OCCURRENCE AND INSURANCE OF

NATURAL DISASTERS

AUFTRETEN UND VERSICHERBARKEIT VON

ELEMENTAREREIGNISSEN

von
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ABSTRACT

The forces of nature are responsible each year for losses and costs of prevention measures that exert a considerable financial load on societies around the world. They also claim tens of thousands of lives not only in the few big but also in a great number of small events. The statistics of natural disasters with respect to number of deaths, economic losses and insured losses are each dominated by different types of events: earthquakes and storm surges represent the deadliest threat, floods and earthquakes exert the most severe economic strains on societies, and storms are responsible for the highest insurance losses. The number of great natural disasters increased by a factor of 3.2 from the nineteen sixties to the nineties. In the same period, the economic and insured losses they generated increased by factors of 8.6 and 16.1 respectively. The main causes for this development are: the increasing concentration of people and values in areas that are exposed to unfavourable natural conditions, the increasing vulnerability of structures and goods, the trust in protection systems and the changes in environmental conditions including climate change. Insurance is an important factor for reducing the risk of individuals, enterprises and even whole societies to natural hazards. It can considerably mitigate the effects of extreme events on them and avoid their being ruined. Insurance companies also must take care that they do not fall victim to extreme natural events themselves when losses exceed their financial capacities, and therefore must care for accumulation control and sufficient reinsurance cover.

I N H A L T

1 Introduction

Nature has always produced extreme and excessive events that change the natural environment and threaten people and their belongings. In former times man was almost helplessly exposed to the forces of nature; he had to accept what happened and often the only way for him to reduce the consequences was to flee the area and leave everything behind. In the scope of a much lower population density than today, the hundreds of thousands of people killed in past disasters such as the Große Mandränke storm surge (North Sea Coast, 1362, 100,000 deaths), the landslides in the Kansu province after an earthquake (China, 1920, 235,000), the Yellow River flood (Henan/China, 1931, 900,000), the Bangladesh storm surge (1970, 300,000), the Tangshan earthquake (China, 1976, >290,000), etc. show the incredibly devastating effects natural events can have (Munich Re, 1999).

Half a century ago people started to believe that mankind was well on the way towards controlling nature. Understanding the genetics of natural processes combined with technical development seemed to be the basis for gradual but continuous improvement in dealing with natural events. Whoever follows the news cannot be convinced of this anymore. Accounts of catastrophic events caused by the untamed forces of nature flood into our living rooms almost daily. A natural disaster has hardly left the news when the next one hits the headlines. The numerous reports of bad news raise the questions: are the number and severity of natural disasters increasing, and how can man best face their threat to his life and belongings?

Before we can answer these questions we must explain the difference between a natural event and a natural disaster (Kron et al. 1996). No extreme event – however large it may be – can become a disaster if it hits a region where there are no people or man-made structures. On the other hand, a natural event that may not even be extreme may cause a catastrophe in a densely populated, little prepared region. A natural disaster can therefore occur only if two conditions are given: a natural event, and people and belongings that can be affected.

The last year of the 20th century reminded people worldwide drastically of the various hazards from nature. It started with the high snow pack and the avalanches in the Alps, continued with a billion-dollar-loss hailstorm in Sydney (Australia), reached its peak in summer with Cyclone 05B in Orissa (East India) that killed more than ten thousand and the four earthquakes of Izmit and Dücze (Turkey), Athens (Greece) and Chi Chi (Taiwan) with a total of more than 20,000 deaths, and ended with the devastating flood and debris-flow events in Venezuela and the series of winter storms Anatol, Lothar and Martin in Europe. We have already become used to the annual series of tornadoes in the United States, the expensive hurricanes in the Caribbean and the wide-spread floods in south-east Asia anyway. No place on earth can be regarded as a "disaster-free zone". However, there are differences in the reasons for and in the effects of these disasters.

A main factor is certainly the dramatic increase in the world's population and in particular in certain regions. This increase creates the necessity to settle in areas that are dangerous. Additionally the movement of political, social and other refugees, increased mobility and the attractiveness of areas that have a beautiful natural environment and a mild climate lead to people settling in environments whose natural features they do not know. They are not aware of what can happen and they have no idea how to behave if nature strikes.

There are different strategies to reduce the impacts of nature's forces: one can avoid hazardous areas, establish early warning systems, flee before and during events, permanently or temporarily strengthen buildings, organise disaster response (i.e. prepare, fight, help, reconstruct) and seek insurance. None of these different strategies makes sense though if followed exclusively. Only the combination of – ideally all – components can improve the situation and guarantee effective disaster management (German IDNDR Committee, 1999).

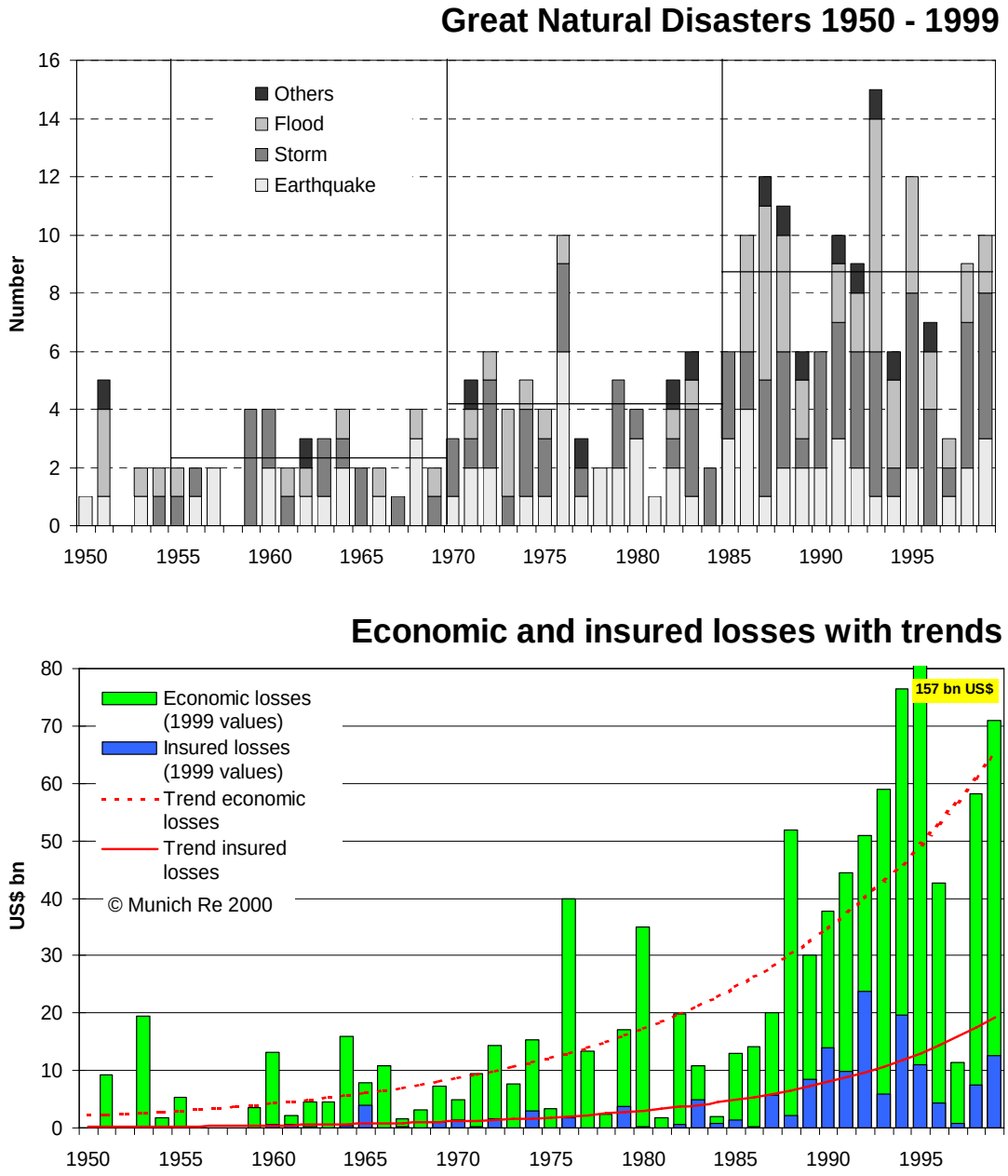
2 Losses from Natural Disasters

Reinsurance companies, due to their world-wide activities, are among the best sources for natural disaster statistics. Their analyses focus on three aspects: the number of people affected (fatalities, injured, homeless), the overall economic damage to the country hit, and the losses covered by the insurance industry.

Natural disasters with thousands of deaths almost always hit poor countries and are caused by earthquakes (Table 1). The one aspect (poverty) is related to the higher vulnerability in less developed countries (poorer quality of structures, more people), the other (earthquakes) to the sudden onset of such events, which strike without warning. In the past (more than 50 years ago), floods were responsible for a huge number of deaths. With the exception of storm surges this is not so anymore today. The table of the deadliest disasters during the past 30 years contains only three great water-related disasters, the 1970 and 1991 Bangladesh storm surges, and the recent flood and debris-flow event in Venezuela. For no other type of natural disaster have early warning methods become more operational, more reliable and hence more effective than for meteorological and hydrological disasters. A 1994 Bangladesh storm surge that ran up to a height comparable to the one in 1991 cost the lives of only 200 people. This reduction in the number of victims has mainly been a consequence of improved early warning methods based on better storm forecast models together with the availability of elevated shelters that allowed people on low land to flee the flood waters.

Nowadays, geogenic disasters (earthquakes, volcanic eruptions, landslides) pose the deadliest threat. In addition to their extremely sudden onset, the prediction of most major geological events is difficult or even impossible, and in most cases there is no time left for warning. In contrast to this, hydrological events almost always build up relatively

slowly. Usually, even the few minutes an approaching flash flood leaves for people to flee may be enough for many to save their lives. However, the Venezuela floods showed that this is not always the case. The extreme risk to which people exposed themselves by settling on and below highly unstable slopes combined with unusual rainfall were the reasons for the shocking event that killed more than 30,000 people (some estimates go even as high as 50,000) just before Christmas 1999.



Great Natural Disasters 1950 - 1999

Decade comparison

	Decade 1950-1959	Decade 1960-1969	Decade 1970-1979	Decade 1980-1989	Decade 1990-1999	Factor 90s : 60s
Number	20	27	47	63	87	3.2
Economic losses	39.6	71.1	127.8	198.6	608.5	8.6
Insured losses	0	6.8	11.7	24.7	109.3	16.1

Losses in US$ billion - 1999 values

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Fig. 1: Development of great natural disasters during the past half century

The statistics for losses display a different picture: the record economic losses (Table 2) occur mostly in rich countries. While two earthquakes still lead the table, floods, which usually affect much larger areas than earthquakes and occur much more frequently, have at least the same importance. Especially in China they cause almost every year billions of dollars of losses for the economy and severe distress in the nation. Not only the great disasters display such a tendency, but also the accumulated annual amount of losses from the many small and medium-sized events. On average, floods cause as much damage as all other destructive natural events together. Additionally, one should bear in mind that the financial means societies all over the world spend on flood control (sea dikes, levees, reservoirs, etc.) is a multiple of the costs they devote to protection against other impacts from nature. For the insurance industry storms are clearly the most critical loss events (Table 3) occurring exclusively in rich countries, although earthquakes – e.g. a major event in California, which may cost the insurance companies several billion dollars – represent the greatest loss potentials.

The tables reveal that all but two of the economic and insured losses occurred in the last third of the regarded 30-year period clearly indicating an increase in these events. An analysis of all great natural disasters in the past half century (Munich Re, 1999) shows that the losses generated by natural disasters have been exploding since the sixties (Fig. 1). Great natural disasters are those in which the affected areas are clearly unable to help themselves and require interregional or international aid. This is normally the case when there are thousands of fatalities, hundreds of thousands of people made homeless, or substantial economic losses (depending on the economic circumstances in the affected country). Only 27 such catastrophes were counted in the sixties, but this number rose to 63 in the eighties and 87 in the nineties. The increase took place more or less in two steps, which becomes quite clear if the averages of 15-year periods are regarded. The period 1955-1969 produced 2.5 great natural disasters per year, 1970-1984 about 4.3, and the past fifteen years 8.7 (Fig. 1, upper part). The graphs for economic and insured losses (Fig. 1, middle part) show a continuous and constantly accelerating upward trend. The total losses from great natural disasters accumulated to almost US$ 609bn in the years from 1990 to 1999, which is – when inflation is taken into account – nearly nine times as much as in the sixties (US$ 71bn). Even more dramatic is the increase in the insured losses: US$ 109bn (last ten years) versus about US$ 7bn (sixties) yields a factor of over 16 (Fig. 1, lower part). The main causes for this development are: the increasing concentration of people and values in areas that are exposed to unfavourable natural conditions, the increasing vulnerability of structures and goods, the – often unjustified – trust in protection systems, and the changes in environmental conditions including climate change. The disproportional increase in insured losses may be attributed primarily to an increasing insurance density.

Rank	Year	Event	Country	Fatalities
1	1970	Storm surge	Bangladesh	300 000
2	1976	Earthquake (Tangshan)	China	290 000
3	1991	Storm surge	Bangladesh	140 000
4	1970	Earthquake, landslide, tsunami	Peru	67 000
5	1990	Earthquake	Iran	40 000
6	1999	Floods, debris flows	Venezuela	>30 000
7	1988	Earthquake	Armenia	25 000
8	1985	Volcanic eruption, lahar	Colombia	23 000
9	1976	Earthquake	Guatemala	22 000
10	1999	Earthquake (Izmit)	Turkey	>20 000

Tab 1: The ten deadliest natural disasters of the past 30 years (not including droughts)

Rank	Year	Event	Country/Region	Insured losses US$ bn
1	1995	Earthquake (Kobe)	Japan	100
2	1994	Earthquake (Northridge)	USA	44
3	1998	Floods	China	30
4	1992	Hurricane Andrew	USA	27
5	1996	Floods	China	24
6	1993	Flood (Mississippi)	USA	16
7	1990	Winter storms	Europe	15
	1991	Floods	China	15
	1995	Floods	North Korea	15
	1999	Floods, debris flows	Venezuela	15

Tab 2.: The ten costliest natural disasters of the past 30 years (original values, **not** adjusted for inflation)

Rank	Year	Event	Country/Region	Insured losses US$ bn
1	1992	Hurricane Andrew	USA	17.0
2	1994	Earthquake (Northridge)	USA	15.3
3	1990	Winter storms	Europe	9.8
4	1991	Typhoon Mireille	Japan	5.2
5	1989	Hurricane Hugo	Caribbean, USA	4.5
6	1999	Winter storm Lothar	Europe	4.0
7	1998	Hurricane Georges	Caribbean, USA	3.4
8	1987	Winter storm	Western Europe	3.0
9	1995	Earthquake (Kobe)	Japan	3.0
10	1995	Hurricane Opal	USA	2.1

Tab 3: The ten costliest natural disasters of the past 30 years for the insurance industry (original values, not adjusted for inflation)

3 The Risk Partnership against Natural Disasters

Preparedness for natural disasters is a task that concerns everyone. The system of risk partnership is essentially made up of three components: public authorities and institutions – individuals and companies – insurance and reinsurance industry. Insurance cover is an important cornerstone of the protection system against natural hazards.

Public authorities are responsible for the basic protection against and preparedness for natural events. This responsibility includes structural and non-structural measures such as the establishment of an infrastructure for disaster reduction, the construction of dikes, observation and warning systems, building codes, land-use restrictions, etc. All these are aimed at protecting the community as a whole and not individuals. Structural measures

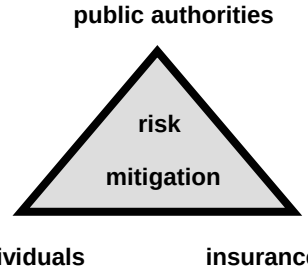

Fig. 2: The components of the risk partnership against natural disasters

are mainly designed to reduce the loss frequency by averting damaging events of smaller size, whereas non-structural measures reduce losses during extreme events. Disaster relief measures all the way from emergency assistance to reconstruction complete the catalogue of public responsibilities.

Disaster preparedness on the part of those threatened by natural events is of crucial importance. Hardly any other measure adopted for the purposes of loss reduction is as efficient the as the contribution made by people themselves. They are the ones who transform the general guidelines of building codes to fit their own individual situation; they are the ones who to try to minimise the damage by supporting civil defence and disaster assistance measures and by moving their belongings to a safe place in good time.

The purpose of insurance is to protect the insureds from excessive losses that threaten their living or business conditions substantially. Insurance is not meant – though often used – to compensate relatively minor damages. While from the point of view of an insured who has paid his premiums for many years it is understandable that he is interested in being reimbursed even in the case of a minor loss, this demand is exactly the reason why premiums are higher than they could be.

The measures taken by the insurance industry go beyond simply providing monetary assistance in the event of a claim. They execute loss analyses and build up loss databases. With risk inspections they make a contribution to a better design of structures so that future events will be less harmful. Finally, they contribute – through publications, seminars and lectures – towards education and towards creating awareness among the public, the decision makers and the technical experts.

The basis for their business is to develop tools for assessing the risks. First they must identify potentially hazardous areas and map the intensities of the respective hazards. One such map is the World Map of Natural Hazards (Munich Re, 1998) shown in Fig. 3. This map displays the exposure of all regions of the world to the various natural hazards. It contains information on earthquakes, volcanoes, tropical storms, extra-tropical winter storms, tornadoes, regional and monsoon storm systems, hail, lightning, extreme precipitation, storm surges, tsunami, high waves and sea-ice. Additionally the effects of climatic changes and El Niño events are shown plus plate tectonics. The map – and in particular its CD-Rom version (Munich Re, 2000) – gives underwriters hints where certain natural hazards exist so that they can be considered if an insurance contract is designed. However, the map is also helpful or at least informative for almost anyone else.

One can clearly see that natural hazards are not uniformly distributed and equally intense in the various parts of the world. Some regions are prone to certain hazards only, other regions seem to suffer from literally any kind of natural threat. In particular coastal areas are very much exposed to natural hazards, of which storm surges are – due to their spatial extent – still among the most devastating and dangerous (c.f. Table 1). For them insurance cover is practically unavailable, but why is this so?

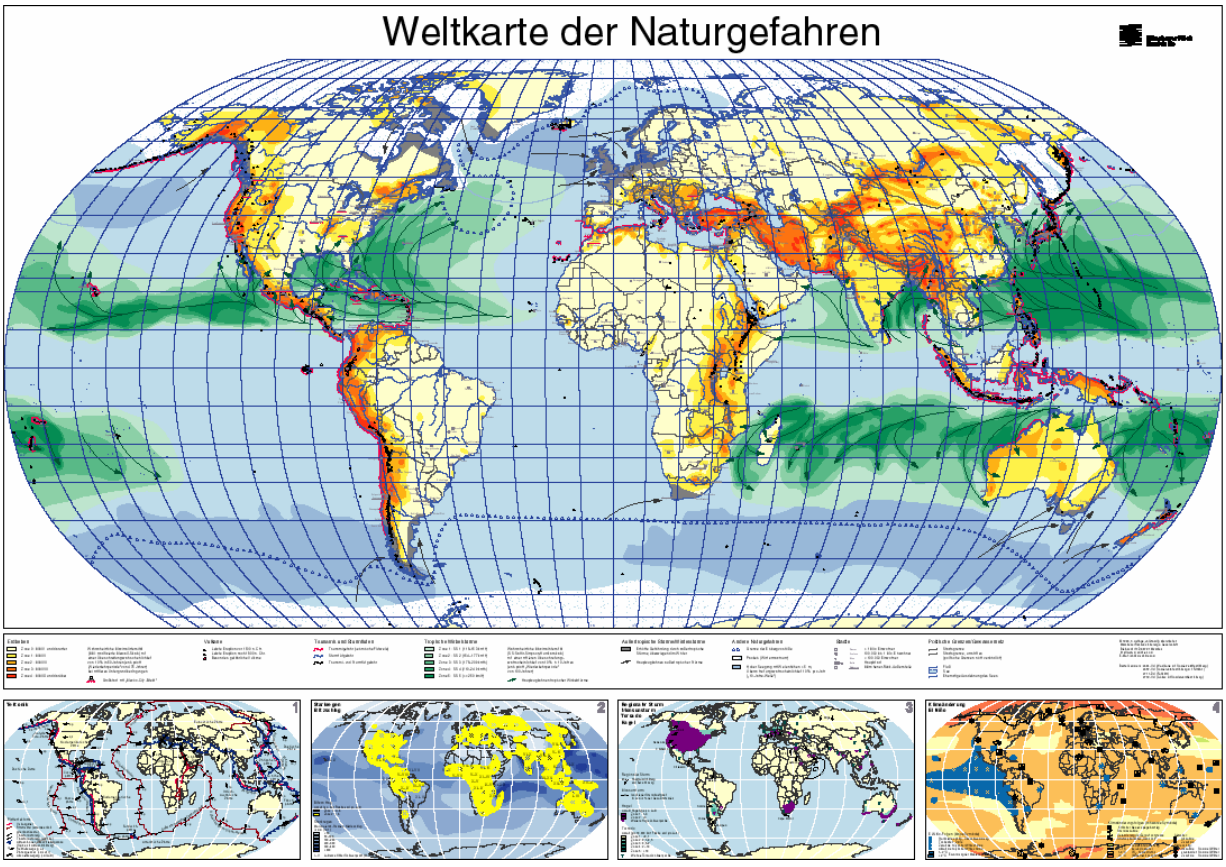

Fig. 3: World Map of Natural Hazards (Munich Re, 1998)

4 Insurance and Reinsurance of Natural Disasters

Before answering this question some general aspects of natural disaster insurance shall be highlighted. Small, medium, and even most large loss events are “business as usual” for the insurance industry. For these events, insurers and reinsurers merely serve as a tool to redistribute funds collected from a large quantity of potentially loss-threatened individuals to an actually disaster-struck group. All losses are – in the long run – paid by the insureds. They can – through adequate measures – reduce their financial burden by adjusting their homes and businesses as well as their behaviour to the loads exerted by rare (and not so rare) natural events. This requires knowledge of the threat, in particular of an imminent threat. Such knowledge can be supplied by well-functioning early-warning systems (Kron et al., 2000).

As a rule insurance companies react very quickly to losses from natural events and reimburse their clients immediately. Apart from the benefits of the very helpful financial support they provide, the psychological effects of prompt assistance are very important for the people concerned. They do not feel left alone in an extremely difficult personal situation. This problem occurs if governmental financial aid is promised but the payments are delayed for a long time because of administrative reasons. Also the actual payments seldom match the amounts promised by politicians right after a catastrophe. For insurance companies, which do not need to go through long political decision-making processes and can react immediately, quick help too has advantages. Their mottoes are "The faster the cheaper" and "Good loss adjustment is the best promotion."

Natural disasters are capable not only of ruining individuals and enterprises, but also, due to their tremendous loss potential, of wiping out entire insurance companies. The Great Hanshin Earthquake of Kobe (1995) caused economic losses of about US$ 100bn. Had the insurance density been higher than just around 3%, the event could easily have topped the costliest natural catastrophe for the insurance industry to date, Hurricane Andrew in 1992, when it had to cover losses of US$ 17bn. On the other hand: Andrew missed the metropolitan areas of Miami and New Orleans by a mere 20-30 km. A slightly shifted path could have tripled the losses. Nevertheless, the hurricane swept 13 primary insurance companies from the market in the American Southeast. This shows the key role reinsurers play within the insurance industry in the context of natural hazards.

Billion-dollar catastrophes cannot be born by a local insurance market without major damage to the insurance industry itself. Even in strong markets such as the United States, great events leave their traces. The burden from claims may exceed by far the capacity of primary companies, and they go bankrupt. To prevent such things from happening and to protect themselves from bankruptcy, insurance companies must assess the maximum probable losses they may be confronted with and prepare for them. One – often the main – aspect of preparation is to seek reinsurance. Reinsurance is nothing but insurance for insurance companies.

While most insurers concentrate their business on a particular country or region (e.g. the United States, Europe) reinsurance companies do business world-wide. How effectively this idea of transferring local losses via the reinsurance sector to a world-wide system works is shown by the example of another hurricane, Gilbert, which hit the Caribbean in 1988. Jamaica in particular suffered great losses; its economy was hit by losses amounting to about US$ 1bn, of which 70% was insured. These US$ 700m would have destroyed the Jamaican insurance industry completely. It survived because nearly 99% or US$ 690m was reinsured and was therefore paid by the world’s reinsurance industry. For the local companies a mere 10-million-dollar obligation remained.

A reinsurance rate of more than 95 percent is typical for developing countries. In developed countries, reinsurance rates range between 50 and 90%, depending on the strength of the primary insurance companies in the region. Since reinsurance costs money, large primary companies tend to keep a larger portion of the risk themselves. Two examples: the series of winter storms in Europe in 1990 cost insurers US$ 9.8bn, of which the reinsurers paid 6.4 billion (65%); of Hurricane Andrew’s 17-billion-dollar insured losses bill 50% was paid by the reinsurance sector.

Even if some people believe that "insurance companies need natural disasters, because they keep the desire for financial security awake", the insurance industry still has a great interest in combating the consequences from them, of course also with the goal of keeping their own losses low. A ruined client, however, cannot be an insurance client at all. Besides ensuring that their insurance conditions are of efficient design, therefore, they put a great deal of emphasis on information that can have far-reaching positive effects. By defining hazard zones, some pressure can even be exerted on political decision-makers on all levels. Only the integrated co-operation of the three described components in the sense of a risk partnership allows efficient risk and loss reduction.

5 Problems of Natural Perils Insurance

5.1 Adverse selection

In some fields such as in the insurance for flood and especially the one for storm surge, there is a difference in the demand for cover from potential clients who are exposed to the hazard and the offer made by the insurance sector (Kron, 1999). Those who wish to buy insurance do not get it because their exposure to the hazard is too high. Those whom the insurance companies are willing to give cover are not interested in insurance because they do not see a necessity.

The phenomenon that only owners of frequently by a certain hazard damaged property seek insurance is called *adverse selection* or *antiselection*. For this group of people two basic conditions of insurance are usually violated:

1. There is no spatial spread of the insured risks; the community of insureds is a relatively small group of people who all bear a risk from the same type of hazard.
2. Temporal compensation of losses is not possible because damage occurs too often, so that loss events cannot be regarded as unexpected events. Unexpectedness, however, is a necessary condition for any insurance cover.

These two factors lead to premiums being so high that insurance does not make sense anymore for the client. Hence, there is no insurance solution that can possibly make insurance companies settle all the losses that may be incurred.

The hazards that tend to produce adverse selection include the geogenic hazards (earthquakes, volcanic eruptions), some hazards that are related to geological and topographical features (e.g. landslides, debris flows, avalanches) and especially some types of floods (river floods, storm surges). These hazards usually are confined to certain areas (coast, mountains, valleys etc.) or their intensities are much higher in some areas as compared to others (e.g. near earthquake faults or volcanoes). The only way to make such types of hazards insurable is to offer packages that include coverage for different natural hazards, or even better, for all kinds of natural hazards. Such "natural hazard packages" reduce considerably – if not avoid completely – adverse selection. Clients in the mountains who may be threatened by avalanches or high snow packs on their roofs are among the insured community as well as those in a valley close to a river and those in an earthquake-prone area. The temporal and spatial distribution of loss events is fully given and the insured community is large enough.

In some countries (e.g. United Kingdom) such packages are even made "all risk packages", i.e. they contain any type of natural loss event. In other countries the various hazards are treated in different ways, often for historic and insurance-political reasons. In Germany, for instance, windstorm insurance is offered separately. After the series of severe winter storms in 1990 storm insurance density went up greatly in the country. Since then, the performance of this "one peril insurance" has been quite well and the insurance industry hesitates to touch this stable and successful (for both the insurers and the insured) line of business by adding other hazards to it. For windstorm, adverse selection is no problem anyway because the hazard is more or less uniformly spread over wide areas.

The above asked question concerning insurance – or better non-insurance – of storm surge remains to be answered. In developed countries disastrous storm surges – due to the high standard of coastal protection – are rare events. At the same time, they are capable to release tremendous loss potentials as coastal areas are densely populated and intensely used by industry, traffic, trade and transport, and contain huge values. Adverse selection is extremely pronounced because only a relatively small coastal strip can be affected. Recently an initiative of some German insurance companies to offer storm surge insurance was stopped by the results of loss calculations. The losses that could occur if the sea dike at only one location fails during an extreme event amounted to more than 6 billion German Marks for the private and small business sectors alone. Only one such every 100 years would require premiums that are way beyond any reasonable limit. Therefore in Germany, as in most other countries, storm surges cannot be insured.

5.2 Insurance premiums and deductibles

Offering natural hazard insurance packages alone is not sufficient to allow proper and fair design of insurance contracts. There must be a component that takes into account the individual exposure to the respective hazards. Based on the overall level of exposure the individual premium can then be calculated. The first step in this calculation is identifying and/or defining risk zones. In the case of earthquakes these zones are based on seismic intensity maps, in the case of river flooding they may be obtained by computing the flood levels and inundated areas for certain return periods such as, for instance, the 10-year or 50-year floods (Kron, 2000).

The price for insurance depends on the risk circumstances in each individual case. A clear definition of the scope of cover is essential. For the premium to be adequate, it must be calculated on the basis of the full insurance value. The basic parameters for a technically correct premium calculation, i.e. return periods and expected losses, usually involve quite a large degree of statistical uncertainty and an adequate fluctuation loading is needed to compensate for this. If necessary, this fluctuation loading will also serve to finance losses that may arise in areas where loss events are so seldom that there can be no balance over time. In mass business – i.e. for private homes and small businesses plus their contents – the effort required to assess the exposure of a certain building must be seen in the context of the annual premium income for one such object, which is in the range of perhaps US$ 50–100. Therefore, an individual assessment of the risk and the calculation of an individual premium for these objects are impossible, so that the premium must be fixed on the basis of a flat-rate assumption.

The second feature of an adequately structured contract is a deductible. This means, a certain amount of the loss has to be borne by the insured before the insurance becomes effective. Such a structure has advantages for both the insurer and the insured. The insurer does not have to settle masses of small losses and saves – besides loss compensation money – a lot of administrative costs. The client may only become insurable at all if he pays a share of the losses and the strong competition in the insurance market

will immediately lead to reduced premiums if the administrative costs sink.

The effect of deductibles becomes clear with the example of Daria, the worst windstorm in the 1990 series of gales in Europe. This event caused losses of a little more than one billion marks in Germany, a large proportion of which stemmed from tens of thousands of minor to small losses in the order of a few thousand marks. The insurance industry settled the claims in a very liberal way, often without checking the reported damage. If private clients had agreed to a DM 5,000 deductible, the number of reported claims would have been reduced by 96%, the total insured losses by 93%. Both reductions would have saved the insurance industry a lot of money, but it would also have saved the customers a lot of money. After all, it is clear that insurance companies only re-distribute the money they get in the form of premiums to clients who claim compensation for losses they have incurred.

One very important side effect of deductibles is that they raise the willingness of home and business owners to defend their property against damage. Financial motivation is the most powerful way of motivating the insureds to take measures aimed at loss reduction.

5.3 Accumulation control

One major task of insurance and reinsurance companies is accumulation control. The assessment of the probable maximum loss (PML) and a business strategy that accounts for this loss is most important for the survival of a company in the case of a very extreme event. The company must decide on the reserves it needs and its reinsurance requirements. PML calculations are based on scenarios that assume a major event hitting a large area or an area with a high concentration of values. It is not obvious beforehand which scenario will determine the worst case for a given company as the expected losses depend on the company's portfolio, and particularly on the spatial distribution of its liabilities. For each company a different scenario may determine the PML.

PML models have been available for many years as a means of calculating maximum losses from earthquakes and windstorms. For the analysis of floods, such tools were not available until recently. Flood events are much more influenced by small-scale and local aspects, which include soil conditions and topography, the exact location (elevation) and the effectiveness of flood control measures. Therefore, such models require considerably more detail and sophistication (Kron, 2000).

6 Conclusions

Losses from extreme natural events have increased substantially in recent decades and will continue to increase in frequency and severity in the 21st century. At the moment there is no indication that the rising trend is going to stop in the near future. Global changes (climatic, political, economic) and the increases in population and values are the main factors in this process. Especially climatic changes are expected to make the situation even more severe as they have just begun to produce noticeable effects, as demonstrated by recent weather patterns.

On the other hand, technical and organisational measures of protection and preparedness including early-warning systems are available and have evidenced a good level of efficiency. Natural disaster reduction, however, is a very complex field which can neither be addressed by structural and organisational measures alone nor just by early warning. After all, it is man who exposes himself to the forces of nature through his behaviour and voluntarily or involuntarily chooses – or accepts – a certain risk. To some extent, though, he can, by taking appropriate measures, control or at least mitigate the risk from an existing hazard. A well-developed risk awareness among the population and disaster managers is of crucial importance. This is – among other things – a precondition for the effectiveness of early-warning systems. Early warning can only be transformed into proper and immediately effective protection measures if everybody understands their meaning well.

Almost everyone is aware of the problem of improper land-use. However, many of the people that settle in high-risk areas simply have no choice. The increasing population will not allow any change in this sector but rather worsen the problem. People not only move to hazardous zones but also increase the hazards by extensively using the land there, which results in the impairment of the environment (including pollution) and the promotion of soil erosion (e.g. by over-grazing, cutting forests, establishing infrastructure, etc.).

Despite the obvious impossibility to prevent natural disasters and to reduce risks to zero, mankind’s belief in its ability to control nature is widely unbroken. This attitude of ignoring and belittling risks leads to their further increase. Great disasters come as a shock but they are soon expelled by other events and other news, and often other disasters.

Today, insurance is widespread in only a few countries. The current slow increase in the insurance density is unlikely to change dramatically in the near future, because both sides, customers and insurers, are not really promoting such a development. On the one hand, customers' demands are impaired by a growing number of people with a lack of financial resources and, on the other, the willingness of insurance companies to cover certain risks is very limited because of their magnitude, the great amount of uncertainty involved or because of accumulation control considerations (e.g. insurance for storm surges). Wherever natural disaster insurance is possible, available and in operation, however, it will help – by spreading the risk throughout the world via the reinsurance sector – to reduce the vulnerability of the society in terms of its exposure to natural hazards.

To sum up one can say that the dramatic trend of disaster losses can only be lessened by a package of integrated

counter-measures including strict land-use regulations, warning systems, education, (financial) motivation and insurance. These measures have to be supported by all the people and institutions involved: public authorities, scientists and relief organisations, individuals and enterprises, insurance and reinsurance companies. The insurance industry and the world of science and technology must join together in formulating their requirements and prepare them in such a way that the political powers can derive clearly recognisable policy options from them.

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