Disaster Mitigation and Insurance: Learning from Katrina

By
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Hurricane Katrina illustrates the *natural disaster syndrome*. Prior to a disaster, individuals in hazard-prone regions do not voluntarily adopt cost-effective loss reduction measures. The federal government then comes to the rescue with disaster assistance even if it claimed it had no intention of doing so prior to the event. There are a number of reasons why individuals do not protect themselves prior to a disaster. They underestimate the likelihood of a future disaster, often believing that it will not happen to them; have budget constraints; are myopic in their behavior; and/or do not want to be the only one on the block modifying their structure. Given this lack of interest in voluntary protection, benefit-cost analysis can determine when a well-enforced building code would be appropriate. The article concludes by highlighting the importance of public-private partnerships as a way of reducing future disaster losses and aiding the recovery process.

Keywords: disaster insurance; building codes; homeowner motivations; community planning; disaster mitigation; risk assessment

Hurricane Katrina has highlighted the challenges associated with reducing losses from hurricanes and other natural hazards due to what I have termed the "natural disaster syndrome" (Kunreuther 1996). It consists of interconnected ex ante and ex post components. Before a disaster, most homeowners, private businesses, and the public sector do not voluntarily adopt cost-effective loss reduction measures. Hence, the area is highly vulnerable and

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unprepared should a severe hurricane or other natural disaster occur. The magnitude of the destruction following a catastrophic disaster, such as Katrina, leads the government to provide liberal relief to victims even if it claimed it had no intention of doing so prior to the event. This combination of underinvestment in protection prior to the event and liberal use of taxpayers' funds after a disaster does not augur well for the future.

One of the reasons for the natural disaster syndrome relates to the decision processes of individuals with respect to low-probability high-consequence events, such as a Category 3 or 4 hurricane. Prior to a disaster, many individuals perceive its likelihood as sufficiently low that they argue, "It will not happen to me." As a result, they do not feel the need to invest voluntarily in protective measures, such as strengthening their house or buying insurance. It is only after the disaster occurs that these same individuals claim they would like to have undertaken protective measures.

The next section examines why individuals do not voluntarily invest in cost-effective mitigation measures. The third section shows how benefit-cost analysis can be used for determining under what situations a well-enforced building code would be appropriate. The fourth section argues for the importance of public-private partnerships for incorporating mitigation measures into a disaster management plan by showing how building codes can be combined with insurance incentives and long-term mitigation loans. The concluding section summarizes the key findings of the article and suggests future research for reducing the natural disaster syndrome.

Why Do Individuals Not Undertake Mitigation Measures Voluntarily?

Extensive evidence indicates that residents in hazard-prone areas do not undertake loss prevention measures voluntarily. A 1974 survey of more than one thousand California homeowners in earthquake-prone areas revealed that only 12 percent of the respondents had adopted any protective measures (Kunreuther et al. 1978). Fifteen years later, there was little change despite the increased public awareness of the earthquake hazard. In a 1989 survey of thirty-five hundred homeowners in four California counties at risk from earthquakes, only 5 to 9 percent of the respondents in these areas reported adopting any loss reduction measures. (Palm et al. 1990). Burby et al. (1988) and Laska (1991) have found a similar reluctance by residents in flood-prone areas to invest in mitigation measures.

In the case of flood damage, Burby (2006 [this volume]) provides compelling evidence that actions taken by the federal government, such as building levees, make residents feel safe when, in fact, they are targets for catastrophes should the levee be breached or overtopped. This problem is reinforced by local public officials who do not enforce building codes and/or impose land-use regulations to restrict development in high-hazard areas. If developers do not design homes so

TABLE 1
EXPECTED BENEFIT-COST RATIO OF INVESTING IN MITIGATION MEASURES AS A FUNCTION OF TIME HORIZON, PERCEIVED LOSS REDUCTION, AND PERCEIVED PROBABILITY (p)

	Loss Reduction ($40,000)	
Time Horizon (in Years)	p = 1/100	p = 1/300
1	0.30	0.10
2	0.58	0.19
3	0.83	0.28
4	**1.06**	0.35
5	1.26	0.42
10	2.05	0.68
15	2.54	0.84
20	2.83	0.94
25	3.03	**1.01**

NOTE: Figures in bold reflect the smallest number of years that the benefit/cost ratio exceeds 1.

that they are resistant to disasters and individuals do not voluntarily adopt mitigation measures, one can expect large-scale losses following a disaster, as evidenced by the property damage to New Orleans caused by Hurricane Katrina.

Consider the Adamses, a hypothetical family whose New Orleans home was destroyed by Hurricane Katrina. They have decided to rebuild their property in the same location but are unsure, however, whether they want to invest in a flood-reduction measure (e.g., elevating their home, sealing the foundation of the structure, and/or waterproofing the walls).[1] Suppose that scientific experts have estimated that the annual chances of a severe flood in the area where the Adamses live is 1 in 100. If they invested in a flood mitigation measure, they would reduce damage from this hurricane by $40,000. In other words, the expected annual benefit from investing in such a measure would be $400 (i.e., 1 in 100 × $40,000). The longer the time period T that the Adamses expect to live in their house, the greater the expected benefit from flood-proofing their house. More specifically, let B represent the expected net present value of the benefit of mitigation over the entire time horizon T.[2]

Suppose the extra cost to the Adamses of undertaking flood-proofing measures is C = $1,200. Let T^* represent the minimum number of years for the loss-reduction investment to be cost-effective. In other words, T^* is the smallest time period where $B/C > 1$. The second column in Table 1 depicts the expected benefit-cost ratio as a function of T associated with such an investment if the Adamses' annual discount rate was 10 percent. It is clear that if the family planned to live in their home for more than four years, they would want to flood-proof their house if they were risk-neutral. If the Adamses were risk-averse, then $T^* < 4$ because they would be more concerned with the financial consequences of suffering a large loss from the next disaster and would thus find the expected benefits of mitigation even more attractive than if they were risk-neutral.

The Adams family and other residents of New Orleans could have debated whether to flood-proof their homes prior to Katrina, but suppose they decided not to do so. It is instructive to ask why they chose *not* to adopt cost-effective mitigation measures.

Underestimation or ignoring probabilities

Many individuals perceive the probability of a disaster causing damage to their home as being sufficiently low that they cannot justify investing in mitigation even if they evaluate the risk systematically by comparing the expected benefits with the cost of protection. Suppose that the Adams family perceived the annual chances of a severe flood damaging their home to be 1 in 300 rather than the scientists' estimate of 1 in 100. As shown in the third column of Table 1, the value of T^* is now more than six times higher, so that the Adamses would have to expect to live in their home for at least the next twenty-five years to want to invest in this mitigation measure.[3]

According to the 2004 Housing Survey for the New Orleans Metropolitan Area, the median tenure of occupancy is eleven years for owner-occupied residences, so if most residents with neighboring homes similar to the Adamses misperceived the risk in this manner, they would not want to flood-proof their structure (U.S. Department of Housing and Urban Development and U.S. Census Bureau 2004).

Prior to Katrina, the Adams family did not focus on the likelihood of their house being flooded when making decisions on whether it should be mitigated. As a result, they did not even think about the consequences of future flooding from a hurricane and hence did not make the trade-offs between expected benefits and costs. Magat, Viscusi, and Huber (1987) and Camerer and Kunreuther (1989) provided considerable empirical evidence that individuals do not seek out information on probabilities in making their decisions. Huber, Wider, and Huber (1997) showed that only 22 percent of subjects sought out probability information when evaluating risk managerial decisions. When consumers are asked to justify their decisions on purchasing warranties for products that may need repair, they rarely use probability as a rationale for purchasing this protection (Hogarth and Kunreuther 1995).

Those individuals who seek out information on the likelihood of a severe disaster causing damage to their home may find that experts disagree. For example, different methods for interpreting identical geologic information for earthquake-triggered liquefaction showed significant differences in the probability of the earthquake hazard for the same location (Bernknopf et al. forthcoming). Those who prefer not to think about the hazard may focus on the lowest-probability estimate so they can justify not investing in any protective measures.

Research shows that decision makers use "threshold models," whereby if the probability of a disaster is below some prespecified level, they do not think about the event[4] in making decisions. In a laboratory experiment on purchasing insurance, many individuals bid zero for coverage, apparently viewing the probability of a loss as sufficiently small that they were not interested in protecting themselves against it (McClelland, Schulze, and Coursey 1993). Similarly, many homeowners

residing in communities that are potential sites for nuclear waste facilities have a tendency to dismiss the risk as negligible (Oberholzer-Gee 1998). Prior to the Bhopal chemical accident in 1984, firms in the industry estimated the chances of such an accident as sufficiently low that it was not on their radar screen. If the Adams family took this approach, they would not have any interest in investing in a loss mitigation measure no matter how large the savings would be.

Extensive evidence indicates that residents in hazard-prone areas do not undertake loss prevention measures voluntarily.

Short time horizons

In making decisions that involve cost outlays, individuals are often myopic and hence only take into account the potential benefits from such investments over the next year or two. This is one reason that consumers are often reluctant to buy energy-efficient appliances that promise to reduce their monthly electricity bills over the life of the appliance.[5] In the example in Table 1, if the Adams family wanted to recoup their investment in less than four years, then even if they had used the experts' estimate of the risk, they would still not have flood-proofed their house. In one study, subjects indicated the maximum they were willing to pay for such protective measures as investing in a deadbolt lock for their apartment, purchasing a steering wheel club, and strengthening their homes against earthquakes (Kunreuther, Onculer, and Slovic 1998). By varying the number of years that each of the measures provided protection, one could determine how much more the person was willing to invest in the item as a function of time. If a person was willing to pay $50 for a deadbolt lock if he planned to live in his apartment for one year, then he should be willing to pay up to $95.45 if he had a two-year lease and an annual discount rate of 10 percent.

Many of the arguments used by respondents suggest that they focus on the cost of the product in determining how much they are willing to pay to invest in a protective measure and do not take into account the expected benefits over more than one year. These justifications are consistent with experiments by Schkade and Payne (1994) and Baron and Maxwell (1996), which revealed that the willingness to pay for public goods was affected by cost information.

This tendency toward myopia is one of the most widely documented failings of human decision making. As a rule, we have difficulty considering the future consequences of current actions over long time horizons (Meyer and Hutchinson 2001).

As pointed out above, decision makers fail to invest in measures that make their houses more disaster-resistant and underinvest in energy-saving appliances. Patients also undervalue the benefits of exploratory medical testing (Luce and Kahn 1999).

Budget constraints

If the Adams family focuses on the upfront cost of flood-proofing their house and they have limited disposable income after purchasing necessities, then they will not even consider taking this step. Residents in hazard-prone areas have used this argument explicitly for their lack of interest in buying insurance. In focus group interviews to determine factors influencing decisions on whether to buy flood or earthquake coverage, one uninsured worker responded to the question, "How does one decide on how much to pay for insurance?" by responding as follows:

> A blue-collar worker doesn't just run up there with $200 [the insurance premium] and buy a policy. The world knows that 90 percent of us live from payday to payday. . . . He can't come up with that much cash all of a sudden and turn around and meet all his other obligations. (Kunreuther et al. 1978, 113)

The budget constraint for investing in protective measures may extend to higher-income individuals if they set up separate mental accounts for different expenditures. Thaler (1999) suggested that dividing spending into budget categories facilitates making rational trade-offs between competing use of funds and acts as a self-control device. He pointed out that poorer families tend to have budgets defined over periods of a week or a month while wealthier families are likely to use annual budgets. Heath and Soll (1996) provided further evidence on the role of budget categories by showing how actual expenses are tracked against these budgets.

A response by several individuals when asked why they were only willing to pay a fixed amount for a deadbolt lock when the lease for the apartment was extended from one to five years supports this mental accounting argument with respect to budgets. One responder said simply,

> $20 is all the dollars I have in the short-run to spend on a lock. If I had more, I would spend more—maybe up to $50. (Kunreuther, Onculer, and Slovic 1998, 284)

Interdependencies

Suppose the Adams family was considering elevating their house on piles to reduce flood losses from a future hurricane. If none of their neighbors have taken this step, their house would look like an oddity in a sea of homes at ground level. Should the Adamses choose to move, they would be concerned that the resale value of their home would be lower because the house was different from all the others. Given that there is a tendency not to think about a disaster until after it hap-

pens, the Adamses may reason that it would be difficult to convince potential buyers that elevating their house should increase its property value.

The question as to how actions of others impact one's own decisions relates to the broader question of interdependencies. If all homes in the neighborhood were elevated, then the Adamses would very likely want to follow suit; if none of them had taken this step, then they would not have an interest in doing so. It is conceivable that if a few leaders in the community elevated their homes, then others would do the same. This type of tipping behavior is common in many situations and has been studied extensively by Schelling (1978) and popularized by Gladwell (2000). Heal and Kunreuther (2005) provided a game theoretic treatment of the topic and indicated that a wide range of problems come under this rubric. They suggested ways to coordinate actions of those at risk ranging from subsidization or taxation to induce tipping or cascading to rules and regulations such as well-enforced building codes.

Disaster assistance

One of the arguments that has been advanced as to why individuals do not adopt protective measures is that they assume liberal aid from the government will be forthcoming should they suffer losses from a disaster. Under the current system of disaster assistance, the governor of the state(s) can request that the president declare a "major disaster" and offer special assistance if the damage is severe enough.

In the case of Hurricane Katrina, Governor Kathleen Blanco declared a State of Emergency on August 26, 2005, and requested disaster relief funds from the federal government on the 28th. President Bush declared a State of Emergency on the 28th (Brookings Institution 2005), an action that frees federal government funds and puts emergency response activities, debris removal, and individual assistance and housing programs under federal control (Congressional Research Service 2005). Under an emergency declaration, federal funds are capped at $5 million. On August 29, in response to Governor Blanco's request, the president declared a "major disaster," allotting more federal funds to aid in rescue and recovery. By September 8, Congress had approved $52 billion in aid to victims of Hurricane Katrina.

Federal disaster assistance may create a type of Samaritan's dilemma: providing assistance ex post (after hardship) reduces parties' incentives to manage risk ex ante (before hardship occurs). If the Adams family expects to receive government assistance after a loss, it will have less economic incentive to invest in mitigation measures and purchase insurance prior to a hurricane. The increased loss due to the lack of protection by residents in hazard-prone areas amplifies the government's incentive to provide assistance after a disaster to victims.

The empirical evidence on the role of disaster relief suggests that individuals or communities have *not* based their decisions on whether to invest in mitigation measures by focusing on the expectation of future disaster relief. Kunreuther et al. (1978) found that most homeowners in earthquake- and hurricane-prone areas did not expect to receive aid from the federal government following a disaster. Burby

(1991) found that local governments that received disaster relief undertook more efforts to reduce losses from future disasters than those that did not. This behavior seems counterintuitive, and the reasons for it are not fully understood. It will be interesting to see whether Hurricane Katrina changes this view given the highly publicized commitment by the Bush administration to provide billions of dollars in disaster relief to victims.

In making decisions that involve cost outlays, individuals are often myopic and hence only take into account the potential benefits from such investments over the next year or two.

Whether or not individuals incorporate an expectation of disaster assistance in their predisaster planning process, a driving force with respect to the actual provision of government relief is the occurrence of disasters where the losses are large (Moss 2002). Following the Alaska earthquake in 1964 where relatively few homes and businesses had earthquake-resistant measures and insurance protection, the U.S. Small Business Administration (SBA) provided 1 percent loans for rebuilding structures and refinancing mortgages to those who required funds through its disaster loan program. Hence, the uninsured victims in Alaska were financially better off after the earthquake than their insured counterparts (Dacy and Kunreuther 1968).

Following Hurricane Betsy, Congress passed the Southeast Hurricane Disaster Relief Act of 1965 (PL 89-339), which authorized the Federal Housing Administration (FHA) and SBA to forgive a part of each loan up to a maximum of $1,800. The forgiveness features were intended to be limited to uninsurable loss or damage. But in practice, anyone who requested forgiveness received it because flood insurance was not available at the time and it was difficult to separate wind damage (normally covered by insurance) from water damage (not covered) (Kunreuther 1973).

The National Flood Insurance Program (NFIP) was established in 1968 to encourage individuals in hazard-prone areas to purchase flood insurance at highly subsidized rates as a way of alleviating the need for disaster assistance. Few individuals voluntarily bought this coverage, so when Tropical Storm Agnes caused more than $2 billion in damage in June 1972, only 1,583 claims totaling $5 million were

paid under the NFIP (Kunreuther 1973). Even though flood coverage has been required since 1973 as a condition for a federally insured mortgage, it has been estimated that less than 40 percent of the victims of Hurricane Katrina in Mississippi and Louisiana had flood insurance to cover their losses (Insurance Information Institute 2005). There are at least two issues at play here. The first is that not all flooded areas were determined to be hazard-prone by the Federal Emergency Management Agency (FEMA) (such as the 9th Ward in New Orleans). The second is that even within hazard-prone areas, many homeowners did not have flood insurance coverage.

Summary

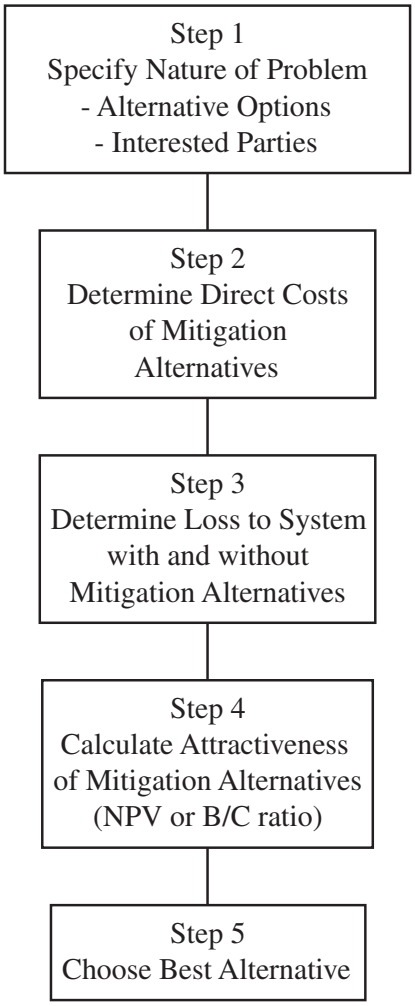
The story of the Adams family is one that can be generalized to many residents in hazard-prone areas. There will be a lack of interest in voluntarily adopting loss-prevention measures for several interrelated reasons: an underestimation of the probability of the disaster occurring or even treating the event as if its likelihood was zero, myopic behavior by individuals as reflected in short time horizons for estimating benefits, and interdependencies with neighbors' decisions. There is limited empirical evidence that the expectation or receipt of disaster relief discourages individuals from investing in mitigation measures. However, if victims suffer large losses for which they do not have financial protection, then the government is likely to come to the rescue with significant disaster relief.

Role of Cost-Benefit Analysis (CBA)

The public sector can play an important role in reducing losses from future disasters by examining measures that will be cost-effective from both the residents' perspective and those of the general taxpayer. Consider whether the city of New Orleans should require that homes in flood-prone areas in the metropolitan area be flood-proofed to reduce the likelihood that they would suffer serious disaster losses or whether they should allow the residents to rebuild to pre-Katrina standards by not imposing any building code. The building code would reflect a balance between the costs of flood-proofing structures and the expected reduction in losses from future hurricanes of different intensities that hit New Orleans. Another alternative would be to provide residents whose homes were destroyed with grants and/or low-interest loans and require them to move to other areas and convert the vacated areas to wetlands.

CBA is a systematic procedure for evaluating options, such as the ones specified above. There are different ways to conduct a valid CBA, depending on the information one has and the nature of the problem at hand. A simplified five-step procedure for conducting a CBA is depicted in Figure 1. A more comprehensive approach, which incorporates several additional steps, is discussed in Boardman et al. (2001). Posner (2004) provided a comprehensive analysis of the use of benefit-cost

FIGURE 1
SIMPLIFIED COST-BENEFIT ANALYSIS FOR MITIGATION MEASURES



NOTE: NPV = net present value; B/C = benefit/cost ratio.

approaches for determining what measures society will want to invest in for dealing with extremely low-probability catastrophes such as an asteroid hitting land.

The five-step CBA procedure includes defining the nature of the problem, including the alternative options and interested parties; determining the direct cost of the mitigation alternatives; determining the benefits of mitigation, via the difference between the loss to the system with and without mitigation; calculating the attractiveness of the mitigation alternatives; and finally, choosing the best alternative.

Step 1: Specify the nature of the problem

To initiate a CBA, one needs to specify the options that are being considered and the interested parties in the process. Normally, one alternative is the status quo. For the above problem, the status quo refers to allowing homes in New Orleans to rebuild their structures to pre-Katrina standards without having to flood-proof them. The status quo is normally the reference point for evaluating how well other alternatives perform. For this example, there are two alternatives: institute a building code that requires all homes in the Adamses' neighborhood to be mitigated based on their flood risk or provide grants and/or loans to residents in this neighborhood to move to safer areas, creating wetlands in the process.

Each of these options will impact a number of individuals, groups, and organizations in our society. It is important to indicate who will benefit and who will pay the costs associated with each option when undertaking a CBA analysis. These include residents and business owners affected by the hurricane; state and local government agencies that must administer the building code or provide low-interest loans and/or grants; federal agencies that deal with the consequences and losses following a disaster; and the general taxpayer who will bear some of the costs of administering the code, the low-interest loans and/or grants, and the disaster assistance provided by the public sector following a disaster. Depending on the stringency and geographic coverage of mitigation policies and standards for communities, CBA analysis has shown that the spatial heterogeneity of the hazard in a region affects the extent of the regulatory burden and the efficiency of its implementation (Bernknopf et al. 2001).

Step 2: Determine the direct costs of mitigation alternatives

For each mitigation alternative, one needs to specify the direct cost to implement the mitigation measure. For a building code, the property owner incurs the monetary costs associated with making the house more hurricane-resistant. Should residents be required to move to a safer area, the costs include not only the financial expenses of moving but the social and psychological impacts of moving to a new community.

Step 3: Determine the expected benefits of mitigation alternatives

Once the costs are estimated for each mitigation alternative, one needs to specify the potential benefits to each of the interested parties. In the case of the above hurricane risk, one considers either a scenario hurricane event or a set of scenario hurricanes of different magnitude, location, duration, and intensity that affect New Orleans. The damage to the property is then estimated for each alternative option, and the expected benefits are estimated relative to the status quo. For the case where homes are flood-proofed due to a building code, the expected benefits are the reduction in losses from hurricanes of different magnitudes over the life of

the home multiplied by the likelihood of each of these hurricanes occurring. The benefits accruing in future years are converted to present value by an appropriate discount rate. Should homes be relocated to safer areas, the expected benefits are computed in a similar manner, except they would then reflect the reduction in damage to these homes from hurricanes of different magnitude because the homes had been relocated to safer areas.

Step 4: Calculate the attractiveness of mitigation alternatives

To calculate the attractiveness of mitigation, the nature of the expected benefits to each of the interested parties is estimated and compared to the upfront costs of mitigation. The impact of a building code could be evaluated by calculating the ratio of the discounted expected benefits to the upfront costs to determine the attractiveness of the alternative as was demonstrated in Table 1 for the Adams family. Whenever this ratio exceeds 1, the alternative is viewed as desirable. Budget constraints may make it difficult for some property owners to incur these extra costs, in which case one may have to consider whether subsidized loans or grants should be provided to these individuals.

A similar analysis could be undertaken for the alternative of moving residents to lower-risk areas. The problem has additional complications since social and psychological costs are involved in relocating to a new area (Heinz Center 2000). For each family, special considerations need to be taken into account, many of which are hard to quantify. Many property owners may resist moving to another area, and it would be difficult to convince them that it is in their best interest to do so. On the other hand, if one only considered the reduction of future disaster losses in the analysis, this alternative may be highly attractive.

Step 5: Choose the best alternative

Once the attractiveness of each alternative is calculated through a net present value calculation or a ratio of the benefits to the costs, one chooses the alternative with the highest benefit-cost ratio. This criterion is based on the principle of allocating resources to their best possible use so that one behaves in an economically efficient manner. As pointed out above, some individuals may perceive themselves as worse off than before and/or feel that they cannot afford the proposed measure.

Incorporating Mitigation into a Disaster Management Program

Suppose that the city of New Orleans decided to impose a building code requiring all homes in the neighborhood where the Adamses live to flood-proof their structures, which would reduce their expected annual flood losses by $275. If the

cost of mitigation was $1,200 and the annual discount rate was 10 percent, then Table 1 indicates that each house would only require a four-year lifespan for the expected discounted benefits to exceed the cost of mitigation.

Implementing building codes

The implementation of such a building code is another matter. We have already shown that if families like the Adams family have misperceptions of the probability of a future hurricane, short time horizons, and budget constraints, they will have no interest in adopting the mitigation measure. The challenge in developing a disaster management plan that encourages mitigation measures is to develop approaches that will encourage individuals to want to undertake these measures. This section of the article suggests ways that mitigation can be incorporated as part of a private-public sector partnership for reducing future losses from natural disasters.

Federal disaster assistance may create a type of Samaritan's dilemma: providing assistance ex post (after hardship) reduces parties' incentives to manage risk ex ante (before hardship occurs).

Current federal disaster policy suggests that the public feels some degree of responsibility toward helping victims of natural disasters. Despite the need to limit building in hazard-prone areas, construction has increased radically in coastal areas subject to hurricanes. This construction has increased both property values and buyer attention for these coastal areas. For example, after Hurricane Camille destroyed the Richelieu apartment complex in Pass Christian, Mississippi, in 1969, a shopping center was built in the same location, housing a Winn Dixie and a Rite-Aid, among other retail businesses. Although the shopping center was leveled by Hurricane Katrina, real estate developers already have plans to rebuild on the site, most likely a condominium development this time (Wharton Risk Center 2005).

Development in hazard-prone areas has resulted in skyrocketing disaster costs in recent years starting with Hurricane Andrew in 1992 where the damage was estimated to be $35 billion and culminating in 2005 with Hurricanes Katrina, Wilma, and Rita where insurance claims are estimated to be between $40 and $60 billion and total losses will be considerably higher.

Building codes are often not enforced in hazard-prone areas. Insurance experts have indicated that 25 percent of the insured losses from Hurricane Andrew could have been prevented through better building code compliance and enforcement (Insurance Research Council and Insurance Institute of Property Loss Reduction 1995). Many communities have inadequate staffing and training to enforce these codes effectively. In Dade County, the area struck by Hurricane Andrew, only sixty building inspectors were required to conduct multiple inspections on an average of twenty thousand new buildings each year. This translates into an average of thirty-three inspections per day for each inspector, a near-impossible task when driving time, report writing, and other administrative tasks are taken into account.

Linking mitigation with insurance

In reexamining strategies for reducing losses from disasters in the future, one needs to strike a balance between satisfying the objectives of the individual living in a hazard-prone area and the general public. Banks can play a key role in this regard if

- they require homeowners in hazard-prone areas to purchase insurance coverage against natural disasters, and
- the premiums reflect the risk of living in the area.

Consider the residents of New Orleans, such as the Adams family, who are residing in areas subject to flooding from hurricanes. If they have a federally insured mortgage, banks could require them to purchase flood insurance. Banks could also require that a third-party inspector ensure that structures meet the building code instituted by the city of New Orleans that homes rebuilt after Hurricane Katrina in the neighborhood in which the Adams family lives have to be flood-proofed.

To make the adoption of these mitigation measures financially palatable from the property owner's perspective, banks holding the mortgage on the property could provide funds for this purpose through a home improvement loan with a payback period identical to the life of the mortgage. For example, the mitigation measure considered by the Adams family costs $1,200. A twenty-year loan for $1,200 at an annual interest rate of 10 percent would result in payments of $116 per year. If the annual insurance premium reduction due to the adoption of the mitigation measure is greater than $116, the insured homeowner would have lower total payments by investing in mitigation (Kleindorfer and Kunreuther 1999). In fact, as shown in Table 1, the expected annual savings in reduced wind damage from adopting the mitigation measure was $400. If the insurance premium were reduced by this amount, the annual savings to the property owner would be $284 (i.e., $400 – $116).

A bank would have a financial incentive to provide this type of loan. By linking the expenditure in mitigation to the structure rather than to the property owner, the annual payments are lower and this would be a selling point to mortgagees. The bank will also feel that it is now better protected against a catastrophic loss to the property, and the insurer knows that its potential loss from a major disaster is

reduced. The general public will now be less likely to have large amounts of their tax dollars going for disaster relief. A win-win-win-win situation for all!

There is an additional benefit to insurers from having banks ensuring that their mortgagees have met existing building codes. The costs of reinsurance that protects insurers against catastrophic losses should now decrease. If reinsurers know that they are less likely to make large payments to insurers because each piece of property in a region now has a lower chance of experiencing a large loss, then they will reduce their premiums to the insurer for the same reason that the insurer is reducing its premium to the property owner.

Suppose that an insurer had one thousand identical insurance policies in New Orleans, each one of which would expect to make claims payments of $50,000 following a hurricane if homes were not mitigated in the way that the Adamses were considering. The insurer's expected loss from such a disaster would be $50 million. To protect its surplus, suppose the insurer would want to have $25 million in coverage from a reinsurer. Given that the hypothetical hurricane has a 1 in 100 chance of hitting New Orleans, the expected loss to a reinsurer would be $250,000, and the premium charged to the insurer would reflect this. If the bank required that all one thousand homes be flood-proofed to meet the local building code and each homeowner's loss were reduced to $10,000, then the insurer's total loss would be $10 million should all one thousand homes be affected, and it would not require reinsurance. This savings would be passed on to the insurer in the form of a lower premium.

Providing seals of approval

Another way to encourage the adoption of cost-effective mitigation measures is for banks and financial institutions to provide a seal of approval to each structure that meets or exceeds building code standards. Such a seal of approval is likely to increase the property value of the home should the owner want to sell it, by informing the potential buyer that the house is built safely.

Other direct financial benefits result from having a seal of approval. *Fortified…for safer living* is a national new home construction designation program of the Institute for Business and Home Safety (IBHS). *Fortified* techniques and construction materials raise a home's overall disaster resistance above the minimum requirement of building codes. An independent inspector, trained by IBHS, verifies that *Fortified* features have been built into the home. The *Fortified* designation is registered with IBHS and remains with the structure indefinitely (unless major modifications are made). The designation or certain program features may qualify for homeowners' insurance credits in some states.

The success of such a program requires the support of the building industry and a cadre of qualified inspectors to provide accurate information as to whether existing codes and standards are being met. Such a certification program can be very useful to insurers who may choose to provide coverage only to those structures that are given a certificate of disaster resistance.

Evidence from a July 1994 telephone survey of 1,241 residents in six hurricane-prone areas on the Atlantic and Gulf Coasts provides supporting evidence for some

type of seal of approval. More than 90 percent of the respondents felt that local home builders should be required to follow building codes, and 85 percent considered it very important that local building departments conduct inspections of new residential construction (Insurance Research Council and Insurance Institute for Property Loss Reduction 1995).

Tax incentives

One way for communities to encourage residents to pursue mitigation measures is to provide them with tax incentives. For example, if a homeowner reduces the chances of damage from a hurricane by installing a mitigation measure, then this taxpayer would get a rebate on state taxes to reflect the lower costs for disaster relief. Alternatively, property taxes could be reduced for the same reason. In practice, communities often create a monetary disincentive to invest in mitigation. A property owner who improves a home by making it safer is likely to have the property reassessed at a higher value and, hence, have to pay higher taxes. California has recognized this problem, and in 1990 voters passed Proposition 127, which exempts seismic rehabilitation improvements to buildings from reassessments that would increase property taxes.

The city of Berkeley has taken an additional step to encourage home buyers to retrofit newly purchased homes by instituting a transfer tax rebate. The city has a 1.5 percent tax levied on property transfer transactions; up to one-third of this amount can be applied to seismic upgrades during the sale of property. Qualifying upgrades include foundation repairs or replacement, wall bracing in basements, shear wall installation, water heater anchoring, and securing of chimneys (Earthquake Engineering Research Institute 1998).

The principal reason for using tax rebates to encourage mitigation is the broader benefit associated with these measures. If a house is not damaged because it is protected in some way, then the general community gains much larger savings than just the reduced damage to the house. For example, residents who would have had to leave their unmitigated homes after a disaster, but who would instead be able to stay there because it was protected, would not have to be fed or housed elsewhere. These added benefits cannot be captured through insurance premium reductions, which normally cover damage only to the property. Taxes are associated with broader units of analysis, such as the community, state, or even federal level. To the extent that the savings in disaster costs accrue to these units of government, tax rebates are most appropriate.

Conclusions and Future Research

Hurricane Katrina has provided additional empirical evidence supporting the natural disaster syndrome. Many victims suffered severe losses from flooding because they had not mitigated their home and did not have flood insurance to

cover the resulting damage. As a result, an unprecedented level of federal disaster assistance has been promised to aid these victims.

Those in harm's way have not protected themselves against natural disasters for many reasons. The principal reason is that many individuals believe that the event will not happen to them. In the case of New Orleans, they may have felt that they were fully protected by flood-control measures such as the levees.[6] This has led to increased development in hazard-prone areas without appropriate land-use regulations and well-enforced building codes, as Burby (2006) has demonstrated. In addition, budget constraints and short time horizons may limit people's interest and ability to invest in hazard mitigation measures and desire to purchase insurance.

If we as a society are to commit ourselves to reducing future losses from natural disasters and limit government assistance after the event, we have to engage the private and public sectors in a creative partnership.

If we as a society are to commit ourselves to reducing future losses from natural disasters and limit government assistance after the event, we have to engage the private and public sectors in a creative partnership. This requires well-enforced building codes and land-use regulations coupled with insurance protection. Economic incentives, making these actions financially palatable to property owners, need to be provided in the form of long-term mitigation loans and subsidies to low-income residents of high-hazard areas. The rationale for taking these measures before the next disaster is to avoid the large-scale disaster relief that will otherwise follow. In addition, if structures are well designed and appropriate land-use regulations are in place, injuries and fatalities will be reduced, as will the need to relocate large numbers of victims. These developments could have enormous psychological and sociological implications.

Cost-benefit analysis can play an important role in determining what types of actions the public sector should engage in to reduce future disaster losses. To undertake these analyses, one needs to incorporate the most accurate risk assessments available and recognize the uncertainties that surround them. For example, one of the issues discussed following Hurricane Katrina is whether to rebuild levees and, if so, to what level of protection. This type of decision cannot be evaluated without considering other measures, such as land-use regulations and building codes, for

reducing the likelihood of another Katrina should the levees be overtopped or fail due to a severe hurricane.

Finally, one may want to rethink the type of disaster insurance that should be provided to those in hazard-prone areas. It may be useful to revisit the possibility of providing protection against all hazards under a homeowners policy rather than continuing with the separate programs that currently exists for floods and earthquakes. I explore this issue in some detail in another paper (Kunreuther 2006) and contend that a comprehensive natural disaster program provides economic incentives for the private and public sectors to work more closely together so that we can reduce the likelihood of another Hurricane Katrina occurring in our lifetimes as well as those of future generations.

Notes

1. A discussion of alternative flood reduction measures can be found in Laska (1991) and Federal Emergency Management Agency (FEMA, 1998).

2. If the resale value of the house were increased due to mitigation, this would be an additional benefit.

3. Note that we are assuming that they will not recoup some of the cost of mitigation should they sell their house.

4. For a discussion of the use of threshold models of choice in protective decisions, see Camerer and Kunreuther (1989).

5. This myopic behavior could also be explained by a high discount rate. See Hausman (1979) and Kempton and Neiman (1987).

6. FEMA clearly thought that the levees would provide this protection. Otherwise, it would have designated the lower 9th Ward as a hazard-prone area, and residents would have been eligible for flood insurance.

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