On Friday, 11 March 2011 at 05:46 GMT (14:46 Japanese time), a 9.0 magnitude earthquake occurred with its epicentre approximately 120 km off the Pacific coast of Sendai in the Tohoku region of northern Japan (approximately 380 km north-east of Tokyo). According to the US Geological Survey the geological fault involved in the earthquake was thrust upwards approximately 30-40 metres, and slipped over an area approximately 300 km long by 150 km wide – around the land mass of Switzerland.

The earthquake was the joint-fourth largest since 1900, behind the 9.5 magnitude Chilean earthquake in 1960, the 9.2 magnitude Alaskan earthquake in 1964 and the Sumatran earthquake (magnitude 9.1) in December 2004. It equalled the 9.0 Kamchatka earthquake in Russia in 1952, and had been preceded by a 7.2 magnitude tremor on 9 March 2011 (which was located approximately 40 km from the 11 March epicentre). By 17 March 2011 there had been some 37 aftershocks exceeding a magnitude of 6.0.

The earthquake unleashed a tsunami which, according to the Japan Meteorological Agency, reached a high point of 7.3m (24ft) at Soma, eastern Japan before washing inland for up to 10km in places. The main areas affected by the tsunami included the prefectures of Chiba, Ibaraki, Tochigi, Fukushima, Miyagi and southern Iwate.

As at 28 March the official death toll stood at 10,019, with 17,541 people officially reported missing as at 25 March. Police in Miyagi prefecture have estimated that the death toll in that prefecture alone will likely rise above 15,000, quite aside from fatalities in the other prefectures listed above.

More than 190,000 people are still living in temporary shelters.

On 14 March the Japanese Fire and Disaster Management Agency reported that over 75,000 buildings had been completely or partially destroyed. This, however, was a preliminary estimate: the magnitude 6.4 Kobe earthquake in January 1995 damaged more than 500,000 properties (albeit Kobe, in the Hyogo prefecture of Kansai, western Japan, was a more densely populated area than the Tohoku region). The tsunami carried hundreds of marine vessels inland and destroyed thousands of cars, trucks and light aircraft, some of which were deposited in and around Sendai airport.

An emergency was subsequently declared at the Fukushima Dai-Ichi and Dai-Ni nuclear power stations owned by the Tokyo Electric Power Company (TEPCO), owing to tsunami-related flooding affecting cooling systems for the plants' nuclear reactors and spent-fuel ponds. Three explosions at the Dai-Ichi plant on 12, 14 and 15 March, which destroyed the containment buildings housing three separate nuclear reactors, led to radiation leakage. On 18 March, the IAEA classified the Dai-Ichi situation a level 5 (of 7) incident on the International Nuclear Event Scale (INES), similar to the classification of the Three Mile Island incident in Pennsylvania in the United States in 1979. The Japanese Government imposed a 12 mile exclusion zone around the site, prompting the evacuation of over 170,000 people, while the US government warned its nationals not to venture within 50 miles of the Dai-Ichi plant.

Aside from the radiation-related element of the Fukushima incident, the earthquake and tsunami forced TEPCO to shut down not only its six nuclear reactors at Dai-Ichi and Dai-Ni, but also five further conventional power plants.
This led to TEPCO being able to supply only 31 million of its usual 41 million kilowatt output, resulting in rolling blackouts being implemented across the Kanto region (including parts of Tokyo) from 14 March. News reports have indicated that the supply shortage may only be resolved by the end of April at the earliest. Further, Japan does not have a unified national power grid: TEPCO generates at 50Hz while the Kansai Electric Power Company (KEPCO), for example, generates at 60Hz, thereby making it harder to reallocate power generated by undamaged plants.

This deficiency in electrical supply, combined with damaged plant, fuel shortages, blocked distribution channels for parts and deliveries and/or transportation difficulties (resulting in workers being unable to commute to their workplaces), triggered complete or partial suspension of output at automakers Toyota, Daihatsu, Hino, Suzuki, Mazda and Nissan for all or part of the period 14 March – 21 March. Similar production interruption issues were reported at the steelworks of Sumitomo Metal Industries, Kobe Steel, Nippon Paper Group's six Tohoku-based paper mills, Bridgestone, Hitachi, Taihleyo Cement and Asahi Glass.

Canon Inc's operations at its Fukushima plant were suspended due to a lack of power and blockage of major roads by landslides, while the exclusion zone around the Dai-Ichi plant reportedly prevented Panasonic from entering its Fukushima digital camera facility. Access problems were also encountered at a further Panasonic site in Sendai in the aftermath of the tsunami. Equipment damage was further reported as having led to a halt in production at the Tohoku breweries of Japan's three prominent drinks manufacturers, Kirin, Sapporo and Asahi.

The Nikkei newspaper reported on 17 March that the total economic damage caused by the Tohoku earthquake and tsunami - being the average of provisional estimates by 5 leading economists – was in the region of 14.5 trillion yen ($181bn), far eclipsing the 9.9 trillion yen ($123bn) suffered in the wake of the 1995 Kobe earthquake. By 23 March, however, the Japanese Cabinet Office had reported far higher economic loss estimates of up to $309 billion: extensive damage to housing, roads, utilities and businesses across seven prefectures is considered to have resulted in direct economic loss of between 16 trillion yen ($198bn) - 25 trillion yen ($309bn). Should these figures prove correct, the Tohoku earthquake and tsunami would far exceed in economic terms the largest previous loss from a natural disaster, namely Hurricane Katrina, which (according to the Insurance Information Institute) occasioned economic damage in the region of $125bn.

In terms of estimated insured losses, however, on 24 March AIR Worldwide reported revised figures (exclusive of tsunami and business interruption) of $20bn - $30bn, while Eqecat has modelled combined earthquake and tsunami insured losses of $12bn - $25bn.

The (re)insurance lines potentially affected include personal accident and life covers, residential and commercial property covers (including nuclear, but see section 6 below), business interruption covers, marine protections and motor policies. We analyse below some of the main issues that may be encountered in the lines of direct insurance business affected1, as well as some reinsurance issues that may be of relevance.

Personal Accident / Life Insurance

PA policies written by Japanese domestic insurers made up nearly 15% of non-life market income for the financial year 2008-2009. Those covers typically insure death, permanent disability and hospitalisation, but in general terms death and/or personal injury resulting from earthquake or tsunami is only written by endorsement, for an additional premium.

PA is one of the few classes of Japanese insurance business in which there is recognisable market share among branches of foreign insurers, accounting for over 18% of the market. Chief among the foreign players in this context is Chartis, which is the fourth largest PA insurer in Japan. PA exposures are only reinsured on an excess of loss basis to a limited degree, however, mainly to protect against aggregations from earthquake and aircraft events.

1 Some of the information which follows can be found in the excellent Japan-related section at www.axcoinfo.com. We are also indebted to Mr Shinichi Takahashi of the Nishimura & Asahi law firm in Tokyo for his input on the Japanese direct insurance sections contained in this article. Any inaccuracies, however, are our own.
In terms of estimated Tohoku-related losses in the life sector, Eqecat has projected life insurance losses to be in the region of $2bn-$3bn. In terms of estimated Tohoku-related losses in the life sector, Eqecat has projected life insurance losses to be in the region of $2bn-$3bn.

Business Interruption Insurance

There is relatively low penetration of business interruption insurance in Japan, where it is estimated that fewer than 20% of businesses purchase cover as part of more general commercial fire/property protections. While it is standard for Japanese business interruption cover to require initial physical loss or damage to the insured, cover is also commercially available for accidental interruption to the insured’s electricity, gas, telephone, heat and/or water supplies. Ordinary business interruption policies do not, however, automatically cover losses resulting from earthquake or tsunami.

One of the most significant covered property/business interruption exposures to have emerged from the Tohoku earthquake is the loss suffered by East Japan Railway Co (JR East). Its trains and facilities were physically damaged in the aftermath of the earthquake, leading to its services (including bullet train services) being suspended in the Tokyo and Tohoku areas. While train schedules have since resumed, there has also been a reduced number of services due to power shortages. Reports indicate that international reinsurers could be facing up to 71 billion yen ($880mn) in property damage and business interruption exposure in this context.

A further specific concern arising out of the Tohoku earthquake and tsunami is contingent business interruption (CBI). CBI insurance is available as a coverage extension in Japan, and is also provided by non-Japanese insurance markets to international businesses that source Japanese supplies. In contrast to conventional business interruption protection, CBI insurance generally covers losses to the insured arising from physical damage to a supplier and/or client of the insured (as opposed to physical damage to the insured itself).

While business interruption and CBI loss estimates are unpredictable at this stage, production in the Japanese electronic, semiconductor, petrochemical and automotive industries was particularly badly affected in the immediate aftermath of the Tohoku catastrophe, due to the stalling of parts and materials shipments, rolling blackouts, transportation difficulties and fuel shortages. In particular, the disaster-stricken north-east is a key automotive production centre, with Toyota, Honda, Nissan and others all operating large plants in the area. As mentioned above, Toyota, as Japan’s biggest car-maker, suspended production of vehicles until 22 March due to a reported parts shortage, while Honda and Nissan similarly imposed complete or partial closure of operations at a number of their facilities. Japanese companies equally account for approximately 40% of the world’s technology components, such as flash memory, capacitors, transistors and high-end cells used in electronic instruments, the supply chains to and from which were disrupted both domestically and internationally.

From the perspective of CBI cover, therefore, and aside from the possible relevance of earthquake and radiation exclusions (if and when inserted), likely key issues will in general terms be factual: was an insured's business interruption caused by physical damage to the supplier’s plant? Or was the supplier’s outage attributable solely to power shortages, such that the CBI cover might not be triggered for lack of physical damage to the supplier? Are the supplier’s difficulties attributable to an inability to access plant in the Fukushima exclusion zone, where material damage might be said to have occurred through radiation effects?

These are the types of issues that will likely arise in the CBI context as a result of the widespread disruption caused by the 11 March earthquake, tsunami and Fukushima nuclear alert.
Property Insurance (Household / Industrial and Commercial)

**Household Policies**

**Co-operative Insurers: Kyosai**

Co-operative insurers known as “Kyosai” (which involve agricultural groups, unions or other organisations arranging cover for their members) provide the main bulk of Japanese household cover. Some of the major regulated Kyosai in Japan include the Agricultural Cooperative Society (JA Zenkyoren), the National Federation of Workers & Consumer Insurance Cooperatives (Zenrosai) and the National Federation of Fire Insurance Cooperatives for Small Business (Nikkaren). In 2008, Kyosai issued more than three times the number of policies issued by commercial insurers: over 34m covers compared to 10m.

Unlike commercial insurance policies (see below), Kyosai policies generally include earthquake/tsunami cover as standard without requiring the policyholder to pay extra by way of endorsement. For example, JA Zenkyoren provides automatic earthquake cover through its household policies for up to 50% of the fire sum insured.

Reinsurance for Kyosai household policies is mostly placed outside of Japan, as co-operative insurers are excluded from seeking reinsurance cover through the Japan Earthquake Reinsurance Corporation (see below): this provides Government-supported reinsurance for commercial household insurers only. For this reason Zenkyoren is reputed to purchase one of the world’s largest catastrophe reinsurance programmes, placed predominantly in the London and Bermudan markets. This is for good reason: gross Zenkyoren losses from the Tohoku earthquake and tsunami are projected to exceed $5.8bn, thereby producing a projected international reinsurance loss (post-retention of 270bn yen ($3.3bn)) of over $2.5bn. Indeed Zenkyoren catastrophe reinsurance limits (above its retention) are in the region of $8bn overall.

**Commercial Insurers**

In contrast to the above position with co-operative insurers, and with the exception of minor earthquake-related fire expenses cover, earthquake/tsunami insurance for domestic properties and their contents is not automatically included in property policies provided by conventional commercial insurers, which cover is usually available by way of endorsement only. Even where policyholders have taken out optional earthquake cover, the policy limits only pay up to the lower of Yen 50mn ($620,000) or 50% of the sum insured.

The take-up rate of optional earthquake cover is difficult to ascertain: it has been reported that only 23% of household policyholders nationally had earthquake cover in 2009: of that, only 33% of households in Miyagi prefecture -- one of the regions worst hit by the earthquake and tsunami - were reported to have had such cover.

Commercial insurers providing household earthquake cover cede 100% of this exposure to the Japan Earthquake Reinsurance Corporation (JER). Under this reinsurance arrangement, private insurers absorb the first ¥115bn ($1.42bn) of earthquake/tsunami-related losses. Government-sponsored reinsurance then assumes 50% liability for losses from ¥115bn – ¥1,925bn ($1.42bn - $23.6bn). Thereafter 95% of losses are absorbed by the scheme within the loss range of ¥1,925bn - ¥5,500bn ($23.6bn - $68bn), with commercial insurers liable for the remaining 5%. It is not understood that commercial insurers purchase further reinsurance to cover their liabilities in this context.

Through the JER pool scheme the maximum household exposure of commercial insurers to any one earthquake/tsunami-related event is approximately $14.8bn, with aggregate JER reinsurance cover overall amounting to $68bn. If losses from any one earthquake/tsunami exceed these limits, recoveries by direct policyholders are reduced proportionately.

**Industrial and Commercial Policies**

In light of how the JER scheme operates to significantly insulate domestic commercial household insurers from the impact of an earthquake/tsunami event, the main exposure for international reinsurers (aside from co-operative household reinsurance, as above) is likely to be from commercial and industrial risks.
Commercial property cover in Japan typically takes the form of fire insurance and extended perils. Earthquake and tsunami coverage is not automatically included in standard property policies, but is available by endorsement. Such covers usually include: (1) earthquake shock and ensuing fire; (2) burst pipes and explosion resulting from earthquake; and (3) flood and tidal wave resulting from earthquake.

Similar to household insurance, however, companies that do buy earthquake/tsunami protection often do not purchase an amount that would cover a total loss, with many small- to medium-size businesses completely uninsured in this context.

As with business interruption insurance, the largest individual risks in the commercial/industrial property line are found in the petrochemical, semiconductor, energy and automotive sectors. One of the severest losses from the combined earthquake/tsunami was at the Cosmo Oil Refinery in Chiba prefecture, whose operations shut down immediately after the earthquake, which caused a storage tank fire. It is expected that local insurers will be liable for the most part: it is understood that international (re)insurers did not provide direct or facultative reinsurance cover to Cosmo. However, there may be exposure for international reinsurers through treaty reinsurance protections of local carriers.

More generally, commercial earthquake/tsunami risks are usually reinsured under 60% - 70% quota share treaties in the international reinsurance markets, with facultative reinsurance seldom sought save for particularly large petrochemical and/or semiconductor plant.

**Motor Insurance**

Motor insurance comprises more than 50% of Japan's non-life insurance market in terms of direct premiums written, comprising:

i) compulsory automobile liability insurance (which provides basic third party liability cover); and

ii) voluntary motor insurance, which provides additional cover for liability in respect of third party property damage, own damage and personal accident.

Although loss or damage arising out of fire, explosion, collision and theft are usually covered, losses arising out of earthquake and tsunami are usually excluded and are available only by way of endorsement.

As a result, it is not expected that auto losses will form a significant part of the total insured earthquake/tsunami loss, with one report estimating insured auto losses of around $1billion only.

**Marine Insurance Cover**

The insured marine loss in the wake of the Tohoku earthquake and tsunami is estimated to be in the region of $1bn – $3bn. This estimate includes losses to ships, cargo, piers and wharves, based on reports that 90 large commercial ships and hundreds of smaller vessels were pushed far inland by the tsunami.

**Hull**

Risks covered by Japanese hull insurance include typhoon and tsunami caused by offshore earthquake.

Over half of Japan's many fishing vessels (of which there are in excess of 300,000) are covered by mutual insurance associations to which reinsurance is provided by the Japanese government. Reinsurance is also provided to commercial insurers by way of a domestic hull reinsurance pool which is managed by Toa Re. The pool covers marine, shipbuilding and war-related hull risks and comprises 16 domestic insurers, along with Toa Re, Swiss Re and Transatlantic Re.
Marine Cargo

The Japanese cargo market is divided into two categories, namely inland transit and ocean marine.

Until mid-2010, the majority of Japanese marine cargo cover was written on the 1/1/1963 Institute Cargo Clauses. However, there has been a major shift to writing business on the new Institute Cargo Clauses 1/1/2009 (A, B or C). As for cargo cover written under the "all risks" A Clauses, earthquake-related losses are likely to be covered. As for the cover afforded by the B Clauses, loss/damage reasonably attributable to earthquake (including cargo damaged by tsunami and by fire) should be covered. However, under the reduced cover afforded by the ICC C Clauses, there is no insurance for earthquake-related losses.

More difficult coverage issues may arise for marine cargo cover still written under the old 1/1/1963 Clauses, depending on whether the loss was caused by the Tohoku earthquake, the ensuing tsunami or subsequent fires.

Many marine cargo claims are likely to arise under the forwarding charges clause of ICC 1/1/2009: due to congestion at many Japanese ports and/or inaccessibility, a number of sea carriers have already decided to discharge cargo at alternative ports. Each case will be fact specific, but the difficult question of whether or not the resulting forwarding costs are covered will likely be resolved in favour of assureds.

Pursuant to the Japanese Clauses which govern coastal cargo transport and inland transit, earthquake losses for shipments on land are usually excluded.

As with hull risks, reinsurance for ocean marine risks is provided by way of a reinsurance pool managed by Toa Re, with only significant earthquake business being ceded abroad.

Nuclear Insurance Cover

The nuclear incident at TEPCO's Dai-Ichi facility in Fukushima (which, as outlined above, was triggered by the Tohoku earthquake and tsunami) obviously renders nuclear insurance cover of particular importance when assessing the potential (re)insurance impact of the catastrophe.

Nuclear Insurance Cover in Japan

After the US Japan has developed the second largest nuclear industry in the world, due principally to Japan's lack of indigenous oil, gas and other natural energy resources.

As with many other countries that have adopted nuclear power, Japan has its own nuclear insurance pool, the Japan Atomic Energy Insurance Pool (JAEIP). Pool coverage, which is collectively provided by 43 insurance companies, insures third party liability, including nuclear site and nuclear transport liability.

Under the Japanese Nuclear Act 1961, nuclear operators are not liable for any nuclear damage arising from a "grave natural disaster of an exceptional nature". Further, while third party liability insurance through JAEIP and the Japanese Government in the sum of approximately $1.5bn is mandatory, liabilities resulting from earthquake and tsunami are excluded from JAEIP indemnity and are covered instead by the Japanese Government under the 1961 legislation. This combination of legislative and coverage exemptions should accordingly operate to restrict liability issues for commercial insurers arising out of the Fukushima incident.

Material property damage cover at nuclear installations is available in the commercial insurance market. However, it has been reported that TEPCO - the operator of the Fukushima Dai-Ichi nuclear plant - had not bought material property damage cover since September 2010. It has also been reported that the nuclear power plant of Tohoku Electric Power Company at Onagawa, whose three reactors automatically shut down in the wake of the earthquake, was the subject of property damage/business interruption cover, but earthquake and tsunami perils were specifically excluded. The Japan Nuclear Safety Agency reported on 13 March that the Onagawa reactors' cooling systems were functioning properly.
While JAEIP and other international nuclear reinsurance pools operate a system of reciprocal reinsurance, the operation of the above earthquake/tsunami exclusions for liability purposes, and non-coverage of TEPCO for property purposes, is expected to limit both domestic and international exposure to the nuclear-related effects of the Tohoku earthquake and tsunami.

**Nuclear coverage under conventional policies**

It is understood that insurance policies issued in Japan (including business interruption policies) contain a nuclear exclusion as a matter of course. Policies issued outside Japan will be impacted too (including global programmes (below), business interruption and marine): most of these should similarly contain such an exclusion.

**Global programmes**

Some multinationals with operations in Japan will have DIC/DIL coverage issued by insurers outside the country. Any such coverage will generally offer higher limits and in some instances may also be broader in scope than the policies arranged in Japan.

**Reinsurance Position**

The direct insurance summaries above contain references to potential reinsurance exposures, which are now gradually being quantified through loss projection reports published by affected international reinsurers.

For example, on 22 March Munich Re reported estimated Japanese exposures in the region of €1.5bn ($2.1bn), while Hannover Re reported a provisional projected net loss of €250mn ($355mn). This Hannover Re exposure is understood to arise primarily from quota share earthquake reinsurance cover provided to Japan’s three main insurance groups (Tokio Marine, MSA&D and NKSJ). Swiss Re has similarly reported estimated Japanese losses in the region of $1.2bn, while SCOR (like Munich Re, a significant reinsurer of Japanese Kyosai co-operative reinsurers) has indicated that its losses will likely amount to approximately €185mn ($262mn).

In light of these exposures, and the massive estimated Zenkyoren reinsurance loss referenced in section 3.1 above, we consider below some of the key reinsurance issues that will potentially arise as a result of the Tohoku earthquake and tsunami.

**Aggregation: Hours Clauses**

Issues can arise under catastrophe excess of loss reinsurance as to whether individual losses are closely enough related to be aggregated together for the purposes of applying the retention and limit. Furthermore, higher layer reinsurers generally wish to limit their exposure where losses continue to arise for days or weeks after the peril first operates. These factors, amongst others, have given rise to a variety of Hours Clauses, the most prevalent in the London market being LP098A. This defines a "loss occurrence" as all individual losses arising out of and directly occasioned by one catastrophe, the duration and extent being limited to 72 consecutive hours as regards earthquake, seake, tidal wave and/or volcanic eruption. The reinsured can choose when this period begins (starting with the time of its first loss) and can separately aggregate individual losses occurring in second and subsequent 72 hour periods.

In the context of the Tohoku earthquake and tsunami, therefore, Hours Clauses are likely to have an impact on business interruption losses in particular, as well as physical losses caused by related aftershocks.

Some policies will have a high excess and limit for losses directly caused by earthquake or tsunami, and a separate, lower excess and limit for losses arising from (say) fire or explosion, even if that peril in turn arises directly from earthquake or tsunami. Catastrophe reinsurances will probably not draw such distinctions and at the margins there may be room for debate about which of these losses are eligible for aggregation.

Under "event"-based property reinsurances one test for aggregation of individual losses is whether they are closely enough related in terms of cause, time and location. Given the strength of the causal connection it would seem unlikely that the location of these other losses will exclude them from aggregation, though of course the Hours Clause (where present) will have an impact.
ILW/OLW

Some catastrophe covers will respond only if the market loss exceeds a specified threshold. Due to the complexities of earthquake/tsunami cover in Japan, practical problems in assessing structural damage, and long-term business interruption (some with multiple causes), it may take some time to assess the market loss. And anything unusual in the ILW/OLW definition may make it harder to apply figures from established sources.

Several major reinsurers have the benefit of catastrophe bonds, placed with an SPV backed by note holders. These can provide conventional indemnity cover or (more commonly) operate on a parametric basis, offering a predetermined benefit on the occurrence of a specified type of event (such as an earthquake of a certain magnitude in a certain region). The benefit might take the form of additional cover for any subsequent events in the coverage period rather than an immediate payout. One such cover was written by Topiary Capital Ltd. The bond's sponsor, Platinum Re, has announced that it considers the Tohoku earthquake to be an activation event which triggers up to $200 million of collateralized retrocessional protection for certain catastrophe events that may occur prior to August 2011.

Catastrophe bonds are typically tightly structured and there should be little scope for dispute as to whether they are triggered or not, though disruption following the catastrophe has delayed the formal evidence required from Japan. Some bonds could be downgraded.

Covered and Uncovered Perils

The majority of original policies should contain a nuclear exclusion (as should the reinsurances). These come in a variety of forms and should exclude any claims relating, for example, to irradiation of food and water, radiation sickness and possibly those relating to the exclusion zone around Fukushima. While there is consumer protection legislation in Japan that can impact insurance-related terms and conditions (including the operation of such exclusions), policy wordings are screened and approved by the Japanese FSA prior to being brought to market, such that the relevance of such legislation in an insurance context is limited. Indeed, the most common clauses will not exclude losses that have nothing to do with radioactivity, even if those losses arise from the above-referenced problems at the Fukushima nuclear power plant and consequent electricity outages.

More generally, there may be practical problems in assessing whether a particular loss was caused by a covered peril. For example, some insurance or reinsurance contracts might conceivably respond differently to earthquake and tsunami. Whole towns along the coast have been all but obliterated by the tsunami and it may not be possible to say how much damage arose from the earthquake. Similar issues arose in relation to Hurricane Katrina, with the scale of the potential problem again considerable in the Tohoku context: it is estimated by AIR Worldwide that ground-shake/fire-related losses total between $11bn-$21bn, while tsunami losses range between $9bn-$9.7bn.