

## Increasing Loss Potential in Earthquake Risk – A Reinsurance Perspective

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### ABSTRACT:

The economic and insured losses from earthquakes have increased dramatically over the last few decades and present the insurance industry with ever greater challenges.

With the earthquakes of Armenia/Colombia, Huajuapán/Mexico, Izmit and Düzce/Turkey, Athens/Greece and Chi-Chi/Taiwan, 1999 was the worst affected year in terms of earthquake catastrophes since 1976, notwithstanding the individual events at Northridge/California in 1994 and Kobe/Japan 1995. In particular, the earthquakes in the second half of the year perfectly illustrated certain aspects of the earthquake risk today, such as predictability, the consequences of the massive growth of cities and the susceptibility to losses of high technology. The findings obtained from these earthquakes should be used to ensure that we are better prepared for such events in the future.

In addition to the findings that can be gained from today's earthquake catastrophes, fundamental research at universities provides an essential contribution to better assessment of global loss potentials. Detailed investigations of potentially active fault zones in seismically weak areas is particularly important, as there is virtually no loss experience for such regions. The importance of such investigations is illustrated by an analysis of the exposure in the Greater Cologne area and for a repetition of the Neulengbach (1590) earthquake in Austria. Just like in Australia and eastern North America, the earthquake risk in Germany is a problem involving a low occurrence probability with potentially devastating effects.

### KEYWORDS

Germany, Austria, Insurance, Loss Potential, Vulnerability, 1999 earthquakes

### 1. Rising loss potentials from earthquakes

The economic and insured losses from earthquakes have increased dramatically over the last few decades and present ever greater challenges to the insurance industry (*Figure 1*). The clearly rising trend to ever more and ever greater losses can be clearly seen. This is true of all natural catastrophes. This increase is documented in Table 1 and applies to varying degrees, both as regards the number of major earthquake catastrophes and their economic and insured losses. The higher number of earthquakes does not result from an increased occurrence of large earthquakes but rather is attributable to the fact that today a much higher proportion of these earthquakes result in serious losses. Mankind has encroached ever further into exposed areas. An earthquake that even in the 1960s would have affected hardly anyone may lead to a catastrophe today. An increasing number of people and values are concentrated in a few highly exposed cities. The maximum loss potentials have mushroomed to almost astronomical heights as a result of this development. For example, a large earthquake in Tokyo today could result in economic losses of over US\$ 1,000bn. The insurance industry is disproportionately affected by this increase. The reason for this is to be found primarily in rising insurance densities: a process that will be further accelerated in the future as a result of the deregulation of insurance markets and governments shifting the onus of payments to the private sector. For example, Belgium is considering the possibility of offering widespread earthquake covers for residential buildings.

	Decade 1960 – 1969	Decade 1980 - 1989	Last ten years 1989 - 1998	Factor last ten : 60s
Number	5	16	12	2.4
Economic loss	13.5	81.9	192.3	14.2
Insured loss	0.1	4.1	24.5	245

*Table 1: Development of losses from great earthquake disasters (Losses in US\$ billion, 1998 values)*

This trend continued in 1999. With the earthquakes in Armenia/Colombia, Huajuapán/Mexico, Izmit and Düzce/Turkey, Athens/Greece and Chi-Chi/Taiwan, 1999 was the worst affected year in terms of earthquake catastrophes since 1976, notwithstanding the individual events at Northridge/California in 1994 and Kobe/Japan 1995.

## **2. Findings from the 1999 earthquakes**

The earthquakes in 1999 should be used to help us to be better prepared for such events in the future. In particular, the earthquakes in the second half of the year were perfect examples of certain aspects of the earthquake risk today, such as predictability, the consequences of the enormous growth of cities and the susceptibility to losses of high technology.

Although it was accepted that area around Izmit was a "seismic gap" and an earthquake of this magnitude was foreseeable, no practical consequences were drawn from this well-founded scientific knowledge, even though the area affected accounts for 40% of the country's industrial production. The existence of another seismic gap to the south of the 10-million city of Istanbul sends a clear warning to all parties concerned of the need to invest in loss prevention if we are to avoid an even more disastrous repeat of events at Izmit. The situation in Athens and Taiwan was quite different. Both events took experts by surprise and should serve as a warning that even faults assigned a low or uncertain level of activity can "spring a nasty shock".

The massive growth of cities does not only contribute to the enormous loss potentials in terms of the resulting concentrations of values but also has a negative effect on the loss susceptibility of urban areas. If Athens had not grown to its present size, the earthquake of 7th September would have only been an "episode on the fringes". As it is, however, the economic losses of US\$ 3.7bn. make it a supreme example of the loss potential of even moderate earthquakes. The problems associated with – in some cases uncontrolled – growth were demonstrated even more clearly (in line with the size of the city affected) in the case of the Izmit earthquake. The necessity of creating housing for millions of "migrants" to the Istanbul area in the space of just a few years resulted in an almost inevitable loss in the quality of construction. The construction boom and the criminal energy of certain building companies led to a situation where all regulations governing responsible construction were cast aside. Unfortunately, the lessons of the Izmit earthquake can be seen everywhere.

Modern high technology has resulted in completely new loss potentials, as the high losses in Taiwan's semiconductor industry amply demonstrated. Although the Science Park at Hsin-chu is more than 100 km from the earthquake fault and suffered only minor material damage, insurers had to pay out several hundred million US dollars. The main reason for this huge amount was the breakdown in the power supply and the resulting business interruption and the loss of chip production.

The path to greater earthquake safety and to a substantial reduction in earthquake losses, as defined on the basis of the 1999 earthquake year, can be summarized in 4 points:

- Effective monitoring of adherence to building codes is necessary to prevent future tragedies such as the one in Turkey. Thousands of deaths and billions of dollars of property damage could have been avoided if current building codes had been adhered to. To a lesser extent this also applies to the earthquakes in Taiwan and Greece.
- The infrastructure has to be improved to be commensurate with the exposure and risk situation. The failure of the infrastructure led to billions of dollars of damage in Taiwan. The maintenance of a minimum supply of power and water is essential for the continued operation of key industries.
- When choosing industrial locations it must be asked to what extent the location of key industries in highly exposed regions is appropriate. The construction of the Tupras Refinery (which accounts for 40% of Turkey's petroleum production) just a few kilometres from a large fault known to be active is a classic example of short-term planning.
- The process of steadily expanding our knowledge of potentially active faults, identifying them and determining their level of activity must be given priority, with absolute top priority being given to structures that threaten major cities. Typical examples are Manila (Marikina fault), Beijing, Caracas (Avila fault) and in Europe, Cologne (Erfurt fault).

## **3. Assessing exposure in weak seismic areas**

In addition to the findings that can be gained from today's earthquake catastrophes, seismo geological research at universities provides an essential contribution to better assessment of global loss potentials.

The reinsurance industry today is using detailed risk models to better assess the earthquake risk. The essential element of all models is as exact assessment as possible of earthquake activity as well as the frequency and strength of the earthquake that can be expected. In areas of high seismicity, records on historical events and instrumental data exist and usually a lot of time and money are invested in researching active structures as a result of this high exposure. In areas of low seismicity on the other hand, only a limited amount of information is usually available. However, it is precisely these areas where buildings, infrastructures and risk management are

not designed for earthquakes, thus making a failure of these aspects almost inevitable. The loss potentials here are disproportionately high compared with earthquakes in other areas. An example of an area with low seismicity and enormous loss potentials is central Europe. The lack of knowledge about occurrence probabilities and magnitudes of large earthquakes in central Europe leads to an enormous level of uncertainty with regard to exposure estimates. The loss potentials, estimated in Allmann et al.(1998) for Cologne, perfectly illustrate the problems involved (Table 2).

Magnitude for scenario Cologne	Focal depth	Losses US\$bn.
M = 6.0	10 km	14.5
M = 6.4	10 km	55
M = 6.7	15 km	106

Table 2: Losses for hypothetical earthquakes near Cologne [source: Allmann et al (1998)]

The starting point for this scenario analysis were studies from the paleoseismological work of Camelbeek & Meghraoui (1996) and Ahorner (1996). The hypothetical earthquakes represent possible scenarios on the basis of our incomplete knowledge at this time. However, statements on activity rates and maximum strength of the earthquakes would be very speculative without further research.

Rather like in, for example, North America east of the Rocky Mountains, in Australia or in Greater Basle, the earthquake risk in Germany is a typical problem of low occurrence probability coupled with potentially devastating effects. In all the aforementioned regions considerable funds have been, and continue to be, invested in special research projects. In Germany such projects are just getting off the ground. Even if one disregards the extreme scenarios outlined above, research projects with the objective of achieving a better limitation of the exposure situation appear essential. This research can be summarized as follows:

- Paleoseismological investigations to determine activity patterns and rates of known fault zones in the Lower Rhine basin, especially in the area of Cologne and Aachen.
- Investigations to establish the spatial and direction-dependent absorption of earthquake energy and loss-relevant parameters on the basis of theoretical modelling of the extent of vibrations.
- Micro zoning of the most heavily exposed urban areas
- Investigating the loss susceptibility of the building stock

The estimates for Cologne can, to a lesser extent, also be applied to the Frankfurt and Stuttgart areas. In 1999 Belgium also became a focal point of interest for the insurance industry. The market pressure in Belgium to offer earthquake insurance on a broad basis for residential buildings has led to increased interest in the exposure situation there. Like Cologne, Belgium is also characterized by a weak seismicity. Although there is a general estimate of exposure, occurrence probabilities of large events and their possible maximum magnitudes are extremely uncertain. For the insurance industry, this can mean differences of billions of dollars in the loss potentials. This not only affects the price level of insurance but also influences the possibility of providing an insurance solution in general. The economic importance of research and the improved level of knowledge it entails cannot be overstated.

Another example to illustrate the loss potentials of earthquakes in low seismicity regions is a scenario based on the repetition of the Neulengbach (1590) earthquake close to Vienna in Austria. The Isoseimal map of this event by Hammerl and Lenhardt (1997) was used to define the area affected by that event and to evaluate the expected intensity (MMI) for each postcode in Austria. Assuming an amount of 1.66 million Austrian Shilling for each resident in the respective postcodes to represent the value of the housing stock we derived the residential values in each intensity zone (Table 3). By using the same loss ratios as described above for the Cologne scenario an expected loss of 140 billion Austrian Shilling (10 billion US\$) has been calculated. Although this result is only a rough estimate it highlights the possible loss potentials in regions of low to moderate seismicity. By using an historic scenario the question is avoided, whether the worst case scenarios is only an academic speculation or can really happen. But even for the region where the Neulengbach event occurred 400 years ago only little is known about the potential of devastating earthquakes.

Intensity	Population	Amount in bn. Shilling	Loss in bn. Shilling
VI	827440	1380	5.5
VII	2537882	4230	84.6
VIII	313986	523	36.6
IX	50549	84	12.6
Total	3729857	6217	139.3

Table 3: Scenario Neulengbach (1590); values per resident: 1,66 million Shilling

That events which are theoretically possible, but difficult to assess without the aid of further research can really happen was shown to be true in 1999 with the events at Athens/Greece and Chi-Chi/Taiwan, Although both faults were already known, the lack of micro seismicity and more detailed investigations meant that a significant earthquake was not expected. If Athens and Taiwan were not exposed to other, more active faults, the consequences of a complete lack of adequate building designs would have been much more serious than they actually were (such as in Tangshan/China 1976)

#### 4. Conclusions

1999 was another year seriously affected by earthquake catastrophes, thus continuing the trend over the last few decades towards increasing economic and insured losses. The loss potentials of major earthquake catastrophes today have reached almost astronomical heights. The reduction of loss potentials coupled with improved loss potential assessment is therefore becoming increasingly important. Catastrophes such as those in 1999 should be used more than ever as something to learn from. However, new findings also have to be implemented in practice. In many regions of low seismicity, especially in central Europe, knowledge of earthquake exposure is nowhere near adequate. Realistic loss potentials can only be estimated with an enormous degree of uncertainty and in some cases such estimates do not amount to more mere speculation. In view of the high loss potentials and their economic importance, an increase in research activity in these regions appears absolutely essential.

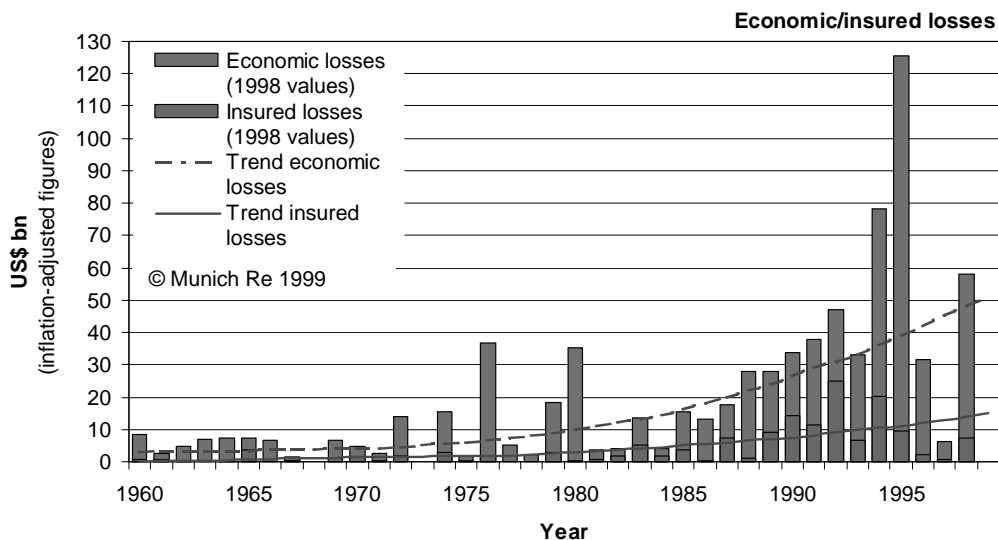


Figure 1: Great Natural Disasters 1960 – 1998. Far exceeding 100 deaths and/or US\$ 100m in claims

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