Information Technology and Its Impact on Catastrophic Risks

A Report on the Conference sponsored by The Wharton School of the University of Pennsylvania, The Annenberg Public Policy Center of the University of Pennsylvania, and Risk Management Solutions, Inc.

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No.8  Information Technology and Its Impact on Catastrophic Risks
      12-13 June 1996
# Table of Contents

Introduction ...........................................3

Comments from Thomas Gerrity ........................4

Keynote Speaker, Harvey Ryland .........................4

Overview of Conference .................................6

Risk Assessment and Challenges in
Dealing with Earthquake Risk ..........................7

Challenges in Estimating Hurricane Risk ..............9

Computer Modeling of Catastrophic Risk
and Demonstration of Information Technology ........11

How Has Information Technology Changed Catastrophic
Risk Management in the Insurance Industry? ........14

The Impact of Information Technology on
the Insurance and Reinsurance Industry ..............19

Future Research Directions of Information Technology
and Its Impact on Insuring Catastrophic Risk ..........24

Issues and Questions for the Future ...................29

Related Publications .................................30
Conference Speakers & Panelists

Bruce Bolt  
University of California, Berkeley

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Applied Insurance Research, Inc.

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University of Pennsylvania - Annenberg School for Communication

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Harvey Ryland  
Insurance Institute for Property Loss Reduction

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Introduction

Howard Kunreuther
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We are using the 50th Anniversary Celebration of the ENIAC computer at Penn as an opportunity to explore the impact that the revolution in computer technology has had on the management of catastrophic risks. The challenges are particularly relevant to the problem of who should pay for the losses from natural disasters. This area has now emerged on the societal radar screen due to large-scale losses from recent hurricanes and earthquakes that have shaken both the insurance industry as well as impacted on federal expenditures.

The insured loss from Hurricane Hugo (1989) was over $1 billion with damages that exceeded $7 billion. Hurricane Andrew (1992) cost the insurance industry over $15 billion while the Northridge earthquake (1994) generated over $12 billion in insured losses. The total damage from these two disasters was over $45 billion.

Our society has become more vulnerable to catastrophic risk, not just hurricanes and earthquakes, which are the focus here, but also environmental and technological catastrophes — Chernobyl, Bhopal, and the Exxon Valdez. The emergence of new information technologies offers an opportunity to explore their role in collecting and utilizing extensive scientific data for developing new approaches for managing and communicating the risk. The three groups that are sponsoring this conference — the Wharton Risk Management and Decision Processes Center (WRMDPC), the Annenberg Public Policy Center (APPC) and Risk Management Solutions, Inc. (RMS) — all have an interest in this exploration.

The WRMDPC has been concerned since its inception 10 years ago with how society can do a better job in managing low probability-high consequence events. The APPC has a special interest in the role of the media in communicating information on L P-H C events. RMS has been a pioneer in developing software and new approaches for utilizing data and risk assessment to evaluate alternative strategies for dealing with potential catastrophic losses from natural disasters.

This is a research conference where practitioners from industry and government are brought together with natural and social scientists for the following purposes:
• to increase our understanding of how risk assessment can be enhanced by information technology
• to discuss ways of linking the risk assessment process with the risk management process through information technology
• to facilitate a dialog between different stakeholders from the public and private sectors who are concerned with catastrophic risks in order to develop new strategies for reducing losses from future disasters and provide more effective relief and recovery to the victims.
Comments

Thomas Gerrity
Dean, Wharton School

I think this is a watershed event. It brings together three rather extraordinarily important perspectives at an important intersection. One is the continuing advancements in computing — unbelievable advances — and the celebration of the 50th anniversary of ENIAC. The second is the whole area of catastrophic risk, where issues of risk assessment and management are looming larger and larger on the board of directors' agendas in every major corporation. The third area where Wharton has considerable interest and expertise is the public policy question of who ultimately pays for all this, an issue that is looming very large in the minds of every government organization.

We think the best way to begin attacking this problem of managing catastrophic risk is to bring together a multi-disciplinary, multi-sector kind of gathering and representation such as this one with top scholars, top corporate executives, government policy-makers. A longer term objective of this partnership is to examine practical, new solution approaches to this whole business of assessing and managing risk more effectively in the area of low probability, high consequence events. Our initial focus is going to be on natural disasters, but clearly there are many implications for environmental disasters or technological risks of all sorts.

Keynote Speaker

Harvey Ryland
Former Deputy Director of FEMA
President and CEO of Insurance Institute for Property Loss Reduction

A Look into the Future

In the year 2020 — 25 years from now — the United States will have a population over 300 million, 25% of which will be over the age of 65; the average life span will be over 120 years; 85% of the population will live in urban areas and most will live within 100 miles of a coast. There have been global climate changes that affect the types of storms we have and where they happen. The economy is information based and technology dependent. Education and training are received through the Internet.

In this changed world of 2020, natural disasters will still exist, despite attempts to modify the weather. In addition, the new technologies and our dependency on them will provide opportunities for new disasters.
Here is what Comprehensive Emergency Management will look like in the future:

1. **Loss Estimation** - precise loss estimation models will be available for a location, a building, and its use, and property insurance will be held by all with rates based on these estimates.
2. **Relocation** - adoption of better land use plans leading to relocation of people and structures out of high risk areas.
3. **Building Codes** - codes appropriate to risks associated with a specific location are adopted and enforced.
4. **Preparedness** - individual warning of disasters and the risks to one's own specific location and circumstances is received through personal communications devices. Individuals, families and businesses have pre-planned response strategies.
5. **Response** - Structures built with internal systems to assess structural integrity after a disaster. Single source damage assessment available to FEMA, Red Cross, insurance companies, and other organizations at the same time.

**The Challenge**

I challenge you to do the following: to develop detailed loss-estimation models; to make mitigation the very foundation of all our actions; to put strong building codes and land-use practices in place with the necessary enforcement to go along with them; to find low-cost techniques for structural and non-structural mitigation, and to identify the incentives that will make sure they are used; continue your preparedness initiatives by providing information to the public, to government officials and to all others about the risks; make sure that they understand what they face, and the consequences of what they face; continue to strengthen our response and recovery programs and initiatives at the state, local and private levels so we can make the best use of the dwindling resources that we have while we are increasing our technology.
Overview of Conference

Paul Kleindorfer  
*Universal Chair Professor of Economics and Public Policy  
Co-Director Risk Management & Decision Processes Center  
Wharton School, University of Pennsylvania*

We, at Wharton, view ourselves as purveyors of the products of the intellect. We hope to see the science of risk assessment and risk management and the new financial instruments that we are going to hear about actually bear fruit in providing a more reasonable course for managing catastrophic risk.

Haresh Shah  
*Obayashi Professor of Engineering, Stanford University  
Director, Risk Management Solutions, Inc.*

For a long time I was surprised at how little science and technology was used to assess risk, so it is especially wonderful to see how far we have come in the last 15 to 20 years. We still have far to go so that we can put this field of very low probability but high consequence events into some kind of acceptable platform by the public, by our colleagues on the science side, by our colleagues on the technology side, and by our colleagues on the financial side.

Two of the major concerns of the various parties are: How do we know the numbers are right? How do we know that what we are currently doing is something that society should accept? The venture that we are starting attempts to answer some of those questions, to challenge the science, to challenge the technology, to challenge the financial markets, to challenge the insurance and the reinsurance industry, to come out with things that not only look right, but represent today's knowledge.

Howard Kunreuther  
*Cecelia Yen Koo Professor of Decision Sciences and Public Policy  
Co-Director Risk Management & Decision Processes Center  
Wharton School, University of Pennsylvania*

There is a revolution going on. Something is changing not only with the insurance industry but with a lot of other industries because of what technology is doing.

The spirit of this meeting is to bring science and policy closer together. In this way we will be able to understand how technology can play a role in this process and how it will enable the various stakeholders who are concerned with these issues to come together so that more meaningful policies for managing catastrophic risks can be developed. A major theme of this conference is the general issue of how we manage and deal with uncertainty and handle it from a policy perspective.
Risk Assessment and Challenges in Dealing with Earthquake Risk

Bruce A. Bolt
Departments of Geology and Geophysics
and of Civil Engineering
University of California, Berkeley

The challenge of the next century will be the enormous risks represented by the possibility of natural disasters taking place in the megacities with populations over 20 million and with structures in poor condition.

Limits of current forecasting knowledge - There are recent improvements in the estimates of the hazards from moderate earthquakes, but estimating the timing of large events leaves great uncertainties. The Charleston, South Carolina earthquake of 1886 is a prototype of earthquakes that could occur along the East Coast, affecting cities such as Boston and New York. Despite enormous geological efforts, the causative fault of that earthquake is not known today, so the usual treatment is to shift this earthquake anywhere along the East Coast.

Diversity of character of events - The three great earthquake catastrophes of the United States — 1811 and 1812 along the Mississippi, 1886 in Charleston, 1906 in San Francisco— present three very different situations in terms of the hazard. It is impossible to have a single black box handle that you turn to treat all the national earthquake risk uniformly.

Importance of type of structure - Present contour maps enable one to graphically show the hazard. This is not the risk. Risk estimation involves people, structures, and the economy. Intensity affects hazard, but the type of structures present dominates risk. In a city, a hazard map might show that the hazard is the same, but the risk is not the same — it depends on the kind of structure. This is why I am critical of being too simple in the estimation approach. The code is supposed to let us design structures now which will make the risk the same everywhere for every credible earthquake, whether high-rise buildings or residential structures. We have to be careful about using simple empirical formulae and assumptions that impose an unnecessary penalty on certain kinds of structures.

Lifelines - Major highways, water and power systems need to be made resistant to devastation. People's lives, the economy of the region and the ability to recover from an event will be affected by the condition of these lifelines.

Current technology - The State of California has seismic strong motion recording systems which provide a ground motion database available to everyone soon after an intense earthquake. There are very few instruments of this type outside California. They are necessary for predicting the earthquake hazard.

Forensic engineering - Bridges, dams, and other important structures should be instrumented to give data about changes in structural response which can influence decisions about closings and evacuations. The number of buildings in California with this instrumentation is growing.
Richard Roth, Jr.
Chief Property and Casualty Actuary
California Insurance Department

John Freeman, an engineer, wrote a book in 1935 in which he proposed that the 1906 California earthquake could have been insurable if one looked only at shake damage. He came up with a rate of $2 per $1,000. Even today the rates charged are close to that — one basic rate for earthquake insurance. Until recently, though, only 6 or 7% of homes in California had earthquake insurance.

Agents accepted or rejected risks based upon their own experience. One agent’s family had lost a house in a landslide so she turned down every application where the house was on the side of a hill. Another agent for the same company rejected applications for houses located near a fault, but accepted landslide risks. There was no management guidance.

Now we are trying to focus the rate on actual risk. There is a premium rate based on zip code, which varies by soil conditions, landslide probability, liquefaction of the soil, proximity of a fault, type of structure, age of structure, and construction type. Reinsurance is also being priced based on these modeling efforts. The reinsurers want to know the “exceedance” probability — the probability of damage exceeding a certain dollar amount — a new refinement.

The ultimate actuarial problem is to take a hazard where you have a very high severity and a very low frequency and make it an insurable risk. This is being done by modeling, by deductibles, by spreading the risk and by managing the risk. Actuaries normally take past data, as with automobile or fire or worker’s compensation, to determine a premium rate for the future. In the case of earthquakes we are doing something quite different. We are supplementing past data with scientific projections. We base rates not only on the 1906 earthquake or the Northridge earthquake or the San Fernando earthquake, but on what scientists and engineers tell us about soil conditions, proximity to fault, attenuation curves, and building characteristics.

A problem that arose is that after Northridge, the California Department of Insurance started approving substantial increases in rates, which made the public question the regulators and their models. Education to demystify modeling is a necessity. In any event, what is very clear is that modeling is here to stay forever. The alternative is nothing. It’s like a weather forecast on television: there may be uncertainty, but the alternative is no forecast, which is unacceptable.

Once piece of advice that I have: This should be looked up upon as a scientific inquiry and should be open. The word “proprietary” has always caused alarm on the outside, among the legislators and the public. What is being sold by modelers is a product based on the expertise and knowledge and years of graduate training, just like actuaries sell their expertise or attorneys sell their expertise. The value of a model is the immense amount of time and energy that is put into creating the database and the immense amount of time and work in creating a user-friendly computer program that surrounds the database and then makes access to the database easy. So modelers definitely do have something to protect, but it should not be a mystery.
Challenges in Estimating the Hurricane Risk

Bob Sheets
Meteorologist and former Director of the National Hurricane Center

The last hurricane season was the most active since 1933. The question is: Is this going to continue?

Education

The big problem we have is education — educating people as to what the risks are — and how we can reduce the losses and make property insurable.

Something that is really not taken into account in most risk analyses is that we have developed our coastlines with an intermixing of different structures, different heights, different densities. As a result structures impact on their neighbors. A building can be undamaged for years and then destroyed in a mild hurricane because of the impact of wind eddies created by a new neighboring building. The destruction of one building might be because of an “act of God,” whereas that of another might be considered the result of an “act of man.”

Contradictory public policies

The private insurance sector is being forced to insure property in high-risk areas. People are rebuilding in hazardous areas because they can get insurance. The lessons from past hurricanes are still with us; we have just not applied them. Every time a hurricane goes through an area, property values there go up rather than down. When you watch to see what takes place, almost always what goes back is bigger than what was there before. Tax dollars pay for more roads, water treatment plants, and other public facilities in the bigger resorts areas that are redeveloped following a hurricane. One counter example to this trend is the town of Seagrove in the Florida panhandle. It is an example of well-planned land-use, houses kept back and beach areas open, undeveloped. Elsewhere people build right on the water’s edge because they can get insurance.

I am a strong believer in prescriptive codes. I can tell you that not all engineers are created equal, just like not all meteorologists are created equal. Hence, the prescriptive code is the only way to go. Certainly, you have to tell builders how to design standard construction. In South Florida we saw damage as a result of an influx of northern-style homes into a high-wind environment. The builder can be good, the prescriptive code can be followed, the home can be expensive, but the style can be prone to hurricane damage.

Clearly we need to emulate what has taken place in earthquake areas, and make a better effort to try to mitigate some of these losses. We have not done a very good job in addressing the research effort to mitigate losses.
Building codes

Building codes are in a state of disarray. Some twenty-nine states have statewide building codes; however, some of those states have no code that applies to residential structures. In some states the codes apply only to government buildings, hospitals and schools. The code process is a consensus process and it can take up to 10 years to get meaningful changes through the system. But there is optimism that by the year 2000 we will have some national standards. That doesn’t mean they are going to be implemented across the nation, nor will they be adequate everywhere. For example, why, in some high-wind risk areas, are we building roofs to an 90 mile-an-hour code standard when we know there are going to be 110 mile-an-hour winds?

We need “incentives” to encourage retrofitting to reduce risk. The insurance industry should provide premium reductions if certain criteria are met, but it will take more than a 10 or 20% reduction in homeowner’s premiums to motivate an individual to undertake the retrofit. Local government needs to waive building permit fees, waive the sales tax on materials that will be used to retrofit the structure, and offer tax rebates.

The Insurance Services Office is implementing the Building Code Effectiveness Grading System, which will grade each community across the nation on its code enforcement effectiveness. This should be fully implemented by the year 2000. As you know, you can have the best codes in the world, but if they are not enforced they mean nothing. Mexico City is a prime example of that: 10,000 people paid with their lives. Hurricane Andrew and the Northridge earthquake are also examples of poor code enforcement.

Does the American public want good code enforcement? Absolutely! In a survey undertaken by the Insurance Institute for Property Loss Reduction and reported in the publication Homes and Hurricanes, 93% of the respondents said they would pay $5,000 more for a $100,000 home if they had a guarantee that the codes were adequately enforced. So the American public is behind the effort, while they may have to be aroused, they are supportive of this kind of effort.
Computer Modeling of Catastrophe Risk and Demonstration of Information Technology

Tom Hutton
President, Risk Management Solutions, Inc.

The impact of computing on catastrophic risk management has been absolutely enormous. It has helped us advance from a poor art to a reasonable science. Yet the changes which will occur over the next couple of years will be of increasingly high impact. One of the key issues we need to consider is that it is not technology that is going to keep us from achieving solutions; it is implementing those solutions. To achieve our goals, we do not merely need software to do a specific set of things tomorrow that it doesn't do today. We have to understand what the issues are that we are dealing with, how to communicate them appropriately, and therefore how to put the technology to work.

Historical view of underwriting

Historically, there was a lot of art in the practice of underwriting highly volatile risks because there wasn't very much information characterizing them. A great deal of emphasis was placed on the experience of the underwriter. There was a presumption that the law of large numbers would provide some protection, and that created some stability in our industry. These practices were supported by manual tools: judgment, inspection, interesting tables. Computers in the '60s were used for accounting purposes. We replaced some of our files with punch cards, which were more efficient. We replaced some of our analyses with adding machines.

The decade of the 70s saw a dramatic proliferation of IBM mainframes in the industry. As many of you will recall, we used to get six-inch thick stacks of reports every week that came out of these printers in the middle of the night. Then the industry went from centralized computing to decentralized computing, primarily through the proliferation of PCs.

Impact of new technology

I think in five years every sophisticated financial institution in the world will utilize client-server computing, whereby we can make real-time decisions with data that is meaningful and that is accessible. We will be able to tap into information from outside as well as inside the company. With respect to catastrophic risk management, insurers and reinsurers are now able to make real-time decisions with respect to how an individual risk impacts a portfolio, what its price implication is, how that changes the capitalization of the company, how that capitalization changes the value it is providing to our shareholders.
The questions

With respect to the property catastrophe problem we have learned, of course, that individual risk underwriting doesn't make much sense in that one doesn't lose just one building. One loses a portion of one's portfolio. This is a portfolio management problem and these risks are highly correlated. So the questions with respect to modeling are: What happens to me if an event occurs? How likely is it to occur? What can I do about it? What kind of decision support do I require?

Past approaches

Not long ago most insurers and reinsurers in the world limited their risk management to taking account of their coverage limits. They wanted to make sure that they could cover a loss if it occurred, no matter where it occurred. They looked at the worst situation that had ever occurred historically, and used this as a benchmark for what could occur in the future. There was a great deal of looking in the rearview mirror.

Not long ago, few companies knew where their risks were located. For example, until fairly recently many reports received by the California Department of Insurance didn't reflect what was in insurers' portfolios. Where structures are located becomes a remarkably important issue, as Professor Bolt described. How vulnerable are they? Were they built to code? How confident am I in this analysis?

The Role of Computer Technology

Insurers today can learn a lot by looking directly at what is in their portfolios. The first issue is one of location. Computer technology can define precisely where any structure is located and relate that to a number of geological features or risk features such as soil types, toxic risk, flood plains. FEMA has provided maps for flood plains throughout the United States. There are 100,000 flood maps, a number of which FEMA has digitized. Probably the most interesting thing that computing has done, however, is allow us to have a sense of the probability of loss as opposed to what a loss would be if an event occurred.

Using computer technology, risk is analyzed by simulating a tremendous number of events using data from a large number of sources. The output information from these models supports a number of traditional functions. The most traditional function is that of pricing, whereby one estimates the probabilities of losses of different magnitudes to determine an appropriate insurance rate. However, the impact goes far beyond that. Today most of us have read about Wall Street's efforts to essentially redefine insurance around the use of different financial instruments. This could not possibly occur without a high degree of risk quantification. And models are making that possible. The likelihood of interesting financial opportunities coming out of greater quantification in the insurance industry is very, very high. That said, I have to defer back to the regulatory issue, which really drives the answer here. It is the regulatory issues which are going to define what happens more than logic and more than numbers.
Bob Klein: How do you see information technology utilized by policy makers, regulators, consumers, voters? Are there some ways that policy makers can make important decisions that benefit from and utilize some of the tools that you are developing for business?

Tom Hutton: One of the issues associated with using a large amount of information to support such decisions is that there needs to be some benchmark against which one can assess validity. We have benchmarks in our mind of what is relevant, and the problem in the insurance industry has been that we have used history as a benchmark against issues which are not historically valid. I think the answer for regulators is going to be simplified benchmarking for reality checks.

Questioner: There is quite a bit of empirical evidence that investments in information technology create a lot of value, but not a lot of it is value that is retained by the company.

Tom Hutton: I think we have discovered that the insurance industry has invested tremendous sums of money in storing data and billing people, not in making decisions. The opportunity to change this industry with decision-making technology is absolutely enormous. It is probably the single largest impact of decision-making technology that I am aware of. Insurance represents 10% or more of U.S. Gross National Product and a number of decisions are currently being made blindly. So I think that the potential impact is great. Today, I would say that insurance institutions and investment banks have incurred similar dollar expenditures on information technology. They are 180 degrees opposite as to what they do with it. At the investment bank, it’s on an underwriter’s desk and he is making decisions with it. At the insurance institution, it is in an air-conditioned room and it’s got my address in it.
How Has Information Technology Changed Catastrophic Risk Management in the Insurance Industry?

Karen Clark,
President of Applied Insurance Research

What is different today, is that current modeling takes into account information from lots of different disciplines. It doesn't just look at historical loss data but at meteorological data, seismological data, and engineering data. The modelers are 'knowledge integrators.'

We are also looking at the very detailed characteristics of the underlying exposures. What are the structural types? What kinds of buildings are we insuring? Where are the true exposures which may produce catastrophes? We are looking at the probabilities of losses of all different sizes, in different geographic areas.

We are providing a lot of detail on the likelihood of different loss scenarios for different insurers and reinsurers. Now the modelers are presenting companies with all this detailed information, and the real challenge for insurers is to figure out how to use it. That is really the future of modeling: helping companies to harness this information and use it to make good risk management decisions.

Questions we have to answer for a primary company: What am I going to do to manage exposures? What are my choices? — I can change deductibles, I can change my construction mix, I can change where I write business or I can transfer risk, I can buy reinsurance, I can buy Chicago Board of Trade options in futures, I can try to have some sort of debt funding — but how do I decide which of these tools I am going to use? How do I allocate my capital appropriately? How do I optimally diversify my risks?

Tools to answer these questions will be developed in the future. We are also going to see a lot more integration of information by primary companies and reinsurers. And what will keep this process going is obviously continued awareness. We can say all we want about how information technology has enabled better catastrophe risk assessment and management. However, what really changed the insurance industry's behavior was Hurricane Andrew — the awareness that, yes, we can have truly catastrophic losses.
Dennis Kuzak,
Senior Consultant
EQE International, Inc.

I view information technology as an organizing thought process. It is basically becoming a central nervous system to supplement your brain. If you are a company, it can ultimately become the nerve center for everything you need to know to run your business.

What are some of its limitations?

Quality of Data - There is a real problem getting quality information.

The Learning Curve - Most of the people we deal with are getting exposed to these concepts for the very first time. It is a tremendous burden to these people to learn this in a very short period of time. Your expectations for having them come up this curve very fast are just unrealistic.

People are Focused on one Number - We are not probabilistic-oriented thinking people. Most people want a number. They don't appreciate the robustness of a curve of numbers. The risk is not in a number. It is in the distribution and the shape of the tail. You need to really understand that. If you don't, you don't understand the risk.

The Issue of Uncertainty - Uncertainty plagues our business. This is rocket science. We don't know enough about earthquakes in the fundamental sense. What we have is something called aleatory and epistemic uncertainty. Aleatory uncertainty has to do with randomness. It is the inherent nature of the physical process, and we don't understand it that well, and we have to model it. Epistemic uncertainty relates to differences between the scientific experts in modeling the hazard. For every kind of physical phenomenon we have to construct models. If I have ten experts I am likely to get ten models. What should I do? I really should look at all ten models and incorporate them into my analysis.

The future of this business

What is going to happen in this business is what happened in the financial services business. We are going to get more intense use of technology. Insurers and reinsurers are going to put a price and a value on every piece of business liability and asset they have in their companies. They are going to use IT to optimize their allocation of capital.

The big caveat is, no matter what tool you have, nothing can replace common sense and judgment. If your only tool is a hammer, every problem begins to look like a nail. We are giving people tools they never had before, but if they don't use them properly, they are going to have a lot of nails out there and, in fact, they may need a screwdriver.
Tom Hutton,
President
Risk Management Solutions, Inc.

I have a couple of concluding points. There is a lack of standards in the information sector which is crippling it. Until there are standards we have some serious barriers to using the tools that are available to us today. Then, there is a potential for a greater community-wide impact. There are some incredible sources of knowledge represented in this room, some of which are not clearly available to all of the others in the room. USGS, for example, has tremendous amounts of knowledge that FEMA could use more effectively. They are both in the same government but there needs to be better communication between them.

We are just beginning to see the future. I honestly think the future is not hidden from us by technology issues; it is hidden from us by implementation and soft issues, which we can all deal with together.

Comments and Questions

Werner Schaad: On the one hand, there can be no doubt that there has been a very substantial improvement in information technology and the transfer of these technologies into executive decision making. On the other hand, I’m under the impression that we still face a lot of surprises. Each disaster in the last decade has shown one or more features where we had to say “Wow.” This leads me to the question, Do we think broadly enough? Do we consider things we haven’t thought of before? Perhaps we give too much credibility to these models.

Charlie Kline: I would say that 50% of the clients that use the modeling tools probably haven’t invested enough in understanding and have no intention of climbing the learning curve. Until there is a catastrophe that affects them personally, very few Boards of Directors actually have the tolerance to learn probabilistic analysis.

Andre Fredetta: I am responsible for underwriting in the Americas, excluding the U.S., and what I find unusual is that here the software providers and the insurance companies and reinsurers are all using slightly different zoning systems. I would think this would slow down gathering information and doing modeling. I was wondering if there had been any discussion about trying to have a more uniform system for reporting.

Tom Hutton: You will be happy to know that the three companies represented on the panel along with Swiss Re, Munich Re and other insurers and reinsurers are all now communicating on this issue. What you are likely to see is Canada, Europe, Australia, Japan and the United States adopting standards which are, in fact, more uniform than what we have today.

Karen Clark: I think we are all in favor of standards; it is just that it is a very complicated issue. I know even within our own company, trying to standardize our own work depends on not only geography,
the peril you are looking at, the kind of standards you want (for flood, windstorm or earthquake they might be different), but the needs of the user. The needs of a primary insurance company are different from that of a reinsurer. Trying to come up with a standard or standards is fairly complicated.

**Dennis Kuzak:** One thing that we ought to do collectively is to think about developing some kind of a clearinghouse. Gene Lecomte already mentioned the need for a claims data clearinghouse. We also need something in the exposure data area, so that anyone using a model would have a shot at figuring out what's in the denominator of the equation to determine what the percent loss would be.

**Bob Hamilton:** I think we always have to ask, to what degree does the historic record actually serve as a good predictor of the future? Thinking as a seismologist, as you look at the historical seismicity of China, for example, where we have the longest historical record of seismicity, what you see is one part of China will light up with activity for a few hundred years, then go quiet. Then another part will light up for a few hundred years, and so on. It kind of jumps around. I am sure the models can depict anything you assume, but are we really thinking broadly enough, with the assumptions we make?

**Dennis Kuzak:** We have an underlying hazard model which incorporates frequency and magnitude relationships for earthquakes, or landfalls for hurricanes. We have a model which, I believe represents the consensus thinking, but time and again consensus thinking has been proven wrong. Usually it is dramatically wrong when it is wrong. Our job isn't to go out on a limb and take a wild view. We are going to adopt what is in the literature. That is all we can do. But people are asking, Should we have another model of seismicity? I would propose that if you have multiple views of seismicity they ought to be in the model. Then you, as risk-bearer and user, can decide. For example, do I want to take a consensus view and weight each one of these equally, or do I want to take an extreme view and focus on a single view of seismicity?

**Howard Kunreuther:** All of you have mentioned the tremendous difficulty we have in understanding and presenting uncertainty. Are there some ways that this technology may help us in learning about uncertainty? I am referring to stakeholders besides the insurance industry, such as the homebuilder and the resident who wants to adopt mitigation measures.

**Dennis Kuzak:** Communicating uncertainty concepts to the general public is not easy. You can do a lot of “what ifs,” and simulate extreme events. You can actually walk through an example on a real-time basis with people and say, “If this happens, this is the loss. If this happens, this is the loss.” By using the simulation capability you can demonstrate a series of events and give people a flavor for what uncertainty really means to them.

**Karen Clark:** I think part of our role as modelers is to educate our users, not just where these numbers come from, but why they make sense given all these theories. Why are the numbers reasonable? Why they would differ based on different assumptions. Users should be educated on what the most sensitive aspects of the models are, and what are the real drivers in the loss estimates.
**Tom Hutton:** I think the differences represented actually are both a problem and a value. They are a problem because it is hard to tell what the differences are driven by. On the other hand, if you take hedge funders investing in catastrophe risk, they know nothing about the topic. But if they get numbers from both of us, they at least have two independently reached conclusions that have some amount of uncertainty between them. They like that. But it would be nice if research could define what are the parameters that we don't have to worry about, and what parameters we have to come to grips with. For example, soil is soil. We shouldn't have two different definitions of what soil is on one block. On the other hand, if the California Department of Mines and Geology and the USGS have a difference of opinion on what an occurrence rate is, based upon two different ways of thinking about the problem, that is probably good to maintain, because we don't know which way is right.
The Impact of Information Technology on the Insurance and Reinsurance Industry

From the perspective of the Insurance Industry:

Mike Mangini
Underwriting Officer
Chubb Group

Evolution of Catastrophe Management

I will take a few minutes and walk through information technology's evolution as a tool of catastrophe management. An event that really started to open people's eyes was Hurricane Gloria in 1985. When it formed, it was categorized as "the storm of the century." Fortunately, by the time it made landfall, it had lost a considerable amount of its punch and spared quite a few people from some very unpleasant consequences. But it did raise a lot of questions about how bad it could have been. It was not easy to answer those questions, for the reasons addressed earlier in this conference.

The Development of Geographic Information Systems (GIS)

The first major change that enabled us to get a better handle on what was going on, was the introduction of a desktop PC that had some database management capability. That enabled us to group things on a state, county or zip code boundary level, but it didn't give us the ability to match that information with definable areas of hazard, such as flood or brush or even earthquake zones. All that changed with the development of GIS which enabled insurers to marry location information about our policies with that of hazard layers.

One of the common uses of a GIS system is to assess our risk concentration. For hurricane exposure, for instance, we can use a thematic map, color it according to exposure ranges, analyze risk concentration and determine how we have been doing in regard to catastrophe management in a particular area. GIS is used also as a location check devise — matching locations to a street-level map and a layer of geographic information about hazards. Without precise street-level matching, we cannot determine whether or not we have a hazard exposure.

The next level of geographic information is elevation. Even within a brush hazard area, for instance, we can differentiate between higher and lower risk based on the fact that fire is going to travel uphill. And then we can add earthquake mapping to the analysis, depicting rupture zones and soil conditions. Through this process of just looking at four layers of geographical information, an underwriter with absolutely no knowledge of the territory would be provided with the information necessary to make an informed decision about the better risk to choose.
From the perspective of the Reinsurance Industry:

**Frank Nutter**  
President  
Reinsurance Association of America

I am struck by the opportunity that we now have to link the natural sciences with the actuarial sciences and finance through modeling. What Needs to be Done:

**Data collection**

The insurance and reinsurance industry ought to be looking at collecting data and using the technology to think about new approaches to data analysis that can play a role in influencing public policy decisions. There is too much information and not enough understanding. There is a problem between insurers and regulatory officials who demand reams of data and mounds of forms and schedules with little valuable analysis. All of us need to make certain that we are not so data-driven that we lose sight of the broader information issues.

**Regulatory community**

The technology to evaluate risk has been there for some time. For the insurance industry, the paradigm changed with Hurricane Andrew. Natural disaster analysis shifted from historical experience to prospective exposure analysis. Insurance regulators initially resisted the change in the paradigm, but are now beginning to rethink how we should deal with catastrophe exposures. It is a real challenge. For the Wharton Risk Management and Decision Processes Center, this is an excellent opportunity to see if something can be done to improve the acceptance of these approaches by the regulatory community. There is a need for public policy makers, who deal with issues such as hazard reduction and building codes, to understand the value of a prospective analysis based on a retrospective look at data.

**Need for long-term database**

We really need to look at natural variability over long periods of time. We often rely on the last 20 years, or even the last 50 years, when we look at the recurrence patterns for hurricanes. Researchers in the natural sciences would say that’s not far enough back and that the past isn’t what it used to be. We really need to look back further to understand the extent of the problem rather than relying on anecdotal or limited data.
Virtual companies

We must make certain that all this analysis is undertaken with an understanding of how the business of reinsurance is actually conducted. In reinsurance there are reinsurance hubs — London, New York, Bermuda, Zurich or Germany in Europe. Singapore will probably emerge as the hub in the Far East. Hubs are where people come together to deal with the problems of managing catastrophic risks. The reality is that we are seeing “virtual” companies.

Common standards

Our organization has been working for about three years on electronic communications standards so that insurers and reinsurers can communicate the data on a fairly consistent basis. This is not a central pooling of data. It is an effort to make certain that there are common standards, so that the communication of data between insurers, reinsurers and clients can continue.

From the Perspective of the Insurance Regulator:

Bob Klein
Former Director of Research, NAIC
Director, Center for Risk Management and Insurance Research
Georgia State University

The value of information

Information has value. Because it has value, there are incentives for firms to invest in information, to acquire information, and to develop information. In order for them to want to incur these costs, firms need to reap the economic value of this information and hence want property rights to it. At the same time, those property rights can raise the cost of entry of other firms into the marketplace. Depending upon what type of information is controlled and how it can be accessed, this can potentially diminish competition. There is a tradeoff between encouraging innovation and acquisition of information, while at the same time making sure that there is sufficient public and broad access to information to encourage competition. This is especially true in the insurance industry where information is critical to many insurers’ functions.

Implications of the electronic marketplace on regulation

There are a number of different opinions about how rapidly the Internet and other information technology will affect the transaction of insurance. I think that it is going to have an impact. It already has raised some interesting questions about regulation. Regulation has tended to focus on the geographic occurrence of a sale of an insurance policy. But is that approach workable in an electronic marketplace?
Where does that transaction occur? Is it possible for regulators to use the same techniques they have used historically to control insurance transactions and to regulate transactions on the Internet or in an electronic marketplace?

If you look at the literature on insurance regulation and try to develop a rationale for why we regulate insurance, the most compelling arguments have to do with incomplete costly information. If we are able to increase the amount of information, there is the potential for relying more heavily on market forces and private choice than on regulation.

Historically, we have tended to approach insurance regulation in a rule-based manner. In other words, regulations say that insurance companies can do X, Y, and Z and not do A, B, and C. Does it make sense to use a rule-based approach as the industry evolves, or are there other approaches that might be more efficient and that would take greater advantage of information technology? Alternatively, regulators place greater emphasis on monitoring market performance and strategic intervention without necessarily monitoring every single transaction to see whether it fits a particular rule.

**Improving public perception**

If we are not effective in making public perceptions more accurate, then we are not going to realize the benefits of information technology. While we are improving the knowledge base for insurance companies and their decision-making tools, we also need to be very conscious of how to improve the knowledge base which consumers, voters, politicians, and regulators utilize.

There is reason to hope that we can improve public perception, that we can have better public decision making and better regulatory decision making. But we have to be strategic about how we accomplish these objectives. One thing we could make clear is that there are cross-subsidies occurring right now between some policyholders and others. In other words, some people who live in high risk areas are being subsidized by policyholders in low risk areas. If we do a better job of informing the people who pay the subsidy, we can start tipping the balance in favor of a more rational insurance pricing mechanism based on risk and improve incentives for mitigation.

**Questions and Comments**

**Doug Shillito:** How might we accelerate the cooperation between insurers, reinsurers, and brokers working together in this new technological age?

**Frank Nutter:** As we have pursued this joint venture in trying to develop a greater sharing of compatible information, we occasionally run afoul of concerns about the U.S. anti-trust laws as to what kind of information can be shared and what kind cannot. There is such an intimidation factor with the U.S. insurers about anti-trust enforcement, which I know is not quite so severe in Europe.

If insurance were priced so that policyholders in high risk areas were paying a risk-based premium, you would start to see the incentives and disincentives for hazard mitigation and for proper loss reduction. But the regulatory system — which is very data-driven, very rate- and solvency-driven — has the effect,
in my view, of diminishing the message that the insurance mechanism ought to be sending to people about the decisions they are making. If they are building houses with a high risk, the insurance mechanisms should say, “Fine. Build it if you want, but your premium is going to be high.” If, on the other hand, you put in hazard mitigation features, you will be rewarded for that. But the system doesn’t tend to do that today.

**Bob Klein:** What are the incentives? What are the constraints? What are the potential market failures that may cause an adverse outcome even in this deregulated environment. I think that regulations certainly could be much more efficient than they are today, but does that mean that we should do away completely with regulation? I think we can certainly make significant advances in the information that market participants have, which will diminish the need for regulation.

The NAIC’s model laws and regulations sometimes help to promote standardization and uniformity. I think there is a recognition among insurance regulators that we need to have more uniformity of regulation. A lot of that is compelled by economics and international competition. As Europe integrates its economic environment and makes it easier for large financial holding companies to cross borders that really drives what has to be done in this country.

**Howard Kunreuther:** What do you think it will take for the available information and technology to lead to customization of rates?

**Bob Klein:** The regulators raise two issues about the barriers to accepting the analyses of catastrophe modeling. One is the concern about the “black box” and proprietary information, and the second is the divergence of opinions among modelers. Consensus might make the regulatory decision making process easier and more accurate, but at the same time we don’t want to constrain differences of opinion among experts to the degree that we point everybody in the wrong direction. So I think we need better understanding among regulators. We need the models to be transparent so regulators can understand them, at least at a certain level.

**Mike Magini:** In a lot of respects there is going to be a major problem in taking this new information and modeling capability and actually using them for rate-making. There can be dialogues between insurance companies and state insurance commissions. There can be agreement as to what the problem is, and probably where the rates should go. But there really isn’t going to be any movement until the public constituencies in those affected states allow their insurance commissioner to move forward and effect radical change. In the short term, I really don’t see a major shift in rate making. The only factor that is actually going to change things is if we have an event that really shakes the industry.

**Frank Nutter:** I deal in the public policy arena. Over the years, I have learned that the only thing that eventually changes things tends to be economics — consumer economics, or government economics, or company economics. I don’t think that regulators have a vested economic interest so much as they have a political interest in this, and therefore I don’t see them leading. I see them following whatever the economics suggests.

**Mike Mangini:** So again it gets back to what I think we have all recognized: that until you affect public perceptions and voters’ perceptions, it is going to be very difficult to greatly modify the regulatory process.
Future Research Directions of Information Technology and Its Impact on Insuring Catastrophic Risks

Oscar Gandy
Professor, Annenberg School for Communication
University of Pennsylvania

What we have talked most about is the use of information technology to improve our assessment of the nature of the risks we face. What is really important, though, within the industry, within the regulatory sector, within the buyers and acquirers of insurance, is risk perception. How do we understand the risks that have now been estimated and determine whether or not certain actors have paid their fair share? Another concern has to do with risk communication. How is the risk communicated by participants? How are others informed about the nature of risk, about the reality of risk, about the range of uncertainty about those risks, and about who ought to bear which share of that risk?

Bob Giegengack
Professor of Geology
Co Director Institute of Environmental Studies and Professor of Geology
University of Pennsylvania

When I study the history of climate, I am thinking in hundreds of thousands, or millions of years. This provides me with an historical baseline. These data could be correlated against potential cause-and-effect relationships, which may lead us to the point where we can predict the climate some time into the future. I also deal with earthquakes. There are two fault systems about which a great deal is known: the complex of faults in coastal California and the complex of faults on the Japanese islands. Each one of these databases is a multi-billion dollar piece of information. There are probably more seismographs in California than there are in the rest of the world combined. The probability of accumulating the same magnitude of data about other areas is small.

In dealing with these two kinds of phenomena, catastrophic storms and earthquake events, we geologists are often asked: If they are not now predictable, when will they be? That is a very important question. We probably will come to the stage where predicting individual earthquake events on fault systems as well-monitored as the San Andreas will become feasible. Hurricanes are a different problem. There are those of us studying this phenomenon who are coming to the realization that it may, in fact, be an utterly random process that may never yield to improved models, improved information technology, and improved equations.
So I think there is a potential for predicting earthquakes, but the cost of generating a database is so high that it will probably only be realized at places where those funds have already been expended. I think the possibility of predicting the number of storm centers in equatorial Africa is probably with us, but the problem of determining the trajectory of those storms across the Atlantic may elude applied mathematics, meteorology, and all the other sciences at our disposal virtually forever.

Paul Kleindorfer
Universal Chair Professor of Economics and Public Policy
Co-Director of Risk Management and Decision Processes Center

Many of us believe that the problems we have been discussing require a greater reliance on private market forces to provide the proper discipline for insurance and risk management decisions. To provide a benchmark for what we might expect, I would like to briefly address the experience we have gained in other sectors which have gone through or are currently going through the process of liberalization and deregulation.

As a first example, consider the airline industry. What has happened as a result of deregulation? Those in high cost areas who were previously being subsidized are now paying their full freight. In some cases, quality of service has also been affected, in that high cost areas are being served by fewer flights. Customers who experienced higher prices and lower quality did not like it, but the outcome is simply a reflection of the way the market works to eliminate cross subsidies and reduce cost. What led to these changes in airline deregulation? There were two factors at work: sound economics went into predicting what one could expect from deregulation (both in terms of benefits as well as costs), and there was a national forum with national regulators (the Civil Aeronautics Board, headed up by the free market proponent Alfred Kahn) which allowed the airing and necessary discussion of alternative pathways to deregulation.

The next example is telecommunications. The idea of universal service was a tremendous driver of the growth of communications service. And for nearly a century this idea was coupled with the notion that monopoly provision was the best way to ensure universal service at an affordable price. But we began to realize around 1960, and certainly by the 1970s, that innovations in information technology required a change in this thinking to enable greater reliance on competition and the private market in providing telecommunications services. In the USA, this led ultimately to the divestiture of the Bell Companies from AT&T in 1984 and to a host of subsequent developments further opening up the telecommunications market to competition. The results have been an explosion of new technologies and significant decreases in the real price of services. The major factors driving this sector towards a more competitive structure were again sound economics, a national forum (this time the Federal Communications Commission) and publicly available data on the costs and benefits of alternative technologies and market structures. In addition, the significant revenues at stake in telecommunications drew the attraction of a number of potential entrants.
A final example is the energy sector. Capping a decade of change in the natural gas industry, and inaugurating further changes in electric power, the Energy Power Act of 1992 codified the requirements for unbundling the elements of generation, transportation (or transmission) and distribution of energy to allow and require open and non-discriminatory access to energy supplies at the wholesale level. What led to these developments? Again, arguably, the key drivers were sound economic and engineering analysis indicating that unbundling was possible and desirable. The existence of national and state forums (such as the Federal Energy Regulatory Agency) to discuss alternative pathways to deregulation and mediate disputes was also clearly an enabling factor. These forums were useful both in mapping out the regulation implementing the Energy Power Act, as well as in enabling participants to share their views, their data and their “theories” concerning the ultimate effects of alternative implementation plans for deregulating the industry. The regulators played, and continue to play, a valuable role in assuring that the transition to competition in those parts of the industry where competition is desirable can occur with some sense of stability and trust in the fairness and efficiency of the outcome.

I believe that these examples provide valuable benchmarks for removing some of the roadblocks to change and more effective competition in the insurance and reinsurance industry in the area of catastrophic risk management. In each of the above examples the increased reliance on private markets has led to increases in product innovation, decreased price and cost of service, and a removal of cross subsidies. These are clearly desirable objectives in any market. To achieve these benefits, however, will require significant changes in philosophy and institutional arrangements across the board, for regulators, insurance and risk management service providers and citizens. Whether we are up to the challenge remains to be seen.

Howard Kunreuther
Cecelia Yen Koo Professor of Decision Science and Public Policy
Co-Director of Risk Management and Decision Processes Center and Professor, Wharton School

I would like to raise some questions about where information technology may guide future research in the area of managing catastrophic risks. Research will be directed to satisfying two principal objectives. One is reducing losses in the future and the second is covering the costs of disaster more equitably. Insurance is a special policy tool in that it has the potential of addressing both objectives by playing dual roles: It can encourage loss reduction through premium reductions and/or lower deductibles. It also provides financial assistance after a disaster by accumulating funds through premiums based on risk and paying out claims to insured disaster victims.

In order for insurance to play these two roles the particular risk must be insurable. Hence, future research must address the question: What is necessary to make catastrophic risks insurable? We now have an opportunity to examine the insurability issue in a much more substantive way than we have been able to do in the past because the available information technology and modeling efforts enable us to understand more fully the probability of certain events occurring and the damages that may result from them.
There is also the opportunity to utilize science-based micro models to evaluate the role that insurance can play in combination with other policy tools, such as mitigation measures and building codes, on the affected interested parties. One could begin by constructing a representative community with a variety of different structures that faces different types of natural hazard risks. A set of representative insurance and reinsurance companies would offer coverage against the losses from these disasters. One would then analyze how different policy tools would fare under a variety of different scenarios. To illustrate, one could determine the potential benefits and costs of a certain mitigation measure for particular structures in the community. Will people adopt this measure voluntarily? Will the banks be able to play a role by providing a low-interest loan or a 30-year loan attached to a mortgage that would make the measure attractive? What role would well-enforced building codes play? Such analyses should increase our understanding of the opportunities and limitations of alternative strategies for managing catastrophic risks.

Haresh Shah

Obayashi Professor of Engineering, Stanford University
Director, Risk management Solutions, Inc.

What is the perception of those in the industry who are using the state-of-the-art technology, information technology, computer models? I hope they do not believe that the only thing they have to do is use these models and their problems are solved. The biggest problem we have, as alluded to earlier, is the quality of data.

The technology and good data can be combined in some exciting ways. Wouldn’t it be nice if there were a “world risk map” where you take into account not only what the hazards are and what the frequencies are, but you look at what is out there, how many people are out there, what infrastructure exists, what the density of the population is, what the gross domestic product per unit area is. We are in the process of developing something called EDRI, the Earthquake Disaster Risk Index. It takes into account a tremendous number of variables, combining life loss, economic loss, and productivity loss.

Another area which the Federal Emergency Management Agency (FEMA) should be looking into is the options that we need to implement today. We call what we are doing the Strategy Evaluation Chart. As an example, without any new strategies, if an earthquake occurs today in Los Angeles, what will happen in terms of economic loss, life loss, and general deterioration of life? Then take a strategy of retrofitting a certain type of home. What is the cost of implementing that strategy? How much did we buy, in safety and reduced economic loss by implementing this strategy? Each strategy has a cost and each one has benefits. If the government pays, what will the government receive? In the private sector, if I pay for this work, how much will I receive?

The most important thing that we need to learn is communication. We don’t communicate well with the government. We don’t communicate well with the consumers. We don’t communicate well with each other. As long as there is a lack of communication, there will be a lack of trust, an increase of fear, and we will not get too far.
Questions and Comments

Moti Levi: How do we want insurance companies and government agencies to present information to the customer? What is their ability to understand this information?

Oscar Gandy: A lot of the systems that we have been developing are created to inform institutional decisions, but individuals don't make decisions on the same bases. They want to know what their probability is. So you have to be able to communicate to the consumers this information in a form they can understand.

Paul Kleindorfer: Anyone who believes that deregulation removes the need for regulators is sadly misinformed. Deregulation initiatives in the industries that I have referred to have given new life to regulators. The regulator is needed to improve and to monitor the quality of information, because if trust goes sour during the deregulation process, you have a real problem.

Howard Kunreuther: In addition to providing better information, you may have to have other kinds of incentives and regulations such as well enforced building codes.

Dennis Kuzak: The idea that the public is not informed about the earthquake risk in California is erroneous. There is a very high degree of communication by the USGS and other institutions as to where the hazards are high, so people are very aware of that hazard. Anybody who has access to the World Wide Web can pull up scenario maps and see where they live to decide whether or not they have a high hazard. They don't need to know the probability of an earthquake. All they need to know is that they are in a red area.

Haresh Shah: Where I think we have not done a good job communicating is in risk perception and risk management on the personal level. People still believe that they can build anything, anywhere without accountability — somebody will bail you out. There's something wrong there.

Bob Giegengack: Information technology is very valuable when you have information. In the absence of information, the technology is of little value, and for most of the world's potential earthquake victims, that information is lacking.
Issues and Questions for the Future

This conference was designed to explore how scientifically-based risk assessments and new advances in information technology can be coupled with the decision processes of the concerned interested parties to better manage catastrophic risk.

A number of important issues have been raised by the participants in this regard. They can be considered around four sets of questions. The first group deals with how catastrophe risk should be measured. What are appropriate methods for estimating an individual’s or company’s exposure to natural disaster risk (disaster frequency and severity)? How can computer simulation models be used to enhance our understanding of this exposure? How can competing models be evaluated by companies and state insurance regulators?

A second set of issues involves the best ways to encourage pre-disaster mitigation to reduce risk and losses. What mechanisms are available for providing incentives so homeowners and organizations mitigate against disaster losses in advance of a disaster? What are the cost-benefit (cost-effectiveness) trade-offs of the loss reduction options? Are insurance discounts for mitigation viable? Are state or federal hazard insurance requirements for mortgages a viable option?

A third set of questions surround the role of insurance and capital markets. How can insurance and reinsurance companies enhance their diversification of disaster risk over time? How can companies restructure their insurance portfolio to reduce disaster risk while continuing to write coverage? What options are available for improving catastrophe reserving? How can capital markets assist in financing disaster risk?

Finally, public policy issues are an important element in this debate. How can federal and state governments improve society’s ability to reduce and finance disaster losses? What is the appropriate role for the federal, state and local governments in carrying out a catastrophe risk program? What role can building costs and land use regulations play in reducing losses from future disasters? How can regulators help catastrophe insurance markets function effectively while maintaining necessary consumer protections?
The Wharton Risk Management and Decision Processes Center’s
Related Publications and Working Papers


96-11-01  Roger K. Raufer, “Market-Based Pollution Control Regulation: Implementing Economic Theory in the Real World,” Center working paper.


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