Natural Hazards and Engineering Insurance

Earthquake, windstorm, flood and frost - these are some of the most important manifestations of the natural hazards to which human beings are exposed everywhere in the world. The dramatic potential inherent in these hazards becomes particularly evident when we consider the frequency and severity of the losses they cause.

At the IMIA meeting in 1986 we discussed the subject of Natural Hazards and Engineering Insurance on the basis of a portfolio of 2,200 individually recorded major losses, reference number 10-13(86)D. In the meantime the loss portfolio usable as a basis for evaluation (1982-92) has grown to encompass 5,600 large losses with a total loss amount of roughly $ 8 billion.

Let us first recall the conclusions we drew in 1986:

- Natural hazards are a major cause of loss in the engineering classes of insurance, accounting for 18% of the total loss amount incurred.

- CAR is the class of business most seriously affected, 47% of losses being caused by natural hazards, followed by EAR insurance with approx. 12% of total losses, and M/MLoP insurance, where these losses still amount to as much as 8%.

- The average frequency of losses caused by natural hazards is noticeably lower than that of other types of loss, whereas the average loss amount is considerably higher.

An analysis based on the extended loss period 1982-92 confirms

by and large the observations made in 1986. Specifically:

- The proportion of engineering insurance losses resulting from natural hazards has increased to 21% (as compared with 18% in 1986).

- In M/MLoP insurance, this percentage has risen substantially, namely from 8% to 22%, whereas in CAR it has decreased from 47% (in 1986) to 35%, and in EAR from 12% to 10%.

An analysis of the individual causes of loss provides the following picture:

	CAR	EAR	M/MLoP
Windstorm	39%	35%	93%
Flood	48%	30%	3%
Earthquake	0	16%	0
Frost etc.	13%	19%	4%

As far as M/MLoP is concerned, this picture matches that of worldwide experience in the property insurance classes as a whole, whereas in CAR/EAR it does not.

Curiously enough, it was the very year following our first investigation, namely 1987, that marked the beginning of a period of noticeably increasing claims burdens for property insurers in general.

- 1987: windstorms in Britain and France (overall economic loss approx. $ 3.7 billion, insured loss approx. $ 3 billion)

- 1989: Hurricane Hugo (overall economic loss approx. $ 9 billion, insured loss approx. $ 4.5 billion)

- 1990: winter gales in Europe (overall economic loss approx. $ 15 billion, insured loss approx. $ 10 billion)

- 1991: Typhoon Mireille in Japan (overall economic loss approx. $ 6 billion, insured loss approx. $ 5 billion)

- 1992: Hurricane Andrew in the USA (overall economic loss approx. $ 30 billion, insured loss approx. $ 20 billion)

- Summer 1993: week-long floods in the American Middle West (overall economic loss approx. $ 12 billion, insured loss approx. $ 1 billion)

- January 1994: earthquake in Los Angeles (overall economic loss approx. $ 20 billion, insured loss approx. $ 7 billion)

Taking together all the losses of the past seven years that have resulted from natural hazards, we can see a worrying increase not only in frequency but also in size.

The obvious question is: did the property insurance classes generally have a much lower exposure in the years prior to 1987, or could it even be that the climate has changed significantly since then?

In the language of the actuaries: was there a discontinuity at the end of 1986 in either exposure or climatic conditions?

The answer has to be a definite no.

There was, of course, no sudden increase in exposure for insurers and reinsurers in 1987; their exposure has tended to increase more or less continuously over the years in accordance with economic growth and greater insurance density. Nor did any dramatic change in climatic conditions suddenly occur in 1987. What does happen is that the intensity and frequency of individual weather phenomena fluctuate, statistically speaking, around a median which can change slowly and continuously (climate) while the individual values may be subject to strong fluctuations (weather). The concentration of windstorm events

between 1987 and 1992 is therefore presumably fortuitous, as was their relatively low frequency in the years before.

We consider it to be the task of the insurance industry, and particularly of the reinsurers, to help even out the economic effects of these random fluctuations by spreading the burden of the resulting losses. For purposes of premium calculation, however, this presupposes that the "risk of random fluctuations" can be quantified to some extent and that allowance is made in addition for a possible "risk of change" (in our context, for example, a change in climate). If underwriters are in a position to project this for the future with a certain degree of accuracy, they will not be surprised by the occurrence of events falling within a statistical range already expected and taken into account; they will be able to react calmly and will not need to make any major rating adjustments, provided that his exposure has been correctly assessed, prospectively, in advance.

The actual extent of the natural hazard exposure that has built up over the last few decades has become gradually clear to the property insurers from the experience in the years since 1987, culminating in the Los Angeles earthquake of January 1994 and - to take a rather more localized example - the floods in Saxony and Thuringia this April. In most cases the exposure had not been correctly assessed in advance and did not become evident until losses had actually occurred, with sometimes drastic consequences as regards rating and acceptance capacity.

We are convinced that the situation in the engineering classes of business is no different. This means that in engineering insurance too, in our opinion, the natural hazard exposure is considerable, and this exposure is probably increasing continuously with the emerging change in climate. By chance, however, this has not been reflected in the actual loss figures of recent years to the extent that might have been expected statistically.

Some examples:

1. When the Rhein flooded its banks in December 1993, the fact that the badly damaged Schürmann Building in Bonn was not insured - or at least insured only inadequately - saved the German CAR insurance industry from a loss in the region of DM 300 million.

   This loss demonstrates particularly dramatically how a class of insurance like CAR in Germany, which has functioned up to now on the basis of retrospective statistics geared to burning cost, partially ignores the actual exposure of the portfolio. The damage to the Schürmann Building - if it had been fully and comprehensively insured - would have cost the German CAR insurers more than their entire premium income for the year.

   The market results in this class of insurance have in any event done no more than break even for years, so that the CAR insurers have been unable to accumulate sufficient premium reserves to cover their actual foreseeable exposure and hence their expected losses.

   If the net annual premium income of the German CAR insurers is estimated at around DM 200 million, even the assumption that a flood loss of the kind in question occurs only once in 30 years would alone necessitate a precautionary loading on all premiums of 5% p.a.. And this assumes, for simplicity's sake, that the positive effects of interest income on the amount of the gradually accumulating reserves and the negative effects of tax expenditure would cancel each other out.

   But how many more exposures are there to potentially very large losses of other kinds that the German CAR insurers ought to be taking into account?

   A method of pricing based on the calculation of "probable ex-

pected claims values" - often referred to these days as "prospective underwriting" - would have shown long ago how inadequate the price basis for the rates charged really was. Prospective underwriting, however, requires a precise estimation of the exposure of a portfolio, which is then compared with the actual loss experience of past risk periods.

2. Hurricane "Andrew" in Florida caused, among other things, damage worth approx. $ 300 million to the technical equipment belonging to a power company, mainly overhead transmission lines. Experience has shown that Florida is hit once in every 30 years on average by an extremely severe hurricane. The resulting mean frequency, when combined with the expected loss amount, yields the annual premium income actually required to cover this exposure from the underwriting standpoint.

   The loss in question was paid under an industrial all risks policy which expressly included the machinery risk. The coverage of machinery and technical installations against windstorm risks is quite legitimate, even under machinery policies, and is offered in many European countries. What needs to be criticized from the point of view of exposure, however, is the premium which, being calculated on the basis of the limit of liability for all the risks together, is equivalent to a gross rate on line of 2.4% and is thus insufficient to cover the windstorm risk alone, not to mention the other risks under an all risks policy that includes machinery.

   As regards Florida in general, it should be noted that <u>before Andrew</u>, as already mentioned, the rates that would have been necessary for exposure reasons were not charged, whereas <u>after Andrew</u> often no coverage at all was available even where the premiums were adequate. It is therefore no wonder that the insurers have been accused by their clients and the authorities alike of approaching the important economic task

of providing hurricane insurance in an unprofessional way. This criticism is justified, for if the underwriting performed before Andrew had been sufficiently careful as regards policy wording, premium rates, deductibles and accumulation control, the serious shortage of cover that arose after the event need never have occurred; local residents had long been aware of the extent of the exposure. The susceptibility of overhead power lines, mobile homes, modern supermarkets and schools to windstorm damage and the often low standard of construction were obvious but were nevertheless largely ignored.

3. The fact that the Paul Getty Museum, a major CAR risk situated in the hills between Los Angeles and Northridge which is insured for $ 500 million, survived the earthquake of 17th January 1994 virtually unscathed does not mean that no significant earthquake exposure is present.

Admittedly, where the earthquake hazard is concerned things are rather different than with hurricane. Whereas with the windstorm risk a major loss event can be expected to take place on average once in every 10 to 20 years in some countries, severe earthquakes occur quite rarely even in highly exposed areas. As a consequence, the assumptions made with regard to the effects of a major earthquake on
- a building or a machine,
- a risk portfolio and
- an insurance or reinsurance market

are tested only very seldom.

No one knows whether today, at the end of the 20th century, a major earthquake hitting a modern metropolis would give rise to a conflagration of the kind experienced in San Francisco in 1906 or Tokyo in 1923. No one knows how the petrochemical installations, the underground railway lines running beneath stretches of ocean, the dams, the skyscrapers or the power stations would stand up to a severe quake. The big test has

not yet taken place.

The PML assumptions, at least in many CAR/EAR policies, can be safely calculated on the basis of limits of liability. But what about the premium rates? Is it sensible business practice to calculate a rate of, say, 1 ‰ p.a. on the limit of liability on the grounds that the seismologists have estimated a return period of 1000 years for the big earthquake event? In the case of a limit of liability equivalent to 10% of the sum insured, this would mean an extra premium of 0.1‰ p.a. on the total sum insured or, expressed differently, a loading of perhaps 5% on the total premium. This may even be correct from the scientific point of view, but is it commercially justifiable?

For purposes of retrospective rating, there are scarcely any earthquake losses included in the engineering portfolio being considered here. The Getty Museum already referred to, and the underground railway construction sites in Los Angeles were barely affected. We estimate, however, that the portfolio in roughly ten separate earthquake zones has an exposure of several hundred million dollars. So what are we to do with the statement that our portfolio will probably be affected by major earthquakes ten times in the next thousand years? And how does this statement tally with the instinctive feeling of even the most rational people who expect at least one earthquake catastrophe to occur during the next 50 years in Japan and California alone?

As already indicated, the burning-cost approach in engineering insurance seems to be even less suitable for the earthquake risk than for the windstorm risk, and even exposure rating on the basis of the currently available geophyiscal data regularly produces premium rates that appear to be inadequate from the commercial standpoint in view of the enormous "risk of error" which the earthquake phenomenon confronts us with from time to time. The few severe earthquakes

that have occurred during the past 30 years in civilized parts of the world and have been studied in detail have given us some considerable surprises, both from the seismological point of view and as regards their impact on human artifacts, notably buildings and machinery. The most recent earthquake in Los Angeles is no exception.

It is therefore not only the risk of random fluctuations, as in the case of windstorm, and by no means the risk of change, as with the climate, that creates such difficulties for engineering underwriters concerned with the earthquake risk - insofar as this is covered at all - but the risk of error. The Newcastle quake in Australia demonstrated that severe earthquakes can occur even in places where they are scarcely expected, and the recent Los Angeles earthquake produced vertical accelerations of up to 2 g. On the other hand, the dam at whose crest these 2 g were measured seems to have withstood this acceleration astoundingly well. In view of such uncertainties one feels tempted to offer the "scarce commodity" which is earthquake coverage for sale only at a minimum price of 1% of the agreed limit of liability and to let science be science.

The last resort would be to exclude natural hazards entirely from all machinery, CAR and EAR policies or to issue separate covers for these perils, which would of course entail a change in the all-risks concept on which these policies have been based up to now.

Finally, just a few remarks concerning the importance of cooperation between insurers and reinsurers in fulfilling the role they have to play within the national economy, which is to provide insurance protection as far as they are able for losses resulting from natural hazards as well.

Regular collection of the most accurate data possible on accumulations of liabilities under obligatory and facultative

agreements in CAR and in all other classes of engineering business covering natural hazards is essential in order to draw reliable conclusions about the extent of gross and net liabilities per event and zone and to determine what measures need to be taken. This applies not only to reinsurers but also to direct insurers who want to protect their retentions against the consequences of catastrophes but are not prepared to pay more than necessary.

Generally speaking, direct insurers are bound to be greatly interested in recording their accumulation data carefully and cooperating closely with their reinsurers, since a reinsurer who does not receive sufficient information in this respect will tend to offer only limited amounts of capacity to his cedents and will demand an extra safety loading on the reinsurance premium. In the event of a catastrophe the direct insurer may even find himself without adequate reinsurance protection.

The severe claims strain resulting from recent natural disasters has shown that there are limits to the extent to which covers based on conventional reinsurance concepts are financially viable. On the one hand the frequency of natural disasters has - by chance - risen; on the other hand, however, the effects of the risk of change, in particular the growing concentration of values, have resulted in a strong increase in the catastrophe claims burden. However financially powerful the insurance and reinsurance industry may be, in the long term it can only bear the strains resulting from events involving insured losses of billions of US dollars, which may occur several times in one year, if they can be balanced in the medium term by means of an adequate premium income. Aside from this, however, reinsurers will still have no choice but to restrict their catastrophe liabilities even under proportional treaties. In practice they will calculate their own limits, on the basis of premium volume, liabilities per zone and natural hazard exposure, up to which they are prepared to provide catastrophe coverage. If these limits are exceeded, their liabilities can be limited in the fol-

lowing ways:

- by implementing per-event limits under proportional treaties, possibly in conjunction with a separate cedent's retention;

- by introducing cession limits, with the reinsurer having the option of providing for the application of an average clause in the event that the cession limit is exceeded;

- by excluding natural hazards from proportional covers and reinsuring them under separate XL covers.

Each of these methods has advantages and disadvantages which can perhaps be dealt with further in the course of our discussion. As a practical consideration, it should be borne in mind, however, that the size of the catastrophe liabilities a reinsurer can assume depends very significantly on the price charged for the coverage of natural hazards under the policies concerned. The better the rating conforms to the severity of the risk, the greater the volume of liability than can be assumed.