Natural Catastrophe Risk Insurance Mechanisms for Asia and the Pacific
4–5 November 2008
Tokyo, Japan
Conference supported by the Asian Development Bank and the Ministry of Finance, Government of Japan

SPECIAL NATURE OF DISASTER RISK IN MEGACITIES

Michael Spranger[1]
Munich Reinsurance

INTRODUCTION

In 1950, the world was home to 2.6 billion people. By today, this number has grown to 6.6 billion; by 2050 it will probably increase another 40% to approximately 9.2 billion people.

At the same time, people are becoming wealthier and more productive. The Gross World product grew by a factor of 8. From about 8 trillion USD in 1950, it rose to an estimated 67 trillion USD in 2005 (Sachs, 2008). Optimistic scenarios, barring wars and unforeseen economic shocks, expect it to be a staggering five to six times higher by 2050.

In a third megatrend of our time, urbanization is increasing at an unprecedented scale (UN-Habitat, 2003). Every week about 1.3 million people are moving to cities, 70 million per year. However, cities in developed countries are only growing slowly, if at all. From 2008 on, more than 50% of the world population will be living in cities, as it is the case in developed countries since around 1950. Urbanization almost exclusively takes place in the developing countries in Africa and Asia. By 2030, the United Nations expects more than 60% of people to be living in cities.

Around 9% of the world's urban population—about 280 million people—currently live in megacities, and this figure is likely to rise to 350 million over the next 10 years. In the People's Republic of China alone, almost one billion people will be living in cities by 2030, according to a recent study by McKinsey Global institute (Woetzel et al, 2008). Due to fast growth in population and economic wealth, Asian megacities will become the center of gravity of the world economy in future.

We believe that, because of the megarisks inherent in megacities, the insurance industry has to deal with the subject of megacities more intensively than most other sectors of the economy. Suitable strategies must therefore be developed and incorporated into the overall risk management to ensure that risks can be kept under control in the future too. Otherwise, they might assume proportions that could threaten the industry's existence.

The causes of losses in megacities are complex, from natural hazards, technological, social, political, and infrastructure risks to economic risks.

This paper, however, only focuses on the challenges of megacities to natural catastrophes and on how the insurance industry can contribute to a holistic approach to risk management of megacities, leading them from "global risk areas" (Kraas, 2003) towards "engines of global change" (Kraas and Nitschke, 2006).

For the insurance industry, the low insurance density in the megacities of all developing countries is one of the big challenges, but also opportunities, of the 21st century.

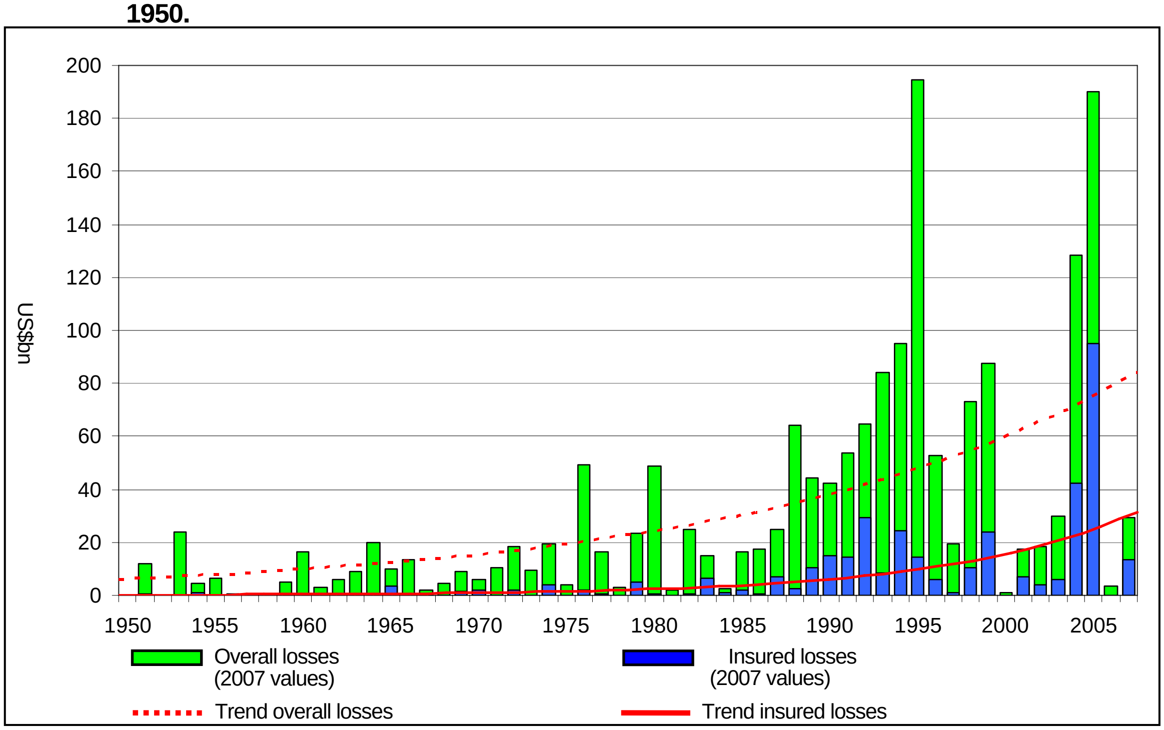
[1] The views expressed in this paper are the views of the authors and do not necessarily reflect the views or policies of the Asian Development Bank (ADB), or its Board of Governors, or the governments they represent. ADB does not guarantee the accuracy of the data included in this paper and accepts no responsibility for any consequence of their use. Terminology used may not necessarily be consistent with ADB official terms.

TRENDS IN LOSSES

The number of natural catastrophes is increasing. In 2007, Munich Re registered 960 events, the highest number ever in a single year and far above the average of 720 events over the last ten years and more than double the average of the 1980s, when the average was 400 events per year (Munich Re, 2008).

About one third of these catastrophes occur in Asia. However, the insured losses in Asia are still only about 10% of the worldwide insured losses so far, but fatalities are about 70% of all, highlighting the vulnerability of Asia to natural catastrophes. Since 1980, more than 1 million people perished in Asia due to natural catastrophes, more than in all other continents together. But not only has the number of registered events increased. It is well documented, that the economic losses are increasing rapidly as well.

Figure 1: The chart presents the overall losses and insured losses from natural disasters worldwide – adjusted to present values. The trend curves verify the increase in catastrophe losses since 1950.



The two most expensive individual catastrophes in history both did affect cities in developed countries: the earthquake of 17 January 1995 in the Japanese city of Kobe, causing an economic loss of US$ 140bn and Hurricane Katrina in the United States (25–30 August 2005), which cost US$138bn (both at 2007 values). Katrina was as well the most expensive insured loss ever with US$ 67.7bn.

By 2015, and within 10 years, loss potentials among the world's 10 largest cities, most of which are in developing countries, are projected to increase from 22% (Tokyo) to 88% in Shanghai and Jakarta (Bouwer et al, 2007).
Given the evident trend of increasing severity of losses, insured market losses of US$ 100bn will only be a matter of time. They will impose significant stress on the national economy of the affected country as well as on the national insurance industry. Most likely, such an event will occur close to or within a major city.

EXAMPLES OF NATURAL CATASTROPHES IN CITIES

Larger Cities have ever existed in the history of humanity and they have been affected by natural catastrophes ever since. Munich Re (2004) lists 49 significant events, starting with the eruption of Mt. Vesuvius in 79 AD.

In the early part of the 20th century, earthquakes in San Francisco (1906) and Tokyo (1923), major economic centres of global importance, caused widespread devastation and paralyzed economic activity for a long time in the affected areas.

The San Francisco 1906 Earthquake

The major magnitude 7.9 earthquake in San Francisco in 1906 was one of the biggest losses in the history of insurance, resulting in 3,000 deaths, economic losses of US$ 524m, and insured losses of US$ 180m in 1906 values (Munich Re, 2006). Since then, the population in the area affected by the earthquake increased by a factor of ten. Even more staggering: the replacement value of buildings nowadays is about 500 times greater than it was in 1906. If this earthquake repeated today, the number of fatalities is estimated to be comparable to what it was in 1906; a clear expression of increased resilience of the city due to better building standards. The expected economic loss from damaged property, however, would be in the range of US$ 90-120bn (Kircher et al, 2006). This modelled figure does not take into account losses due to fire following, which in 1906 made up to 80% of the overall losses. However, the conflagration risk seems to be much lower nowadays, mainly due to higher fire resistance of today's high-rise buildings and the installation of the Auxiliary Water Supply System (Munich Re, 2006).

The expected gross insured property damage from such a scenario is estimated at around US$ 40bn. However, as it is usual in California for the policyholder to pay a deductible of 10–15% of the sum insured, the amount payable by the insurance industry would be reduced to about US$ 20–25bn—if the deductible really holds in such a large event.

The values of exposed property will continue to grow rapidly, leading to even higher loss estimates in the near future. The odds for a large earthquake striking the San Francisco Bay Area in the next 30 years are 63% (WGCEP, 2007).

The Kobe 1995 Earthquake

In recent times, the city of Kobe has been hit by a M6.9 earthquake in 1995. This earthquake still is the most expensive earthquake of all time. It produced an estimated economic damage of more than 100bn USD. The factors indicated below clearly show why the amounts of loss in megacities are pushed up so high:

- The density of development and the narrowness of the streets made it very difficult to fight the conflagration that broke out following the earthquake
- Capacity bottlenecks made it difficult to fight the fires from the air
- Supplies of drinking water, electricity and gas failed after the supply networks were destroyed
- The capacity of hospitals and shelters for those made homeless was soon exhausted
- Transport and communication links were interrupted over large areas
- The port, the city's economic artery, was out of action for many months

Although the capacity of the port of Kobe had been restored by 1999 completely, it never regained the importance it had before the earthquake. At the time of the earthquake, Kobe was the busiest port in Japan and one of Asia's top ports. By 2006 Kobe has dropped to the fourth in Japan and thirty-eighth busiest container port worldwide (AAPA, 2006).

Hurricane Katrina

Katrina, after having crossed Florida near Miami as a Cat 1 hurricane, made landfall on 29 August some 50 km east of New Orleans as a Cat 3 hurricane. The wind and storm surge damage was horrendous: parts of New Orleans were flooded when levees along Lake Pontchartrain and artificial drainage channels failed; many offshore plants in the Gulf of Mexico were destroyed; more than 1,300 people were killed. The direct overall losses are about US$ 138bn at today's values. Some particular aspects of Katrina are:

Dimensions of the storm surge

The storm surge triggered by Katrina hit the states of Louisiana, Mississippi, and Alabama along a 150-km stretch of coast. The flood wave, which was 10 m high in parts, was able to penetrate several hundred meters inland and in some cases, where the topography allowed, as much as a kilometer. This resulted in areas being flooded that were outside the 500-year zone (areas which, on a long-term average, are flooded less than once in 500 years) on the flood hazard map used by the Federal Emergency Management Agency (FEMA). The majority of buildings in this region were total losses. The restoration of risks took time as the infrastructure (roads, bridges, and utility lines) was also damaged or destroyed.

Partial flooding of New Orleans following levee failures

The insurance industry must not only reconsider the structural engineering methods and design criteria for the levee protection around Lake Pontchartrain but also the accumulation assessment of other well-known loss scenarios. In spite of the warnings from scientists and disaster management organizations, the insurance industry underestimated New Orleans' exposure to storm surges and floods.

Inordinate increase in insured losses as a result of macroeconomic influences

After the 2004 hurricanes in Florida, an attempt was made to explain the often underestimated losses by citing such effects as demand surge and major catastrophe surcharges. Following Katrina, many insurers found that the losses they finally had to pay were often far higher than their initial forecast. This was due to the fact that the scale of a major catastrophe is enhanced by the shortage of resources (construction materials and workers needed for reconstruction work) and the limited availability of infrastructure installations. A number of fundamental questions emerge: Do the methods used hitherto in the analysis of accumulation loss potentials need to be supplemented by appropriate components? Can past experience be applied to future megacatastrophes in the form of a quasi-linear approximation or are new approaches needed here too?

Tokyo Earthquake

The most probable scenario for a strong earthquake to strike Tokyo currently is not a repetition of the 1923 M7.9 earthquake, but an event similar to the 1855, so-called "Ansei-Edo earthquake". This event had a moderate magnitude of approximately 7.3, but occurred directly beneath the city, at an estimated depth of 40-60 km. According to a study released by the Japanese government, such an earthquake could cause an economic damage of 112 trillion Yen. Up to 11,000 people would be killed if this quake was to hit on a winter day at 6 p.m. The chance of a strong earthquake to happen in Tokyo from any of the mentioned sources in the next 30 years is about 35-40% (Stein et al, 2006).

In order to reduce the direct physical damages, among other measures, the Japanese Government has been promoting to improve the quake resistance of houses and buildings in the Tokyo metropolitan area. It offers subsidies and tax breaks to Tokyo property owners who reinforce their buildings in a bid to raise the portion of quake-resistant structures to 90% from the current 75%.

Death and destruction from a huge quake in Tokyo may well be followed by financial repercussions for the world, even more if the world economy is already under stress like today.

NEW RISKS IN MEGACITIES

The figures speak for themselves: today almost one-fifth of the world's gross domestic product is generated in the ten economically most important world cities. No wonder more and more people are moving to megacities in search of work and prosperity—and this is especially true of developing countries.

For the insurance industry too, this development presents major opportunities, because for every high-rise building, every underground railway system and every manufacturing company—and of course also for the people who live and work in the cities—there is a need for insurance. Given that the density of insurance in the megacities of developing countries is still far lower than in the industrialized countries, the business potential for the insurance industry is particularly large there. The risks that go hand in hand with global urbanization are also large, however.

Owing to the high concentration of people, values and infrastructure in a very confined area, the loss potentials in megacities are very much higher than in rural areas. Consequently, even small occurrences can cause severe losses. For example, when Typhoon Nari passed over Taipei in September 2001 with relatively low wind speeds; it nevertheless caused insured damage of around US$ 500m. Heavy rains left the city's underground railway stations flooded after the pumping system failed, paralyzing its most important traffic artery for weeks on end.

The long-term risks are much more serious though, with many megacities being virtually predestined to suffer major natural disasters. The decisive factors here are essentially their geographical location and their sheer size and vulnerability.

From the economic point of view, the ever-increasing global interdependence of flows of goods, finance and information—especially in world cities which are also economic centers—harbors major risks. Depending on the degree of global interconnection involved, a business interruption in an Asian metropolis can lead to production losses in Australia, Europe or elsewhere in the world.

For international reinsurers, the main risk associated with megacities is the accumulation risk, i.e., when a single loss occurrence can also have far-reaching negative consequences for numerous economic sectors. A prime example of this is an earthquake in Tokyo, which according to some economic experts could trigger a worldwide recession.

Sea Level Rise

Most megacities are situated where there are good transport links, e.g. on the coast or on rivers. Low-lying areas near coasts now have the largest concentration of people on earth (Small & Cohen, 2004). By 2015, 17 of the 21 largest megacities are coastal. 12 of them are Asian megacities (Klein et al, 2002). Subsidence, as well as sea level rise due to climate change will significantly increase the exposure in these cities to natural catastrophes. According to estimates by Munich Re, a sea level rise of 40 cm would increase the annual number of people flooded in SE Asia from 13 million to 91 million.

Weather and Climate in Megacities

Large cities have their own climate. And to some extent they only have themselves to blame. For cities are actually a "causative factor" in changing their own climate conditions. At the same time, they are also affected by these changes in a remarkable way: weather extremes in cities have further-reaching consequences than elsewhere. For insurers, this means huge loss potentials.

Industry, commerce and infrastructure, as well as the availability of an abundant energy supply and a transportation system in cities offer good prospects for work and prosperity. Yet it appears that megacities determine and affect the weather and the climate, not only locally but also on a global scale.

City climate

Summers and winters mean temperatures are several degrees higher (in some cases up to ten degrees Celsius) in cities than in the surrounding countryside. Weather extremes in the summer such as heat waves or thunderstorms are more frequent, whereas extreme weather conditions are moderated in the cold season (cold snaps, snow).

Solar radiation is lower in large cities. Industry, traffic and private households emit exhaust gases and other pollutants, as well as dirt and dust particles that do not enter the higher atmosphere but get trapped and hang like a smog dome over inner cities. Apart from having a negative impact on health (smog, respiratory diseases, allergies), they also reduce the level of solar radiation. After all, rust and dust particles reflect and dissipate the rays of the sun. The annual total number of hours with visibility at the Hong Kong Observatory Headquarters below 8 km is increasing by approximately 599 hours per decade since 1988 (Lam, 2006).

It is not only the immediate environment that is affected. Cities are large furnaces powering the greenhouse effect: Although they cover only 0.2% of the earth's surface, they emit around 80% of the greenhouse gases that affect the climate. Weather and climate changes are therefore at least partly caused by cities themselves. In addition, the impact of such changes is especially marked in cities, conurbations being particularly prone to damage and severely affected on a regular basis.

As a consequence of climate change, we can expect the future to bring more extreme weather events such as windstorm, hail, and flooding. Hail has caused –insured losses of US$ 1bn and more in recent years, and hail damage in big cities has regularly demonstrated this loss potential to us, for example in Sydney (1999) or in the Munich hailstorm (1984).

Although the silhouette of a conurbation may initially slow down approaching windstorms due to the increasing surface roughness, the storms can still wreak considerable damage in/to cities, partly as a result of the domino effect: When wind speeds are high, roof tiles or cladding may be torn off and damage neighboring buildings, causing flying debris that in turn leads to more damage to streets and other buildings.

Due to the high concentrations of values in cities, (motor vehicles, buildings, public utilities, etc.) a single hailstorm can bring about substantial damage.

As urban areas are mostly paved with concrete and asphalt, the water cannot drain off and has to run away on the surface. During and after intense precipitation events the water cannot easily drain away as the canalisation systems are not designed to cope with such quantities of water. As a consequence, flooding occurs regularly after such events. In megacities, torrential rainfall can soon lead to local flooding, and even to devastating flash floods and landslides, which then affect mostly the poorer social strata.

People in cities are much more dependent on infrastructure (i.e. supply water, electricity, district heating, etc.) than people who live in the country. Furthermore, the latter are more likely to help one another in emergencies. Numerous natural catastrophes over the past years have made it patently clear just how susceptible the infrastructures of large cities are even to small losses and how critical bottlenecks can develop within a very short time.

The decisive point is to take possible city-climate effects into consideration right at the planning stage, including evacuation plans following natural or weather-related catastrophes. Insurers have to expect large loss accumulations in megacities and take particular account of highly insured urban and suburban districts in their scenarios. They must be aware that the weather and climate in megacities often obey their own laws.

Spatial Impact of Individual Natural Catastrophes

Earthquakes

Strong earthquakes can affect areas of up to several hundreds of thousands of square kilometers. The damaging effects and intensities of earthquakes are also heavily dependent on the local subsoil conditions, as the Mexico City earthquake of 1985 demonstrated – over an enormous damage zone, devastated houses stood right next to ones that were almost undamaged. Because of their intensity and the geographical extent of the damage they cause, earthquakes generally pose the biggest accumulation risk in megacities, partly also because the fabric of buildings is not designed to withstand them sufficiently.

Windstorm

Windstorms can affect entire cities and regions (e.g. tropical cyclones and winter storms) or be confined to small areas (tornadoes and local storms). Where they develop over oceans and lead to storm surges, large-scale storms can cause enormous devastation, especially in coastal cities. Severe weather events (hail tracks, torrential rain, and lightning strokes) often cause considerable devastation over a small area.

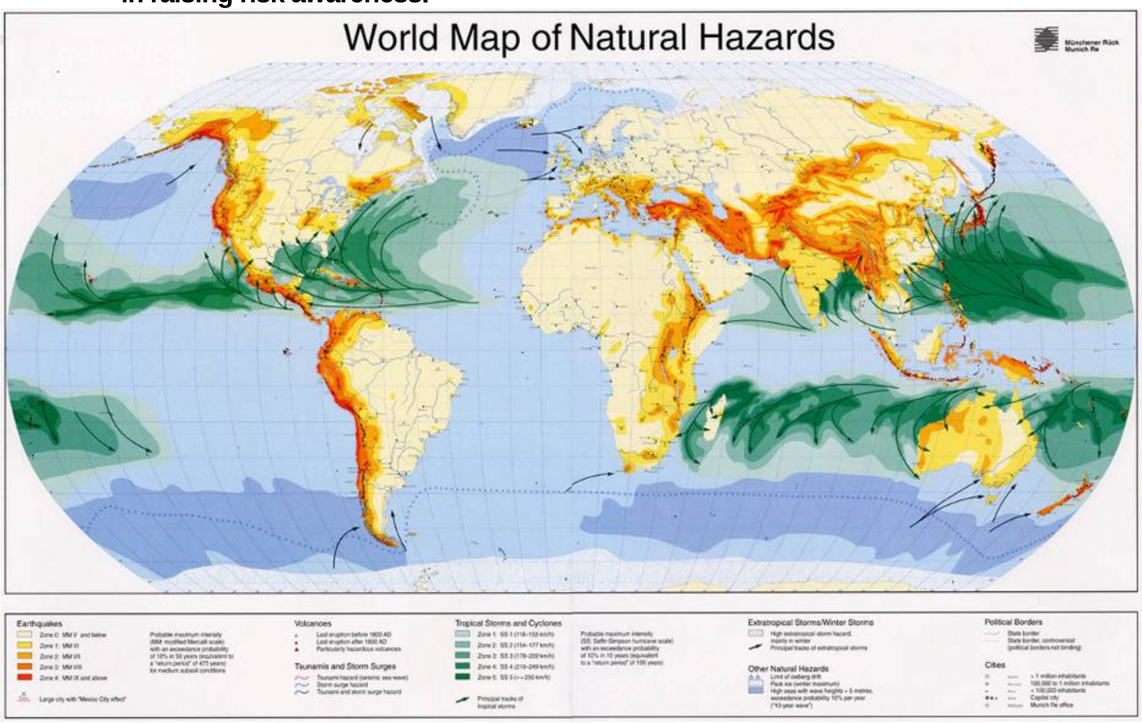
Flood

Compared to earthquakes and large storms, floods affect mostly fairly small, predetermined areas. Nevertheless, since the technical facilities, stockrooms, heating systems, laboratories and garages of high-rise buildings, hospitals and public institutions often lie in basement levels, high insured losses can result if they are damaged by flooding. Flooded hospitals quite often lead to exceptionally high peak losses, like for example during Tropical Storm Allison in Houston, Texas, in 2001. Floods can often cut off roads and railway lines, making it considerably more difficult or even impossible to carry out relief operations or evacuations.

ROLE OF INSURANCE INDUSTRY

The role of the insurance is to provide tools to minimize risk and to maximize awareness. Society tends to forget and to underestimate low-frequency-high-impact risks. A thorough analysis of historical events and a visualization of the objective risk is an important and efficient tool to raise realistic risk awareness, correcting the biased risk perception. Only if the people at risk are adequately informed about the consequences of earthquakes, cyclones and floods and know how to protect themselves in such a situation is there any chance of actually reducing the devastating effects of catastrophes.

Figure 2: Maps showing potential hazards like the World Map of Natural Hazards are an important tool in raising risk awareness.



However, this is not a static process. The risk landscape is constantly changing, driven by technological developments and changing societies. As the previous chapter showed, urbanization leads to completely new types of risks. To discover and evaluate these emerging risks is also a key task for the insurance industry.

The insurance industry is also faced with new tasks, especially in the area of risk management. This means that forward-looking risk-control tools like geospatial analysis—a precise system of georeferenced liability assessment and control—must be further developed. As yet unidentified accumulation risks—whether in the area of terrorism, liability or business interruption—must first of all be identified and modeled for the most important megacities. An objective ranking based on level of risk can be obtained using a risk index like the one presented here for the overall natural hazards exposure of megacities. Traditional risk-limiting measures like limits of liability or exclusions of certain types of risks or particularly exposed areas must also be applied consistently.

Risk Management

Megacities are particularly prone to losses because of their high concentration of people, values and infrastructure. The risks inherent in such concentrations in megacities call for tailor-made methods, especially from reinsurers. Two approaches help to make the risks transparent: bottom-up and top down. On the one hand there is geospatial analysis, which allows risks to be recorded also for small areas, and on the other hand there is an index that makes it possible for the potential extent of a loss in a megacity to be assessed in its entirety.

Risk Index for Megacities

Indices to relate risks to natural catastrophes among very different cities can be designed manifold. The Munich Re risk index differs from previous work on this subject in two ways. Firstly, it adopts an absolute approach, i.e., the aim is to establish not only a relative classification but also a relation to at least the order of magnitude of the absolute loss potential. Secondly, it is the first risk index to consider all the relevant natural hazards at once. As soon as data of the required quality are available, it can be converted into an absolute index that directly reflects a megacity's loss potential.

The Munich Re risk index is geared to the risk of material losses, without including the insurance density or the insurance terms and conditions, which vary by region and hazard. However, its modular structure means that the index can easily be adapted for either underwriting or other purposes. As the index is intended to be a measure of loss potential, it embraces all three components: hazard, vulnerability and exposed values. The hazards considered in the calculation were earthquake, windstorm, and flood as the main hazards, and volcanic eruption, bush fires, and winter damage (frost) as the most important secondary hazards.

Hazard
As far as exposure to hazard is concerned, the various natural hazards are best weighted objectively by allocating average annual losses (AAL). These can then simply be added together. A catastrophe loss with a low occurrence probability is then calculated. Here the uniform basis of a 1,000-year loss (probable maximum loss = PML) is used. The values are allocated to the various exposure classes on the assumption of equal vulnerability.

The total exposure to hazard is derived in the following steps:

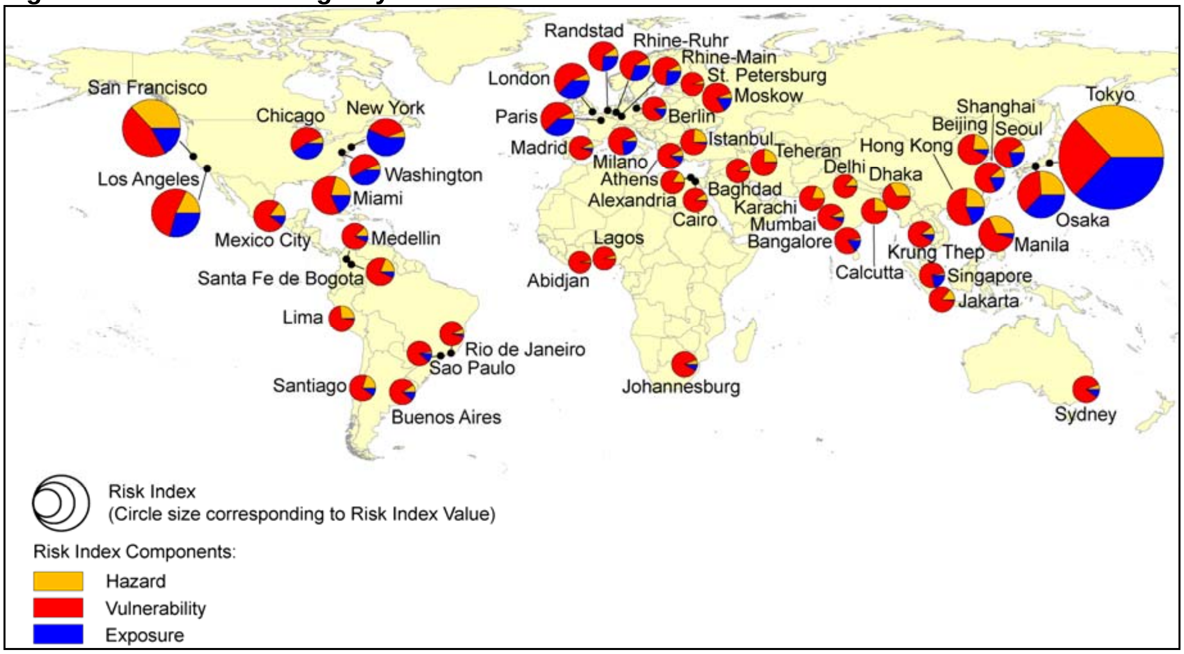
- Adding the AAL values for the individual hazards
- Selecting the highest PML value for all hazards
- Weighting the AAL total at 80% and the highest PML at 20%, then
- Adding the two values up.

Vulnerability
In order to determine the index for vulnerability, three main components were examined; two of them are related to exposure, the third is of a general nature: hazard-related components include vulnerability specific to the building class, i.e., the vulnerability of the predominant form of residential construction to natural hazards. For commercial and industrial risks, a similar type of construction (but not quality!) was assumed throughout the world. The second hazard-related component is the standard of preparedness and safeguards. This includes, for example, building regulations and town-and country planning in respect of specific hazards, as well as flood protection. The general component is made up of general quality of construction and building density. The indicator of building density is population density. The greater the density, the greater the risk.

Exposed values
As the derivation of genuine value inventories goes beyond the scope of this study, indicators were defined for the total value of an urban area in the form of a relative grading. The average value per household was used as the indicator for the residential building sector; while for commerce/industry gross domestic product (GDP) was used. Value in the overall context was based on global economic significance.

Calculating the total risk index
In order to produce a total index, the three main components of hazard, vulnerability and exposed values must be standardized. For this purpose, the maximum values in each case were set to 10 and the other values calculated proportionally based on this. The last step is combining the components. The most meaningful and practicable results are obtained by multiplying the main components.

Figure 3: Munich Re's Megacity Risk Index



Outlook
The natural hazard risk index for megacities is to be seen as a basis for discussion. It enables the risk potential to be identified quickly and makes risks comparable and transparent. Assessments of vulnerability can be confirmed and objectified through specific surveys. As far as hazard is concerned, one weak spot is flood. For a sound assessment, more detailed data is needed here. As far as total exposure is concerned, earthquake plays a surprisingly important role that requires more detailed examination. There is further need for research with regard to the analysis of main components, with the aim of objectifying their weighting. Precisely against the background of ever-faster-growing megacities and mega-urban regions, this top-down approach is an effective tool for obtaining a preliminary and broad assessment of the risk and loss potential as quickly as possible. The advantage of the megacity index lies in its modular methodology. It can be expanded and developed as required and applied to smaller towns or even to entire countries (Munich Re, 2004).

Geospatial Analysis

Since 11 September 2001 and the devastating hurricane years of 2004 and 2005, the insurance industry has been seeking ways to analyze and control its risk exposures more efficiently. However, the ability to manage catastrophe risks depends to a great extent on how well insurers know the risk situation, the risk concentration, and the affected lines of business in the insured area. The questions insurers and reinsurers must first ask in this regard are: "Where are the risks. What are the indemnity limits?" The answers are an important step towards improving risk transparency – something that is also required in the context of Solvency II, the updated set of regulatory requirements for insurance firms operating in the European Union.

High-quality geocoding of portfolio and claims data is crucial for risk management and portfolio optimization in lines of business involving natural hazards. It is therefore vital to identify and analyze the geographical location of risks. In geographical underwriting, the geographical location of insured property is stored in a database; this data can then be actively used. Geocoding may be performed using various levels of detail – countries, postcodes, towns, addresses. For megacities, however, "coarse" geocoding, e.g. at country or regional level, is not sufficient. Even risk allocation on the basis of CRESTA zones (see www.cresta.org), often used today in property insurance, is frequently too coarse for megacities. It is precisely for assessing fire, flooding, and business interruption and workers compensation insurance that accurate input data are required. This is the only way in which exposures in small areas or spatially concentrated exposures such as hazardous industrial plants or potential terror targets in megacities can be identified and modeled. With geocoding, policies can be combined and analyzed at will. Different spatial resolutions within megacities can be combined with each other. For example, treaty and facultative business can be examined at the same time and a multi-class assessment of the risk situation at corporate or divisional level carried out. Geocoded liability data is also helpful in evaluating risks of change (e.g., risk of thunderstorm in connection with climate change) or hitherto unknown risks in the area of terrorism: the current portfolio can be linked with new scenarios at any time and new loss potentials calculated Geographical underwriting also offers new opportunities when it comes to allocating insurance capacity. For example, in highly exposed megacities, potential exists for development and expansion which can only be used if detailed portfolio data is available. If a loss has occurred, the anticipated amount of loss for all classes of business affected can be estimated quickly and accurately. If the area of the loss is known, such as in the case of flooding, losses reported outside the loss zone can be clearly identified and clarified in cases of doubt.

Current status of geocoding

Munich Re’s innovative web technologies provide underwriters with access to the Geo Data Service (GDS) and thus to the address-based geocoding of risks. Portfolio and claims data may be georeferenced in unlimited numbers and used for detailed simulations and analyses.

FINAL REMARKS

Globalization and the increasing interdependence of commerce and trade can cause economic and insured losses on a scale that is difficult to assess. Losses may not necessarily have an impact on the megacity alone. Depending on how metropolises are globally connected, worldwide losses can arise. The spectrum of possible effects ranges from slowing the economic development of a region, or the loss of various key industries (e.g. semiconductor production), all the way up to a worldwide effect on the capital markets, as is discussed if there should be a repeat of the major earthquake that hit Tokyo in 1923. More than ever, the insurance industry therefore has to keep an eye on natural hazards, concentrations of values, vulnerabilities and connectivities if it is to meet the special challenges that megacities pose.

The Industry as a professional risk taker has the tools to serve as a partner on the way to sustainable urbanization.

There is no doubt about it: megacities are “where the action is” for (re)insurers—but whether the “action” turns out to have positive or negative results will largely depend on the individual (re)insurers themselves, and the adequacy of their risk management.

REFERENCES

AAPA (2006): American Association of port authorities (http://aapa.files.cms-plus.com/Statistics/worldportrankings%5F2006.xls), retrieved Sept 26, 2008.

Baker, J.L. (2008): Urban Poverty: A global view, The World Bank Group, Urban Papers UP-5.

Bouwer, L. M., Crompton, R. P., Faust, E., et al (2007): Confronting Disaster Losses, Science, Vol. 318, p.753.

Gurenko, E. and R. Lester (2004): Rapid onset natural disasters: the role of financing in efficient risk management, World Bank Policy Research Working Paper 3278.

Kircher, Ch., Seligson, H.A., Bouabid, J., et al (2006): When the Big One strikes again – estimated losses due to a repeat of the 1906 San Francisco earthquake, Earthquake Spectra, Vol. 22, No. S2, 297-339.

Klein, R.J.T., Nicholls, R.J. and F. Thomalla. (2002): The Resilience of Coastal Megacities To Weather-Related Hazards: A Review. In: Kreimer, A., Arnold, M. and Carlin, A. (eds.) Proceedings of The Future of Disaster Risk: Building Safer Cities, December 2002, Washington D.C. World Bank, pp. 111-137.

Kraas, F. (2003): Megacities as global Risk Areas. In: Petermanns Geographische Mitteilungen. Vol. 147, no. 4, 6-15.

Kraas, F. & Nitschke (2006): Megastaedte als Motoren von globalem Wandel. In: Internationale Politik, Vol. 11, 18-28.

Lam, C.Y. (2006): On Climate Changes Brought About by Urban Living, Hong Kong Meteorological Society Bulletin, Vol. 16, No. 1-2, available at: http://www.weather.gov.hk/publica/reprint/r700.pdf

Munich Re (2004): Megacities – Megarisks, Trends and challenges for insurance and risk management, Munich, 83 pp.

Munich Re (2005): Topics Geo, Annual review: Natural catastrophes 2005, Munich.

Munich Re (2006): The 1906 earthquake and Hurricane Katrina: Similarities and differences – Implications for the insurance industry, Munich, 20 pp.

Sachs, J (2008): Common wealth: Economics for a crowded planet, Penguin, London, 386 pp.

Small, C. and J.E. Cohen (2004): Continental Physiography, Climate, and the Global Distribution of Human Population, Current Anthropology, Vol. 45, no. 2, available at ftp://ftp.ldeo.columbia.edu/pub/small/PUBS/SmallCohenCA2004.pdf

Stein, R.S., S. Toda, T. Parsons and E. Grunewald (2006):

UN-Habitat (2003): The challenge of slums: Global report on human settlements. Nairobi.

WGCEP (2007): The Uniform California Earthquake Rupture Forecast, Version 2 (UCERF 2) USGS Open File Report 2007-1437

Woetzel, J., Devan, J, Jordan, L, et al (2008): Preparing for China's urban billion: summary of findings, McKinsey Global Institute, 42 pp.