyosai also provide insurance to their members and are classified according to affiliation (e.g., agricultural, fishery, consumer). The largest agricultural co-operative is JA Zenkyoren. There are also numerous other regulated Kyosai in Japan, such as JF Kyosuiren (fishery), Zenrosai (consumer), and Nikkaren (small business).

Earthquake coverage purchased through a regulated co-operative is most often included as part of the standard policy and covers building and contents losses at an amount less than the total sums insured (TSI) for fire coverage. For

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example, JA Zenkyoren covers 50% TSI, whereas JF Kyosuiren and Zenrosai cover 20% TSI. Coverage for living expenses or loss of income (in the case of enterprise co-operatives) is not offered. Insurance payouts are tiered or stepped up as a function of the damage ratio—though often subject to a franchise deductible.

As a result, relative to their participation in the market, co-operatives cover a larger portion of the earthquake damage. As regulated co-operatives do not participate in the J.E.R. scheme to provide capital protection, they place a significant proportion of their risk into the global reinsurance market.

Commercial and Industrial

In Japan, commercial and industrial earthquake coverage is a separate endorsement to a standard commercial fire policy. Such policies can either be purchased from a Japanese domestic insurer, whose portfolio will often be reinsured in the international marketplace, or alternatively, purchased directly through a foreign insurer. Endorsements associated with the earthquake coverage include payments for structure and contents damage from earthquake shaking, fire following earthquake, and tsunami inundation (e.g., flooding following a dam break or tsunami). However, coverage is generally purchased for less than the property's full replacement cost (i.e., in the form of a reduced indemnity or first loss policy). Earthquake insurance rates among Japanese corporations remain low. According to one estimate, the average take-up rate for commercial and industrial coverage through the local insurers (Tokio Marine, MS&AD Insurance Group, and NKSJ) is less than 15%.

Business Interruption and Contingent BI

For business written in the local market, there is generally restricted or no business interruption (BI) coverage included. Foreign insurers writing direct business in Japan are more likely to offer BI coverage as a competitive differentiation, particularly to multinational firms with offices or facilities in Japan. However, overall business interruption remains a small share of the total insured sum for commercial and industrial risks.

The highest uncertainty in loss estimates for the Tohoku Earthquake relates to the degree to which corporations are successful in claiming under contingent business interruption (CBI) protection, relating to payments in lieu of interruptions at key suppliers. The disruption in the global supply chain of critical parts for just-in-time (JIT) manufacturing is already leading to downstream interruption in manufacturers' operations. The most highly impacted industries include electronics (e.g., Japan is the sole source for certain batteries and flash memory), semiconductors (13% of suppliers are in Japan), and key parts in automotive production (e.g., U.S. plants subject to slow downs or temporary closures). Factories in Iwate, Miyagi, and Fukushima prefectures produce 7.2% of electronic devices and 8.8% of IT devices in Japan, with many factories in the region subject to damage or disruption in manufacturing operations. In Aomori, Akita, and Yamagata prefectures, factories produce 5.1% of electronic devices and 5.6 % of the IT devices manufactured in Japan. While most factories in these prefectures sustained slight (or no) damage, operations in some cases have been curtailed, as sensitive equipment has been moved out of alignment, or where rolling blackouts are impacting recovery.

Toyota announced closures of all of its North American factories and General Motors temporarily shut down its Shreveport, Louisiana plant due to parts shortages. If shortages continue, the second and third quarters of 2011 could see significant reductions in automobile availability. In the marketplace, it is understood that insurers and reinsurers on the Toyota and General Motors policies are expecting CBI losses.

The details of any CBI coverage available to a large manufacturer will vary by policy and wording. According to their terms of coverage, currently policyholders of manufacturers suffering from a loss of key parts from Japanese suppliers will be considering the potential to claim on the Tohoku event. For example, the broadest coverage offered in some CBI coverage provides payouts for the actual loss sustained due to the interruption of all suppliers while other CBI coverages only apply to named suppliers listed on the policy. In addition, coverage does not generally begin until a certain time

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period has passed (e.g., a time deductible of 14 days) and Japanese companies will be working hard to attempt to restore or transfer production.

International Facultative Placements

The number of major facultative placements for major corporations in Japan significantly affected by the earthquake and tsunami is considered relatively small. However, one of these concerns the East Japan Railway Company (JR East), which has filed an indicative loss in excess of JPY10 billion (USD$120 million), with the anticipation that this loss will increase as the full extent of damage to the rail company is assessed—in particular where the rail tracks ran close to the coast in northeast Japan. It is understood that the company has up to JPY71 billion (USD$850 million) of property damage and BI (re)insurance in place.

Over the past decade, energy companies in Japan, which used to purchase facultative protections, have largely transferred their business to the local market. Nevertheless, losses from some high excess layers will pass to the international market. Tokyo Electric Power Company (TEPCO) has an international facultative placement, including reinsurance coverage outside Japan (organized by Willis). It is anticipated that this coverage will pay out for damage and interruption to TEPCO's non-nuclear generating and transmission assets, including five thermal stations at Hirono, Hitachinaka, Kashima, Ohi, and Higashi-Ohgishima, which were all non-operational for at least a week after the earthquake. Between the loss of nuclear stations at Fukushima Daiichi and Fukushima Daini and disruptions to its five thermal plants, TEPCO had lost around 25% of its generating capacity, resulting in the imposition of rolling blackouts.

Marine and Aviation

The tsunami caused significant damage to marine exposures. Japan is the number one market for marine cargo insurance, with 14% of the global premium, and is the number three hull insurer, in writing the Japanese fleet. This business has been reinsured on a "one event" basis in Europe and London. The 2011 Tohoku Earthquake and Tsunami is expected to be one of the most significant marine reinsurance losses ever, reflecting correlation across a wide range of hull, cargo, and "removal of wreck" covers.

Hull and Cargo

While there were initial estimates of at least ten ocean-going ships considered total hull losses in the tsunami, with a total insured value between USD$200-300 million, some of these craft were eventually located adrift. Currently, known losses include the following:

- A Capesize 175,775 deadweight (dwt) bulk carrier (*China Steel Integrity*), carrying iron ore and belonging to Kawasaki Kisen Kaisha, ran aground at Kashima and sustained hull and machinery damage, with no injury to its crew or oil pollution from the vessel.
- Three 80,000-dwt Panamax bulk carriers, belonging to Yusen Kaisha, were damaged or run aground.
- A 32,385-dwt Bulk carrier (*CS Victory*), chartered by Mitsui OSK, was tossed into the breakwater and left on the bottom of the shallow harbor at the northeastern port of Ishinomaki, although none of the Panamanian-flagged vessel's kaolin or fuel oil cargo had spilled, and the crew was uninjured.
- A smaller 6,175-dwt general cargo ship (*Asia Symphony*), belonging to Mitsubishi Logistics Corporation, was grounded.

The drill ship Chikyu, insured in the Lloyd's market for USD$680 million, was stationed in Hachinohe, located 150 km northeast of Sendai. Initially, there were concerns that the ship was a total loss (which would be the first example of an offshore platform loss from tsunami), but damage is now estimated at approximately USD$100 million. In addition, 90

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ocean-going ships and thousands of smaller marine craft were stranded inland. Some reports put the number of fishing vessels lost at over 18,500. However, it is understood that small commercial fishing boats are only covered under the fishery co-operative (JF Kyosuiren) policy if they were in storage (e.g., in a warehouse) at the time of the event. While the government has committed to fund the cost of debris removal for homes and cars, the removal of ships is said to be the responsibility of individual insurers.

Other anticipated (significant) losses in the marine sector are cargo coverages. Thousands of twenty-foot equivalent units (TEU) (i.e., containers) were smashed and inundated by the tsunami or washed away at Sendai port. There are also large quantities of stock spoiled by salt water inundation or while stuck in warehouses at port level.

Aviation

For aviation hull insurance, earthquake coverage is provided as standard and is ceded to the Japanese Aviation Insurance Pool (JAIP), which is reinsured in the global reinsurance market through the JAIP's treaty placements. Seventeen small general aviation aircraft, damaged at Sendai Airport, were covered in the local market with a value of USD$30-40 million. There was also minor damage to two 777 aircraft at Haneda (Tokyo International) Airport in Tokyo. Fortuitously, no major aircraft were on the ground at Sendai Airport when the tsunami arrived, although a spare parts facility for Ibex Airlines was damaged at a value not likely to exceed USD$10 million. Insurance coverage for Sendai Airport was written in the local market.

Auto

Insured losses due to automobile damage will be minimal. While the automotive industry and car carrier sector was badly affected (e.g., the tsunami damaged thousands of new cars waiting on the quayside about to be shipped out of the Port of Hitachi in Ibaraki Prefecture), individuals rarely purchase separate natural hazard (earthquake) insurance coverage on their automobiles, not perceiving this to be a likely hazard.

Life

Current casualty estimates from the Tohoku Earthquake stand at close to 13,000 confirmed deaths, with another 14,600 people still missing. Building collapses due to ground shaking resulted in hundreds of casualties, but the vast majority of the loss of life was the result of the tsunami. Current U.N. estimates indicate that a significant proportion of the casualties were older individuals with lower mobility or desire to evacuate from their houses. The age profile of the casualties indicates that 64% were over 60 years old, 45% were age 70 or older, and 23% were age 80 or older.

Payouts will be through death benefits on individual life and group life policies, and death and injury compensation on personal accident insurance. However, with the localized, severe impact of the tsunami wiping out entire villages in some coastal areas, it is possible that some proportion of the policies will never be claimed. Workers coverage and health care insurance are provided by the Japanese government, so these are not discussed here.

A very high proportion (approximately 90%) of Japanese households has at least one life insurance policy, with the average amount of life coverage for an insured person in Japan exceeding $300,000. Life insurance coverage falls off rapidly with older age, and the older age profile of the victims suggests that life insurance coverage in this event will be much lower than the national population average.

Individual life is by far the largest exposure, with group life and group personal accident exposure significantly less. Many of the factory workers and municipal employees affected by the tsunami are expected to have group life and personal accident coverage for modest benefit levels. Personal accident policies, which are usually group policies purchased through an employer, only cover earthquake and tsunami injury if they have an additional endorsement (the Earthquake and Similar Disaster Coverage). An estimated 25% of personal accident policies have this endorsement.

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As many of the victims were over 60 years of age, they will have a private pension. The life and health insurance industry provides annuity coverage to individuals with private pension plans and corporate pension plans to supplement their state pensions. The annuity reserves released by the premature deaths of the victims will offset some of the death benefit payments incurred to life insurers, although the annuity providers may not necessarily be the same companies as those paying out the death benefits. RMS estimates that the total annuity reserves released from the premature mortality of the victims will be within a range of USD$0.6 billion to $2.6 billion, however this is not discounted from the death benefit payouts assessed in the overall RMS loss estimate.

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INSURED LOSS ESTIMATES

Immediately following the earthquake, RMS determined an initial estimate of the ground shaking footprint of the event by applying the modeled attenuation to the earthquake fault rupture. This initial reconstruction was then refined using actual strong motion data, recorded at a dense network of strong motion recording stations across Japan (e.g., K-Net and Kik-Net stations). At the same time, using high-resolution aerial and extensive satellite imagery, RMS generated high-resolution maps of the tsunami's extent and water depth, in order to assess the scope of flooding damage.

At the time of the event's occurrence, RMS employed pre-existing databases of total property exposure and inventory distributions to determine a total estimate of economic damage from the earthquake (reflecting both property damage and interrupted economic activity). This estimate of USD$200 to 300 billion was issued on March 14, 2011, and ten days later on March 24, 2011, the Japanese government issued a total economic loss estimate of JPY16 to 25 trillion (USD$197 to 308 billion).

To estimate insured losses, RMS employed the pre-existing total property and inventory databases, in conjunction with Japanese insurance structures and take-up rates across different lines of business and sectors. In particular, different proportions of insurance take-up, as well as the varying insurance structures for co-operative offerings, BI coverage and limits, first loss and reduced indemnity terms, were tested against ground shaking and tsunami inundation footprints.

RMS also began a process of detailed ground truthing of the levels of damage, as an RMS team of engineers from California partnered with our Japanese colleagues to survey a wide range of towns and cities in the impacted region. This ground truthing has been combined with local government damage statistics, as well as collected intelligence on specific high-valued insurance losses.

Summary of Losses

Based on the information available within the first four weeks of the 2011 Tohoku Earthquake and Tsunami, RMS estimates that the total insured loss to property coverage is between JPY1,500 and 2,170 billion (USD$18 and 26 billion). This total is derived from several lines, including residential, co-operative, commercial and industrial (including BI and CBI), facultative placements, marine, aviation, and auto. No consideration is given to additional impacts from the damage at the nuclear power facilities (as nuclear risks are excluded from all coverages).

Losses to household coverage purchased through a commercial or co-operative insurer is estimated between 50% and 60% of the total property loss, with commercial and industrial payouts estimated to be between 30% and 35% of the total property loss. These losses consider the impacts of post-event loss amplification (PLA), particularly to the commercial and industrial lines, as well as the uncertainty of certain assumptions in arriving at estimates at this time. After combining the potential total death benefit payout, the total insurance loss from this event is likely to be between JPY1,750 and 2,840 billion (USD$21 and 34 billion), as shown in Table 1.

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Table 1: Total insured losses from the 2011 Tohoku Earthquake and Tsunami

Line of Business	In JPY billion	In USD$ billion
Residential*	JPY330–460 billion	USD$4.0–5.5 billion
Co-operatives (Kyosai)	JPY540–710 billion	USD$6.5–8.5 billion
Commercial/Industrial	JPY460–750 billion	USD$5.5–9.0 billion
Other (railway, marine and aviation, auto)	JPY170–250 billion	USD$2.0–3.0 billion
Property Total	**JPY1,500–2,170 billion**	**USD$18.0–26.0 billion**
Life (death benefits)	JPY250–670 billion	USD$3.0–8.0 billion
Overall Total	**JPY1,750–2,840 billion**	**USD$21.0–34.0 billion**

* Net of Japanese government liability

Key Insurance Industry Assumptions

The 2011 Tohoku Earthquake and Tsunami is a complex super catastrophe (Super Cat) event, resulting in significant negative macroeconomic consequences on the impacted area. As such, consideration must be given for the impacts of post-event loss amplification (PLA) on overall insured loss estimates. The majority of PLA will result from economic demand surge increases in the cost of repair (mostly associated to increased cost of materials). These increased costs, however, are muted in the insured loss estimates, due to policy coverage and structure conditions.

Residential and Co-operatives

Totals for the residential line of business, covered by commercial non-life insurers and the J.E.R. itself, do not include the government liability under the J.E.R. scheme. Given the level of residential losses expected in this event, the loss will likely fall within the second tier of the J.E.R. scheme, in which the J.E.R. will cover the first ¥115 billion (USD$1.4 billion) and losses above this level will be evenly split between the non-life insurers and the government. The co-operative losses, expected to be higher than those covered by commercial insurers, will be significantly ceded to the international reinsurance market. Payouts on the automatically extended earthquake fire expenses insurance (EFEI) coverage are expected to be negligible. Due to the structure of household policies (e.g., tiered payouts tied to damage state), the economic demand surge component of PLA is not expected to increase losses to the residential and co-operative lines of business, but the estimate does include a small factor for additional deterioration-linked damage.

Commercial and Industrial

For the commercial and industrial lines, the wider range of expected loss reflects the variation of coverage between the domestic and international insurers, as well as the uncertainty of contingent BI claims and PLA impacts. Overall, PLA effects are expected to be between 15%-20% on most insured commercial and industrial policies, with current estimates primarily reflecting the economic demand surge for structure repair (e.g., increase in cost of materials that will be in short supply, additional costs of transportation of materials and labor, lodging and additional costs of labor due to overtime costs and shortage of skilled labor in some cases). Policies with direct BI coverage could be affected much more, but these are relatively uncommon in the Japanese market. For CBI claims, if most industries in the Tohoku region (e.g., electronics, IT, auto) are non-operational through June, with only partial recovery for an additional three months due to rolling blackouts, lost profits will be substantial. However, if production starts soon, CBI claims will be restricted. Based on information available to date, it is likely that most CBI claims will be triggered outside of Japan (i.e., United States, Europe).

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The remaining insured property losses (to the facultative placement on the East Japan Railway Company, marine hull/cargo, aviation hull, and auto lines of business) will likely not exceed USD$3 billion, with marine losses estimated at USD$1.2 to $2.2 billion, comprising the largest proportion of this category of loss.

Life

In developing the range of potential death benefit payouts, the main uncertainty lies in the current reported number of deaths, with some additional assumptions around policy coverages and penetration that widen the range of losses. Individual life coverage represents the majority of the loss, with contributions from group life coverage assumed at less than 5% of the total individual life coverage, and personal accident claims (based on the number of serious injuries expected from this event) at around 15% of the individual life coverage.

Total Industry Loss

The 2011 Tohoku Earthquake and Tsunami will rank among the largest insurance industry losses, with consequences for the local Japanese marketplace and the global insurance industry. The final insured loss will be dependent upon how the property and death benefit claims ultimately play out against a backdrop of regional devastation and societal disruption. Furthermore, many months, if not years, may pass before the actual number is known. Nonetheless, as in the cases of other large industry loss events, such as the 2001 World Trade Center attack, the 2011 Tohoku disaster reveals how numerous lines of business can be affected by a single event. And in the final accounting for insurers, this disaster may make its own mark as a concrete illustration of how natural catastrophes can propagate through interconnections in the global economy to generate significant contingent business interruption losses. RMS remains committed to its continuing efforts to understand the local and global impacts of the 2011 Tohoku disaster and assist its local and international clients in managing Japanese earthquake risk.

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