



# Securitizing the Risks of Climate Change. Institutional Innovations in the Insurance of Catastrophic Risks

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# **Securitizing the Risks of Climate Change**

## **Institutional Innovations in the Insurance of Catastrophic Risk**

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## **Abstract**

The present vulnerability of regions, communities and activities, to changes in the frequency, intensity and distribution of extreme meteorological conditions presents a problem that may be complicated by climate change. Society has many different ways of responding to catastrophic risks and distributing the financial losses. This paper contrasts different approaches on grounds of efficiency and equity. The main focus is on securitization: a new mechanism for spreading risks that is of interest to insurance companies to assure the supply of adequate financial capacity, and also to governments as the insurers of last resort. The 1997 flood in Poland that amounted to a cost of 3% of GDP is analysed, and securitization is proposed as a possible alternative to traditional insurance for ex ante coverage of the risk.

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# Securitizing the Risks of Climate Change

## Institutional Innovations in the Insurance of Catastrophic Risk

*Johannes Stripple*

### **1. Introduction - Governing the Unexpected**

The 1990s have already set a record in terms of the insured losses from natural disasters caused by extreme weather events. The floods in China and Central Europe, Hurricane Andrew in Florida, and the drought in Sudan are tragic examples of a possibly growing trend in disaster losses. In the recent decade, the number of major natural catastrophes has been three times as large, and has cost the world's economies eight times as much as the decade of 1960s (Munich Re 1997).

The increasing losses from extreme weather events is worrying governments and insurers. Governments have traditionally taken responsibility for disaster aid, victim compensation, and reconstruction programs. However, private insurance also plays an important and increasing role in mitigating catastrophic risks and sharing the financial burden.

Society has many different ways of responding to and managing catastrophic risks and distributing them financially. Governmental disaster relief spreads the financial costs among the taxpayers, while private insurance spreads the risk among the premium payers. Issues of efficiency and equity are invoked in the analysis and practical use of public and private mechanisms for managing catastrophic risks.

In the 1990s, there has been increased societal concern about the perceived trend of increased frequency and intensity of extreme weather events. The United Nations established the IDNDR (International Decade for Natural Disasters Reduction) program. The media reported daily on the impacts of the recent El Niño, and the insurance industry has been vocal on the international scene. By 1995, leading insurers had spoken of the threat of bankruptcy from unmanageable catastrophe losses (Legget 1996).



The traditional way of ceding or “securing” insurance risks is through reinsurance. However, Hurricane Andrew<sup>1</sup> showed that the costs now imposed on the insurance industry is of an order of magnitude not thought possible one decade ago (Doherty 1997). Insurance companies have recognized that they may need to develop alternative means of risk transfer to assure themselves of adequate capacity (Goldman Sachs 1998). Therefore, the past decade has brought a development of new types of financial instruments for handling catastrophic risks. These new instruments entail the absorption of the risks directly on the capital market. These instruments have taken two forms, options, which trade on at least two separate markets (Chicago Board of Trade and Bermuda) and catastrophe bonds.

Securitization means that the risk is packaged in a standardized form (for example as a bond) and sold on the capital market. Hence, the risk is “secured” on the capital market. The investor who buys the bond issued by the insurer will lose his or her interest, or even principle, depending on the structure of the contract, if there is a catastrophe of a defined magnitude of loss. If there is no catastrophe, the investor will get the money back with an attractive rate of interest.

Insurance-linked securities are not only a means of spreading the risks of traditional insurance, but they may also be interesting to governments, which are often the insurers of last resort. This is therefore the main question addressed in the paper: *Can governments utilize securitization to more efficiently and equitably cope with the financial cost of natural disasters?* Since the trend of extreme weather related events might be linked to global warming, the background section frames the catastrophic risk management as a means of increasing society’s ability to cope with climate change. Different mechanisms of societal risk management are discussed in terms of efficiency and equity, and the mechanics of securitization transactions (private and governmental) is outlined. Further, I present a case of catastrophic risk response, namely to the 1997 flood in Poland. The cost of this flood amounted to 3% of Polish GDP, and was borne internally by the Polish public. The concluding section summarizes the theoretical arguments for securitization as part of a risk management strategy, and proposes this strategy for the Polish case.

## 2. Background

There are many reasons for the escalation in the scope, frequency and cost of natural disasters. While the scientific community is not unanimous in its judgement, there is growing support for linking natural catastrophes to the increase in greenhouse gases and the ensuing and complicated effects on regional and local climate regimes. But the losses from natural catastrophes are increasing for many other reasons. Developed countries have become wealthier, many more people live in coastal areas with costly infrastructure, more assets are insured in heavily exposed areas, and higher density in population is observed (Watson et al. 1995; Berz 1998). These observations have an important implication; future changes in society, not only changes in climate, will influence the impacts of changing meteorological conditions.

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<sup>1</sup> Hurricane Andrew hit Florida in 1992 and brought about \$16 billion US dollars in losses. Losses could have exceeded \$40 billion if Andrew had been more intense or if the storm had made landfall on the Miami coast around five miles farther north. This event could have driven even the major insurance companies toward bankruptcy. Nonetheless, the extreme events of 1991-1994 caused nine smaller insurance firms to become insolvent (Changnon *et.al.*, 1997)

Climate change is generally viewed as *slowly* occurring and gradually influencing the way science, technology, institutions, economies operate, and how the innovations, conventions, assessments etc. are made. This is the view underpinning the Framework Convention of Climate Change (FCCC) and the Intergovernmental Panel on Climate Change (IPCC) science and policy responses. However, and more relevantly, climate change can also be viewed in terms of *high rates of change*, and with very rapid rates of change in the variability of climatic factors, sending “shock-waves” through the international institutional system. What follows are catastrophes and disasters, which are not created by the climatic factors alone, but in the interaction with human systems and structures.

The first view - changes in mean temperature over long time periods - has historically been the focus of climate change analysis. Much less emphasis has been placed on anticipated changes in weather variability, such as windstorms, hurricanes, floods, and droughts (MacDonald 1998). Among geophysical agents, weather and climate are by far the most lethal to humankind world-wide. Together flood, hurricane and drought account for 75 % of the worlds natural disasters (Munich Re 1997).

The precise timing, frequency, and location of weather related disasters are difficult to predict (Mitchell and Ericson 1992). While contemporary society has difficulties with managing present climate-sensitive societal activities, which result in dangerous situations and threats to security, future patterns of climate change *add* increasing complexity and dangers. For the industrialized world, losses from catastrophic weather events are still small compared to GDP. However, for the developing world and countries in transition<sup>2</sup>, these events can cause severe local and regional economic losses as well as social disruption (Meyer et.al. 1998).

The IPCC, however, came to no firm conclusions as to the relationship between climate change and extreme weather events. According to MacDonald (1998), the reason for this failure is that far more attention has been given to changes in averages rather than to changes in variability of weather. MacDonald states that:

The spatial scale of many extreme events is too small to be captured in the relatively coarse grid of large computer models to climate. Furthermore, extreme weather events have their origins in the linkages between atmosphere and ocean. These linkages remain poorly understood and are difficult to represent in climate models (MacDonald 1988).

Even though there is scarce research on the impact of climate change on the frequency and intensity of extreme weather events, some general statements can be made. Warming of the oceans will increase water vapor content of the atmosphere and one can therefore anticipate increased precipitation. According to statistics from Munich Re (1997), the analysis of precipitation trends in Europe between 1891 and 1990 shows a distinct increase in winter precipitation in central and northern Europe. Given the mild temperatures of recent winters, heavy rain in winter and spring has often caused large-scale river flooding in central Europe. Further, studies carried out at the US National Oceanographic and Atmospheric Agency (NOAA) shows that total precipitation in the United States has increased by about 10% in the period 1910-1995. As a result of the heavier precipitation the frequency of flooding has increased in many parts of the

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<sup>2</sup> The flooding cost in Poland in the summer of 1998 amounted to 3% of Poland's GDP.

United States. Because the little coverage of insurance for flooding, these trends do not show up in the insurance statistics (MacDonald 1998).

### *2.1 Responding to climate related risks today and tomorrow*

Responding to climate change can encompass two strategies; mitigation and adaptation. Mitigation refers to the reduction of climate change and its impacts mainly through the limitation of greenhouse gas emissions. Adaptation refers to adjustments in individual, group, and institutional behavior in order to reduce societies vulnerabilities to climate change (Pielke 1998). In a review of the IPCC WG II report (Impacts, Adaptations, and Mitigation of Climate Change: Scientific and Technical analyses) Kates (1997) concludes that the report is weak on adaptation, in spite of the word appearing in the title. Mitigation has, and for good reasons, been the central focus of discussion for the climate change debate, but recent years shows an increasing literature on adaptation (for example: Smithers, J. and Smith, B 1997; Tol et al. 1998; Smith, J. 1998; Pielke 1998). While much of this literature relates to climate change in the “first view”, as outlined above, adaptation to climate change in the “second view” (fast rate of change in climate regimes, including extreme events) is gaining increasing interest. For example, the IPCC conference in Costa Rica (29 March to 1 April 1998) on “Adaptation to climate variability and change”.

Many reasons exist for acquiring a better understanding of adaptation as a means of reducing societal sensitivities and vulnerabilities to climate change and climate related impacts. For example, regardless of whether the Kyoto agreement will or will not be fully implemented, preparing for the impacts of climate change seems to be inevitable given the existing greenhouse gas concentrations, projections of emissions and projected future impacts (Bolin 1998). Further, even under a fully implemented Kyoto protocol, there remain significant cause to expect more rather than less adverse impacts on environment and society, due to increasing societal vulnerability (Pielke 1998). Example of limits to our current levels of adaptation is given by last year’s losses and damages associated with El Niño related extreme events such as droughts and floods.

## **3. The Flooding in Poland, Summer 1997**

### *3.1 Background*

The torrential rains on July 7-9 drenched south-western Poland, causing the rivers Oder, Nyza, and Mozara to overflow their banks and break through flood dikes. Historians and chroniclers have not documented flooding of similar magnitude since Poland emerged as an independent country over 1000 years ago (Polish-American Journal 1997 09 01). The damage to the 20 million people living in affected areas, the cities, agricultural land, and infrastructure was severe and included:

- 55 confirmed deaths
- At least 150.000 people evacuated
- 86 cities, 875 villages, 40.000 farms and 450.000 hectares of agricultural land inundated
- 110 medical facilities, 250 schools damaged or destroyed
- 140 bridges, 1600 km of roads destroyed
- 1200 small and medium sized factories destroyed

- Estimates showing that the economic cost amounted to 2.9 billion US dollars or approximately 3% of GDP.

### *3.2 National and international responses*

The national emergency response was organized by the government and the local communities. Where necessary, civil defense units and the army helped in distributing aid in isolated areas. Government efforts were co-ordinated by a national committee under the leadership of the Ministry of Interior. The emergency operations involved 35,000 men from the army, the National Fire Service with 220 amphibious vehicles, 76 helicopters, 4 aircrafts and 387 boats and pontoons. Further efforts carried out by the Polish Red Cross, CARITAS and thousands of volunteers be added to the overall national response (UNDHA 6 Aug. 1997).

The international community reacted immediately and spontaneously to the emergency situation. Countries dispatched cash, expertise and equipment even before the request for assistance by the Polish government was received (UNDHA 6 Aug. 1997).

### *3.3 The distribution of costs; government, international, private insurance, individual*

In the summer of 1997, the Polish government spent more than a half billion dollars on flood relief, which includes one-time compensation grants, subsidized loans and the rebuilding of infrastructure. Another half a billion dollars have been allocated for flood relief in the 1998 budget. Poland's government rushed a package of emergency measures through the parliament, including a pledge to give \$840 compensation to every family whose home was flooded and \$6,200 to everyone who lost a spouse in the deluge. The government also said it would build 1,000 inexpensive houses for the poorest flood victims and provide cheap credits to others who wanted to rebuild (Polish-American Journal 1 Sep. 1997).

Faced with the consequences of the floods, the government is politically obligated to provide relief to the victims. However, the government is also seeking to reduce its financial costs from the flooding in order to maintain its original budget deficit targets for this year. The government would like to cut its budget deficit from 2.8 per cent of GDP in 1997 to 1.9 per cent in 1998. At the "horizon" of Polish politics lies a possible membership in the European Union, which puts special constraints on public finance. The Central Bank, backed by the International Monetary Fund (IMF), is pushing for yet a lower target of 1.5 per cent of GDP in 1998 and balanced revenues and spending in 1999. In anticipation of the Polish elections that took place shortly after the floods, however, many politicians were generous with public money.

Generally, governments do not possess a plethora of options in raising money for unanticipated sudden expenses. If transferring within the budget is undesirable or insufficient, the government can borrow or raise taxes. Funds can be borrowed from investors by issuing bonds or obligations, or by taking a loan from national or international banks. In Poland, when the massive task of reconstruction began in late July, the Finance Ministry declared it would introduce a flood tax in the next year to help finance the rebuilding (Reuters, 31 July 1997). Further, it was reported that the

Polish Government hopes to raise money in a special lottery for flood victims (The Guardian, 13 August 1997).

The government also offered subsidized loans at two percent interest with one year grace period (i.e. borrowing from its citizens). Generally, disaster relief for events that are not predictable is an attractive humanitarian gesture that has few adverse incentives (Doherty 1996). However, the disaster relief can be an adverse incentive for future location in the area, i.e. people move into the area, but do not pay for the risk of living there since they can rely on governmental relief. From another perspective, the actual relief was a loan, and it certainly depends on the actual conditions of re-payment if it is to be considered as “generous”. Hence, this mechanism still implies that the victims have to bear the partial cost of the event.

According to a global analysis of losses related to natural catastrophes in the period 1986-1995, floods were responsible for about a third of overall losses. Very little of these economic losses were insured (Munich Re 1997). There is traditionally little private insurance coverage for flooding, and in many kinds of markets this cover is not available at all (Munich Re 1997). The cost of the flooding to the insurance industry was minimal. It amounted to between 5% and 15% of the total losses. Allianz AG in Munich was the insurer affected most by the central European flooding. It had purchased the former East-German state-run monopoly, Staatliche Versicherung, which included flood related losses in its standard household policy (World Insurance Report 1997). However, Allianz AG stated the losses would not amount to more than a three digit-million sum (Lloyd's 1997). An opinion stated by the insurance business was that the flooding would create a new demand for insurance and re-insurance in a market that had previously been closed, and that people would realize that they need to cover this kind of risk (Reuters, 30 July 1997). Recent reports from the industry in the Czech Republic seem to indicate this trend (Leonard 1998).

Victims without insurance have for the most part had to bear the costs themselves. The government's promise of 1000 temporary homes for the people worst hit has not been finalized (as of December 1997). The bulk of the repairs will have to be paid by charity, family and friends, as well as from the victims' own savings (Finance East Europe, 25 July 1997).

#### **4. Voices in the Flooding Response Choir: Interpretations and Perceptions**

A common feature of disastrous events is that the cultural and institutional setting will color perceptions and interpretations. The event, the responses, and the overall management of the issue take place in a social context. In the following are a few voices in the aftermath of the flooding.

##### *4.1 Solidarity and Blame*

There seems to be a general perception that the flooding was an unexpected and extremely rare event. The central government and the public were taken by surprise (an “Act of God”), which implies there is no one to blame for the flooding. This does not mean, of course, that there is no one to blame for not being prepared for a “surprise” flood that is expected to occur every 500 to 1000 years. As the waters rose, former Prime Minister Cimoszewic said that uninsured individuals had no one but themselves to

blame, and they should expect no governmental help. The Prime Minister later apologized for his remarks, but confidence in government had already taken a hit. The public interpretation of the Prime Minister's statement was that he had no "human touch", a dangerous deficiency for a politician facing parliamentary elections in two months (Economist, 26 July 1997). Alternatively, the Polish public placed the blame for the flooding largely on the government. According to a survey, nearly half of the Poles believe the damage could have been avoided, and more than 70 percent believed the government was to blame (AP, 28 July 1997). In post-communist societies, there may still be a widespread belief that the state should take care. Further, the government was criticized for being slow in responding to the flood. This may have contributed to the government's election defeat in September 1997.

However, the choir is not univocal regarding the role of government and its response. The United Nations Disaster Assessment and Co-ordination Team (UNDAC), with their previous experience of natural disasters in developing countries, recognized the professionalism and preparedness demonstrated by the Polish rescuers, who, assisted by thousands of volunteers, evacuated people at risk and erected dams and other emergency barriers to contain the floods (UNDHA 6 Aug. 1997).

According to an old Polish saying: "Nie ma takiego zlego, co by na dobre nie wyszlo" (There is nothing so bad that some good won't come of it), the floods released an unprecedented tide of human solidarity and goodwill (Polish American Journal, 1 September 1997). This response to the flooding makes sense in light of Poland's present status, where a widespread belief is that society has become "tougher" and more competitive. The solidarity felt mainly emanated from the national and the local level (AP, 17 October 1997).

There was also some, albeit limited, solidarity from the international community. Only about 0.4% of the flooding costs were covered by international disaster relief, mainly from the Germans, but close to 17% were covered by loans from the EBRO and other international banks (International Federation of Red Cross and Red Crescent Societies, 1998). Interestingly, the Czechs did not request international aid. The Czechs feel they send a better signal (internationally) if they show they're not a burden. The Czechs have partially financed the damage by offering a five year bond worth \$150 million at 12.5 percent. It would be easier to finance a longer term bond (10 or 20 year), but the government appears to be opposed to taking a long-term debt. The government is also speaking of special taxes to cover the damages (Investment 1998). Further, the Czech Republic has dealt with the risk of flooding by increased reinsurance expenditures (Leonard 1998).

The flooding in Poland's other neighbor, Germany, also created a languishing solidarity within the divided country:

Hundreds of thousands of westerners, who have spent the past eight years grumbling about the burden of paying for the east, cheerfully stumped up for an appeal to help victims (The Guardian, 13 August 1997).

Chancellor Helmut Kohl interrupted his holiday twice to visit the disaster zone in Germany to "show the spirit of solidarity that unites the German people in the hour of catastrophe". Since the flooding originated outside Germany's border, it changed the

present re-unification discourse with increasing discord about western support to the east.

In Poland, however, people had far less money to offer as donations than in neighboring Germany. In the Czech Republic and Poland this solidarity created a sore interpretation; “a solidarity that results in generous help for German victims, but much less help for their hard hit neighbors” (The Guardian, 13 August 1997).

#### *4.2 Vulnerability and resilience*

Disasters are usually the result of interactions between physical and human systems. The concept of vulnerability stresses the potential for negative outcomes or consequences from natural or human made events, and is used as an umbrella concept for those factors that mediate between geophysical events and human losses (Meyer et al. 1998). The vulnerability of individuals, groups, societies, and systems is determined by their sensitivity, preparedness, as well as their ability to adapt to a new situation (Watson et al. 1995). Resilience is a term used to capture the ability to maintain a system and to recover after impact (Kasperson 1993). Therefore, a resilient system, activity or population is characterized by low vulnerability. Or, alternatively, the vulnerability is dependent on the responses taken. The literature clearly emphasizes the differences in availability of responses. Cultural and institutional structures influence the way different responses are available, perceived, and carried out (Meyer et al. 1998). For example, the Polish government offered subsidized loans to the victims. However, applying for the loan required paperwork, which appears to have created an institutional constraint to many people. The bank required an assessment of the damage and a timetable. One victim had this to say:

It's crazy you've got your friends to help you, they come today. They don't come tomorrow. You can't make a timetable, and still the bank requires this (AP, 17 Oct. 1997).

In the affected cities, there appear to be large differences in the ability to cope. Poland's communist society with stable and defined roles for citizens and public institutions has been replaced. The drastic social and institutional reorganization has made the Polish society more vulnerable to flooding. Further, because of the communist cultural heritage, there is an expectation among people that the state will take care of the situation.

Poverty is generally recognized as one of the most important correlates of vulnerability. Other correlates include differences in health, gender, ethnicity, and education (Liverman 1990; quoted in Meyer et al. 1998). On a global scale this is exemplified by far higher losses of life from similar extreme events in the developing world than in the developed (Meyer et al. 1998). Some of the differences in vulnerabilities are overcome by societal risk spreading mechanisms, to which we now turn.

## **5. Catastrophic Risk Management**

Societies have developed different mechanisms and styles for managing catastrophic risks and dangers. The concept of risk appears in very different settings in contemporary science. The most striking dichotomy is that between the “technical” and the “social” (or “perceptual”) use of the concept. The technical perspective focuses narrowly on the

“probability of events” and the “magnitude of the consequences”. Risk is usually defined as the multiplication of the two terms. Many social theorists have pointed out that this way of characterizing risk is inadequate. Consequences can be satisfactorily characterized only through the analysis of human activity and values; “damage” is socially dependent (Kasperson 1992). Human beings, therefore, have invented the concept of “risk” to help them understand and cope with dangers and uncertainties. Risk, in the social tradition, does not exist “out there”, independent of our perceptions, and, therefore, there is no such thing as “real risk” or “objective risk” (Slovic 1992; Ashworth 1997). Rosa (1998) argues that there is a growing consensus that while the standard model of scientific investigations remains a necessary form of analysis (especially in the form of risk identification and estimation), it is no longer a sufficient form (especially in the areas of risk evaluation and management). Context matters, especially when identifying and comparing risks. Society is not only concerned about risk minimization. People are willing to suffer harm if they feel it is justified or if it serves other goals (Renn 1992). Fair process for making decisions on risk, irrespective of the outcome, is also considered important (for example: Kunreuther and Linnerooth 1982).

Society has many different ways of responding to the adverse effects of disastrous flooding, e.g. direct victim relief, rebuilding infrastructure, spreading the financial burden. Many diverse actors are actively involved in the management of catastrophic risks, for example; public policy makers, disaster management communities, insurance industry, non-profit organizations, and social networks. Further, institutions such as international agreements and national law are also a part of societal risk management.

A distinction can be made between proactive and reactive catastrophic risk management. Proactive risk management refers to responses taken before or in advance of the event (*ex ante*), while reactive refers to responses after the event has occurred (*ex post*). Proactive measures must be taken in a context of social and environmental uncertainty in preparing for the event, and also preparing for *ex post* management. Table 1 exemplifies some of the tools available for reducing the losses of weather-related disasters.

## **6. Financing Catastrophic Risk Management**

Freeman and Kunreuther (1998) single out three general mechanisms for societal risk management: governmental benefit programs, tort liability, and private insurance. The three mechanisms play major roles in the management of *environmental* risks. In the US, managing environmental risks through the legal system is very common. By setting strict standards of care through regulation, the US government has made the tort system the mechanism for reallocating liability. The “Polluter Pays Principle” is a common buzzword within this framework. For natural disasters, however, the tort system plays a less important role - compared to the other two. It is difficult to hold someone liable for earthquakes or changing frequency and intensity of extreme weather events. However, in the case of “predictable” natural catastrophes, liability for not taking mitigative initiatives may be relevant.



<b>Table 1. Responses to weather related disasters.</b>		
<b>Long-term</b>	<b>Short-term, ex ante</b>	<b>Short-term, ex post</b>
Controls on investment, planning development and management of land, resources, infrastructure, and facilities.	Monitoring/tracking	Emergency management
Education and training	Prediction/forecasting	Hazard fighting
Public information	Warning	Search, rescue and salvage
Hazard insurance	Evacuation	Disaster relief
Weather modification	Shelters	Loss bearing
Structural engineering works		
Hazard resistant construction techniques		
Adapted from Mitchell and Ericksen (1992)		

With regard to both the proactive and reactive response, there are different ways of spreading the financial burden. The allocation of costs for catastrophic risk management in an efficient and equitable manner is central to the discussion in this paper. The descriptive diagram below identifies some of the possible options and mechanisms for catastrophic risk management and displays how the financial cost can be allocated - who bears the financial burden of risk or disaster management.

The mechanisms for spreading the financial costs can, as shown in Table 2, take many forms<sup>3</sup>. A general feature of natural catastrophic risks (such as hurricanes, earthquakes, flooding etc.) is the large amount of inherent unpredictability and uncertainty. Generally, when probabilities and consequences are difficult to estimate, private sector risk spreading is unusual since it is difficult to calculate the premium in advance of future expected losses. Hence, the most common institution for risk spreading in modern western societies is governmental relief programs.

The diverse societal mechanisms for catastrophic risk management raise issues of efficiency and equity. A complete discussion of these two often interrelated concepts and their interpretation lies beyond the scope of this paper. However, some introductory comments can be made. While there normally is consensus on what efficiency means, there is seldom consensus on interpretations of equity or fairness. In a restricted sense, economic efficiency is often taken to mean that resources or inputs should be used to produce an output in the cheapest possible way. An efficient allocation of costs for societal catastrophic risk management implies a maximization of net benefits, while the related cost effectiveness criteria refers to the minimization of aggregate costs to achieve some risk management objective.

<sup>3</sup> Note that the other types of costs (social etc.) may not be possible to compensate for due to irreversible impacts. Hence, the discussion concerns monetary consequences.

**Table 2. Spreading the financial costs in the management of natural catastrophic risks  
(Selected possibilities)**

	Proactive management (Ex Ante)	Reactive management (Ex Post)
Individual (victims)	First party insurance: cost spread on the premium payers. Private mitigation such as investing in a “waterproof door system”.	“Individual bears the loss” Borrow from banks. Help from family and friends. Reliance on social networks for assistance.
Local community	Local provided insurance such as California Earthquake Authority. Local mitigation	Rebuilding of local infrastructure possibly through local budget redistribution or borrowing.
National (Taxpayers)	Saving for a catastrophe fund. Emergency planning Governmental subsidized insurance such as the US National Flood Insurance Program Risk identification and mitigation such as early warning systems and building dikes.	Rebuilding of infrastructure Disaster aid and subsidized loans financed by temporary catastrophe tax, such as the Chernobyl tax, borrowed money or budgetary redistribution
International	Securitization AOSIS proposal on climate change pool	UN disaster relief IMF emergency loans International charity

Economic efficiency in the “Pareto sense” has a broader interpretation. A policy change is socially desirable if at least some are made better off, while no one is made worse off. The economic efficiency argument based on utilitarian ethic is a moral argument, as the Pareto criterion serves as the basis for what is to be considered as a fair allocation, (i.e. a fair allocation must not leave anybody worse off than before). However, the utilitarian notion of fairness is not the only one. Thompson and Rayner (1998), for example, contrast market and administrative based utilitarian with “egalitarian” distributional preferences. The egalitarian discourse implies a focus on responsibility and, therefore, losses should be spread according to strict fault liability. Generally, there does not exist a universally set of moral principles that can inspire decisions on a fair distribution of burdens of environmental risk management (Linnerooth-Bayer 1998).

When discussing, comparing and prescribing mechanisms for catastrophic risk management, questions of efficiency and equity often dominate the discourse. For example, Freeman and Kunreuther (1997) point out that in the US, the use of government programs to reduce societal risk is subject to the public's ever-changing notion of fairness. For instance, if the entire financial cost of recovery from natural disasters is financed through government grants, those living in high risk areas will benefit from those living in safer regions of the country. In the US, the federal government generally subsidizes 75 percent of the costs of repairing public structures and infrastructure (Freeman and Kunreuther 1997). After Hurricane Andrew in 1992 and the Mississippi floods in 1993, however, the government covered 100 percent of the costs of damage to the public sector. Whether a governmental program to aid victims is considered fair by the public, depends in large part on their feelings of responsibility to pay for the damages (Freeman and Kunreuther 1997).

An important point of comparison for public and private mechanisms for risk spreading is their efficiency. Governmental aid programs rely on *ex post* remedies, which give little incentive to *ex ante* mitigation measures that could reduce the ultimate damage and cost to society from the environmental risk. A government can increase incentives for mitigative measures by indicating that *no* disaster assistance will be provided to uninsured victims of natural disasters. Private insurance, as an alternative to government relief, can serve as an important mechanism for ensuring increased private mitigation measures, but only to the extent that premiums are linked to mitigative efforts on the part of the insured. "Moral hazard", of course, operates against personal protection. If private insurance is an alternative to public aid, it is important that the risks are insurable. Insurability depends on, among other factors, the predictability of the risk. With respect to efficiency, it is important to note again that disaster relief discourages mitigation measures, e.g., people are more likely to live in flood plains. Also, disaster relief discourages the purchase of private insurance, which if properly designed to avoid moral hazard can have a positive effect on mitigation (Doherty 1997). The choice between government aid and private insurance also invokes difficult issues of equity. Disaster relief transfers resources to the victims at the expenses of the taxpayers. Yet, sometimes government programs are efficient, for example, the low transaction costs involved in the social security administration when distributing benefits (Bernstein et al. 1988 quoted in Freeman and Kunreuther 1997).

## **7. Securitization; Theory, Policy and Practice**

There are thus many different ways of managing catastrophic risks, and they can be contrasted on grounds of efficiency and equity. In theory, securitization can spread the financial costs beyond national borders, and place the financial burden voluntarily on investors over the world. Further, securitization may involve low transaction costs compared to traditional reinsurance. Finally, securitization can reduce the financial unpredictability of disaster relief. In the next section, I turn to this novel approach for financing the costs of natural disasters. I describe the general features of securitization and the institutional structures involved in the securitization process. I then turn to the question addressed in this paper; whether securitization of catastrophic risks can be a useful and desirable instrument for a government, such as Poland, in preparing for natural catastrophes. Specifically, the paper examines the institutional structure involved if a government would issue the catastrophe bond. A recent securitization transaction is examined, and the general arguments in favor of this approach compared

to traditional reinsurance are examined regarding efficiency, equity and financial predictability.

### 7.1 ILS: An insurance based novel approach

Insurance Linked Securities (ILS) or “securitization” of insurance risks has emerged as a complement or alternative to traditional reinsurance. Securitization means that the risk is packaged in a standardized form (for example as a bond) and sold on the capital market. Hence, the risk is “secured” on the capital market.

The investor who buys the bond will lose his or her interest, or even principle, depending on the structure of the contract, if there is a catastrophe of a defined magnitude of loss. If there is no catastrophe, the investor will get the money back with an attractive rate of interest. The first form of securitization is actually “debt forgiveness”, which dates back to the medieval origins of insurance in Italy. A primitive arrangement was for merchants to fund ventures by borrowing to pay for the ship and/or the cargo. However, in the event of the loss of the ship or cargo, the debt would be forgiven; lenders were “insuring” the vessel and it's cargo (Doherty 1997).

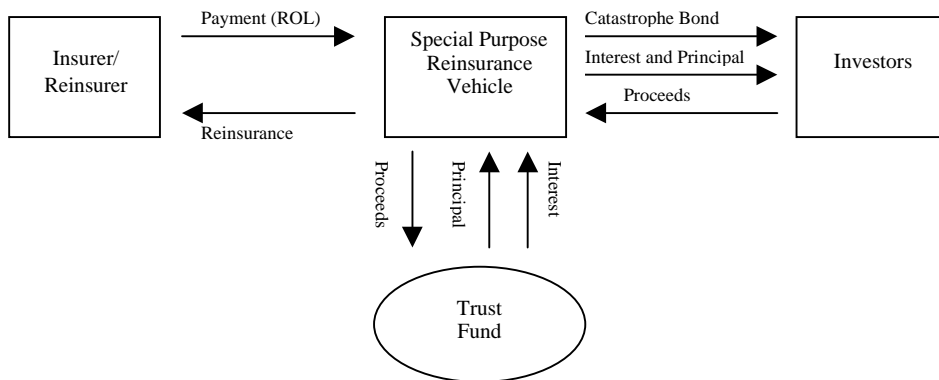


Figure 1: Institutional structure for Insurance Linked Security transactions.

To issue an ILS, the insurance company forms a special purpose reinsurance vehicle (SPRV), which acts as both reinsurer to the ceding company and issuer of the bond<sup>4</sup>. The SPRV sells the insurer a catastrophe reinsurance contract and receives a payment calculated on the rate on line (ROL)<sup>5</sup>. However, to offset the reinsurance contract sold, the SPRV issues the catastrophe bond. The bond can be “principal at risk” or “interest at risk”. Hence, the investors will lose their principal (the invested capital), or part of it, or only the interest if a catastrophe occur. If there is not a catastrophe, the investors will get their money back with interest. The SPRV invests the money received for the bond in a trust fund and receives the interest on the trust fund. The rate earned at the trust

<sup>4</sup>The bond is a contract where the realization depends on the outcome of future events.

<sup>5</sup>The concept of rate on line can be explained by a brief example. Say that the rate to the investors, to make the bond attractive, must be equal to the treasury rate (TR) plus, for example, 400 basis points (BP). Hence, if the treasury rate is 4% and we need to add 400 basis points, the rate we have to pay the investors will be 8%, which is equivalent to the rate on line.

fund level must be supplemented by the rate on line payment to offset the interest cost of the bond. This means that the actual risk premium paid for the catastrophe reinsurance is the difference between the interest cost of the bond and the rate earned on the trust fund. This is important to note when we move the concept of ILS into the governmental sphere.

A government issued catastrophe bond, is a new idea, with only very few cases. I will examine one case, that by the California Earthquake Authority.

By referring to Figure 2, it is possible to understand the institutional setting of a governmental catastrophe bond transaction. If a government would issue an ILS, for example in the form of a catastrophe bond, the structure of the transaction will be similar to the structure of securitization transactions described earlier, but there will also be some important differences. To issue a catastrophe bond, the government may form a “Special Purpose Financing Vehicle” (SPFV). The SPFV acts as both a financial partner to the government and to the issuer of the bond. The SPFV sells the government a catastrophe reimbursement contract, the price of which depends on the price of the bond<sup>6</sup>. To offset the reimbursement obligation undertaken, the SPFV issues the catastrophe bond. The SPFV invests the money received for the bond in a trust fund and

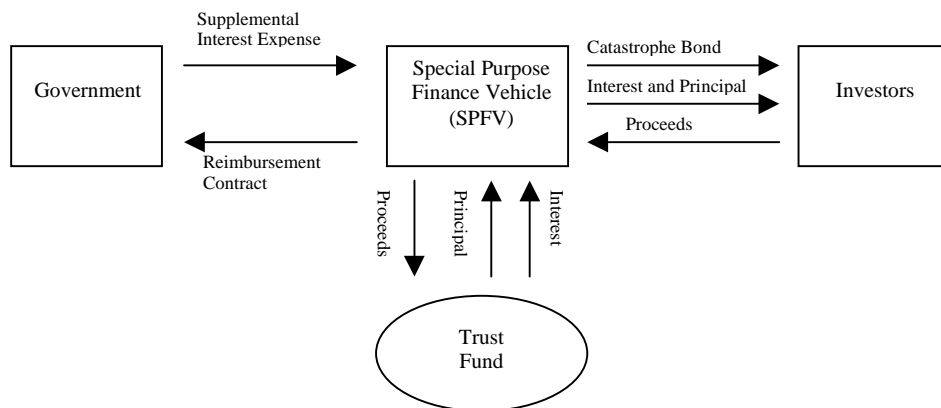


Figure 2: Institutional structure for a government issued catastrophe bond.

receives the interest on the trust fund. One difference to the earlier example is that the capital management in the trust fund can take on larger risks since the government, with the supplemented interest expense, guarantees the interest to the investors. The government can also guarantee the principal, which makes even more aggressive investment styles available for the trust fund.

<sup>6</sup> See the discussion on rate on line in Footnote 5.

## 7.2 *The Res Re deal as an example*

In April 1997, USAA<sup>7</sup>, a Texas-based insurer, established a special purpose reinsurance company called Residential Re that issued a \$477 million catastrophe bond to 62 different investors. Technically, the bond was composed of two tranches: \$313 million of A-2 notes with a coupon (the interest) of 5.75% plus LIBOR, in which the principal was completely at risk, and \$164 million of A-1 notes with a coupon of 2.82% over LIBOR in which the coupon is at risk, but the full return of the principal was guaranteed. A default of these notes was to be triggered given a hurricane on the East Coast between July 15, 1997 and December 31, 1997, that caused over \$1 billion of claims against USAA. A complete default would have occurred if the damage from any one hurricane caused claims on USAA of \$1.5 billion or more (Canter and Cole 1997).

USAA gives many arguments for issuing the bond: the need for the industry to meet mega-catastrophes and to reduce the variability and uncertainty to the insurer from these events. Interestingly, these arguments can also be used for the case that the government can benefit from securitizing catastrophic risks.

The USAA bond that closed on June 16, 1997, was successful. It was oversubscribed by more than \$500 billion, which means that USAA could have issued more than twice the amount they offered and sold them all. The transaction was evidence that securitization on a large scale is possible. Hence, the question to examine is why these instruments are attractive for investors?

## 7.3 *The first governmental catastrophic bond; California Earthquake Authority*

The California Earthquake Authority (CEA) was created after the devastating Northridge (California) earthquake to provide earthquake insurance at a time when the insurance companies were threatening to abandon the California housing market. CEA is a privately financed and publicly managed state agency. The debate around the function of this institution, for example, regarding the new high deductibles and increased insurance rates, lies beyond the scope of this paper (Sacramento Bee 28 Feb. 1997). However, it is worth noting that the CEA was early on in the “securitization market” to cover their risk. The CEA issued an earthquake catastrophe bond worth \$1.5 billion in 1996, but the bond was withdrawn because Warren Buffet's insurance company, National Indemnity, came in and offered better terms through a traditional reinsurance program. This highlights the crucial point of pricing the risk. The different possible reasons for Buffet's move is described below:

To some observers this left the impression that traditional reinsurance was more efficient and better priced than what the capital markets could offer. More skeptical observers felt this was an attempt by Warren Buffet and Ajit Jain to protect National Indemnity's franchise on the “super cat” business. In the end, bankers made the best of a disappointing situation by using Warren Buffet as a perfect example of a capital market person who includes catastrophe risk in his equity and bond portfolio (Canter and Cole 1997).

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<sup>7</sup>United Services Automobile Association. USAA is one of the leading home and auto insurers in the US.

The CEA was not the only “securitization” failure in 1996, at least two more small deals were withdrawn, and the jargon in business was that securitization was a sort of “emperors new clothes”. But in 1997, the investment bankers apparently got it right. The result was five major offerings (the Res Re deal was one of them) that hooked investors and may have given credibility to the market for risk-backed securities (MacDonald, L. 1998).

#### *7.4 Why does securitizing insurance risks make sense for investors?*

Indeed many players are now talking of catastrophe risk being a new “asset class” and new instruments such as catastrophe options and catastrophe bonds are starting to appear (Doherty 1997).

Interestingly, two thirds of the reinsurance provided by Res Re is backed up by investors who could lose all of their principal. According to many analysts within the insurance sector, this institutional innovation is likely to grow in importance (Goldman Sachs 1998). So the question becomes, what are the arguments from an investor’s perspective to buy an ILS?

The first argument is the interest rate. Obviously, if the bond will be subscribed, the interest rate has to be attractive, i.e. it has to be higher than the treasury rate. How much higher is an open question depending on the risk of the catastrophe, the amount of damage and other factors<sup>8</sup>. Second, since an insurance linked security is for the most part uncorrelated with traditional market risks, it is attractive for investors who hold a diversified portfolio. So from the investors perspective, the risk premium may increase his or her return without adding to the portfolio variance or risk. In assessing risk, investors must have a good idea of the probability of loss. The loss characteristics of ILS can now be better understood by highly sophisticated modeling. Even though historical data to predict future losses is scarce in these cases, the situation is not unmanageable<sup>9</sup>. From the investors’ perspective, the probability of loss from a natural catastrophe may be no more uncertain or ambiguous than to the probability of loss on an emerging market investment. The recent ILS transactions have been assessed by rating agencies, which make it much easier for investors to assess their risk. For example, “the principal at risk” of the Res Re deal was rated BB and paid 575 basis points over LIBOR, whereas the average BB corporate bond pays 200 basis points over LIBOR. Thus, relative to other bonds determined to be of similar risk by the rating agencies, the USAA catastrophe bond paid a substantial premium to the investors (Canter and Cole 1997).

#### *7.5 What are the advantages compared to traditional reinsurance?*

In the Czech Republic, the risk of flooding has recently been dealt with by increased reinsurance expenditures (Leonard 1998). Even though securities and derivatives, as a

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<sup>8</sup> The ILS market is in the early stages of its development, and prices have not yet reached equilibrium levels. The recent major ILS deals indicate a spread over LIBOR between 367 basis points (Trinity Re) and 576 basis points (Res Re) (Goldman Sachs 1998).

<sup>9</sup> New techniques for stochastic and deterministic modeling of these events exist. Further, the situation differs greatly from case to case. For example, hurricanes on the American west coast, has a quite good historical record, which can be supplemented with data on current El Niño patters, to increase current probability. Compared to assessing the probability of earthquake risk in Italy, where a very scant historical record exists: Pompeii etc.

substitute for reinsurance, are very novel approaches, some comments on the advantages can be made. The relatively high level of property catastrophe losses from 1987 until 1993 caused many leading reinsurers world-wide to substantially reduce their commitment to the catastrophe reinsurance market. At the same time, the demand for reinsurance increased resulting in a substantial overall increase in premium rates (Goldman Sachs 1998). At present, the traditional reinsurance business is very well capitalized and rates are therefore very low<sup>10</sup>. However, Swiss Re's (1997) SIGMA report argues that the capital earmarked for catastrophe reinsurance is only a small part of the total industry surplus. As a result the ratio of catastrophe losses and catastrophe surplus looks less favorable, and therefore the area of property catastrophe reinsurance appears undercapitalized. It has already been pointed out, that securitization expands the potential source of reinsurance capacity, which can make a wider use of catastrophe coverage possible.

For reinsurance provided by securitization to be regarded as attractive to insurers, the premium must be attractive in comparison to traditional reinsurance. As indicated above, the premiums are presently low, but the rates can increase again as they did after Hurricane Andrew. Given a series of major catastrophes, the rates of reinsurance will likely rise again. Some proponents argue that securitization will be cheaper than traditional reinsurance, due to the large transaction costs within reinsurance, but it is too early to confirm this hypothesis.

Another argument can be added to the list. There is almost no credit risk involved. Normally, in a reinsurance contract in the event of a large catastrophe, the risk exists that the traditional reinsurer would not be able to meet its share of the losses. The structure with the trust fund presented above partially eliminates this risk.

### *7.6 Why do ILS transactions make sense for governments?*

In this section, I explore the arguments for insurance-linked securities as financial instruments for national and local governments to provide ex ante coverage for catastrophic events. The securitization of public risks has some of the same advantages as for private risks, however, new arguments also arise.

One main advantage for governments is that the financial uncertainty to the public budget is reduced, which enhances governmental control over the risks. The possible future financial costs of a catastrophe are transformed into a predictable budgetary item. Further, ILS transactions can substantially increase the geographical spread of the cost of a catastrophe. Many natural disasters are borne by the country and people affected. International catastrophe aid amounts only to a small part of the financial relief. The Polish case study examined the advantages of temporal and geographically spreading of the financial side of catastrophe risk.

The economic efficiency arguments for ILS transactions may also hold depending on the government's alternatives for raising funds. If the alternative is for the government to undertake the financial costs involved in responding "when it happens", for example, by borrowing the money on the capital market, then it has to compare the costs. Further, the government has to consider the possibility of shifting budgetary spending, which

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<sup>10</sup> It is argued that at present, the international reinsurance industry is taking on risks in such a way that the value of incoming premium is lower than their expected outpayments.



means lowering the resources allocated for other purposes. The case can also be that the primary insurance market is very limited, such as in the case of flooding, then it is not possible to require people to purchase private insurance.

## 8. Conclusions

There are many different ways of managing and spreading the financial cost of catastrophic risks. This paper has contrasted different approaches on grounds of efficiency and equity. The main focus of the paper has been to frame and analyze one novel approach: insurance-linked securities or securitization of the insurance risk. Securitization is a new mechanism useful to the insurance industry to assure the supply of adequate financial capacity, and the approach may also be interesting to governments, who are the insurers of last resort.

The question who should bear the financial burden of catastrophic risk management is a question of equity. Securitization is an opportunity for broadly spreading the risks over the international investment community. The ex ante coverage may increase intergenerational equity to the extent that it does not postpone the burden to future generations.

For governments, securitization transforms possible future financial costs of a catastrophe into a budgetary item, thus enhancing the government's control over its budget. The 1997 flooding in Poland, that amounted to a cost of 3% of the Polish GDP, was to a large extent borne by the Polish people. This type of event might benefit from insurance both because ex ante insurance would help stabilize the budget (at a cost) and possibly spread the losses more equitably. In countries like Poland, where the primary insurance market is small or non-existent, securitization might be a viable financial alternative for ex ante coverage.

There are two main reasons for the investors' interest in catastrophic bonds. First, they pay an additional yield compared to other types of bonds<sup>11</sup> albeit at a greater risk of loss. Further, the performance of a catastrophe bond is not significantly linked to the performance of the financial markets. Therefore, catastrophe bonds are means of diversifying an investor's portfolio.

If present societal management of catastrophic events can be improved, the global society is better positioned to cope with global change and its impacts on the losses from natural disasters. Improving the spread of the burdens through insurance and insurance-linked securities may be an important aspect of adapting to global change.

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<sup>11</sup> U.S Treasury bonds pay about 6 percent interest, meanwhile the average catastrophe bond pays 10 to 12 percent.

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