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# *Chapter 3*

# Natural Catastrophe Risk and Insurance

*This final chapter is devoted to the analysis of the role of insurance in the management of* natural catastrophe risk. *The author underlines the role of insurers as well as the limits of private insurance solutions for the coverage of such extreme risks, due to the magnitude of their economic consequences and the difficulties faced in pooling risks. He also gives an overview of complementary or alternative risk management options already tested in different institutional contexts and analyses the crucial role played by governments in partnerships with the private sector. Besides he describes the main features of several governmental disaster schemes and other institutional arrangements that have been designed in order to supplement or replace traditional reinsurance and provide regulatory incentives for the development of private coverage. The overview of alternative risk management techniques also includes an analysis of the development of new financial instruments* (e.g. *catastrophe bonds or weather derivatives) aimed at providing additional funding and economic protection against large losses from natural disasters.*

## 1. The increasing risk of loss from natural catastrophes

The risk from natural disasters is increasing. Large losses created, among others, by hurricane Andrew in Florida in 1992, the Northridge earthquake in California in 1994, the Kobe earthquake in Japan in 1995, the Kocaeli earthquake in Turkey in 1999, windstorms Lothar and Martin in Europe in 1999, the Bhuj, Gujarat earthquake in India on January 26, 2001 and tropical storm Allison in the USA in 2001 put large strains on the financial capacities of the international reinsurance market and, consequently, catastrophe insurance coverage availability has substantially diminished over the past years.

The increase in the magnitude of actual and insured losses from natural disasters in the past fifteen years has significantly exceeded the predictions of the insurance industry. The size of the losses resulting from an environmental catastrophe depends on both the severity of the natural forces involved, the vulnerability of buildings and infrastructures and the efficacy of plans and emergency strategies for disaster control and mitigation implemented in the afflicted region.[1] Not surprisingly, among the several causes of this unprecedented increase in losses and risk estimates are new urbanization developments in hazard-prone areas and the lack of enforcement of building codes and land-use regulations; higher population densities, the increased concentration of values in exposed locations and the adverse meteorological effects of global climate change contribute to amplify the magnitude of the problem.

In the recent years, therefore, the threat of a mega-disaster striking a major inhabited area has dramatically altered the insurance environment. Today many insurers and reinsurers indicate that they cannot continue to provide the same level of coverage against hurricanes, floods and earthquakes, without incurring an excessive risk of insolvency or substantial losses of capital or surplus. These concerns stem from a balanced reassessment of the insurance industry's financial exposures following the severe losses cited above.

## 2. The financial burden of natural disasters

The financial burden of natural disaster is extremely large and the insurance and reinsurance industry may be able to handle a substantial part of it only within the appropriate legal and regulatory framework. With respect to natural catastrophe risk, in fact, insurers face several difficult challenges.


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The essential problem concerns the ability of the traditional insurance mechanism to properly manage low probability and high consequences (LPHC) events, such as natural catastrophes. As mentioned in the previous paragraph, the insurance and reinsurance capacity for natural hazards risks is currently quite limited. The financial management of natural catastrophe risk is quite costly and troublesome for the industry, mainly because of:

- the **magnitude** of expected insured losses (*i.e.* the size of aggregate claims in case of a disaster); and
- the **inter-temporal mismatch** between the size of annual premiums and the size of the annual expected losses.

In other words, it shall be noted that the risk of loss from natural catastrophes is **correlated both temporally and spatially** and this creates both **geographical and inter-temporal risk spreading problems**.

The **risk of accumulation** is quite high in the primary market, since the same catastrophic event can cause losses involving many different insured properties and infrastructures at the same time, giving rise to immense claims burdens in a single policy period.

**Adverse selection** is another problem that may negatively affect the ability of insurance company to spread the risk of loss geographically, even on a national market.[2] Effective risk spreading, therefore, can be performed only on a global scale, through a series of international reinsurance arrangements.[3]

Another problem concerns the **low level of predictability of natural hazards risk**: until recent years, in fact, there has been a general lack of reliable data and objective information concerning the economic effects of natural disasters. Considerable uncertainty is associated with the estimation of the probability of disasters of different magnitudes occurring and the size of the resulting losses. Technology and computer modelling of natural perils have only recently reached the point where the risks can be clarified. As already pointed out in Chapter 2 of this report, it has been demonstrated that the limited (bounded) rationality of several individuals may lead them to underestimate or ignore LPHC risks:[4] even a reasonably priced catastrophe insurance coverage, therefore, may often be perceived by prospective insureds as too costly.

## 3. The importance of public-private partnership for disaster management

In light of the above considerations, it seems clear that the financial burden of natural catastrophe risk cannot be carried exclusively by the private insurance sector. Some of the major obstacles to insurability, however, may be overcome through the proactive intervention of the public sector. Besides, the

general trend in OECD countries is towards some sort of co-operation between governments and the private sector in the management of natural disaster risks.

The public authority can play a fundamental role by:

- providing the requisite legal framework;
- subsidizing the cost of administering the disaster management scheme;
- subsidizing the cost of insurance to the beneficiaries;
- being a reinsurer of last resort.

The public authority as the insurer of last resort is in a better position to deal with the extreme loss potentials than are private insurance companies with limited capital and capacity:[5] governments, moreover, have the power to enforce the adoption of appropriate risk mitigation measures and to make catastrophe insurance coverage mandatory, thereby spreading the risk throughout the entire society.

The private insurance sector, in turn, has the requisite technical expertise for providing:

- proper risk assessment and risk allocation mechanisms;
- expedite loss adjustment services;
- effective surrogate regulation.

The payment of losses through risk-based insurance policies is self-funded from premiums received. This mechanism makes insurance a reliable financial tool for managing and funding risk, because insurance specializes in reserving and investing collected funds for the purpose of claims payment. With respect to natural catastrophe risk, an insurance-based mechanism is more likely to have funds to cover losses over time than an *ex post* governmental aid disaster program, which may have to compete for funding with other programs that are subject to changes in the political climate.[6] The solid experience of the private insurance sector in assessing risks and adjusting losses, moreover, may offer great advantages. Efficient and expedite claims settlements practices may lead to socially beneficial results. Risk-based insurance, finally, may be able to provide additional precautionary incentives for policyholders, through the mechanism of private surrogate regulation already described in Chapter 2.

The establishment of government-subsidized insurance-based schemes for disasters management is a common example of public-private partnership in OECD countries.


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## 4. A comparative overview of different legal and regulatory frameworks

Complex governmental risk management strategies have been implemented in several legal systems. Some of the most significant institutional arrangements involving an insurance-based public-private partnership are discussed in this section. Comparative tables summarizing these arrangements are presented at the end of this section.

- **FRANCE**: **National Disaster Compensation Scheme (CAT NAT) and the role of the Caisse Centrale de Réassurance (CCR).** In France, a national disaster compensation scheme has been established by law in 1982. Law No. 82-600 of 13 July 1982 (*Loi relative à l'indemnisation des victimes de catastrophes naturelles*) provides for a compulsory natural disaster extension on all property damage policies purchased on the voluntary market.[7] Coverage under the catastrophe extension is triggered when the state of natural disaster is declared by inter-ministerial decree; the damaged property must be covered by a "property damage" insurance policy and a causal link must be established between the catastrophe declared in the decree and the damage suffered by the property insured.[8] Pursuant to a decree of 10 August 1982 (defining standard clauses), the catastrophe insurance guarantee must cover the cost of direct material damage suffered by the property up to the value stated in the policy and subject to the terms and conditions of the said policy at the time the risk first occurs. The natural disaster coverage is also extended to in all business interruption policies. In this case, it covers loss of gross profit and additional operating costs during the indemnity period specified in the policy. Claims are settled on the basis of the "damage" cover under the policy with the widest scope and indemnity is provided in the same way as under the basic cover. According to the rules of the scheme, the insured parties must retain a portion of the risk, by means of a statutory deductible that cannot be bought back even by means of another policy. Deductibles are compulsory – *i.e.* they apply even when the basic policy does not include them – and their amount is determined and updated by means of decrees issued periodically of the competent authority. Since 1 January 2001, a sliding scale has been introduced to vary these deductibles so as to encourage loss prevention measures. This scale applies to those districts, which do not yet have a prevention plan for foreseeable natural risks (PPR). In other words, when a state of natural disaster is declared in such a district as a result of the occurrence of a given peril (*e.g.* flood), a coefficient is applied to the applicable statutory deductibles based on the number of decrees already issued in such area, in respect of the same peril, since 2 February 1995 (date of creation of PPR's). The sliding scale ceases to apply as soon as a PPR is set up for the peril in question, but it will be reapplied if the PPR is not approved within five years.

As in the case of deductibles, the rates of additional premium for the compulsory catastrophe extension are set by decree. Since 1 September 1999, the rate of catastrophe premiums for property other than motor vehicles is 12% of the premium or contribution paid for the basic property coverage. This complex scheme is able to work effectively due to the fact that the Caisse Centrale de Réassurance (CCR), a state-owned company, entered into an agreement with the authorities that allows it to offer reinsurance cover with a **government guarantee** in the field of natural disasters. CCR does not have a monopoly in natural disaster reinsurance: primary carriers, therefore, are free to seek coverage from the reinsurer of their choice, and may even take the risk of not underwriting reinsurance. In any event, CCR remains the only company within its sector of activity which offers a whole range of reinsurance solutions with **unlimited cover**. This is, of course, a great advantage for insurers, since it gives them absolute security in the event of a major loss, be it a large-scale event such as a flood occurring every hundred years or a geological problem such as subsidence, which causes all kinds of damage. CCR thus provides a guarantee of solvency and security for insureds within the French natural disaster compensation scheme.[9] CCR offers two reinsurance solutions, which are combined to provide **two-fold reinsurance cover** to primary catastrophe risk carriers. Under the first solution, known as "quota-share", the insurer cedes a certain proportion of the premiums collected to the reinsurer and the latter, in return, undertakes to pay the same proportion of losses. Quota-share reinsurance ensures that the reinsurer truly follows the fortunes of the insurer, since the latter has to cede a percentage of each of the accounts in its portfolio to the reinsurer. Thus the risk of anti-selection is avoided. The second solution, known as "stop-loss", covers the portion not ceded on a quota-share basis by the Insurer, in other words the Insurer's retention. This is a non-proportional form of reinsurance because, contrary to the "quota-share" system, the reinsurer only intervenes if the total annual losses exceed an agreed figure, expressed as a percentage of the premiums retained. ln particular, this type of reinsurance enables the insurer to protect itself against the frequency or accumulation risk, *i.e.* the risk of many claims occurring at the same time. Although most "stop-loss" reinsurance treaties contain a limit of indemnity, CCR's cover in the field of natural disasters is unlimited thanks to the State guarantee from which it benefits. The deductible under the CCR treaty therefore represents the maximum amount which an insurer will have to bear in the course of a single underwriting year, however many losses occur.[10] Pursuant to the provisions of the Insurance Code, the Natural Disaster Central Rating Bureau (*Bureau Central de Tarification des Catastrophes Naturelles*) is entrusted with several regulatory powers with respect to the governance of the CAT


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NAT scheme. Articles R 250-2 and R250-3, for example, lay out the procedure for referring certain controversial matters to the Bureau, such as the refusal to grant coverage by at least two insurance companies and the failure of the insured to conform to the provisions of a disaster prevention plan.

- **SPAIN: Consorcio de Compensación de Seguros.** Set up in 1941 as a provisional body[11] to face the needs for indemnities resulting from the Civil War (1936-1939), the Spanish Consorcio de Compensación de Seguros was given its permanent status from 1954. After that date, the activity of the Consorcio focused on the coverage of the so-called extraordinary risks and it began to play a central role in the related indemnity system. Since the approval of its Legal Statute in 1990,[12] which came into force in 1991, the Consorcio lost its legal monopoly for covering extraordinary risks in Spain and it is no longer a self-running body of the Ministry of Economy and Finance, but a state-owned company – currently a public business entity – with full powers to act. The Consorcio has its own assets and liabilities, separate from those of the State, and its activity is governed by private law. This means that the new company, when doing insurance business, apart from being governed by the terms of its own Legal Statute, is subject, like any other private insurance company, to the legal rules laid down in the Private Insurance Ordering and Supervision Act and its enacting regulations, and to the Insurance Contract Act, while its activity is governed by private law. The aim of the Consorcio is to indemnify claims made as a result of extraordinary events, such as natural disasters or other events with heavy social repercussion, that occur in Spain and cause injuries and damage to people and assets in Spain, whenever any of the following conditions are met: *a)* the extraordinary risk is not specifically and explicitly covered by another insurance policy; *b)* the extraordinary risk is covered by another insurance policy but the company that issued this policy cannot face its obligations. To sum up, the Consorcio currently acts in the Spanish system of coverage of extraordinary risks in a subsidiary way, as it only pays out indemnities when the private insurance company does not cover the risks in question, or when it does cover them but is insolvent. In case of occurrence of an extraordinary event of the type included in the system, one is only entitled to indemnity when he has a policy in certain classes of insurance, which cover persons and assets located in Spain, and if the insured is up to date with payments of the premium receipts, which include the Consorcio's surcharge for covering extraordinary risks. On the other hand, whenever insurance cover of a certain type[13] is taken out, the same assets covered for the same sums insured must be necessarily covered against extraordinary risks. In other words, the extraordinary risk coverage is compulsorily linked with a base policy. Contracting this policy with any

company operating in the market is an optional choice, but it is, however, a "sine qua non" condition for entitlement to an indemnity in the event of an extraordinary claim. In respect to the cover for natural catastrophes, a change was made in 1986 from a system of indemnities based on a prior official declaration of a disaster area which took the geographical area of the loss and the volume of losses into account to a system of **automatic indemnity**, which provides cover subject only to the prerequisite that the policies, the damage and the events giving rise to the loss meet the legally established parameters. Another qualitative change in the same year concerned the surcharge used to fund the Consorcio in order to face extraordinary claims: instead of charging a percentage on the premiums, a system of own rates is now applied on the sums insured in the policies. The Consorcio's surcharge must be compulsorily incorporated into the premium charged for every policy of insurance in the mentioned classes, irrespective of whether the said policy provides for the coverage of extraordinary risks to be effected by the private Company, or whether this is excluded (in which case the Consorcio shall be responsible).This compulsory nature lies in the principles of "compensation" and "solidarity" that govern the Spanish system, without which it would not be possible to cope with the natural anti-selection of these risks. The surcharge of the Consorcio is the result of applying its own rate on the sums insured in the policies. With respect to property damage, the indemnity paid by the Consorcio solely covers **material** losses, regarded as being the destruction or deterioration of the property insured, and **direct** losses (not including, therefore, loss of profits), so damage caused directly by the event. It should also be pointed out, furthermore, that protection against extraordinary risks is entirely separate from protection against other risks provided for in the policy. In other words, the coverage of the extraordinary risks protects the same property or persons at least for the same sum insured. The main sources of the Consorcio's funds for meeting its commitments in covering extraordinary risks are the aforementioned surcharges. Just like any other insurance company, the Consorcio applies current rules on the Solvency Margin and for setting up Technical Reserves. Besides this, given the special features of frequency and intensity of the risks that are to be faced there is a need for special funding capacity, based on an adequate and sufficient accumulation of resources and on broad compensation in time, which in the case of the Consorcio takes the form of a **stabilization reserve.** This is something rather like a loss fluctuation reserve, commonly used when insuring against disasters in many countries, which is accumulative -in some cases up to certain limits- and is tax exempt. In the Spanish system, it is a reserve with no accumulation top, which is tax deductible up to a certain limit set by law. But it should be borne in mind that, in actual fact, the aim is not to compensate


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unexpected deviations, but rather to accept the certainty of cyclical points of losses which occur in a fortuitous manner, and to time the funding of their costs by means of a constant premium. Taking into account the special features of this cover and the very nature of the Consorcio as a state-owned company, it is essential that the Consorcio be backed by the Government guarantee in order to meet any indemnity obligations that overrun its financial capacity. However, the adequate reserves collection have enabled the Consorcio to meet its indemnity liabilities without ever having to resort to this Government guarantee.

- **USA: National Flood Insurance Program (NFIP).** The US Congress established the NFIP on August 1, 1968 – with the passage of the National Flood Insurance Act of 1968 –, in response to the rising cost of taxpayer funded disaster relief for flood victims and the increasing amount of damage caused by floods. The NFIP makes federally-backed flood insurance available in communities that agree to adopt and enforce floodplain management ordinances to reduce future flood damage. The NFIP was broadened and modified with the passage of the Flood Disaster Protection Act of 1973 and other legislative measures. It was further modified by the National Flood Insurance Reform Act of 1994, signed into law on September 23, 1994. The NFIP is administered by the Federal Insurance and Mitigation Administration (FIMA) and the Mitigation Directorate (MT), components of the Federal Emergency Management Agency (FEMA), an independent Federal agency.[14] The NFIP is a federal program enabling property owners in participating communities to purchase insurance protection against losses from flooding. This insurance is designed to provide an insurance alternative to disaster assistance to meet the escalating costs of repairing damage to buildings and their contents caused by floods. Participation in the NFIP is based on an agreement between local communities and the Federal Government that states if a community will adopt and enforce a floodplain management ordinance to reduce future flood risks to new construction in Special Flood Hazard Areas (SFHA), the Federal Government will make flood insurance available within the community as a financial protection against flood losses. The NFIP, through partnerships with communities, the insurance industry, and the lending industry, helps reduce flood damage. The NFIP is self-supporting for the average historical loss year, which means that operating expenses and flood insurance claims are not paid for by the taxpayer, but through premiums collected for flood insurance policies.
- **CALIFORNIA: California Earthquake Authority (CEA).** California law requires all insurers to offer earthquake insurance with every homeowners policy. Established in 1996 to relieve pressure on private insurers, the California Earthquake Authority is a privately financed, state-run insurance

program that sells a "mini-policy" with a larger deductible and more limited coverage of external structures than conventional earthquake insurance policies. The State offers no guarantee: therefore, if losses from an earthquake drain the established fund, the CEA may run out of business and claims will be paid out on a pro-rated basis.

- **FLORIDA: Florida Hurricane Catastrophe Fund (FHCF).** In 1993, the State of Florida established the Florida Hurricane Catastrophe Fund (FHCF) to allow insurers to transfer a portion of their catastrophic risk. The Fund reimburses a fraction of insurers' losses caused by sever hurricanes and it is funded by premiums paid by insurers that write policies on personal and commercial residential properties. An important provision limits the Fund's obligation to pay losses to the sum of its assets and borrowing capacity. This fund is tax-exempt, enabling it to accumulate funds rapidly. The industry is responsible for losses up to a certain level; the premiums they pay for the reinsurance can be passed onto policyholders. In addition to premiums, these programs can use bonding and other financing arrangements if they have a shortfall. The policyholders, however, would have to foot the bill for the financing through assessments on their policies. If the funds are not adequate, claims are paid on a pro-rated basis so policyholders have no guarantee claims their losses will be covered.
- **HAWAII: Hawaii Hurricane Relief Fund (HHRF).** In 1993, Hawaii created a voluntary homeowner's catastrophe fund in order to provide hurricane insurance for customers of insurers which would no longer voluntary offer such coverage. The Hawaii Hurricane Relief Fund (HHRF), a state-run insurance company, is made up of premiums paid, loans from the federal government, bond proceeds, mortgage fees and insurer assessments. The Fund discontinued its operation by the end of 2000, in light of improved private market conditions.
- **NEW ZEALAND**: **Earthquake Commission (EQC).** The Earthquake Commission (EQC) is New Zealand's primary provider of seismic disaster insurance to residential property owners.[15] The EQC is a Crown Entity, wholly owned by the government of New Zealand and controlled by a board of commissioners. Crown Entities are not Government departments or state-owned enterprises but nevertheless belong to the Government and are subject to public sector finance and reporting rules. EQC administers the Natural Disaster Fund. The Government guarantees that this fund will meet all its obligations. It does this by securing New Zealand residential property owners against the cost of these disasters and by helping organize repair and replacement after the event. The main mechanism for this is the provision of seismic disaster insurance to property owners who insure against fire. All residential property owners who buy fire insurance from private insurance companies automatically acquire EQCover, the


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Commission's seismic disaster insurance cover.[16] EQCover premiums are added to the cost of the fire insurance and passed on to EQC by the insurance company. EQC's administration of the natural disaster insurance scheme involves: collecting premiums via insurance companies; processing and meeting claims by insured people; administering a disaster fund; investing the fund in accordance with Government directions; organizing reinsurance as a potential supplement to the fund; accounting to its shareholder (the Government). EQC also encourages and funds research about matters relevant to natural disaster damage and it educates and otherwise informs people about what can be done to prevent and mitigate damage caused by natural disasters.

- **JAPAN**: **Japanese Earthquake Reinsurance (JER).** Japan has had an earthquake program covering residential properties since 1966. The Earthquake Insurance Act entered into force in such year and it had been reformed several times since its enactment. In accordance with the promulgation of this law and following the launch of sales of residential properties earthquake insurance to be written in conjunction with dwelling and shop-owners comprehensive insurance policies, Japan Earthquake Reinsurance Company (JER) was established by 20 domestic non-life insurance companies. Under the Japanese earthquake insurance program, primary carriers sell earthquake policies with large deductibles on the voluntary market and then reinsure their risk 100 percent with JER, which, in turn, retrocedes part of the risk to the government and the private reinsurance market.[17] Since coverage costs home owners considerable amounts of additional premiums and is not mandatory, not so many purchase it.[18] JER is Japan's only specialized reinsurance company for residential properties earthquake insurance and, according to the relevant provisions of law, its solvency is supported by special arrangements with the Japanese government.
- **TURKEY**: **Turkish Catastrophe Insurance Pool (TCIP).** Following 1999 earthquake disasters occurred in the Marmara Region and Duzce, earthquake insurance has been made compulsory primarily for dwellings, through a Earthquake Insurance Program. The Turkish Catastrophe Insurance Pool (TCIP) was launched by the Turkish government in cooperation with the World Bank on September 27, 2000. Earthquake insurance premiums are ceded to the TCIP, which is managed by the Natural Disasters Insurance Council, DASK in the Turkish abbreviation. The TCIP was set up in fulfillment of the government decree-law as a separate state owned legal entity, with its Board and management, to provide compulsory earthquake insurance to all registered residential dwellings in Turkey. The pool provides earthquake coverage up to certain limits for a premium which varies across the country depending upon seismicity, local soil conditions, and the type and quality of construction. The TCIP's Board has representatives from the government,

Table 2. **Natural Catastrophe Risk and Insurance: a comparative overview of different legal and regulatory frameworks**

| | | Perils covered and triggers | Compulsory nature | Role of public and private sectors | Limits |
|---|---|---|---|---|---|
| **FRANCE**<br>NATIONAL DISASTER COMPENSATION SCHEME<br>(CAT NAT) | 1982 | NATURAL DISASTERS IN GENERAL.<br>Coverage is triggered when the STATE OF NATURAL DISASTER is declared by inter-ministerial decree. | Law No. 82-600 of 13 July 1982 provides for a compulsory natural disaster extension on all property damage policies purchased on the voluntary market. | Primary disaster coverage is offered and managed by PRIVATE CARRIERS, as an extension to property damage policies. Private insurers can obtain full CATASTROPHE REINSURANCE from the Caisse Centrale de Réassurance (CCR), a state-owned company. | Thanks to the GOVERNMENT GUARANTEE, CCR is able to offer catastrophe reinsurance WITHOUT LIMITS. |
| **SPAIN**<br>CONSORCIO DE COMPENSACIÓN DE SEGUROS | 1954 | EXTRAORDINARY RISKS.<br>The event is covered if it occurred in Spain and caused injuries and damage to people and assets in Spain, provided that: (a) the risk is not expressly covered by the base policy; (b) the risk is covered by the base policy, but the company cannot face its obligations. | The extraordinary risk coverage offered by the Consorcio is compulsorily linked with a base policy.<br>The Consorcio's surcharge is automatically included in the base policy's premium. | Extraordinary risk insurance is administered directly by the Consorcio, a state-owned enterprise, whose solvency is guaranteed by the State. | Financial capacity is UNLIMITED due to a STATE GUARANTEE, but coverage does not include loss of profits. |
| **UNITED STATES**<br>NATIONAL FLOOD INSURANCE PROGRAM<br>(NFIP) | 1968 | FLOOD LOSSES. | Not compulsory. The NFIP makes federally-backed flood insurance available in communities that agree to adopt and enforce floodplain management ordinances to reduce future flood damage. | The NFIP is funded by the federal government. | Coverage limits offered under the NFIP depend on the community's level of qualification. |
| **CALIFORNIA**<br>CALIFORNIA EARTHQUAKE AUTHORITY (CEA) | 1996 | EARTHQUAKE LOSSES. | California law requires all insurers to offer earthquake insurance with every homeowners policy. | The CEA is a privately financed, state-run insurance program. | The State offers not guarantee; if losses exhaust the CEA fund, claims will be paid out on a pro-rated basis. |

Table 2. **Natural Catastrophe Risk and Insurance: a comparative overview of different legal and regulatory frameworks** *(cont.)*

| | | Perils covered and triggers | Compulsory nature | Role of public and private sectors | Limits |
|---|---|---|---|---|---|
| **FLORIDA** FLORIDA HURRICANE CATASTROPHE FUND (FHCF) | 1993 | HURRICANE LOSSES. The Fund reimburses a fraction of insurers' losses caused by severe hurricanes, declared by the National Hurricane Center. | Contribution to the Fund is compulsory for insurers that write primary coverage on personal and commercial residential properties. | The FHCF is tax-exempt. The private industry is responsible for losses up to a certain level. | An important provision limits the Fund's obligation to pay losses to the sum of its assets and borrowing capacity. |
| **HAWAII** HAWAII HURRICANE RELIEF FUND (HHRF) | 1993 | HURRICANE LOSSES. | NO. | The HHRF is a state-run insurance company. | The HHRF discontinued operations in 2000. |
| **NEW ZEALAND** EARTHQUAKE COMISSION (EQC) NATURAL DISASTER FUND | 1994 | NATURAL DISASTER LOSSES. Including: earthquake, natural landslip, volcanic eruption, hydrothermal activity, tsunami and, in the case of residential land, also storm or flood. | Automatic earthquake coverage upon purchase of fire insurance from private market. Premiums are added to the cost of the base policy and passed on to EQC by the insurance company. | EQC, a Crown Entity, administers the natural disaster insurance scheme by: collecting premiums via insurance companies; processing claims; administering the disaster fund; organizing reinsurance. | The Government guarantees that the natural disaster fund will meet all its obligations. |
| **JAPAN** JAPANESE EARTHQUAKE REINSURANCE (JER) | 1966 | EARTHQUAKE LOSSES. | Not compulsory. Primary carriers sell earthquake coverage for considerable amounts of additional premiums and with large deductibles on the voluntary market and then reinsure with JER. | JER, a private entity was established by law in 1966. JER retrocedes part of the risk to the government and the private reinsurance market. | JER's solvency is supported by arrangements with the Japanese government. |
| **TURKEY** TURKISH CATASTROPHE INSURANCE POOL (TCIP) | 2000 | EARTHQUAKE LOSSES. | Yes. Since 2000, earthquake insurance has been made compulsory to all registered residential dwellings in Turkey. | The TCIP is a separate state-owned legal entity, managed by a Council. Local insurance companies act as distributors of the TCIP policies. Excess coverage could be obtained on a voluntary basis from the private market. | Per policy, Turkish lira equivalent of current exchange rate of $25,000. |

the private sector, and the academic community. The pool has no public sector employees as its management function has been contracted out to Milli Reinsurance, the oldest national reinsurance company. Local insurance companies act as distributors of the TCIP policies. Coverage in excess of the TCIP coverage could be obtained on a voluntary basis from private insurance providers. To issue policies, in addition to the insurance companies underwriting systems, the pool agents and the insurance companies can use an internet-based underwriting platform that will enable the TCIP to control its risk accumulations in real time and maintain the quality of underwriting. The TCIP operates as a catastrophe risk transfer and risk financing facility. Established as the national sole-source provider of earthquake insurance, it will raise the financial preparedness of Turkey for future disasters, reduce government fiscal exposure to major catastrophic events and will make liquidity readily available to insured homeowners affected by such future events. The TCIP is modeled after the California Earthquake Authority and New Zealand Earthquake Commission programs, which provide similar earthquake coverage for homeowners and rely mainly on international reinsurance and capital markets for their risk capital capacity.

## 5. Risk sharing trough capital markets

Because of the current strains on the financial capacities of the international reinsurance market and the potentially enormous size of catastrophe risks, insurance companies, governments and corporations have recently sought to spread these risks to the capital markets. In this respect, the landscape of risk transfer alternatives has evolved significantly: governments, corporations, primary carriers, as well as global reinsurers today have the option of turning to the capital markets for supplemental catastrophe protection.

In light of the cyclical nature of the insurance business, when cost of reinsurance is very high, capital market solutions may become quite appealing. Catastrophe securities are a recent development in investing: by floating such bonds for specific risks over limited time periods in defined geographic regions, insurers and reinsurers reduce risk by transferring it to investors. Investors, in turn, have viewed the introduction of the insurance-linked security as an opportunity for the development of a new market, with the added attraction that so-called **cat bonds** are largely uncorrelated with other financial instruments. Investors – usually hedge funds or other major institutional investors – get a high rate of return, in exchange for the possibility of losing much of their principal or interest, or both, in the event of disasters.[19] Catastrophe bonds entail almost **no credit risk**, since the money paid upfront by the investor and put in escrow, in a trust fund or invested in liquid securities and is therefore readily available. However, the use of physical trigger cat


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bonds[20] entails a different risk, named **basis risk**. In contrast to traditional reinsurance, in fact, **this kind of coverage may not be a perfect hedge** for the insured portfolio, being only imperfectly correlated to the actual insured losses caused by the occurrence of the triggering event. In this respect, the reinsurance credit risk needs to be balanced against the indexed cat bonds basis risk.[21] There is little evidence yet, however, of a major increase in the use of non reinsurance options like catastrophe bonds or weather derivatives.[22]

These relatively new financial products have been made possible because of relevant improvements and developments in scientific studies, engineering analyses and information technologies. Today natural hazards risks and the potential losses of future disasters can be predicted with more accuracy than in the past: new risk assessments techniques have reduced the uncertainty associated with estimating the probabilities that certain disasters will occur in specific regions, while recent engineering studies have provided additional information on how structures and infrastructures perform under the stress of extreme environmental conditions.[23] Due to the growing knowledge of cat risk among institutional investors cat bonds have the potential to increase the amount of capital available for catastrophic risk, as well as alter the pricing of risk.[24]

## 6. Regulation and catastrophe insurance

Regulatory policies may greatly affect the development of markets for disaster risk coverages and, consequently, the availability of effective catastrophe insurance.[25] Governments' policies often imposed significant cross-subsides from low-risk to high-risk areas and sometimes even imposed cross subsidies from non-catastrophe lines of insurance to the catastrophe lines. Such policies distort incentives and undermine the ability of market forces to make necessary adjustments and operate effectively in managing catastrophe risk.

Significant effects may also be generated by:

- **Regulatory constraints.** Regulation imposes further indirect costs on insurers in complying with regulatory requirements.
- **Market entry/exit rules.** Rules imposing limitations on the ability to enter/exit the market for certain risks may discourage the willingness of the insurance industry to undertake such risks.
- **Rules on the admissibility of ART.** Regulators must be aware that alternative risk transfer mechanisms can be essential when there is a shortage in reinsurance capacity.
- **Financial and fiscal issues.** Monitoring the solvency of insurance companies is fundamental in order to be able to rely on insurance as an

effective funding mechanism for natural hazards. Rules allowing for tax-exempt catastrophe reserves may also prove to be highly beneficial.

- **Regulation of claims practices.** With a view to assuring expedite payments, effective rules concerning settlement practices and procedures to be followed by the insurance companies upon occurrence of the insured event (*i.e.* the natural disaster) may turn out to be fundamental.
- **Antitrust and competition policies.** In some jurisdictions, the formation of catastrophe insurance pools aimed at raising adequate financial capacity and sharing data and information may be considered as incompatible with the antitrust and competition policies in force.[26]

## 7. Integrated risk management strategies: catastrophe bonds and insurance can be coupled with incentives and other regulatory mechanisms to reduce disaster losses

In light of the above considerations, an effective disaster risk management strategy requires an integrated approach and the proactive involvement of all the relevant stakeholders, including:

- Homeowners and businesses at risk.
- Governments.
- Insurers and reinsurers.
- Investors in cat bonds.

The following points, therefore, appear to be quite important in the future development of catastrophe risk management strategies:

- The adoption of an integrated approach.[27]
- The development of scientific risk evaluation techniques aimed at improving:
  - ❖ Risk predictability.
  - ❖ Expected loss estimates.
- The implementation of effective measures for structural mitigation and vulnerability reduction.[28]

Enforcing building codes in hazard-prone areas would likely reduce future disaster losses significantly. Well-enforced building codes would reduce the magnitude of losses, enable insurers to provide additional coverage to property owners, and decrease the need for reinsurance and funds from other sources such as the capital market and state pools. It also would enable insurers to lower prices. At the same time, the costs of building code enforcement can be significant for the local community. As a result, it is important to redistribute some of the benefits from the reduction in exposure back to the local community pay for environment of codes. Thus, understanding the


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interdependence among property owners, insurers, and state and local agencies is critical to designing workable solutions. Well-enforced regulatory measures, such as building codes, can complement insurance and other financial instruments by forcing the adoption of **cost-effective risk mitigation measures** (RMMs).[29] Incentives are needed since property owners often underestimate the risks from disasters:[30] as mentioned, empirical research have shown that individuals' and firms' decisions with respect to mitigating and insuring natural hazard risks do not conform to rational models of choice.[31] In addition, effective mitigation measures may produce **positive externalities** by reducing other costs arising out of a disaster.

## 8. Conclusions

This section of the report presents some of the insurability problems associated with the natural catastrophe risk and offers an overview of several economic and institutional alternatives to the traditional insurance and reinsurance mechanisms. It also briefly discusses the implications of an **integrated approach to disaster management** based on insurance, prevention, mitigation, compensation and a close partnership between the public and the private sectors. On the basis of the above risk partnership, it seems that the international insurance and reinsurance industry is able to play a central role in the future management of natural hazards.

### *Notes*

1. See: Swiss Reinsurance Company (2002), Natural Catastrophes and man-made disasters in 2001, Swiss Re SIGMA series 1/2002. Zurich, Swiss Reinsurance Company; Kunreuther, H.C. and R.J. Roth (ed.) (1998), Paying the Price: The Status and Role of Insurance Against Natural Disasters in the United States. Washington DC, Joseph Henry Press; Pollner, J. (2000), Catastrophe Risk Management Using Alternative Risk Financing and Insurance Pooling Mechanisms: The Insurance Market and the Case of the Caribbean Region. Washington DC: World Bank; Kunreuther, H.C. (2000), Linking Insurance and Mitigation to Manage Natural Hazard Disaster Risk, *Handbook of Insurance,* Georges Dionne (Ed.), Kluwer Academic Publishers, Boston; Froot, K. A. (ed.) (1999). The Financing of Catastrophe Risk. Chicago, University of Chicago Press.
2. See, *supra* Chapter 1 at § 2.b.
3. See Swiss Reinsurance Company (2002), Natural Catastrophes and man-made disasters in 2001, Swiss Re SIGMA series 1/2002. Zurich, Swiss Reinsurance Company.
4. See *e.g.*: Camerer and Kunreuther (1989), Decision Processes for Low Probability events: Policy Implications, 8 Journal of Policy Analysis and Management 1989, 565-592.
5. See Swiss Reinsurance Company (2002), Natural Catastrophes and man-made disasters in 2001, Swiss Re SIGMA series 1/2002. Zurich, Swiss Reinsurance Company.

6. See: Freeman, P.K. and Kunreuther, H.C. (1997), Managing environmental risk through insurance, Boston [etc.]: Kluwer, c1997 (Studies in risk and uncertainty: 9).

7. Pursuant to Article 1 of the Law 82-600: "Les contrats d'assurance, souscrits par toute personne physique ou morale autre que l'État et garantissant les dommages d'incendie ou tous autres dommages à des biens situés en France, ainsi que les dommages aux corps de véhicules terrestres à moteur, ouvrent droit à la garantie de l'assuré contre les effets des catastrophes naturelles sur les biens faisant l'objet de tels contrats. En outre, si l'assuré est couvert contre les pertes d'exploitation, cette garantie est étendue aux effets des catastrophes naturelles, dans les conditions prévues au contrat correspondant. Sont considérés comme les effets des catastrophes naturelles, au sens de la présente loi, les dommages matériels directs ayant eu pour cause déterminante l'intensité anormale d'un agent naturel, lorsque les mesures habituelles à prendre pour prévenir ces dommages n'ont pu empêcher leur survenance ou n'ont pu être prises. (…)". For the detailed legislative provisions currently in force see: Code des Assurance (Partie Législative) Titre II – Chapitre V: L'assurance des risques de catastrophes naturelles (Articles L125-1 to L125-6).

8. "The legislators did not want to limit the 1982 Law by creating a list of the natural phenomena covered. Nor did they want to create a list of exclusions. They limited themselves, therefore, to the idea of 'uninsurable damage' (this idea was then clarified by the Laws of 25 June 1990 and 16 July 1992). The following list is not, therefore, exhaustive: floods and/or mudslides, earthquakes, landslides, subsidence (collapse of land due to a sudden fall in the ground water level, after a drought for example), tidal waves, flows of water, mud or lava, moving masses of ice or snow." Les catastrophes naturelles en France. Natural disasters in France, CCR: June 2001.

9. See: Les catastrophes naturelles en France. Natural disasters in France, CCR: June 2001. See also: Guy Carpenter and Co., Inc. (2001), The World Catastrophe Reinsurance Market: 2001.

10. Les catastrophes naturelles en France. Natural disasters in France, CCR: June 2001.

11. The original name was: Consorcio de Compensación de Riesgos de Motín – Consortium for the Compensation of Riot Risks.

12. See: Law 21/1990 of 19 December 1990, amended by Law 30/1995 of 8 November 1995.

13. With regard to personal insurance: accident coverage taken out separately or as a complement to life insurance or pension plans or funds. With regard to property insurance: fire and natural perils, motor vehicles (damage to vehicle), vehicles running on rails, theft, plate glass, machinery breakdown, electronic equipment and computers, and damage to completed civil works.

14. See: *www.fema.gov/nfip/*

15. See: *www.eqc.govt.nz/*

16. Perils insured by the EQC catastrophe coverage are: earthquake, natural landslip, volcanic eruption, hydrothermal activity, tsunami and, in the case of residential land, also storm or flood.

17. See: Guy Carpenter and Co., Inc. (2001), The World Catastrophe Reinsurance Market: 2001.


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18. See: Gastel, R. (ed.) (2002), Catastrophes: insurance issues, Insurance Information Institute, III Insurance Issues Update, April 2002 (available in LEXIS).

19. "A catastrophe bond (cat bond) is an instrument whereby the investor receives an above-market return when catastrophes do not occur, but shares the insurer's or government's losses by sacrificing interest or principal when catastrophes do occur. With cat bonds or other capital market instruments, insurers (and governments as insurers) can pay to transfer catastrophe risk to investors." Kunreuther, H.C., Linnerooth-Bayer, J. (1999), The Financial Management of Catastrophic Flood Risks in Emerging Economy Countries, paper presented at Global Change and Catastrophic Risk Management, Laxenberg, Austria: IIASA, June 6-9, 1999.

20. Examples of these triggers are: earthquake strength and wind speed.

21. "In contrast to an indemnity contract where the entity providing protection (*e.g.* the reinsurer) can become insolvent if it suffers catastrophic losses, the firm does not face any credit risk from an indexed-based cat bond. The money to pay for the losses is already in hand. On the other hand, such a cat bond creates basis risk. Basis risk refers to the imperfect correlation between the actual losses suffered by the firm and the payments received from the cat bond. Insurance sold to firms or excess-of-loss reinsurance to insurers has zero basis risk because there is a direct relationship between the loss and the payment delivered by the reinsurance instrument." Kunreuther, H.C. (2001), Mitigation and Financial Risk Management for Natural Hazards, *The Geneva Papers on Risk and Insurance*, Vol. 26, No. 2 (April 2001) 276-295.

22. Guy Carpenter and Co., Inc. (2001), The World Catastrophe Reinsurance Market: 2001.

23. See: Kunreuther, H.C., Linnerooth-Bayer, J. (1999), The Financial Management of Catastrophic Flood Risks in Emerging Economy Countries, paper presented at Global Change and Catastrophic Risk Management, Laxenberg, Austria: IIASA, June 6-9, 1999.

24. In 2002, for example, Swiss Re has received USD 255 million of four-year protection against a series of natural catastrophe risks. As part of the transaction, Swiss Re signed a financial contract with PIONEER 2002 Ltd. ("PIONEER"), a special purpose Cayman Islands exempted company and the issuer of the USD 255 million of securities. Subsequently, Swiss Re Capital Markets Corporation, acting as sole bookrunner, privately placed the securities with institutional investors. The proceeds from the offering fully collateralise PIONEER's financial contract with Swiss Re and will serve to replenish Swiss Re's capital should any of the specified natural catastrophes occur. Source: Swiss Re. In 2001 Munich Reinsurance Company announced the successful private placement of a total of USD 300 million of risk-linked securities, the largest ever to provide protection against US hurricane, Californian earthquake and European windstorm events, based on an innovative parametric trigger structure for a package of the three perils. Source: Munich Re.

25. See: Kunreuther, H.C. and R.J. Roth (ed.) (1998), Paying the Price: The Status and Role of Insurance Against Natural Disasters in the United States. Washington DC, Joseph Henry Press, especially at Chapter Eight (authored by Robert Klein).

26. In Italy, for example, the Antitrust Authority expressed serious concerns about a pending legislative proposal aimed at setting up a national disaster scheme based on the introduction of a mandatory disaster extension on all fire policies

and on the formation of a special catastrophe insurance pool. See: Decision AS168 of 12/04/1999 in Antitrust bulletin 13-14/1999.

27. "Based on an understanding of the vulnerability of the city or region and the decision processes of the key interested parties, one needs to develop a strategy for reducing losses and providing financial protection to victims of future disasters. This strategy will normally involve a combination of private and public sector initiatives which include insurance and new financial instruments as well as well enforced building codes and land-use regulations. These measures will differ from country to country depending on the current institutional arrangements and existing legislation and laws. In summary, a combination of building codes, reinsurance and indexed cat bonds can form a useful strategy for reducing losses to property owners as well as insurers and the investment community. The implementation of this strategy requires a concerted effort by both the public and private sectors. For example, the implementation of mitigation measures requires inspections by certified personnel. Banks and Financial institutions can play a role in this process by making their mortgage and related loans conditional on such an audit. Insurers can offer lower premiums for those adopting these mitigation measures." Kunreuther, H.C. (2001), Mitigation and Financial Risk Management for Natural Hazards, *The Geneva Papers on Risk and Insurance*, Vol. 26, No. 2 (April 2001) 276-295.

28. "In determining the vulnerability of a city or region one needs to know the design of each structure (*e.g.* residential, commercial, public sector) and infrastructure, whether specific mitigation measures are in place or could be utilized, and their location in relation to the hazard. *(e.g.,* distance from an earthquake fault line or proximity to the coast in a hurricane prone area) as well as other risk-related factors. The ingredients for evaluating the vulnerability of a city or region to natural hazards are risk assessment and societal conditions. Ideally a risk assessment specifies the probability of events of different intensities or magnitudes occurring and the impact of the direct and indirect impacts of these events on the affected interested parties. Societal conditions include human settlement patterns, the built environment, day-to-day activities and the institutions established to deal with natural hazards" Kunreuther, H.C. (2001), Mitigation and Financial Risk Management for Natural Hazards, *The Geneva Papers on Risk and Insurance*, Vol. 26, No. 2 (April 2001) 276-295.

29. "Building codes mandate that property owners adopt mitigation measures. Such codes may be desirable when property owners would otherwise not adopt cost-effective RMMs because they either misperceive the benefits from adopting the measure and/or underestimate the probability of a disaster occurring. If a family is forced to vacate its property because of damage that would have been prevented if a building code had been in place, then this additional cost needs to taken into account by the public sector when evaluating the costeffectiveness of an RMM from a societal perspective. There are several key interested parties who can enforce building codes. Banks and financial institutions could require an inspection of the property to see that it meets the code before issuing a mortgage. Similarly insurers may want to limit coverage only to those structures that meet the building code. Inspecting the building to see that it meets the code and then providing it with a seal of approval provides accurate information to the property owner on the condition of the house. It also signals to others that the structure is disaster-resistant. This new information could translate into higher property values if prospective buyers took the earthquake risk into consideration when making their purchase decisions." Kunreuther, H.C. (2001), Mitigation and Financial Risk Management for Natural Hazards, *The Geneva Papers on Risk and Insurance*, Vol. 26, No. 2 (April 2001) 276295.


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30. "An alternative way to encourage consumers to adopt mitigation measures is to change the nature of their insurance coverage rather than reducing the premium. More specifically, the insurer could offer a lower deductible to those who adopt mitigation at the same or lower price than if they had decided not to invest in the RMM. Such a program is likely to be very attractive given the empirical and experimental evidence that suggests that consumers appear to dislike deductibles even though they offer considerable savings in premiums." Kunreuther, H.C. (2000), Insurance as a Cornerstone for Public-Private Sector Partnerships, Nat. Hazards Rev., 1, 126-136.

31. Camerer and Kunreuther, "Decision Processes for Low Probability events: Policy Implications", 8 *Journal of Policy Analysis and Management* 1989, 565-592.

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