

## **INSURANCE AND DISASTER REDUCTION**

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**ABSTRACT:** Insurance can not reduce the level of death, injuries and financial loss, but it does provide readily available cash to cope with these at a time of extreme stress, and by just doing this can significantly improve the recovery phase of disasters and thereby reduce disruption of normal life. The widespread lack of insurance in the regions devastated by the Great Indian Ocean Tsunami would not have reduced the death and injury toll, but is contributing to the human distress of the survivors who without it are totally dependent on government relief and international aid. However coastal locations are a particular problem because of the concerns about the insurability of property exposed to the combined effects of wind, rain and storm surges from tropical cyclones, and, since December 2005, to inundation from tsunamis possibly in association with earthquake damage. This paper looks at the special problems of insuring catastrophic losses from natural hazards and some of the solutions that have evolved including the use of reinsurance and national disaster insurance schemes.

### **1. INTRODUCTION**

Disasters are measured by the level of impact of natural or man-made hazards on human society and the environment. In relation to human societies the scale of disasters is measured by the cumulative effect of death, injuries, financial loss and disruption of normal life. Insurance can play a role in reducing the impact of each of these. Insurance can not reduce the level death, injuries and financial loss, but it does provide readily available cash to cope with these at a time of extreme stress, and by just doing this can significantly improve the recovery phase of disasters and thereby reduce disruption of normal life. The widespread lack of insurance in the regions devastated by the Great Indian Ocean Tsunami would not have affected the death and injury toll, but is contributing to the human distress of the survivors who without it are totally dependent on government relief and international aid. Indirectly insurance can also be used as an incentive for mitigation of damage.

Modern disaster management is based on four major areas of activity - preparation, response, recovery and mitigation. Catastrophe insurance is a disaster management tool primarily focussed on recovery. Restoration of damaged property and financial losses to individuals and businesses arising from disasters costs money. Readily available sources of funds following a loss enhance the ability of those who have suffered loss to recover from the loss quickly and with a minimum of trauma. Insurance is a tool which provides this. Other tools with which it competes in this respect are government emergency aid, charity, and the insured's own accumulated assets (or self-insurance as it is known in the industry). The incentive of insurance to the individual or business is that, like self insurance, it is readily available through well established delivery channels following an event. The disincentive to the individual is that, also like self insurance, it has to be paid for in advance. In much of the developed world the incentive outweighs the disincentive, but in the developing world for most individuals and small to medium sized businesses the disincentive outweighs the incentive leading to low levels of insurance. Cultural factors in many of these countries also play a role in this. The result is that there is a much greater use of insurance against losses arising from major disasters in developed countries than in developing countries, which greatly adds to the difficulties these latter countries can face when they suffer major disasters.

## **2. INSURANCE AGAINST HAZARDS**

### **2.1 General History**

Insurance against catastrophic losses has a long history going back the beginnings of modern fire and marine insurance.

Property insurance has its origins in fire insurance, by which it is still commonly known in the commercial area. In the English speaking world it can be traced back to the Great Fire of London in 1666 [1]. It is based on the formation of a pool of funds by contributions from the members of the pool, known as premiums, from which those suffering a loss are compensated. Property insurance works best where there is a significant number of randomly occurring independent losses each year to members of the pool that are large in respect of their individual economic circumstances, but in total are small relative to the total insured value covered by the pool. Although there may be considerable variability between individual claims, the annual variability of the total losses will be small as a result of the Central Limit Theorem of probability theory - or law of large numbers as the insurance industry calls it. Consequently a premium rate can be set which is only a small multiple of the burning rate or average annual loss relative to insured value, ensuring affordability for the insureds.

There are essentially three types of property insurance pools - mutual societies, commercial insurance companies, and government schemes that generally incorporate a compulsory element. The earliest English insurance pools formed after the Great Fire of London were mutual societies with the first commercial insurance company being the Sun Fire Office formed in 1710 [2]. In Europe the early pools appear to have been more government controlled.

In extending fire insurance to cover other hazards it was recognised that a number of conditions of insurability need to be met including a large demand for cover, a large spread of risks by type and location, random occurrence of risks free of moral hazard, affordable premiums, and events that are capable of definition. Providing certain conditions are met in terms of building construction, these conditions are met by fire losses. However the inclusion of losses from natural hazards created a problem in meeting these conditions that does not appear to have been initially recognised. This is the problem of accumulation of risks subject to loss from a single event. The Great Fire of London was an example of this, but insurability was achieved by fire insurance being conditional on fire spread being restricted by either separation of buildings or providing buildings with a fire resistant outer envelope, as well as a fire brigade being located in close proximity, which is why early fire engines were owned by insurance companies to protect their clients.

It is not so easy to limit the number of losses from single natural hazard events such as earthquakes, tropical cyclones, floods, severe storms, wild fires, volcanic eruptions, landslides and tsunamis. The problem with such losses is that although the average annual risk may be small, a large number may occur simultaneously. This breaks the basic condition of the Central Limit Theorem that the occurrence of individual risks must be independent of each other, and results in a high variability of annual losses to be recompensed from a pool due to the occasional very large demands when major events occur. Consequently the extension of insurance to cover losses from major natural hazards is more recent and rather patchy with only wind damage being almost universally offered in association with normal fire insurance

In some countries all natural hazards were considered too risky for the commercial insurance industry on its own and government based schemes have been put in place to provide insurance. Spain, Norway and France are examples of countries where this approach has been adopted. In general however, the commercial insurance industry has extended its fire insurance to cover natural hazards – but on a hazard by hazard basis. Much of this extension was more by accident than by design.

### **2.2 Wind Events**

Wind insurance as an addition to normal fire insurance began about 100 years ago in an environment where local storms were considered the main hazard. These typically arise as a result of thunderstorms and severe squalls associated with the passage of a weather front. Because they are generally very local in extent, at a time when the penetration of insurance was relatively low even in relatively developed countries and populations were relatively widely spread geographically, total losses from such events were regarded as manageable by the insurance industry. During the 20<sup>th</sup> century insurance became much more widespread in developed countries, and major demographic changes occurred that greatly increased the exposure to severe wind events such as

tropical cyclones. This has seen an escalation in the losses from wind damage suffered by the insurance industry. However in general the insurance industry worldwide has continued to regard wind as a standard risk covered is association with property fire insurance.

### **2.3 Earthquake Events**

The first major pay out by insurance companies following a major disaster occurred as a result of the 1906 San Francisco earthquake when about two thirds of the estimated US\$330 million dollars worth of property damage was covered by insurance [2]. Damage due to shaking was not covered. But most of the building damage was attributed to fire, and fire policies at the time did not exclude fire following earthquake. As a result of the San Francisco earthquake a cautious approach was adopted to earthquake insurance in the United States and other places known to have significant earthquake risks. This led to three different approaches to earthquake insurance as follows [3]:

- Earthquake included as a standard peril within a fire policy;
- Earthquake offered as an additional peril either on its own or in connection with a standard fire policy to which special conditions may be attached;
- Earthquake insurance covered by a government based, and often compulsory, scheme.

The inclusion of earthquake as a standard peril within a fire policy was generally restricted to home insurance and to areas where earthquake risk was considered negligible. Australia, where it was introduced in this form in 1927, is one of the few countries where this approach was adopted. More commonly earthquake is offered as an additional peril in connection with a fire policy. This is the usual approach worldwide for the insurance of commercial and industrial property. In countries or regions where earthquake is a major risk government based schemes are commonly in place, particularly for home insurance. Examples are to be found in New Zealand, California, Japan, Taiwan and Turkey.

### **2.4 Floods**

#### **2.4.1. Rain Induced Flooding**

Insurance against flooding induced by rain is available in most countries, generally as an optional addition to a normal fire policy with the insurance company reserving the right to refuse cover if the risk is considered to be too great. In some countries such as the UK and New Zealand it is a standard inclusion in home and contents policies. A major exception is the US where flood insurance is not normally available from commercial insurance companies, but is available from a government scheme run by the Federal Emergency Management Agency (FEMA). In Australia the situation is mixed, particularly in relation to home and contents insurance, with most companies providing cover against water damage arising from run-off, but many excluding water damage arising from the overflow of streams and rivers.

In many countries flood insurance is a significant issue of concern for the insurance industry because of the selective nature of those who want to purchase it – ie only those at significant risk are generally interested in purchasing it – and in urban areas flood risk can change significantly as a result of urban development, making the assessment of risk even more difficult than it already is..

#### **2.4.2. Marine Inundation**

The two main hazards giving rise to marine inundation with the potential to cause disasters are storm surges arising from tropical cyclones and tsunamis. These hazards are generally covered under cover provided for other hazards. In some countries they are both treated as floods and covered under flood policies. Where storm surge is covered this is nearly always the case but in some countries tsunamis are covered under earthquake policies. In the US they are covered under the FEMA flood insurance program. In Australia they are generally not covered at all as a result of insurance policies generally excluding inundation from the sea.

While it may seem logical to cover tsunami under earthquake policies since they are generated by earthquakes, because tsunamis can arise from very distant earthquake the relationship between earthquake risk and tsunami risk can be almost non-existent. It is also a problem if tsunamis arise from other causes such as landslides, volcanic action or meteorite impact.

## **2.5 Other Hazards**

Other hazards with the potential to cause major disasters are volcanic action, landslides and wild fires (or bush fires as they are known in Australia).

Losses arising from volcanic action, if covered by insurance policies, are generally covered as a specific inclusion in earthquake policies.

Landslides are often not covered by insurance policies. The reason for this seems to be historical, as the overall risk appears to be very small. However again this is a very selective area as only a small proportion of buildings are generally at risk from landslides.

Wild fires are usually covered under ordinary fire policies.

## **3. REINSURANCE**

A characteristic feature of insurance against major natural hazards such as earthquakes and tropical cyclones is that the major losses are relatively rare, but when they occur they may be very large. When they do not occur, which is the normal annual situation, the annual premium income will generally well exceed the annual losses, but when they do occur the loss may exceed the annual premium income by many times. Ensuring sustainability in the face of this large volatility is generally achieved by a combination of reserve funds and reinsurance and, to a more limited extent, alternatives to reinsurance such as catastrophe bonds. To be effective, reserves need to be very large, and since the generation and maintenance of such high levels of reserves is not efficient from a business point of view, private insurers tend to rely heavily on reinsurance. This is certainly true in Southeast Asia and Australasia.

Reinsurance operates by spreading hazard risks globally [2]. Reinsurance companies accept risks from around the world. Most hazard events have limited extent geographically and by spreading the risks to them geographically the annual volatility relative to average annual loss is reduced, thus providing a more efficient form of insurance and reduced premiums.

Insurance companies use reinsurance in two ways. One is to reduce their exposure to individual risks by ceding a proportion of large risks to reinsurers through various forms of reinsurance such as facultative reinsurance, and per risk reinsurance. The other is to reduce their overall exposure, either generally by using proportional treaty reinsurance, or to reduce their exposure to large catastrophic events by using excess of loss treaty reinsurance.

Excess of loss treaty reinsurance provides an insurance company with protection against event losses, net of other forms of reinsurance, within a defined band of losses. A characteristic feature of such reinsurance is that it is provided by a group of reinsurers who each accept only a portion of an insurance company's total risk. In this way the loss is spread very widely, and each reinsurer can limit its own exposure to any risk. Reinsurance premiums depend on a combination of factors including the average annual risk being ceded by the insurance company, the reinsurer's additional exposure to the same risks, the reinsurer's geographic spread of risk and hence the volatility of the risks to which it is exposed, the amount of capital invested in the reinsurer, the income from invested reserves, the target return on capital, and the target risk of insolvency [4]. Because of the competition and the use of modern financial risk management tools modern pricing tends to be relatively stable, with premiums rising in a controlled manner after a major worldwide drain on reserves to pay the cost of re-establishing the capital reserves, and falling back once this has occurred under the competitive forces at work.

Insurance against large natural disasters in most countries is dependent on the availability of reinsurance. Only in the US is it of lesser importance due to the large geographic spread of risk available within the US to major national insurance companies.

## **4. ROLE IN DISASTER REDUCTION**

### **4.1 Mitigation of Damage**

In general the availability of insurance does not reduce the damage losses from disasters, its primary contribution being to reduce the human stress associated with coping with these losses, particularly those arising from

financial losses, and to facilitate the recovery from disasters. Indeed instead of acting as an incentive to disaster reduction it can be a disincentive as the ready availability of insurance can lessen the pressure on society to take effective mitigation measures [5].

Direct incentives to mitigation through insurance systems are commonly advocated as a significant tool for mitigation of disasters. However, their use to date has been limited, and there are reasons for this.

Incentives imply options are available, and usually this implies a voluntary system. They also assume a sufficiently high level of public concern that policy holders will be prepared to do something which will generally mean some upfront costs which may be recuperated in the longer term. These are the stumbling blocks. In general compulsory schemes do not have incentives, and where voluntary schemes have them, very often they do not have a great impact.

The most direct incentive is to make insurance subject to a certain level of mitigation measures being in place. This can only work where insurance is voluntary, and where a significant proportion of the population want insurance. This is largely the situation in the United States and consequently most of the examples of this approach are to be found there, although one of the earliest examples was in Fiji where these conditions are also present.

In Fiji, following Cyclone Oscar in 1983 and Cyclones Eric and Nigel within two days of each other in 1985, in order to continue obtaining reinsurance the local insurance companies introduced a condition into their homeowners policy that in order to get cover against tropical cyclone damage the construction of the homes had to meet a specified minimum standard or be retrofitted by an approved method. As a consequence of this requirement many older houses were retrofitted to meet these requirements.

Shortly after this in 1988 the Texas Windstorm Insurance Association made it a condition of all new construction within a specified coastal area of Texas that in order to get cover from hurricane wind damage from the scheme, which is the primary source of such cover in the area, it must meet the requirements of its own building code. This has had the effect of ensuring that almost all new construction in the specified meets the requirements of this building code which is designed to minimize damage from the estimated probable maximum winds, irrespective of whether it is subsequently insured for hurricane winds or not. The effect on the resale value of buildings not complying makes it almost obligatory to comply. This is one of the best examples of how insurance can be used as a mitigation tool – but it is only applicable in a voluntary situation where there is also a significant desire to be insured – so it probably would not work in Taiwan without a change in the culture.

Another form of direct incentive is the use of risk rated premiums which take into account the standard of construction relevant to the risk at the location of the property. This is a more complex form of the schemes described above, but because it does not preclude insurance cover, it can be used in association with compulsory schemes. An example of the latter is the new Turkish Catastrophe Insurance Pool (TCIP) which is a compulsory scheme with differential premium rates, depending on construction standard and zone, for the same level of cover. The primary purpose is probably to encourage new construction to be built to the highest standards, but it may also provide some incentive for retrofitting to meet the higher standards, and therefore lower premiums. However there seems to be a general reluctance of homeowners to bear the upfront cost of retrofitting with the promise of eventually recovering it from the reduction in premiums.

To overcome the latter problem the California Earthquake Authority (CEA), which runs the Californian earthquake insurance scheme for dwellings and also has risk rated premiums, provides a grant towards the cost of retrofitting. However it is understood that even with this additional incentive there has not been a great deal of retrofitting.

Greater success appears to have been made in Florida where by State law insurance companies are required to provide hurricane wind cover as part of standard home insurance. The premiums have to be approved by the Insurance Commissioner, and must incorporate differential premiums reflecting the use of different forms of risk reduction including shutters.

#### **4.2 Enhancement of Recovery**

The primary role of insurance in the reduction of disasters is the lessening of the human and economic impact of financial losses arising from the damage.

For individuals and businesses it does this by providing an assured source of funding to cover all or part of the financial costs of repair and reconstruction following damage, as well as other costs such as additional living expenses until homes have been repaired or reconstructed, or loss of profits due business interruption. Because it is part of an existing system with established procedures the processing can begin immediately with all the protocols in place, and those affected can be quickly informed of the situation. This contrasts with other systems of funding recovery like charity or government relief, which generally require systems to be set up following the disaster, and in the case of government relief a considerable bureaucratic process to be followed applying for relief and getting any funds approved, all of which takes time and creates uncertainty at a time when those affected are seeking certainty.

From an economic perspective, insurance means that funds become rapidly available for repair and reconstruction enabling the building and construction industry in particular to respond rapidly to the disaster, and in turn get money flowing through the local economy. At national level where there is a high level of reinsurance, as in Australia and many Asian countries for instance, it generates foreign income at a time when the national economy may be under strain from the disaster.

## **5. NATIONAL DISASTER INSURANCE SCHEMES**

### **5.1 Importance**

A very low penetration of insurance, particularly in respect of residential buildings, exacerbates the magnitude of disasters created by major natural hazards when they occur. This was very well demonstrated in Taiwan following the 1999 Chi Chi earthquake. Tens of thousands of residential units were destroyed by the earthquake leaving about 100,000 persons homeless. Very few of these homes were insured so the burden of providing funds for the reconstruction fell on the Government, who responded by organising low interest loans. The Taiwanese government had the funds to do this. In 1999 Turkey also suffered a devastating earthquake that destroyed large numbers of uninsured dwellings, but did not have the funds to finance the reconstruction so sought a loan from the World Bank.

Loans provide the cash to rebuild, but they have to be repaid by those who receive them. This can produce a long-term burden on the individuals in the case of personal loans, and the national economy in the case of World Bank loans. Loans spread the burden over time, but not across the community. Governments may use taxes to mitigate the individual impact within their own borders, but the advantage of insurance is that, through reinsurance, it can spread the burden across the whole insured population worldwide. Both the World Bank and Taiwanese government recognised this, resulting in moves in both Turkey and Taiwan to increase the penetration of residential earthquake insurance.

### **5.2 Requirements**

To be effective in regards to disaster mitigation the provision of catastrophe insurance should meet the following criteria:

- Provide adequate funds for the reconstruction and repair of damaged buildings, restoration of contents, and temporary accommodation if the building is made uninhabitable
- Be affordable
- Be sustainable over a long period
- Have an efficient administrative system including response to claims
- Be free of moral hazard
- Be linked with mitigation activities
- Have high penetration
- Be politically acceptable
- Be culturally acceptable

Lack of catastrophe insurance or low market penetration generally reflects an inability to satisfy all these requirements. In Southeast Asia where penetration of residential insurance for major natural hazards is low, affordability and cultural acceptability are particularly significant factors. Government can bring a degree of compulsion that is not available to the private insurance, but in this case political acceptability is particularly important.

### 5.3 Design

If there is to be no intergenerational transfer of risk then the premium charged should closely approximate the market value of the risk. For property risks from natural hazards this will generally be the cost of transferring the risk to the reinsurance market. It can be shown [4] that this will be a function of the average annual loss, the administrative costs associated with collecting premiums, paying claims and the management of the process, and the additional charges which reinsurers must make in order to ensure a satisfactory return on capital while maintaining a low risk of insolvency. The latter depends on the total risk to the reinsurance industry from the hazard events covered, not just those ceded from a particular insurance company or disaster insurance scheme, and can be expressed in terms of a multiplier of the annual average loss, which will in general vary from one country to another.

Figure 1 shows in diagrammatic form the basic design process required for the development of a sound disaster insurance scheme [6].

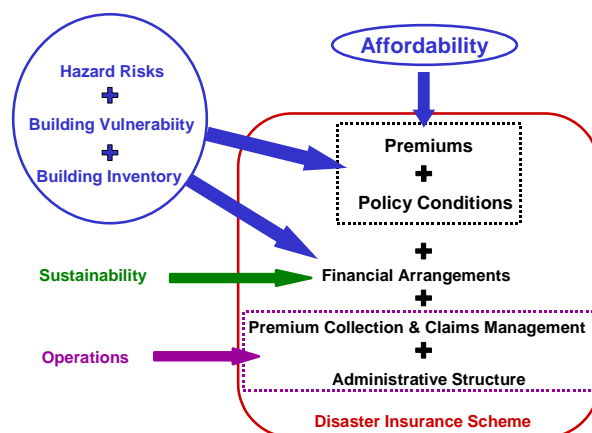


Figure 1 Design Process for Disaster Insurance Schemes

Normal insurance is generally based on either indemnity or replacement value, with deductibles and sub-limits being used to limit the risk covered at low levels and high levels of loss respectively. For normal private insurance in Southeast Asia and Australasia deductibles are commonly applied, although they vary significantly from none in some countries to up to 2.5% of sum insured plus 10% of the loss in Indonesia.

Government disaster insurance schemes are attracted to the concept of generating reserves, in combination with reinsurance, but a big challenge for them is the establishment of the reserves in the first place. Modelling shows that for earthquake type risk the most effective way of doing this is for the Government to initially take a significant proportion of the risk and allow the reserve funds to build up, and then use reinsurance to protect these funds, relying on no major disaster to occur during this period [6,7]. Such an approach in combination with the lack of a major loss since the inception of its scheme 60 years ago underlies the success of the New Zealand earthquake insurance scheme.

### 5.4 Options

Although the basic requirements and determination of premiums, policy conditions and financial risk management options is the same for all catastrophe insurance systems, systems of delivery vary widely.

Where natural hazard insurance is a standard inclusion or optional addition to a normal fire policy, the system of delivery will generally be determined by the insurance company's wider operations. Where governments intervene to increase the penetration of natural hazard insurance, especially if it is to be through a separate national disaster insurance scheme, there are many options that have to be considered. A review of existing schemes around the world shows that there are almost as many different systems of delivery as there are schemes suggesting that there is no single set of these options that is universally applicable. Indeed it suggests that for each country there may be a unique combination that best suits its own history and socio-economic characteristics.

Some of the questions that arise are:

- Will only residential insurance be offered or will it also cover small businesses, or all commercial and industrial property, or include agricultural risks as well, or also include government infrastructure as well like the Spanish system?
- Will it cover buildings only, or buildings and contents, or buildings contents, and will their cover be based on replacement value or indemnity value or something else? What about business interruption and temporary living expenses?
- Will only earthquake losses be covered, or will losses from other hazards be covered as well?
- Will it be a purely Government scheme, a joint operation of the government and insurance industry, or a purely insurance industry operation under government regulation?
- Will participation be voluntary or compulsory? If compulsory will this be as an addition to a normal fire policy, or universally compulsory irrespective of whether it is covered by fire insurance or not?
- Will premiums be a uniform fixed amount, a uniform fixed rate, or a variable rate based on risk?
- Will the provider have unlimited liability, which is the most common case, limited liability with a government guarantee covering losses above the limit, or limited liability with proportional cover if this limit is exceeded.
- Will it's administration be undertaken by a special body set up for the purpose, outsourced to an existing insurance or reinsurance company or organisation, or undertaken by a government department as part of its normal activities?

Virtually all the different options listed can be found in the different national disaster insurance schemes around the world.

## 6. THE FUTURE

During the past 20 years the insurance industry has shown a great capacity to meet challenges posed by provision of catastrophe insurance as the insured losses from catastrophic events both natural and man-made have increased dramatically from those previously experienced. Some have attributed the increase to greenhouse induced climate change, but the prime reason is demographic change leading to dramatically increased concentrations of insured wealth in hazard prone locations, particularly in coastal locations in combination with natural random behaviour of extreme events, and an increasing penetration of insurance [8]. A major factor in the resilience of the insurance industry has been the adoption during this period of sophisticated technical approaches to modelling the risks and managing the resulting financial risks.

The demand for catastrophe insurance is likely to continue to increase as governments recognise its value in reducing the overall impact of disasters. The World Bank is playing a key role in this development as it recognises the need for communities to develop the degree of self sufficiency in the event of disasters that is provided by insurance. The challenge will be to integrate the high technology and sophistication of the solutions and tools available with the political and social restraints that currently militate against the widespread adoption of catastrophe insurance in many places.

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