

Creating a Technical Foundation for Earthquake Insurance in China



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INTRODUCTION | 序



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宋瑞祥
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China is located in an active continental seismic zone with extensive coverage, high magnitude, and severe disasters. The Chinese government, with the guiding principle of “Preparedness first, response and rescue combined,” is working hard to mitigate earthquake disasters.

Earthquake insurance is a well-recognized cornerstone of any plan for economic compensation, since it reduces the government’s economic burden, speeds recovery of the disaster area, and stabilizes society. However, lacking strong policy support and other reasons, a 20-year earthquake insurance scheme ceased in China in 1996. Since then, disaster recovery has been supported mainly by government funds and social donations.

In early 2003, the Chinese government asked the China Earthquake Administration (CEA), China Insurance Regulatory Commission (CIRC), and Ministry of Finance (MOF) to restore earthquake insurance as soon as possible. The CEA, as the main agency for earthquake disaster mitigation, strengthened earthquake insurance research while also developing regulations and policies to promote earthquake insurance. In collaboration with CIRC and MOF, a draft residential earthquake insurance scheme was completed.

In July 2004, experts from China and other countries gathered in Beijing for the third International Conference on Continental Earthquakes. Mr. Liu Jing Sheng of CIRC delivered a keynote address on “The Status Quo and Outlook for Catastrophe Insurance in China,” followed by excellent presentations on the technical and policy issues of earthquake insurance. This report arose from the proceedings of the conference, which, by bringing together so many international perspectives, will surely help to promote renewed earthquake insurance in China.

I would like to take this opportunity to express my sincere gratitude to RMS for their contribution in organizing the insurance session of the conference and publishing this report. I hope RMS will continue to strengthen cooperation with China in developing the Chinese earthquake insurance market in the future. ■

中国是一个多震的国家，地震发生地分布广、强度大、灾害损失严重。为了减轻地震灾害，在“预防为主、防御与救助相结合”的工作方针指导下，中国政府进行了不懈的努力。

地震保险作为地震灾害经济损失的重要补偿方式和实现社会互助、减轻国家财政负担、快速恢复灾区生产社会秩序和重建家园的有效途径，已被国内外公认为减轻地震灾害的重要手段。在过去由于多种原因、缺乏政策支持，商业保险公司完全依据市场法则来经营，地震保险存在着巨大的经营风险，为此，地震保险在中国施行二十余年后于1996年被迫停止。目前，中国震后灾区恢复基本靠政府财政支持和社会捐赠。

2003年初，中央政府责成中国地震局、保监会、财政部等有关部门尽快在中国恢复地震保险业务。中国地震局一方面坚持不懈地加强地震保险相关理论问题研究，努力为地震保险提供技术支持；另一方面与有关部委密切合作，努力在法规、政策上为地震保险提供保障。第一，在1998年3月1日颁布实施的《中华人民共和国防震减灾法》中明确规定“国家鼓励单位和个人参加地震灾害保险”；第二，通过积极争取，中国保险监督管理委员会已于2003年同意“关系国计民生，具有重大社会影响的大项目”可以扩展地震责任；第三，与中国保险监督管理委员会、财政部等合作于近期完成中国家庭财产地震保险初步方案。

2004年7月11日至14日由中国地震局主办的第三届大陆地震、紧急救援暨巨灾保险国际会议在北京召开，会上中国保险监督管理委员会财产保险监管部主任刘京生做了《中国巨灾保险现状及展望》的主题报告，来自世界八个国家和地区的数十位地震、保险专家对地震保险的相关技术和政策问题进行了研讨和交流。这次会议将促使中国政府在借鉴国际经验的基础上，进一步加强相关技术研究和提出切实可行的实施方案，做好政策准备，尽快恢复地震保险。为宣传和扩大这次会议的成果和在中国尽快开展地震保险工作，我们将这次会议的论文收集起来，以一个小册子出版发行，希望能为在中国开展地震保险起到一个带头作用。我要感谢美国的阿姆新风险管理公司为这次国际会议的召开和这本册子的出版所作的贡献，感谢该公司为中国的地震保险工作所提供的帮助，希望阿姆新公司能够在未来中国的地震保险业务方面与中国加强合作。



Hemant Shah
President & CEO
RMS

夏海盟
执行总裁
阿姆斯风险管理公司

RMS was honored to partner with the China Earthquake Administration in organizing the session “Scientific and Engineering Research, Implementation, and Administration of Earthquake Insurance,” one of seven parallel sessions of the third International Conference on Continental Earthquakes in Beijing in July 2004. Over two days, this session brought together 16 global thought leaders in insurance and risk markets, academia, and the modeling community, to share views with the Chinese insurance industry and government on the formation of a technically sound and commercially viable market for earthquake insurance.

This workshop was a key milestone in China’s renewed commitment to developing a world-class earthquake insurance market. Before the sessions were over, Mr. Liu Jing Sheng of the China Insurance Regulatory Commission issued a clear call for action. Mr. Liu and several workshop participants note in this report that as China’s economy surges ahead, so does its economic exposure to catastrophic loss. I applaud the leadership of the China Earthquake Administration, the China Insurance Regulatory Commission, and the Ministry of Finance for recognizing the importance of these issues and their linkage to China’s overall economic development, and for involving the global community in the solution. I am particularly grateful to Minister Song of the China Earthquake Administration for inviting RMS to assist in laying the foundation for such an earthquake insurance market. As the acknowledged worldwide leader in assessing catastrophic risk, RMS looks forward to contributing its expertise not only to quantifying such risks within China, but also to assisting in the development of efficient reinsurance and insurance market solutions.

We also thank our many insurance industry colleagues who collaborated with RMS to develop and conduct the conference sessions and produce this report. The approaches outlined in Beijing in July 2004, and detailed further in this report, represent an important step forward toward a state-of-the-art risk market for the most dynamic economy in the world. And most importantly, we again thank the China Earthquake Administration for inviting us to serve as partners in this enterprise. ■

阿姆斯风险管理公司很荣幸地与中国地震局合作组办了于2004年7月在北京举行的第三届“大陆地震、紧急救援暨巨灾保险”国际会议的“科学和工程研究及地震保险管理”分会。来自保险与风险管理业及相关的巨灾模型学术与科研界的16位专家学者参加了会议。在两天的议程中，这些专家学者与中国保险业和政府主管部门就构造一个技术上可靠经济上有效的地震保险模式交换了意见。

这次会议是中国在创建世界水平的地震保险进程中的里程碑。在会议中，中国保险监督管理委员会的刘京生先生明确表示要积极采取行动恢复地震保险。刘先生和其它发言人还指出，随着中国的经济发展，灾害所造成的经济损失也日益严重。阿姆斯风险管理公司对中国地震局，中国保险监督管理委员会及财政部对这些问题及这些问题对中国经济乃至全球经济影响的关注感到高兴。阿姆斯风险管理公司由衷感谢宋部长和中国地震局邀请我们来协助地震保险市场的基础工作。作为业界所公认的领头公司，我公司不仅愿为中国巨灾保险业的风险定量作贡献，而且愿为创建有效的保险市场模式提供方案。

在此，我们也向与我公司合作，并为本次会议议题和本论文集作贡献的保险业界的朋友表示由衷感谢。在本次会议中所商酌的并在本论文集中阐明的行动方案标志着中国这个全球最活跃的经济在创建一流的保险市场进程中的重要一步。最后，我们特别要对对中国地震局邀请我们参与这个进程表示衷感谢。

■ THE SOCIETAL ROLE OF CATASTROPHE INSURANCE

The Rise in Catastrophe Losses

The growing number of people who live in locations exposed to natural perils such as earthquakes, floods, and typhoons, along with higher concentrations of value and the increased vulnerability of infrastructure, has led to a rapid rise in worldwide exposure to losses from natural catastrophes.

The role of catastrophe insurance in protecting societies from the effects of disasters varies by country and peril. In general, insurance is more widely available for wind perils than for earthquake or flood risks. For example, the Northridge Earthquake, which ranks second only to the September 11 terrorist attacks in terms of insured property losses, caused total economic losses of US\$40 billion with insured losses at approximately US\$15 billion. The Great Hanshin Earthquake in Japan caused even more damage. Total economic losses exceeded US\$100 billion, but insured losses reached only US\$2 billion due to limited payout rates from Japan's residential insurance at that time. By contrast, insurance claims for Windstorms Lothar and Martin in western Europe are estimated to have paid for more than 50% of the total economic losses.

The Insurance Industry in Developing Countries Today

As Figure 1 shows, a growing discrepancy exists worldwide between economic and insured losses. In developing countries in particular, the risk tends to be carried not by the insurance industry, but by governments and individuals. This gap exists in part because individuals will purchase insurance only when their financial circumstances consistently rise beyond a fairly high threshold. In addition, governments are reluctant to invest in the insurance market when their resources are already heavily tied up in development and public service projects.

The insurance schemes that do exist in emerging economies tend, furthermore, to rely on outdated procedures. Typically, government regulators determine tariffs; underwriting practices seldom incorporate rationally calculated risk parameters; and risk transfer conditions are controlled by the global reinsurance market. In several countries, insurers refrain from offering catastrophe insurance because of the fear of ruin, while governments focus on response and rebuilding efforts instead of pro-active mitigation, or on finding mechanisms for financial protection.

The Burden of Loss on Individuals in Developing Countries

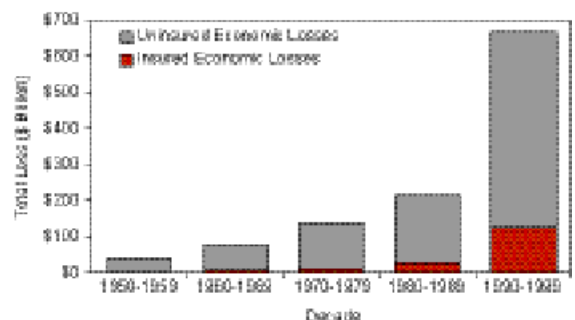
In regions with low insurance penetration, catastrophic events such as earthquakes can have devastating effects on uninsured individuals even when fatalities are low. An individual's loss to annual earnings ratio in a developing country could be 9:1. A family that earns US\$6,000 a year, that is, might suffer a loss of US\$55,000 if their apartment is destroyed in an earthquake.

Small business owners can be further jeopardized by interrupted services and structural damage. If a restaurant with annual earnings of \$24,000 is destroyed and remains closed for several months, the owner might suffer some \$70,000 in total losses. The loss to annual earnings ratio would be 3:1.

When individuals and small business owners do receive financial compensation from the government for catastrophic losses, the payout may amount to only a fraction of actual losses. It can also take years for compensatory funds to reach the local economy.

The Burden of Loss on Governments in Developing Countries

When many thousands of uninsured individuals are affected by an earthquake, the ripple effect across the economy can threaten a developing nation's economic growth. The government cannot by definition plan for a single catastrophic event, which may strike at any time, and most developing countries have little available capital to divert into recovery schemes. Yet without a mature insurance sector providing coverage for the losses, the burden falls to the government. Legislators might need to make a painful decision between maintaining public investments in vital projects such as public transportation, or funding post-earthquake recovery and reconstruction.



Source: Munich Re, Natural Catastrophes 2003

Figure 1 Insured and uninsured losses for major natural catastrophes worldwide

The overall size of the economy significantly influences how much governments can diversify risk between regions. In smaller territories with high earthquake hazard, such as Chile and Taiwan, losses for a 500-year return period (equivalent to a 0.2% annual probability) can significantly exceed all non-life premiums collected in a given year. Potential losses in these smaller territories underscore the urgent importance of reinsurance and other forms of financial backing such as catastrophe bonds. Larger territories – including China – are better protected in this regard, with the capacity to sustain a more diversified insurance market and a greater likelihood that any given catastrophe will impact only a subset of key urban areas.

Expanding Penetration in Emerging Economies

If higher earthquake insurance penetration rates are to be supported in at-risk emerging economies, three key criteria must be met:

1. Claims adjustment practices must be swift and fair in order to build customer trust. In many emerging economies, the general public sees insurance as an additional tax burden that provides unreliable financial protection.

2. Insurance premiums must be within the reach of the poor in emerging economies. Some countries have created catastrophe funds dedicated to the protection of the poor by taking a small percentage of the accumulated premium (or surplus), or by some other process such as an allocation from building permit fees.

3. Premium revenue must ensure a profitable business for insurers. Government-sponsored pools with mandatory participation can improve the risk-sharing equation and keep premiums affordable while increasing the insurance market.

In addition to these key factors, earthquake insurance schemes must reflect the socio-political and cultural factors of the country, with broad support from government regulators, the financial markets, the business community, and civil society representatives.

Emerging Solutions

Several emerging solutions can support the development of earthquake insurance schemes. For example, as the

following section of this report shows, software models can project losses for thousands of potential earthquake scenarios. Such projections help governments to develop disaster management strategies and to prepare communities and institutions for disasters. New technologies have in turn helped the financial markets to develop innovative and more flexible solutions, ranging from public/private partnerships to consortial reinsurance and catastrophe bonds.

Despite such promising new avenues, an emerging economy's market dynamics do not generally support state-of-the-art approaches such as catastrophe models. It thus becomes more difficult to manage catastrophe exposures, establish disaster risk management plans, or establish objective benchmarks for pricing and trading risk. As a result, current earthquake insurance schemes in most emerging economies do not play a significant role in the event of a catastrophic loss. The burden continues to be shifted to individuals and governments.

How Catastrophe Insurance Can Drive Economic Development

The development of the catastrophe insurance industry in emerging economies can support a government's ability to manage the impacts of earthquakes and other disasters in several ways:

- The rapid influx of funds protects communities and fosters a faster recovery
- The conservation of public funds ensures economic and social stability
- Governance is improved by:
 1. Enforced liability mechanisms
 2. Greater transparency in procurement processes and financial transactions
 3. Improvements in the standards for construction and the maintenance of buildings and facilities
- Capital flow helps to create white-collar jobs

The social benefits of a sound catastrophe insurance scheme can clearly be broad-scale and long-lasting. As challenging as it is to create catastrophe insurance schemes, the financial and technical solutions available today mean that catastrophe insurance schemes can protect the social welfare of whole communities while expediting the recovery from disasters. ■

■ CATASTROPHE LOSS MODELING FOR CHINA

China has the largest concentration of earthquake risk in any country in the world. Almost half of the population of China is located in areas of moderate to high hazard, where damaging earthquake shaking can be expected every one to few hundred years. This proportion is far higher than in other large countries such as the U.S., Canada, or Russia.

Such an enormous potential for catastrophic loss calls for a comprehensive risk management strategy. As far back as the 1980s, the China Earthquake Administration (CEA) was leading ambitious projects to map the earthquake risk in China based on the distribution of historical earthquakes. The Administration first measured probable Modified Mercalli Intensity (MMI) expected at a given return period, and more recently calculated the peak ground acceleration expected at a 10% probability of exceedance over the next 50 years.

Such nationwide seismic risk maps are important for engineering decisions and for the application of building design codes. However, earthquake insurance, which is a cornerstone of comprehensive risk management, also requires a financial quantification of potential outcomes. How likely is it that a whole city or even a series of towns and cities might experience destruction and losses in the same large earthquake? What would the levels of damage and financial losses be?

To answer such questions requires the development of a fully probabilistic catastrophe loss or 'Cat' model, in which tens of thousands of potential earthquakes are sampled and an annual rate of occurrence is attributed to each one. Output from the Cat model can be used to

determine the probability that many separate locations can be affected within the same earthquake event. It can also determine the technical price for risk, whether for a single property or a whole portfolio of properties across multiple locations.

Risk Management Solutions (RMS) is the acknowledged leader in catastrophe modeling, with the greatest market penetration and most sophisticated models covering 50 territories. RMS' development of an earthquake catastrophe model for China comprises three core modules: a Stochastic Module, a Hazard Module, and a Vulnerability Module. Results of the analysis of risk then can be processed through a Financial Module that accounts for insurance and reinsurance payment terms.

RMS is now in the process of developing a catastrophe analysis model for China earthquake hazards. What is described below reflects the structure of the model and some of the underlying research.

The China Earthquake Stochastic Module

The Stochastic Module is founded on the state of knowledge of earthquake occurrence: how the distribution of past earthquakes relates to the active tectonics of the region.

The tectonic environment of China is driven by the ongoing collision of the Indian-Australian plate into the Eurasian plate. As a result of the prolonged collision, zones of active deformation fan out across northern and northeastern China into Mongolia and toward the Korean peninsula. Offshore to the east of China lie the circum-Pacific subduction zones, where the ocean floor of the Pacific descends beneath the island arcs of the Japanese islands and the Philippines. The island of Taiwan has been raised into high mountains where the subduction zone comes hard up against the edge of the continental crust of China.

Across much of China, including the region around Beijing, the active tectonics are driven by distributed strike-slip shear systems, predominantly involving horizontal movements on near vertical faults. The active tectonics of central and northeastern China are manifest in the landscape of mountains and plains, separated by faults which create disrupted river gradients and large subsided areas prone to extensive flooding.

Nature of the Historical Record of Earthquakes

China has the longest documented catalog of earthquakes of any country, extending back more than 2,000 years. For western China, however, the pre-1900 record

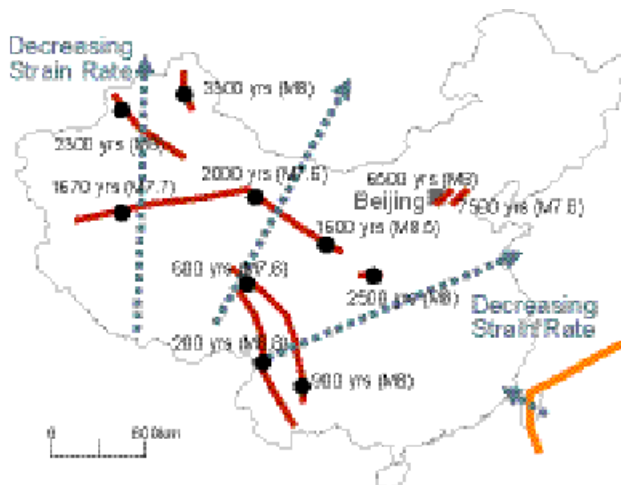


Figure 1 Paleoseismic/historic earthquake recurrence intervals

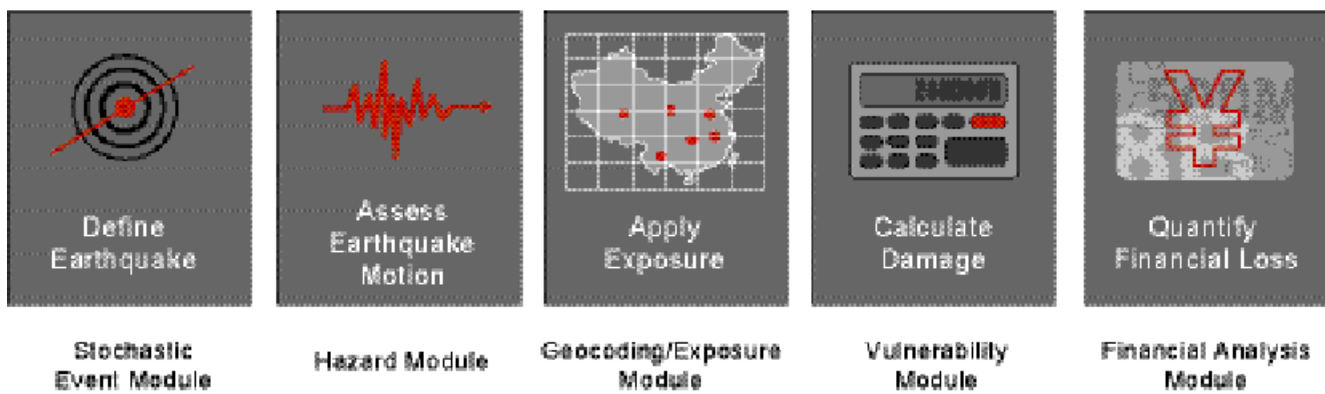


Figure 2 The RMS earthquake modeling methodology follows a multi-step process to quantify financial risk for a specified set of exposure

is not complete, even for the larger magnitude earthquakes, while for eastern China the historical record of the larger earthquakes can probably not be considered complete before the 15th or 16th centuries (Ming Dynasty, 1368-1644).

Even where the record extends back hundreds of years, historical seismicity on its own does not give a complete perspective on the locations and magnitudes of potential earthquakes, as evidenced by the unexpected and historically unprecedented earthquake beneath the city of Tangshan in 1976. Nonetheless, by dating past episodes of fault displacement, recurrence intervals of major earthquakes have been identified for a number of the principal faults across China. These recurrence intervals increase away from the Himalayan collision zone (reflecting reduced rates of tectonic deformation), from a few hundred years to many thousands of years in northern and northeastern China (see Figure 1). These changes drive an order of magnitude difference in earthquake recurrence and earthquake hazard between these regions.

On certain major faults where information exists regarding both the average recurrence interval and the date of the last major (historical) earthquake, we can use the principles of ‘time dependence’ to determine the conditional probability of the occurrence of a major earthquake in the near future. These faults include the Tangshan and Xiadian, Xianshuie, Tan-Lu, and Haiyuan. In particular, slow moving faults in northeast China that have suffered major earthquakes within the past few centuries have very low probabilities of a repeat earthquake in the immediate future.

The length of a fault is closely related to the maximum size of an earthquake that could occur along it. Along the longest faults, however, the pattern of earthquake rupture can vary from one episode of fault rupture to the next. ‘Cascade’ fault ruptures can also occur, starting on one fault, and then jumping to a second or third fault with similar alignment, creating a much larger

earthquake. Detailed geological investigations on the Haiyuan Fault revealed that the fault comprises three distinct segments, which in ten major earthquakes in 9,000 years have sometimes ruptured independently and at other times in combination.

Stochastic Modeling

Tens of thousands of simulation years of earthquake activity inform the stochastic set of earthquake events in the RMS model. The model consists of fault sources where the geometry and activity of active faults are well defined, and zonal sources for regions where the specific locations or activities of faults are not known in detail. For each zonal source, the seismicity is based on the Gutenberg Richter magnitude frequency relation, defined from historical seismicity and with two parameters: the ‘a value’ that determines the level of activity on that fault, and the ‘b value’ that determines the relative number of earthquakes of different magnitudes (the slope of the Gutenberg Richter relation). Importance sampling is used to ensure a rich population of potential high magnitude earthquakes in the probabilistic event set.

The Hazard Module

The hazard module for China comprises two separate components: attenuation and geotechnical hazard. Ground motion attenuation is concerned with the regional decay of shaking between an earthquake source and a site. The available geotechnical hazard data determines how the regional ground shaking will be modified by the local conditions at a site.

Ground Motion Attenuation

Ground shaking, the main component of seismic hazard, is analyzed using attenuation functions. These functions vary widely because of regional differences in tectonic and geological conditions that affect the transmission of seismic energy. Ground motion is calculated through one

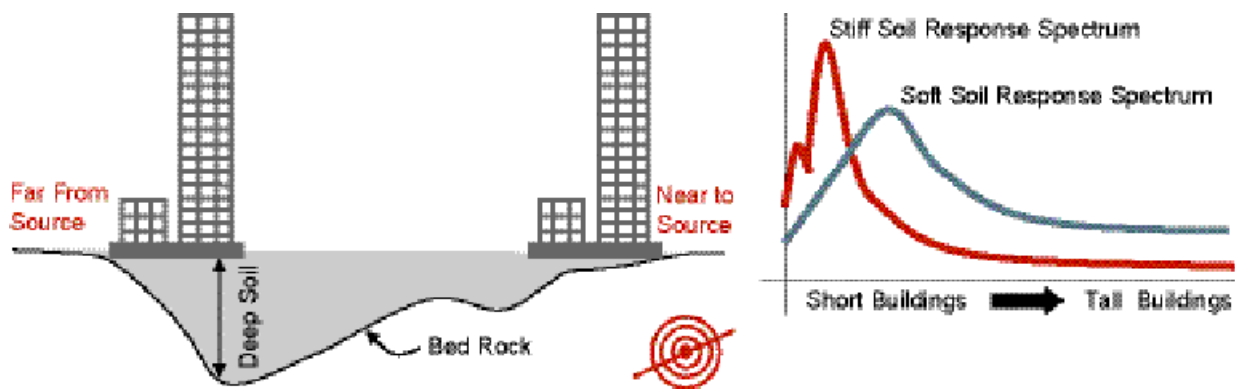


Figure 3 The RMS spectral response methodology determines building performance and potential damage based on several factors, including distance to source, local soil conditions, ground motion frequency, and structural period

of three classes of parameters: Modified Mercalli Intensity (MMI), peak ground acceleration (PGA), or spectral acceleration (Sa). The most important of these is spectral acceleration, which is derived using the full frequency content of ground motion and thus better represents the full character of building response.

Geotechnical Hazard Data

A comprehensive database of the surficial geology is used to calculate how ground shaking is amplified at a specific site. Softer soil classifications with lower shear wave velocities give larger ground motions than rock classifications. Long-period effects can impact the damage to taller buildings (greater than 10 stories) for earthquakes over M7.0 at distances greater than 50 km (31 mi). These effects are of particular concern for mid- and high-rise buildings in the principal cities of China, such as Beijing, Shanghai, and Hong Kong.

Liquefaction occurs when strong ground shaking causes the soil particles to become re-arranged so that the intervening water develops an overpressure that forces the soil particles apart. As the soil loses its strength, buildings sink into the ground, often leading to pronounced damage. The highest potential for liquefaction is on flat delta or alluvial soils in floodplains or in areas of reclaimed land. Liquefaction was widespread both in the 1976 Tangshan Earthquake, and in the M8.0 1679 earthquake to the east of Beijing.

Landslides are slope failures caused either directly by strong ground shaking, or indirectly by failure along planes of weakness lubricated by temporary liquefaction. In central China, hills of unconsolidated wind-blown loess soils are highly susceptible to earthquake induced landsliding, as in the 1556 Huaxian Shaanxi Earthquake, which led to the highest number of earthquake mortalities on record in China.

The Vulnerability/Inventory Module

Once the ground motion (expressed in MMI or Sa) has been calculated at a location, a vulnerability relationship is employed to estimate the damage. Information that is considered in the vulnerability assessment includes:

- Structural characteristics of a building
- Type of contents
- Function of the building (determining time element coverage)

Additionally, the potential for ground failure from liquefaction and/or landslides is included to estimate losses. Separate vulnerability functions are employed for different coverages.

The characteristics of a building that affect how a given level of ground motion may damage it include the structural lateral system, building height, and building materials. The maximum relative displacement between stories (inter-story drift) is employed to predict the amount of damage a building will sustain during an earthquake.

The damage analysis also includes casualties, which will vary significantly according to whether people are asleep in their apartment buildings at night, working in factories and offices during the day, or traveling between work and home.

The development of earthquake vulnerability functions for China takes into consideration regional design, construction practices, and past earthquake performance. The 1976 Tangshan Earthquake clearly demonstrated the vulnerability of older unreinforced brick buildings. After Tangshan, the building code was revised, and reinforced concrete columns were retrofitted around many of the 2-4 story brick buildings in Beijing that had proved susceptible to damage. Since 1976, there has been no comparable major earthquake in the vicinity of a large Chinese city, so empirical evidence regarding the vul-

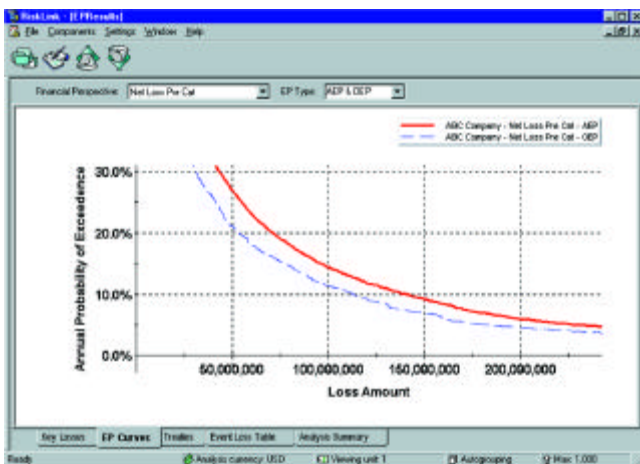


Figure 4 RMS uses the EP curve to show the probability of exceeding various levels of financial loss for each stakeholder in the risk

nerabilities of more modern buildings has to be derived from other regions with comparable building styles and standards (e.g. the 1999 Chi-Chi, Taiwan Earthquake).

The enormous amount of new construction in China underscores the urgency of understanding the vulnerabilities of more modern reinforced concrete frame high-rise buildings. Between 1997 and 2002, 3.3 billion square meters of new housing was built (equivalent to the total constructed over the previous four decades) along with equivalent amounts of commercial and industrial development. Another 500 km² (193 mi²) of older construction was rebuilt or renovated.

The Financial Module

The catastrophe analysis model can accept information about the nature of the exposure at risk (for a building this would include items such as age, height, construction materials, and value). Damage is then estimated for each modeled earthquake event by assessing earthquake ground motion at each location, and applying appropriate vulnerability functions. Overall loss distributions for the hundreds or thousands of stochastic events are then processed in the financial model and displayed in the

EP Curve Applications

- Manage and diversify portfolio risk
- Underwrite and price business
- Ensure capital adequacy
- Structure risk transfer
- Communicate risk to key constituents
- Respond to catastrophes

Figure 5 The EP curve can be used to inform a wide range of risk management decisions, from individual risk evaluation to portfolio management

form of the annual exceedance probability (EP) curve. The integral under the EP curve defines how much money would need to be set aside each year to fund the full range of potential losses, ranging from a single earthquake to aggregate earthquake loss in the course of a year. This amount is known as the average annual loss (AAL) or 'technical rate' for the risk.

Often an insurance policy will restrict what is paid out on a loss by imposing a deductible, expressed either as a monetary sum, or more often, as a percentage of the value of the property (so that the property owner has to pay the first part of any loss). Limits may also be imposed on the maximum payout on the building. The financial module accounts for such insurance and reinsurance terms.

A final perspective on risk comes from mapping the geographical variability in the technical price for earthquake risk, whether for a specific building type or for the average across a range of residential or commercial building types, or even the average across a whole city. This matrix of technical data rates by location, class of property, and coverage type can then be employed for setting rates for earthquake insurance. ■

■ THE ROLE OF DATA IN MANAGING & PRICING COMMERCIAL/INDUSTRIAL RISKS

■ Kevin Huang, Director, Research & Development, Ace Tempest Re ■

Key Variables in the Commercial and Industrial Market

In order to better manage exposure, underwriters are requesting ever more information regarding risks, especially following the terrorist attacks of September 11, 2001, and associated insurance losses. Insurance companies face increased scrutiny from regulators, shareholders, and rating agencies, while senior executives are under pressure to demonstrate risk-adjusted return on capital. As a result, more emphasis is being placed on the importance of quality data when underwriting risks. The quality of data, more than any other factor, directly affects the amount of insurance bought or sold, the coverage, and the price.

In considering commercial or industrial risks, there are two noteworthy differences compared to residential property. First, the risks are more diverse. Hotels, retail stores, stadiums, office buildings, schools, manufacturing facilities, and power plants are all included in this sector, and each has special structural and operational characteristics. Therefore, uncertainty around expected losses is likely to be greater for a commercial book of business.

Second, depending upon the nature of the peril, business interruption (e.g. loss of revenue due to building damage, power outage, or supply chain disruption) can become a major component of the loss. However, business interruption is notoriously difficult to model because of the interconnectivity of the influencing factors and the degree to which these factors are not known at the time of underwriting. This dimension adds another level of uncertainty to the catastrophe modeling

process and consequently to the pricing of catastrophe coverage for commercial and industrial insurance risks.

Commercial risks also differ from industrial risks in terms of available information, as shown in Table 1. Exposure data quality is typically poorest for industrial risks, making catastrophe modeling more challenging. Recognizing these differences, particularly for business interruption, RMS has built an industrial facilities model, allowing underwriters to fine-tune their risk calculation.

The Quest for Better Data

The information needed to support the transfer of catastrophe risks passes along a chain: from corporate clients, or captives, via brokers to insurance companies, and from insurance companies to reinsurers via reinsurance brokers. As the data passes along the chain, different formats or assumptions may come to bear, degrading the data at each juncture. Also, because default assumptions around a class of risk or location tend to benefit the cedant, brokers and reinsurers need to be aware of the cedant's temptation to withhold critical information.

Quality control has been aided to some extent by the growing amount of data passing from corporate clients to brokers and from brokers to insurers and reinsurers in the past three years, primarily as a result of increased geographical resolution. However, challenges still exist, chiefly because of the cost associated with collecting high quality data for use in international catastrophe models. When coding information into a catastrophe model, construction type, building height, and year built are typically entered as unknown. Secondary characteristics are rarely collected, particularly for international exposure, even when catastrophe models call for their use.

Gathering and standardizing location data will be crucial to the Chinese insurance industry as it seeks to assess catastrophe risk. Exact soil types must be taken into account when assessing earthquake risks, just as flood zones must be carefully delineated. Although no international address-level geocoding engine has yet been implemented in commercial catastrophe models, and international addresses can only be assigned to the next level of resolution (such as postal code), insurance industry data or a commercial data depot can supplement missing information. Engineering inspections should be required for complex commercial and indus-

	Commercial	Industrial
Exposure Data Quality	Relatively high	Low
Risk Size	Often can be insured 100% by one carrier	Almost exclusively placed in layers with multiple insurers
Coverage Limit	Natural peril limits typically equal to the fire limit	Natural peril limits are often less than the fire limit
Sub-limit	Exist for less critical perils	Often exist for different perils
Catastrophe Modeling	Relatively easy	More difficult

Table 1 Comparison between commercial and industrial risks

trial facilities (such as chemical and petroleum factories) or risks with high business interruption coverage (such as pharmaceutical or semiconductor manufacturers). A number of proactive insurance companies have started to use hand-held GPS devices to find the exact longitude and latitude associated with the property or to pre-geocode international addresses using a third-party geocoding engine before feeding data into catastrophe models. The increased awareness of industry-wide data transfer standards, such as ACORD, will surely make transactions between counterparties more transparent.

Market pressures pose a further challenge. In an ideal world, underwriters follow two basic rules: the risk to be taken must be quantifiable, and taking the risk will generate profit. However, under market pressure, particularly in a soft market, underwriters often sacrifice these rules to chase premium growth and market share. To mitigate the impact of market pressures, insurers and reinsurers in the Chinese market may rely, as do many companies worldwide, on a minimum data quality standard. If an exposure file falls short of the standard, underwriters should be required to request more detailed data from the brokers or clients. ■

■ LESSONS FROM OTHER EARTHQUAKE INSURANCE SYSTEMS

In designing a new earthquake insurance system, much can be learned from how insurance systems have been established in other countries with high earthquake hazards. This section provides some case studies in earthquake insurance systems, ranging from three in developed regions (New Zealand, California, and Japan) to two in emerging economies (Taiwan and Turkey). As we review these different systems, we can see that the same questions have faced the architects of all residential earthquake insurance schemes:

- How to maximize the number of homeowners to be included
- How to cover as much as possible of the economic losses caused by earthquakes
- How to link earthquake insurance to mitigation activities that over time will reduce risk

The focus here is chiefly on residential insurance because commercial and industrial insurance systems tend to be more similar in different territories, subject to less regulation, and often covered by international insurance organizations.

New Zealand provides the best example in the developed world of a residential earthquake insurance system that has been financially viable from the outset. It has high penetration rates, a high level of coverage, and is linked to a strong mitigation culture. It should be noted, however, that it is fortunate not to have been tested by a truly catastrophic earthquake. California's insurance system seemed to be developing on sound lines, expanding its penetration rates through the 1980s, until the 1994 Northridge Earthquake revealed that the insurance premiums were insufficient to cover the magnitude of the risk. The subsequent rushed restructuring of homeowner's earthquake insurance, which involved the creation of the California Earthquake Authority, has resulted in a system that is significantly hampered in its ability to provide adequate coverage. Japan, meanwhile, provides an example of a system that has evolved in a series of steps of expanded coverage, but that still, with the exception of schemes such as that employed by the agricultural cooperative, Zenkyoren, provides only partial coverage.

Newly established earthquake insurance systems in rapidly developing economies provide realistic examples of some of the challenges ahead for those creating such schemes. In Turkey, many buildings fall outside the purview of the government-sponsored system even though residential earthquake insurance is deemed to be 'compulsory.' Taiwan, where penetration is rising slowly, is perhaps even more relevant to China, having similar styles of building and similar cultural attitudes to the individual's role in protecting newly acquired wealth.

One striking lesson from this review is that the quality of insurance protection is not simply correlated with wealth. High-quality protection is more often the result of developing an effective, politically-backed system to support the delivery of insurance products. In fact, the level of residential insurance penetration in Turkey after just one year of a government run scheme equates to that achieved in California, where insurance has been available for decades but where penetration rates have diminished in the face of rising costs and post-catastrophe reductions of coverage.

All the schemes described here also reflect some combination of public/private initiatives. The balance between the two shapes the scheme that emerges. In some instances, such as Turkey, the World Bank has played a key role; in others, the government uses legislative process to enforce public/private partnerships. The examples show how difficult it can be to strike the correct balance. Even the best intended partnerships can be flawed in the implementation, such as in California, where residential insurance schemes were restructured after major losses and protection was reduced. We can also see that merely calling a system 'compulsory' doesn't necessarily result in universal take-up. Turkey shows us the inherent limits to imposing compulsory schemes in developing countries.

Another lesson to consider is that all of these schemes developed in the aftermath of major earthquakes. As such, they are reactive, at best learning from the past, rather than designed in anticipation of future events. The challenge for China is to create a new earthquake insurance system, founded on best practices, before the shock of a major earthquake serves as a call to action. ■

■ NEW ZEALAND

■ George Walker, Senior Risk Analyst, Aon Re Australia ■

History

At the time of New Zealand's 1931 Napier Earthquake, property was only insured for fire, if at all. Subsequently, insurance coverage was offered for shaking damage as an optional addition to fire policies, but the 1943 Masterton Earthquake revealed that most properties still had no earthquake insurance. Because the Masterton Earthquake occurred during a war, the Earthquake and War Damages Commission assumed responsibility for coverage, which was for indemnity value and was a compulsory addition to fire insurance.

The initial premium was 0.25%, but after World War II, the residual earthquake component was reduced to 0.05%. When the sum insured by fire insurance changed from indemnity to replacement value, insurance companies offered the additional cover on a voluntary basis. In 1993 the scheme was reorganized, limiting coverage to residential properties, capped on a first loss replacement value basis. For the first time, scenario-based modeling was employed to assess earthquake risks to Wellington, and the name of the administering body was changed, to the Earthquake Commission (EQC).

For commercial and industrial properties, earthquake insurance is generally offered as a standard inclusion in fire policies on a full replacement value basis. Insurance companies remain the sole providers for commercial and industrial risks.

Structure

Under the EQC scheme, residential properties are covered for earthquake up to NZ\$100,000 on buildings and NZ\$20,000 on contents, on a first loss basis. For those with higher value properties, excess coverage is available through insurance companies. The inclusion of EQC coverage in fire insurance is compulsory; insurance companies collect the premium as a levy when insuring residential property for fire. The EQC also includes coverage against losses from ground failures caused by geothermal hazards and landslides, as well as erosion from flood. Water damage from floods and storms is not covered.

Practice & Regulation

The EQC is considered a government body, and operates under an act of the New Zealand Parliament. A small staff manages the National Disaster Fund and the claims

handling system, using an in-house financial risk management software system that incorporates output from catastrophe models, as well as asset and dynamic financial analysis models to simulate the EQC's financial performance over the next 10 years. The claims simulation model uses output on the estimated number and size of claims, informing preliminary decisions on the required resources or claims management and how they should be deployed. Loss adjustment for claims under the program is outsourced to an offshore Australian company.

Reinsurance

During the first 40 years of the original scheme, very little reinsurance was purchased. However, the Earthquake and War Damages Fund accumulated rapidly, and since the mid-1980s, an increasing amount of reinsurance has been placed, primarily to protect the fund. Premium income pays for reinsurance premiums and administration expenses, allowing the National Disaster Fund to accumulate reserves from investment returns. It now stands at over NZ\$4 billion. This sum corresponds to a loss with a probability of exceedance equivalent to several hundred years, and yields an annual investment return several times larger than the annual premium income. About half the fund is covered by reinsurance. In the unlikely event of both the fund and reinsurance being exhausted, the fund is guaranteed by the New Zealand Government.

For the last eight years, catastrophe models have been used to develop reinsurance purchasing strategies. As EQC administrators become more adept at financial modeling, catastrophe models will play a greater role in informing strategic decisions about reinsurance and reserve funds.

Effectiveness

Only owners and occupiers who are covered by fire insurance are covered by the EQC. The penetration of insurance in New Zealand is high, however, with approximately 95% of privately owned dwellings and 75% of contents insured.

Equally significant is the EQC's effective integration of an array of models – catastrophe models, asset models, DFA models, and claims system models – into an established scheme that assures solvency at the same time as offering low-cost premiums. ■

JAPAN

■ Harumi Yashiro, Manager, Property Division, Tokio Marine & Nichido Fire Insurance Co., Ltd. ■

Introduction

Earthquakes in Japan, with its dense urban population, have a high financial and social impact. The Japanese insurance market thus faces an unusual degree of challenge in accumulating sufficient reserves while diversifying its exposure and covering catastrophic losses. Indeed, in part because of the high degree of exposure, no earthquake coverage was offered at all in Japan until 1956, when industrial earthquake insurance was introduced, with international reinsurers providing the backing.

	Total Damage	Half Loss Damage	Partial Loss Damage	Limit
Residence	> 80% loss of value of the structure	> 20% and < 80% loss of value of the structure	> 10% and < 20% loss of value of the structure	¥30 million
Household Goods	> 80% loss of value	> 10% and < 80% loss of value	> 10% and < 20% loss of value	¥10 million
Payment	Full value of insurance policy	80% of value of insurance policy	8% of value of insurance policy	

Table 1 Residential earthquake insurance in Japan: definitions of damage

Today, residential earthquake insurance in Japan covers both property and alternative accommodations, paying claims on a basis of tiered damage, as shown in Table 1. Premium discounts are also offered according to the building's age, location, and type of structure, based on four geographic zones throughout Japan and two types of structure: wooden and non-wooden.

The Evolution of the Japanese Residential Earthquake Insurance Market

Japan's residential earthquake insurance scheme has evolved in a series of steps over time. It has always been at least partially government-backed. Like many other schemes, Japan's has undergone refinements and modifications as a result of major earthquakes and consumer demand. Penetration rates have also changed in response to events, as Figure 1 shows.

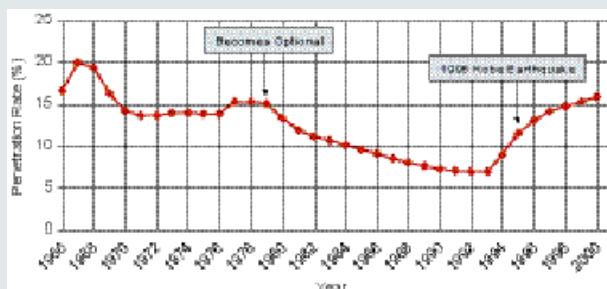


Figure 1 Historical change of penetration rate for residential earthquake insurance in Japan, 1966-2000

Residential coverage was first offered in response to the Niigata Earthquake in 1964, which led to 26 deaths and the complete destruction of almost 2,000 homes. Residential neighborhoods were heavily damaged, as was infrastructure such as bridges and highways. This early residential earthquake coverage was regulated and supported entirely by the government. Policies were included along with standard fire coverage, and total benefits for a single event were capped at ¥30 billion. As Figure 1 shows, penetration rates quickly reached 20%—a level not achieved since.

The insurance structure remained largely unchanged until the 1980 Miyagiken-oki Earthquake, which led to considerable partial damage to residential property as well as the outright destruction of 5,574 homes. At that time, insurance payments were only made in the event of an effective total loss, and the insurance structure was thus revised once again, with half-loss coverage and attachment points introduced. Limits were also raised and premiums refined. For rating purposes, five regions were delineated, as opposed to three, and coverage for household goods was added. Also, earthquake insurance coverage became an optional endorsement to the fire policy.

In 1987, another earthquake caused significant damage in Chiba prefecture near Tokyo, followed in 1989 by a series of smaller earthquakes that caused extensive partial damage. Once again, the insurance structure was revised in the face of policyholder demand, with partial loss coverage added to total and half-loss coverage (see Table 1), and contents likewise were covered on a partial-loss basis.

None of the earthquakes from 1956 until 1989 matched the Great Hanshin Earthquake in January 1995 (commonly referred to outside of Japan as the Kobe Earthquake) in terms of mortality or damage. Over 6,000 people died, and over 240,000 houses were totally or half destroyed. The earthquake occurred in a densely populated urban setting, and the Japanese government was severely challenged in its ability to compensate all insured losses. From the policyholder's point of view, the Great Hanshin Earthquake highlighted the shortcomings of policies that assessed loss of household goods proportionally to the damage to the structure. In some instances, policyholders' homes emerged relatively unscathed, but their household goods were extensively damaged. Further changes to insurance regulations

Date	Event	Overview
1960	Miyagi Earthquake	<ul style="list-style-type: none"> Residential EQ insurance offered No coverage for partial damage
1960	Miyagi/Kan-ai Earthquake	<ul style="list-style-type: none"> Half loss coverage introduced Attachment points introduced Limits raised Locations defined for discounts Optional earthquake insurance introduced
1987 1989	Chiba Earthquake Smaller earthquakes	<ul style="list-style-type: none"> Partial loss coverage introduced Contents covered on partial basis
1995	Great Hanshin (Kobe) Earthquake	<ul style="list-style-type: none"> Contents assessed independently Coverage limits raised
2002		<ul style="list-style-type: none"> Mitigation incentives introduced

Table 2 Historical changes in Japanese residential earthquake insurance coverage

resulted in damage to household goods being assessed independently from damage to structures.

The most recent major revisions to the insurance structure were implemented in 2002. For the first time, earthquake insurance policies provided incentives for structural upgrades and risk mitigation.

Reinsurance and the Residential Market

The earliest residential earthquake insurance policies were backed entirely by the Japanese government. The Japanese government now shares the burden of reinsurance with private insurers on a sliding scale basis, wherein the government assumes an increasing share of the costs of covering earthquake damage, and total coverage is capped for a single event at ¥4.5 trillion.

The Japanese Earthquake Reinsurance Company (JER), founded in 1966, handles earthquake claims exclusively and plays a key role in this process, assuming responsibility for a portion of the residential reinsurance coverage not provided by the government. (Commercial and industrial insurance, by contrast, is backed by international reinsurance companies.) Figure 2 shows the accumulated reserves for future claims, and the portion assumed by primary insurers, the JER, and the Japanese government.

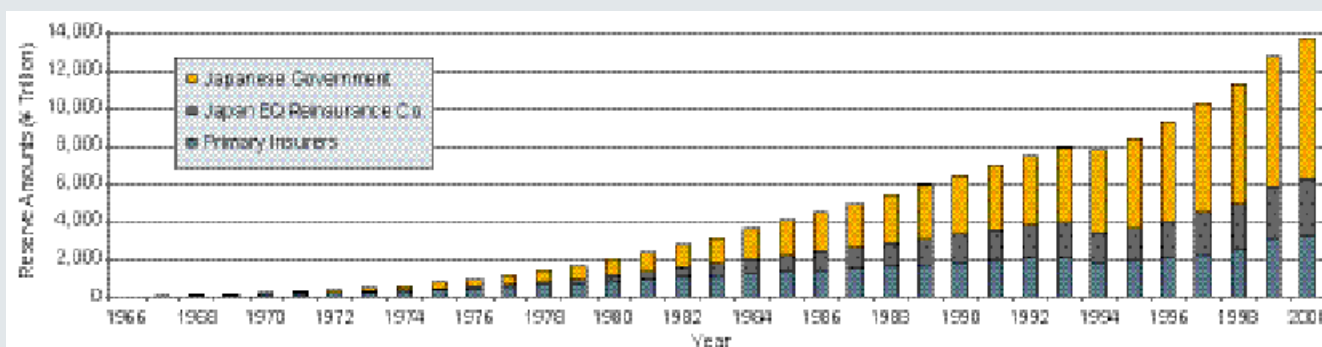


Figure 2 Accumulated reserves for future claims

Assessing Earthquake Damage

Tokyo's metropolitan government has assessed the potential for earthquake damage to the region's residential market since the 1970s, and increasingly the government has supplied other regions with results of each earthquake damage assessment as a means of raising awareness of effective loss prevention strategies and reliable approaches to damage assessment. Given the relatively rare occurrence of earthquakes and the lack of past damage data, the Japanese government also relies on simulations, taking into account seismic ground motion, the spread of fire, and, in maritime areas, the effects of tsunamis. These damage rates are then correlated with current insurance coverage in order to arrive at a rate that reflects estimated annual risks.

Deregulation

An additional key evolution in the Japanese insurance market was deregulation in 1998. While the government continues to control an operational audit process and also to provide a tier of reinsurance for the residential market, private insurance companies now compete for business. Results have been mixed. The commercial and industrial insurance sector has grown and become more diversified, with the development of new products such as multi-location policies and natural catastrophe derivatives. Competition has also resulted in lower rates in all sectors. On the other hand, some companies have been forced into mergers, or have faced bankruptcy or severe management problems. The reinsurance market for commercial and industrial properties has hardened, and little earthquake insurance is available to date for business interruption. ■

■ THE CALIFORNIA EARTHQUAKE AUTHORITY

■ Richard J. Roth Jr., Former Chief P/C Actuary for the California Insurance Department ■

Overview

It was not until the 1971 San Fernando Earthquake that the demand for earthquake insurance in California started to grow. The amount of earthquake insurance sold in 1980 was six times higher than the amount sold in 1970. In 1990, the amount sold had increased tenfold over the amount sold in 1980. The reasons for these dramatic increases were:

- The occurrence of many small earthquakes during this time
- Publicity about earthquakes on television and in the newspapers
- The rise in home and building values

The Role of Regulation in the California Insurance Market

As with all U.S. residential insurance, the California homeowner's earthquake insurance market is regulated and all rates approved by the state's Department of Insurance. Prior to 1994, California law mandated that insurance companies offer earthquake insurance at the tariff rate whenever they sold a homeowner's insurance policy, regardless of the condition or age of the residence. Many people declined the offer because of high premiums. The insurance industry itself had little control over the degree of take-up.

The market at the time was ruled by several untested assumptions. Commercial vulnerabilities were considered significantly higher than residential ones because wood-

frame construction was considered relatively immune to earthquake damage. Also, no consideration had been given to the rising values of appurtenant structures surrounding houses such as swimming pools, garages, patios, and walls, or to their inherent vulnerability to strong earthquake shaking. Finally, when reporting their exposures each year, insurers used criteria for calculating aggregate Probable Maximum Losses that relied upon broad earthquake zone definitions that did not capture the true geography of the California earthquake risk. Therefore, insurers had unintentionally exposed their own capital to unprecedented losses.

After Northridge

Two weeks into 1994, the Northridge Earthquake occurred on a fault underlying the San Fernando Valley. The event caused some \$15 billion in claims payments within the Los Angeles area, two-thirds of which was to the residential sector. As a result, a number of insurance companies came near to insolvency in the wake of the event. Claims exceeded the aggregate earthquake premium collected in 1993 by a factor of about 28, and exceeded the total earthquake premiums collected over the previous 25 years by a factor of four.

The insurance industry responded to this challenge to solvency by demanding permission to set higher premiums for the residential sector. At the same time, homeowners affected by the Northridge Earthquake were demanding more affordable earthquake insurance. It soon became clear that the regulatory process would not allow rapid change. The insurers, concerned about whether or not they could charge adequately for earthquake risk in an environment where offering earthquake insurance remained mandatory, threatened to pull out of the residential market altogether. This move would have significantly jeopardized the mortgage market and consequently the overall state economy. In response, the state legislature created the California Earthquake Authority (CEA) in 1996.

The CEA is a semi-governmental agency designed to prevent further catastrophic losses to the residential market by ensuring availability of at least limited coverage for all homeowners. It constitutes the largest single earthquake insurer in the world, and is the only such state provider of earthquake insurance in the U.S. Today, it provides about 70% of the residential earthquake

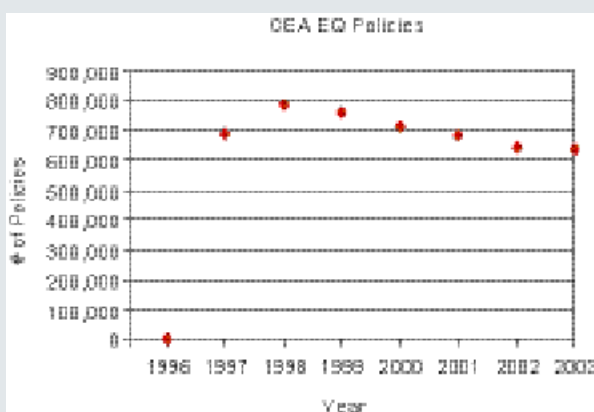


Figure 1 The California Earthquake Authority currently holds approximately 650,000 residential earthquake insurance policies

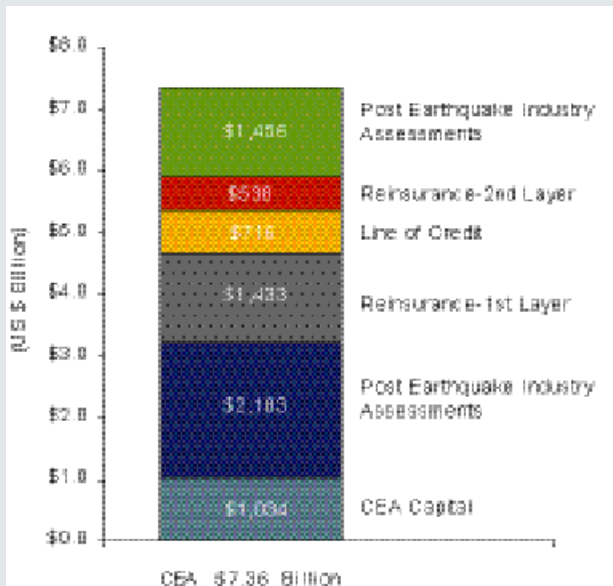


Figure 2 CEA claims paying capacity as of November 30, 2001

insurance purchased in California, or 650,000 policies, in a market of 8 million single family dwellings.

The CEA's current claims paying capacity of some US\$7 billion is supported primarily by reinsurance and post-earthquake industry assessments to primary insurance companies, as Figure 2 shows – not by accumulated capital. Were the Northridge Earthquake to occur again today, the CEA losses would be approximately US\$2.3 billion, or less than one third of its claims paying capacity.

Coverage Provided by the California Earthquake Authority

The CEA offers a highly standardized earthquake policy as a voluntary endorsement to a standard fire policy, and covers only the replacement value of the home. Premiums are set according to location and building type. The self-retained deductible remains high, at 15% of the home's value, as opposed to the pre-Northridge rate of 10%. CEA policies also exclude Coverage B

(appurtenant structures), in contrast to pre-Northridge policies, which included appurtenant structures. Homeowners thus share a large portion of the risk with the CEA. In addition, the typical CEA policy pays homeowners only in the event of a large earthquake.

Coverage of personal belongings is capped at US\$5,000, and temporary living expenses at US\$1,500—an insignificant amount in the San Francisco and Los Angeles areas. Renters and condominium owners can also purchase policies, and homeowners can lower their deductibles or purchase greater coverage by paying higher premiums, although few choose to do so.

Consequences of Establishing the CEA

The CEA's establishment has had several consequences. Premiums are high, in part to protect capital from the cost of demand surges after an event, and in part because of the CEA's heavy reliance on the reinsurance industry to ensure its claims paying capacity. Compared to the typical pre-Northridge policy, a CEA policy is four to five times more costly—providing half the coverage, that is, for about twice the rate.

The decline in the residential market has been dramatic. About 30% of the homes in California had earthquake insurance in 1994 (40% in the Northridge area). Today, only about 10% of the homes have earthquake insurance. Most homes in California are essentially uninsured (certainly, underinsured) for earthquake damage. In contrast, the commercial earthquake insurance market is flourishing, with the amount of risk (as measured by the Probable Maximum Loss) significantly greater than in the residential market. In the commercial market, there is no mandatory offer requirement. It is an open and free insurance market, where the risks can be managed and priced appropriately. Without the mandatory offer requirement, the residential market would also be an open and free market with many coverage options for homeowners. ■

■ George Walker, Senior Risk Analyst, Aon Re Australia ■

History

Taiwanese insurance companies have long offered earthquake insurance for commercial and industrial enterprises, with sub-limits on a first loss basis that are typically 50% of the total replacement value. While the take-up of earthquake protection has always been reasonably high for property associated with medium or large commercial and industrial enterprises, it was very low for residential property.

This low rate was highlighted in the aftermath of the 1999 Chi Chi Earthquake, when tens of thousands of dwellings were destroyed. Although about 50% were covered by fire policies, fewer than 1% of them were covered by earthquake insurance, which was sold as an optional addition to fire policies with premiums set by a tariff system.

The chief reason for this disparity between fire and earthquake insurance was that fire insurance was required to obtain a loan for the purchase of a dwelling, whereas earthquake insurance was not. As in many developing countries, Taiwanese homeowners are reluctant to purchase property insurance if it is not obligatory. It was not until the political fallout from the 1999 disaster that the government addressed the very low rate of earthquake insurance by forming the Taiwan Residential Earthquake Insurance Program (TREIP), which commenced in May 2002.

TREIP Structure

TREIP offers a good example of a new insurance scheme that benefits from catastrophe model results. The TREIP policy conditions and premiums were based on the results of earthquake catastrophe models for Taiwan (see Figure 1), but premiums are not adjusted according to modeled outputs. TREIP instead charges a uniform fixed premium as a levy for each dwelling when it is insured for fire. Premiums were fixed by the government at a level considered politically acceptable, and policy conditions were then adjusted to ensure that the scheme was financially sound.

This levy provides a fixed amount of coverage, mostly for buildings, with a smaller amount for temporary accommodation that can only be claimed if the dwelling is declared a total loss. The amount of coverage is modest, sufficient to rebuild only a very basic dwelling. It is

intended to relieve the financial burden, rather than remove it altogether, and may therefore be regarded as a form of finite co-insurance. The total liability of TREIP is capped at NT\$40 trillion. If the total aggregate loss exceeds this value, then building claims are reduced proportionally.

Practice & Regulation

TREIP operates under government legislation and is a joint government/industry insurance scheme managed by the Central Reinsurance Corporation (CRC). Insurance companies collect premiums for earthquake coverage when underwriting fire policies. In Taiwan, almost all fire policies are taken out with loans.

Prior to the introduction of TREIP, fire insurance was purchased for the whole period of the loan at the time when the loan was taken out. Consequently, there were few renewals of residential fire policies. After the introduction of TREIP, fire policies taken out for new loans had to be renewed annually. Since new policies are associated with new loans and the average loan period is about 10 years, with actual payout periods averaging around five years, the growth of TREIP is directly related to new loan acquisition.

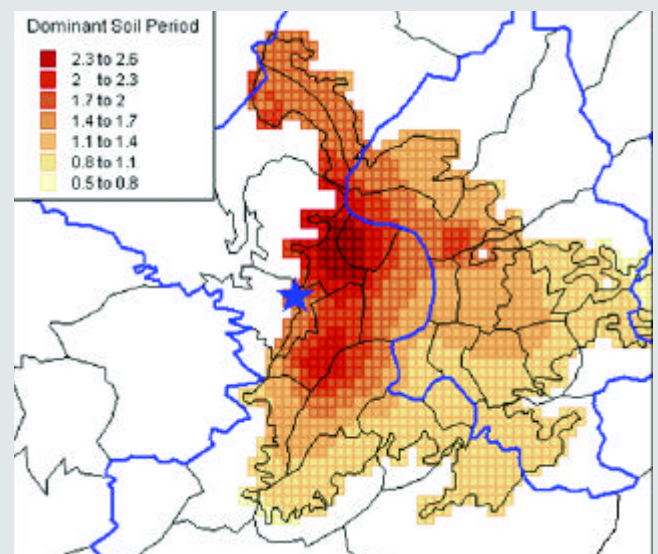


Figure 1 Sophisticated catastrophe modeling such as this RMS analysis of response spectra for high-rise buildings in Taipei was used in the development of TREIP policy conditions, premium levels, and reinsurance strategies

Reinsurance

The reinsurance strategy has been largely determined by catastrophe model results, as has the purchase of the Cat Bond (see Figure 2). The reinsurance and reserve strategies do not, however, take into account dynamic financial analysis model outputs.

Future Developments

TREIP was introduced as an interim scheme pending the outcome of a major six-year program of research on disaster insurance schemes for Taiwan. It is anticipated that the scope of TREIP will be widened to include typhoon losses, and maybe other perils.

Effectiveness

As a result of TREIP, about 13% of dwellings in Taiwan have a limited level of coverage against losses from earthquake damage. It is anticipated that this will rise to about 40% within the next four to five years. Unless there is a change in the cultural attitude toward insurance in Taiwan, the maximum penetration will be limited to about 50%— the proportion of dwellings with a mortgage. ■

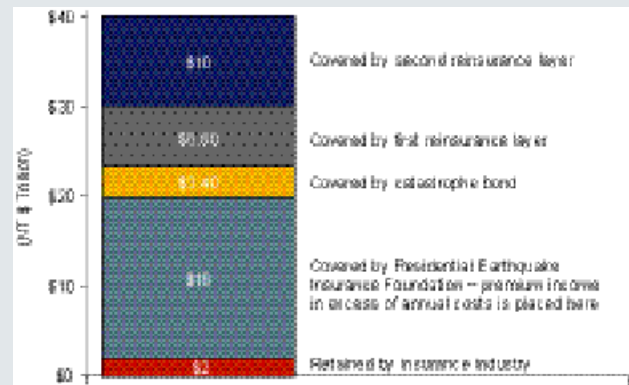


Figure 2 Financial structure of the Taiwan Residential Earthquake Insurance Program (TREIP)

TURKEY

Richard Sanders, Divisional Director, Willis Re

Developed in the aftermath of the devastating Kocaeli and Duzce earthquakes in August 1999, the Turkish Catastrophe Insurance Pool (TCIP) is another recent example of the creation of a national natural catastrophe pool. It is already the second largest catastrophe pool in the world in terms of numbers of policies issued, and has served as a model for several other national pools. Although developed as part of the Turkish Emergency Flood and Earthquake Recovery Program (TEFER), the scheme covers only earthquakes.

The impact of the 1999 earthquakes was truly catastrophic, causing over 18,000 fatalities and as much as US\$13 billion in losses, according to the State Planning Organization (the World Bank estimated losses between US\$6 billion and US\$10 billion). Insured losses, however, amounted to only US\$1 billion to US\$2 billion. The fiscal impact on the nation's economy was thus considerable, peaking in 2000 at US\$4.2 billion, or almost 2% of the GNP. Such events are more than likely to recur, with similar losses: Turkey is historically earthquake prone, and 98% of the population lives in areas at risk.

The Structure of TCIP

Prior to the initiation of TCIP in September 2000, the Turkish government effectively was financially responsible under the Turkish Disaster Law for the replacement of residential buildings damaged by earthquakes. The population, relying upon the government, saw little need for other coverage. Hence, there was minimal penetration of earthquake property insurance across the country, and a great burden placed upon the government.

After the 1999 earthquakes, the government (through the General Directorate of Insurance) and the World Bank moved quickly to establish a compulsory earthquake insurance cover (the TCIP) that would spread the burden of coverage more broadly. A government backed insurance program, the TCIP covers only residential buildings. Policies are sold through a network of insurance companies and their agents, who issue policies on behalf of the pool. Top-up insurance (beyond the pool limits) is available from conventional insurers, but as the pool limit encompasses around 90% of properties, top-up insurance is not widely purchased. The pool itself is protected via risk transfer into the international reinsurance market, and the scheme is administered and run by Milli Re, the national reinsurer.

Initial development of the state pool was carried out by a consortium led by Willis. The consortium took responsibility for developing earthquake and flood models to assess the risk to property and to the state, developing an economic model, and designing the insurance pool and a risk transfer (reinsurance) program, along with research into possible mitigation measures. The whole process was transparent and subject to academic and peer review.

Coverage and Reinsurance

The scheme, as initiated in 2000, covers earthquake only and has five tariff zones (based on CRESTA Zones) and also some sensitivity to construction type (steel and reinforced concrete, stone and brick, and "other"). TCIP also requires some compliance with building standards, in that any buildings constructed after September 27, 1999 must have construction licenses in order to be covered. The scheme has a maximum payout per property of approximately US\$42,000 (at July 2004) which is regularly reviewed, and a deductible of 2% of the sum insured for each loss.

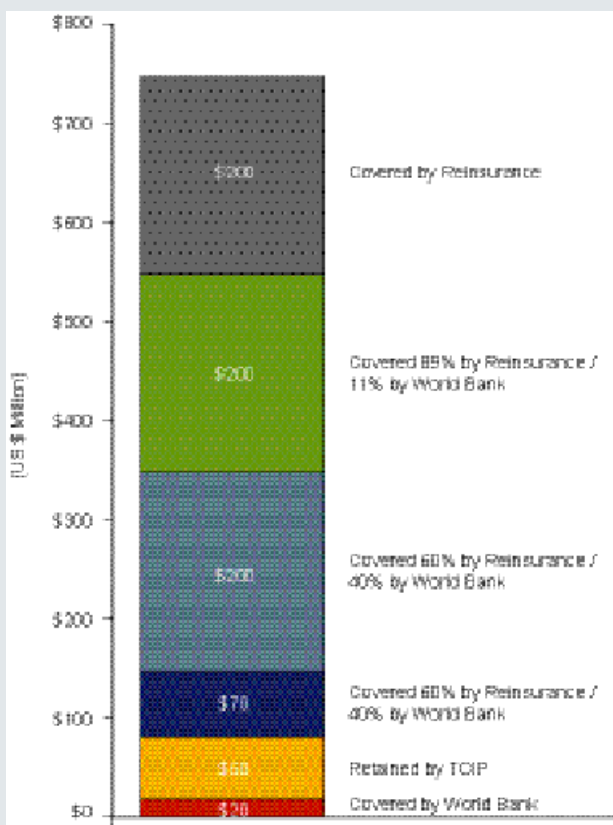


Figure 1 Turkish Catastrophe Insurance Pool (TCIP) risk financing program, 2004

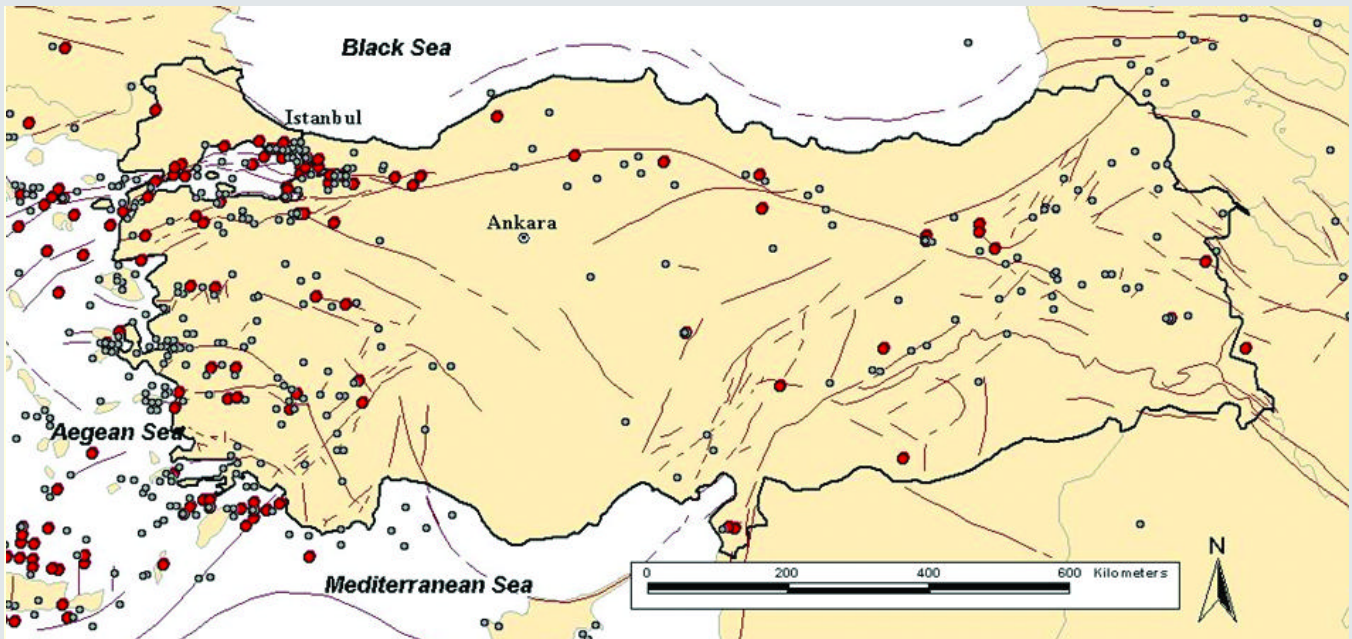


Figure 2 Turkey has an extensive catalog of earthquake data dating back to 550 BC, as shown in this plot of earthquakes exceeding M_w 6.0

After the consortium completed the initial development project, a further consortial scheme provided reinsurance through approximately 50 reinsurers worldwide. Exposure analysis is carried out for the consortium using the earthquake tools developed in 2000 and commercially available catastrophe models. By diversifying the risks, the pool can spread and leverage premium income over time, so as to ensure that the inflow of funds, post loss, would be many times that generated in any one underwriting year.

Successes and Challenges

The scheme, although intended to be compulsory, has a penetration of approximately 16% nationally with a much higher rate of approximately 27% in Istanbul and surrounding areas. While the scheme has been successful in expanding coverage into areas that previously had almost no earthquake insurance, the penetration rates

suggest some of the challenges in implementing a compulsory nationwide scheme. Many buildings exist outside government planning regulations or are not captured in government building statistics. The number of policies sold since 2001 has in fact dipped slightly, from over 2,166,000 in 2001 to fewer than 1,950,000 in 2004, despite a total of approximately 13 million properties eligible for coverage.

The scheme is nonetheless considered a great success by the government. Theoretically it would provide enough additional economic support to the economy to reduce undue financial burden to the state in the event of earthquakes comparable to those of 1999. It has yet to be tested, however, by a serious loss. While some US\$5.5 million has been settled in losses to date, all losses sit well below the level for reinsurance recoverables, and are insignificant when compared to the losses of 1999. ■

■ THE ROLE OF THE REINSURANCE COMPANY

■ Martin Bertogg, Head of Earthquake Team, Swiss Re ■

The individual homeowner in one of China's major cities purchasing residential insurance for the first time may not be aware of the protections afforded to homeowners indirectly by the global reinsurance industry. That industry, however, is integral to the health of the local insurance industry, especially when new systems are being established and capital has not yet accumulated.

Swiss Re and China

The reinsurance industry is not new to China, as Swiss Re's long-standing relationship to China's insurance industry shows. Swiss Re's first Chinese reinsurance contacts date back to 1930. In 1979, Swiss Re concluded its first treaty with the People's Insurance Company of China (PICC). Over the last 30 years, the cooperation between the two companies has gradually strengthened, and in 1996 Swiss Re opened its first representative office in Beijing. A second office opened the following year in Shanghai. Swiss Re has had full branch operations in China since 2003.

Non-life reinsurance cessions within China as well as to the international markets are currently dominated by property and engineering exposures for industrial facilities. Personal line exposure is small, with the exception of car insurance. Property programs are placed in the reinsurance market as surplus shares covering the largest industrial accounts proportionally, with additional per-risk and overall catastrophe protection. Typical insured hazards are fire and explosion, although from an insurer's perspective when building a property portfolio, these hazards play a far less significant role in overall loss estimates than various natural perils.

In just the last two years, China's capacity to strengthen and refine its insurance industry has changed dramatically. China became a member of the World Trade Organization (WTO) in 2001. In accordance with WTO agreements, a compulsory proportional cession for any insurance company to China Re is gradually phasing out, from 20% in 2002 to 0% in 2006. Insurers are instead required to reinsure in accordance with regulations set by the China Insurance Regulatory Commission. These regulatory changes are paving the way for a rapidly growing market for new and international reinsurance companies that seek to support Chinese domestic insurers when underwriting natural perils.

1. Establishing a Risk Sharing Community for Earthquake Hazards

Earthquakes affect entire regions and insurance portfolios at once. They may cause an untold number of casualties and enormous property damage and subsequent losses. It is thus impossible, over a reasonable period of time, to balance premiums and losses within the affected area alone.

In order to prevent the insurance industry from being overwhelmed, countries can participate in large global risk-sharing communities. In contrast to the domestic insurance industry, which typically establishes and administers a risk-sharing community on a national basis, the global reinsurance industry creates a worldwide diversified portfolio of peak risks, thereby absorbing domestic peak exposures. The reinsurer typically covers the rare, but extreme losses. At the other end of the spectrum, property owners typically cover nuisance losses themselves.

2. Providing Sufficient Risk Capital

An insurance company's underlying claims paying capacity, or the needed risk capital, has to correspond at all times to the assessed loss potential in order for the company to meet potential claims. Yet a natural catastrophe can expose a large portion of a local insurance company's portfolio. A reinsurance company provides competitive claims paying capacity to the local insurance industry by assuming many independent loss potentials at once. Because the reinsurance company spreads its exposure worldwide, it can balance local losses with worldwide premium income. The financial capacity of the insurance industry to absorb catastrophe losses has grown substantially through this approach, as well as through the addition of different lines of insurance exposure.

Since a reinsurance company's portfolio will be only partially affected by a strong earthquake, the company can use the same risk capital more than once. This diversification greatly reduces the cost of risk capital. The larger and better diversified a reinsurer, the lower its capital costs will get.

3. Assessing Earthquake Risk

Classic actuarial methods are not well suited for analyzing and assessing natural perils, which occur too infrequently for a reliable tally of losses or possible occurrences. In

the late 1980s, Swiss Re was a leader in developing probabilistic earthquake models. Since then, the entire insurance and reinsurance industry has supported the development of sophisticated exposure-based modeling, which yields the annual expected loss to a portfolio as well as a loss exceedance curve—the two cornerstones of an insurance scheme.

Earthquake Hazards in China: The Reinsurer's Perspective

Reinsurers increasingly play a role in creating earthquake insurance rating frameworks in different countries. Such proposals must take into account the key requirements for a sustainable earthquake protection scheme, on the part of primary insurers as well as reinsurers.

When addressing earthquake hazard exposures in China, the reinsurer will first ensure that the long-term premium level and total annual premium collected for the original insurance product are adequate to cover the long-term expected annual loss burden. Administration costs and capital cost margins need to be included in these calculations. Second, premiums should be offset by well-defined coverage and the careful use of self-retained deductibles. Finally, the earthquake risks themselves will be assessed using comprehensive datasets and seismic hazard models that reflect the geographic location of an insured building and the up-to-date replacement value of the building and contents. Additional risk-adjusted modification factors can include the seismic resistance of facilities within building types, which can vary significantly, according to factors such as the type of subsoil at the building site or the structural type of the building.

The rating framework in China will be further influenced by the degree to which evolving schemes are compulsory. In a compulsory scheme, insurers need to build a high level of solidarity by evening out premiums into the rating framework and creating more “risk sharing” between consumers in order to support the system and promote social stability. A fully voluntary insurance framework, on the other hand, leads to a highly risk-adjusted rating scheme.

By far the biggest challenge facing the insurance and reinsurance industry when underwriting exposures in China is assessing the risk to portfolios from earthquakes, typhoons, and floods. As shown in Figure 1,

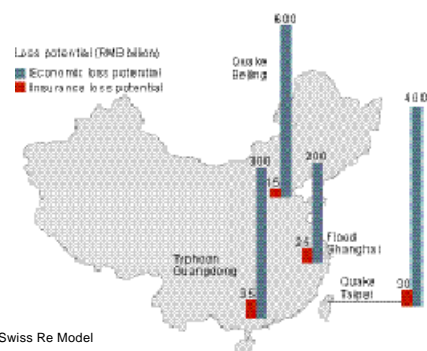


Figure 1 Insured and economic loss potential in China—only a small portion of the loss potential is currently insured

the potential for large losses from earthquake and other natural perils has already reached several hundred billion RMB, endangering stable development as well as social stability. The examples in Figure 1, which range up to an estimated RMB600 billion (US\$72.5 billion) for a large earthquake in Beijing, represent only a small portion of the overall economic loss potential from natural disasters across China. Only a small portion of this loss potential is currently insured.

In the face of such tremendous exposure, a risk-sharing community, consisting of the policyholder, the insurer(s), the reinsurance industry, and possibly other participants, can provide significant capacity. Such a community requires solid rating techniques and risk management methodologies for natural disaster risks. Risk management methodologies, in turn, require a comprehensive exposure dataset for assessing expected losses and loss-exceedance probabilities. The resulting methodologies can then allow insurers to set meaningful premiums that provide the core fuel for the entire system.

Conclusion

China offers perhaps the most dramatic discrepancy in the world today between the degree of earthquake risk and the extent of insurance. This discrepancy is poised to diminish fast, however, with the reinsurance industry's rapidly intensifying involvement in China and China's fast-growing domestic insurance market. A sound technical framework for risk-sharing communities will guarantee long-term loss payment capacity at stable price levels. Ultimately, such a framework will enable China to absorb the financial consequences of natural disasters more efficiently and effectively in the future. ■

■ THE ROLE OF THE REINSURANCE BROKER

■ James Nash, Managing Director, Guy Carpenter ■

A Changing Culture

The role of the reinsurance broker has changed radically over the past decade. In the early 1990s, brokers traditionally provided clients with services that focused on the placement of reinsurance transactions and related advice. Now, in the 21st century, the broker's role has expanded, to encompass a full range of risk management solutions and associated services to insurers. With this expanded role, the reinsurance intermediary share of the market is growing, and will likely continue to do so as long as risks increase in both size and complexity.

This transition is most clearly seen in the catastrophe reinsurance market. Catastrophe reinsurers previously priced their product using data from historical losses, an assessment of market share, and some actuarial analysis. Insurance companies took a similar approach. They let management memory guide their coverage and buying decisions, which often led to bias in assessing catastrophic risk. Relationships were an important aspect of the business, as was the concept of payback (recouping losses through adjusted premium rates). Against this background, the broker's role was to advise the client on appropriate coverage and to manage the reinsurance placement.

The Growth of Risk Management Services

As catastrophe models were developed and accepted in the mid 1990s, the broker's role was radically altered, evolving to that of a full-service risk management consultant. Utilizing in-depth quantitative analysis, brokers began to review all aspects of an insurer's exposures to catastrophic loss, and to develop solutions relating to many aspects of the insurance process beyond sales transactions.

During the market dislocations of 1992 and 2001, brokers also became more actively involved in creating new reinsurance capacity. Some \$25 billion in capital entered the market within six months after the events of September 11, 2001, much of it due to the initiatives of brokers. A new generation of reinsurers and capital providers contributed in turn to an environment in which insurers increasingly expect high-quality data, catastrophe model development, and state-of-the-art risk management services.

In order to fulfill their enhanced role, today's brokers are deeply involved in educating their client base about the benefits of data quality. They need to take into account the external pressures on their clients from rating agencies, investors, and regulators. More and more, reinsurance brokers assume an advisory role: they host fact-finding and educational delegations to various insurance markets around the world. Increasingly, brokers act as catalysts of change rather than reactors.

The Example of Taiwan

A prime example of the expanded role of the reinsurance broker can be seen in the establishment of the Taiwan Residential Earthquake Insurance Program (TREIP).

This program, put in place following the devastating 1999 Chi-Chi Earthquake in Taiwan, provides earthquake coverage to homeowners in Taiwan. Guy Carpenter was involved from the outset. The company first brokered a partnership with RMS and local scientists that allowed for the collection of extensive information on property exposures and for the re-tooling of the earthquake model for Taiwan's earthquake exposure.

A key feature of TREIP was the incorporation at the outset of loss prevention and mitigation measures. As TREIP was developed, Guy Carpenter also provided strategic consulting service in the areas of claims handling procedures, policy design, modeling cash flows, and losses. Areas that needed to be addressed included:

- Notification of claims
- Establishment of an earthquake claim committee and joint claim service center of the non-life insurance association
- Loss survey
- Indemnity basis and loss payout
- Handling of double insurance
- Claims documents

The creators of TREIP also needed to strike a balance between basic coverage of residential earthquake insurance and extended earthquake insurance coverage.

Guy Carpenter's role went beyond assisting with the creation of an insurance infrastructure. Through its affiliate company Marsh & McLennan Securities¹, Guy Carpenter assisted with the design of a catastrophe bond. The catastrophe bond was designed as an independent

block of risk transfer capacity, outside of the reinsurance structure on a per occurrence basis. The bond greatly increases the overall capacity of TREIP, and when integrated with the flexibility of TREIP's traditional reinsurance program, eliminates basis risk. The program is simple, attractive to investors, and very flexible, taking advantage of the strengths of both the catastrophe bond market and the reinsurance market while minimizing the costs and challenges of the catastrophe bond marketplace.

Conclusion

The example of TREIP clearly demonstrates that the broker of the 21st century is involved in a wide range of activities, ranging from simple tasks, such as arranging a press conference, to advising on a complex alternative risk transfer program via a catastrophe bond. The successful broker cannot view the world as standing still, but will understand and value client and market relationships, while mastering a whole new set of financial and consulting skills. ■

¹ This information is not an offer, recommendation or solicitation for the purchase or sale of any securities, financial instrument, reinsurance or insurance product. Securities are offered in the United States through MMC Securities Corp., a registered broker-dealer and member NASD/SIPC; reinsurance products are placed through Guy Carpenter & Company, Inc. ("Guy Carpenter"); and insurance products are placed through qualified affiliates of Guy Carpenter. MMC Securities Corp. is an affiliate of Guy Carpenter.

■ EARTHQUAKE INSURANCE IN CHINA: RECOMMENDATIONS FOR A SOUND FUTURE

As with many other aspects of its spectacular economic development since 1980, China now has the opportunity to select the best from what has been learned in the operation of earthquake insurance systems in other countries. China can also take advantage of the latest technical understanding of earthquake risk gained from catastrophe loss modeling, thereby creating a science-based earthquake insurance system appropriate for the 21st century.

This report outlined earlier the three essential criteria for promoting catastrophe insurance: fairness, affordability, and a financially sound insurance sector protected by strong government regulation. What steps should China take to promote a science-based earthquake insurance system that fulfills these criteria, and that also serves as a principal component of national earthquake catastrophe risk management?

1) Fairness: Creating a Technical Pricing Structure

Any insurance system should be fair and equitable, so that property and business owners are charged an appropriate price for their risk in the form of an annual insurance premium. This premium will be adequate to reconstitute those future losses likely to be incurred.

Before catastrophe models, rating schemes tended to be very simple. Catastrophe modeling, however, has made it possible to determine the technical rate for the risk, taking into account how risk varies by location and building type. Insurers and regulators are thus increasingly able to design an earthquake insurance system that reflects this new knowledge.

In areas where there is a free market in earthquake insurance, as for example in the commercial sector in California, all underwriters use catastrophe models as they compete with one another to offer the best rates for the risk. Using the same catastrophe model or blend of models does not, however, result in each company charging the same premium to insure a particular property. Prices vary according to the degree to which the new risk overlaps with the portfolio of risks the company has already underwritten. If the new property is located in the middle of highly concentrated exposures in the portfolio, then it increases the scale of the most extreme 'tail loss' events, requiring some additional purchase of reinsurance. If the greatest loss to the property, however, comes from earthquakes that do not cause significant losses to the remainder of the insurer's

existing exposures, there will be no need to charge the cost of additional reinsurance.

Furthermore, earthquake insurance premiums for commercial properties tend to be set in the open market, while many residential insurance schemes have tariffs set by insurance regulatory authorities. In designing residential schemes, an important decision must be made: should the rates match, as closely as possible, the modeled rate for the risk, or should they achieve some measure of risk sharing? Many older schemes included inadvertent risk sharing simply because it was not possible to know how risk actually varied geographically. Since the arrival of catastrophe models, however, decisions about risk sharing can be made explicitly.

The greatest degree of national 'solidarity' in any earthquake insurance system is achieved when everyone pays the same rate, irrespective of their risk. Such level premium rates can be seen in Taiwan and New Zealand. In contrast, technically sophisticated schemes can now require that every insurance rate be set according to output from an established and robust model, and that the model be approved by a regulator for this purpose, as is the case for residential hurricane risk in Florida.

When creating a suitable scheme of earthquake insurance rates for China, the simpler the scheme the easier it will be to implement. On the other hand, the more that the tariff structure disguises significant variations in the underlying risk, the more it incurs hidden cross-subsidies for risk bearing and potentially introduces poor incentives for risk mitigation. Uniform rating systems work best for smaller territories located on plate boundaries, such as Taiwan and New Zealand. A country like China, which is both very large and also host to a tremendous variability in earthquake hazard, needs to create a rating scheme that reflects the best modeled output available.

2) Affordability: Providing a Flexible Range of Coverages

The earthquake insurance product should provide sufficient coverage so that after an earthquake, individuals can rebuild their homes and businesses. In the 'hard' (expensive) market for reinsurance after the major catastrophic losses between 1987 and 1994, insurers restricted the terms of coverage to control reinsurance costs, in particular by imposing higher deductibles. From the insurer's point of view, raising deductibles can also help limit the number of claims they need to investigate and review in the aftermath of a catastrophe. A striking

example of the insurance market's response to a hard reinsurance market arose in California in 1994-1995, when the California Earthquake Authority's mini-policy set a standard deductible of 15% of the value of the property insured.

It also remains to be seen how 10-15% deductibles actually perform in the event of a major catastrophe. Those who carry such deductibles in their policies are often unaware of their possible implications. In societies with a strong consumer voice, such as the U.S., insurers may face political pressure after a major catastrophe to be more lenient in how they respond to claims. For pragmatic reasons, therefore, deductibles should ideally be set no higher than at 5% of the value of the property. The impact of a particular deductible on the technical rate for the risk can be measured using the output from the catastrophe analysis financial model.

Payments for damages after an earthquake can also be restricted by imposing a limit on the amount that can be recovered. In this regard, Japan provides an interesting lesson in how earthquake insurance limits tend to lag behind consumer demands for effective protection. In the first generation of earthquake insurance in the 1960s, only those people whose homes were destroyed received a payout. Over the past 40 years, each major earthquake led to popular demands for a system that provided more satisfactory and graduated compensation. On each occasion, the coverage was expanded. Even today, however, coverage in Japan has not reached the level found in Europe and the U.S., where, after the deductible has been taken into consideration, losses paid reflect the actual level of damage suffered. A scheme that matches the post-deductible payment to the loss will require greater attention on the part of a loss adjuster and greater discussion with the insured, but it has clear political advantages in satisfying consumer demands.

Taiwan has taken the first steps in imitating the path taken in Japan. Taiwan's first generation earthquake insurance product offers payment only when the owner's property is not worth repairing (that is, when the damage represents more than 50% of the sum insured). Inevitably, as the economy grows, political pressure is likely to force this system to offer more complete protection.

Clearly, then, a link exists between fair pricing for insurance and the level of coverage. Consumer education thus becomes a key ingredient of a successful insurance scheme. The people who purchase insurance need to be aware how the coverages would work in the event of a loss, and to have some choice over the level of protection. For example, homeowners should know how much money they may need to set aside for reconstruc-

tion, or how readily they could secure a reconstruction loan. Ideally, some alternative insurance structures should be offered—as is often the case with an ordinary homeowner's policy—where, for a higher deductible, a lower premium is available.

3) Creating a Financially Sound Insurance System

The third requirement for a successful earthquake insurance scheme is that the organizations offering insurance are able to withstand the financial shocks of all credible disasters. If the impacts of earthquakes are well understood and planned for, then earthquakes do not need to be financial catastrophes for the insurance industry. The ability to withstand catastrophe losses at long return periods requires that the insurance organization is collecting sufficient premium to support the magnitude of the risk. If the cost is too low, as it was in California before the 1994 Northridge Earthquake, then insurers face the prospect of insolvency following a major earthquake with higher than anticipated losses.

The responsibility of ensuring that insurance companies have sufficient reserves or additional sources of funds to support their liabilities falls on the owners, managers, and shareholders of the insurance organization as well as on the government insurance supervisory system. Whatever the role of the government—and in China, it can be anticipated that the government role will remain central—the role of the regulator is always two-fold: on the one hand, to ensure that the insurance companies themselves have enough capital to withstand catastrophic shocks, and on the other, to protect those who purchase insurance.

The only way that an insurance organization can demonstrate the ability to survive catastrophes and to protect those insured is through the proper use of reputable catastrophe analysis models. It is crucial that the regulators are themselves familiar with the models being employed and are able to confirm that the model components, architecture, and calibration meet suitable international standards for this purpose.

In order to ensure they have sufficient capital to withstand individual catastrophic losses, insurance organizations can diversify their portfolio to create several separate uncorrelated concentrations of risk, and they can buy reinsurance for peak exposures.

For managing portfolios of earthquake risk, China has advantages over a country like the U.S. or Japan because of its large size and the well distributed nature of exposure relative to the hazard. There is, for example, no Chinese equivalent of San Francisco or Tokyo, both major cities built at locations of the highest hazard: close

to plate boundaries. In general, the largest concentrations of exposure in China, such as at Shanghai and Hong Kong, are in areas of relatively low earthquake risk. However, given that the earthquake insurance market is currently very small, the insured risk in these separate concentrations is likely to grow fast. Such rapid growth will demand that the major insurers and reinsurers deploy optimum risk management strategies, bearing in mind that losses at key return periods are likely to be increasingly dominated by major cities like Beijing and Xian, which also have moderate levels of earthquake hazard.

Regional insurers in China, which operate largely at province level, will need a greater proportion of reinsurance than strong and well-diversified national insurers. Given the fact that even the largest and most diversified insurance organizations in China will underwrite concentrations of earthquake risk in specific areas such as Beijing, it will be financially prudent to require the purchase of reinsurance for tail loss events. Reinsurance costs will need to be taken into account when insurance coverage for these major concentrations of urban risk is priced.

Earthquake Insurance and Risk Mitigation

Beyond the three criteria for a successful catastrophe insurance system, improving the quality of the building stock will help to reduce the level of earthquake risk over time. Therefore, a successful earthquake insurance system should also provide incentives for risk mitigation activities. In areas of high risk such as California, reductions in the cost of earthquake insurance are provided to building owners who have had an older structure retrofitted to a higher design standard.

One reason for avoiding a uniform rating system is that 'solidarity' does not create the right circumstances for rewarding risk reduction activities. The most obvious risk mitigation against earthquake damage concerns the implementation of building codes. Property developers must be encouraged to understand the link between satisfying code requirements and lowering the subsequent cost of insurance. Constructing better buildings also helps reduce casualties in earthquakes. Many deaths in earthquakes are ultimately caused by the absence of proper planning scrutiny around the building location, construction materials, and compliance with building codes.

Earthquake Insurance and Mortgage Markets

As in many other countries, a key driver of the development of an earthquake insurance system in China will come through the emerging requirement that property owners take out earthquake insurance when securing a mortgage. Currently, China is unusual in not requiring building insurance for mortgaged properties. In the event of a catastrophic earthquake in which many apartment buildings are badly damaged and buildings collapse, the losses would fall not only onto the individual owners, but also, if the owners were no longer able to service their loans, onto the banks themselves. This additional risk-bearing may not be adequately reflected when interest rates for loans are set in China, or when identifying the risk to the bank's own loan portfolio in its solvency requirements. In order to protect the Chinese banking sector, the building's insurance policy should at a minimum match the terms of the loan, in duration and in the proportion of the value protected.

Conclusion

Historically, new earthquake insurance schemes have emerged only in the aftermath of a catastrophic event. First-hand experience of the disruption that earthquakes inflict has created the political will to establish a new insurance system, typically funded by property owners. More recently, with the advent of catastrophe analysis modeling, countries can design and implement an earthquake insurance system before catastrophes occur—yet so far, no country has done so. Catastrophe models can also be used to inform an educational campaign, so that property owners understand why the system is needed, and why their participation is for the good of the whole society.

A unique opportunity exists in China today: to be the first country ever to develop a new earthquake insurance system without the undesired incentive of a major catastrophe. Increasingly, governments, insurers, reinsurers, international agencies, and risk modeling experts are working together as partners, fully exploiting the rich potential of new technology. Such partnerships make this an ideal time to create a sustainable scheme that will protect individuals in China as well as the Chinese government itself from unforeseen and disastrous catastrophic events. ■

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