MAKING AMERICA MORE RESILIENT toward Natural Disasters

A Call for ACTION

by Howard Kunreuther, Erwann Michel-Kerjan, and Mark Pauly

Hurricane Sandy caused an estimated $65 billion in economic losses to residences, business owners, and infrastructure owners. It is the second most costly natural disaster in recent years in the United States, after Hurricane Katrina in 2005, but it is not an outlier; economic and insured losses from devastating natural catastrophes in the United States and worldwide are climbing.

According to Munich Re, real-dollar economic losses from natural catastrophes alone have increased from $528 billion (1981–1990), to $1,197 billion (1991–2000), to $1,23 billion (2001–2010). During the past 10 years, the losses were principally due to hurricanes and resulting storm surge occurring in 2004, 2005, and 2008. Figure 1 depicts the evolution of the direct economic losses and the insured portion from great natural disasters over the period 1980–2012.

Extreme events highlight the challenges in encouraging residents in hazard-prone areas to protect themselves against future disaster losses. A 1974 survey of more than 1,000 California homeowners in earthquake-prone areas revealed that only 12% of the respondents had adopted any protective measures. Fifteen years later, there was little change despite the increased public awareness of the earthquake hazard. In a 1989 survey of 3,500 homeowners in four California counties at risk from earthquakes, only 5 to 9% of the respondents in these areas reported adopting any loss reduction measures. Residents in flood-prone areas have demonstrated a similar reluctance to invest in mitigation measures.
Even after the devastating 2004 and 2005 hurricane seasons, a large number of residents had still not invested in relatively inexpensive loss-reduction measures with respect to their property a year later, nor had they undertaken emergency preparedness measures. A survey of 1,100 adults living along the Atlantic and Gulf coasts undertaken in May 2006 revealed that 83% of the responders had taken no steps to fortify their home, 68% had no hurricane survival kit, and 60% had no family disaster plan.7

A survey of nearly 800 residents in coastal counties during Hurricane Irene in 2011 revealed that less than half of storm-shutter owners in the state of New York actually installed them to protect their windows before the hurricane came. The others did not install them because it would have “taken too long.” This is an interesting example of mitigation measures being purchased but not utilized.8

On the positive side, 89% of respondents to this same survey in North Carolina and 88% in New York indicated undertaking at least one storm preparation activity, such as buying water, food reserves, and batteries. But these are short-term preparation actions that require limited effort. Many fewer households invest in protective measures when preparedness requires considerable foresight, effort, and capital.

Key decision makers who authorize development in hazard-prone areas after dams or levees are built may unintentionally reinforce this behavior. There is compelling evidence that residents who move into these areas feel completely safe, when in fact they are still at risk for catastrophes should the dam or levee be breached or overtopped.9 If a catastrophic disaster occurs, the damage is likely to be considerably greater than would have occurred had the lower but positive flood risk been correctly perceived. This behavior with its resulting consequences has been termed the levee effect. Public officials also exacerbate the problem by not enforcing building codes and implementing permissive zoning. A graphic example highlighting this point is the development of New Orleans following Hurricane Betsy in 1965 after the Corps of Engineers agreed to build massive hurricane protection levees to surround New Orleans and nearby communities. The city planning commission approved new subdivisions between 1967 and 1972 in areas that had been flooded by Betsy.10

Why Are Those at Risk Reluctant to Invest in Loss Reduction Measures?

Consider the following two illustrative scenarios.

**Example 1:** The Anderson family recently moved to a community that is subject to flooding, and has been asked by a local company if they want to invest $1,200 to flood-proof their house so it is less susceptible to water damage. They are told that hydrologists have estimated that the chance of a severe flood affecting their home over the next five years is one-in-twenty (i.e., the annual chance of a severe flood is approximately 1/100) and that, should such a disaster occur, flood-proofing their home will reduce their damage from what it would have been by $40,000. The family is not willing to incur the cost—even though doing so would avoid an expected loss of $2,000 over the next five years. The family is not really worried about the likelihood of flooding, even when offered an opportunity to look at the data.

**Example 2:** The Benson family has lived in the same community in a house identical to the Andersons for many years. They are concerned about the flood problem, and have looked at the data, but feel they are not in a financial position to incur the $1,200 up-front cost of flood-proofing because of budget constraints. They are postponing this decision “until next year” as they have in previous years.
Decision Making Under Risk and Uncertainty

A key challenge in taking steps to reduce losses from natural disasters is to recognize the limitations of public and private decision makers in dealing with risk and uncertainty and then design incentives that help them make more informed and efficient choices.

Many of the biases and simplified decision rules that characterize human judgment and choice under uncertainty reflect automatic, emotional, non-analytic thinking. In this regard, risk is often treated as a feeling rather than as a statistical concept. While intuitive perceptions of risk are relatively accurate over a broad range of situations, they can lead to systematic deviations from expert assessments, especially for unfamiliar risks that involve small probabilities and high degrees of uncertainty but do not trigger natural reactions of dread. The risk associated with natural hazards falls into this category.

Logical assessments of risk, such as probability estimation and Bayesian updating, require considerable time and attention. If the Andersons or Bensons in our examples were to use analytic processes to make better decisions, they would have weighed the up-front investment in flood-proofing their home against the expected discounted benefits over time in the form of reduced losses from future disasters and found the measure to be cost-effective.

Ways of addressing and overcoming this challenge include coupling long-term strategies for managing disasters with short-term incentives, so that those at risk are willing to undertake the required measures now.

Behavioral Factors Impeding Adoption of Mitigation Measures

There is considerable evidence indicating that individuals do not make efficient trade-offs between expected costs and benefits. The simplest explanation as to why individuals fail to invest in adaptation and mitigation measures in the face of transparent risks is affordability.

If the Bensons have no way to borrow at reasonable interest rates, and limited disposable income after purchasing necessities, they might choose not to make these investments.

The Bensons’ decision to avoid making this investment is reinforced by their focusing on the up-front costs of risk reduction measures relative to the delayed benefits of experiencing less damage from floods that might occur in the future. Even before making this trade-off, individuals residing in harm’s way might decide not to undertake mitigation measures if the likelihood of the disaster is below their threshold level of concern. In a laboratory experiment on purchasing insurance, many individuals bid zero for insurance coverage against low-probability events, apparently viewing the probability of a loss as so small that they were not interested in protecting themselves against it. This might explain why the Anderson family did not invest in loss mitigation measures.

The Role of Insurance in Incentivizing Mitigation

Well-designed insurance can play an important role in linking mitigation with financial protection should a disaster occur. People often use good economic sense in buying insurance. They buy property insurance on their homes. They buy collision insurance on their new cars. They buy life insurance if they have dependents. But they have problems with insurance against extreme events, such as floods and earthquakes, because these events are rarely experienced. People tend to ignore them or be unaware of their consequences until it is too late.

Yet insurance—if priced properly—delivers the greatest value precisely in cases of relatively rare events that can cause large losses: high benefits in the form of claim payments in return for relatively low premiums. The insurance premium itself can act as a powerful signal as to the likelihood of a loss in the face of individual attempts to ignore the risk. Insurance also has the potential to encourage investment in loss reduction measures if homeowners can receive premium reductions based on investment in such measures, reflecting expected reduced claims following a disaster.

Guiding Principles for Insurance

For insurance to play these important roles we propose the following three guiding principles.

Principle 1: Premiums reflecting risk. Insurance premiums should reflect risk to signal to individuals how safe or exposed they are, and the extent to which preventive or protective measures will reduce their vulnerability to property losses. Risk-based premiums should also reflect the cost of capital that insurers need to integrate into their pricing to ensure adequate competitive returns to their investors.

Principle 1 provides a clear signal of the expected damage cost to those currently residing in areas subject to natural disasters and those considering moving into these regions. Insurers will also have an economic incentive to reduce premiums to homeowners and businesses that invest in cost-effective loss-reduction measures; those at risk will have an economic incentive to implement those measures.

On the other hand, if insurance is poorly designed and premiums are unrelated to risk or to changes in risk, individuals are likely to underinvest in loss reduction measures. For example, if high-risk premiums are heavily subsidized, this will lead to an underinvestment in mitigation because the premium reduction for undertaking this investment would be smaller than it should be, or even zero.

Insurance commissioners (who regulate the price of premiums for many insurance lines) in several states have constrained premiums in hurricane-prone coastal regions by suppressing the rates private insurers may charge and/or by providing coverage at distorted premiums through state organizations. The most extreme example is in Florida. Through its state-operated insurance company, Citizens Property Insurance...
insurers may discontinue coverage for some policyholders in high-hazard areas following catastrophic losses, particularly if state regulators do not allow them to increase premiums. An advantage of multi-year contracts for insurers is a decrease in their marketing costs, as they do not have to concern themselves with renewal of policies. This also reduces the variance with respect to claims payments, since insurers are now diversifying their risk across time as well as across policyholders.

Multi-year insurance can be implemented only if insurers are permitted to charge prices that reflect long-term risk, and to adjust these premiums over time if risk changes. Today, insurance premiums in many states are restricted to be artificially low in hazard-prone areas, contributing to the non-marketable character of multi-year insurance for protecting homeowners’ properties against losses from large-scale natural disasters. In addition, uncertainty regarding the cost of capital and changes in risk over time deters insurers from extending their contracts beyond a single year.

**Encouraging Investment in Loss Reduction Measures**

The three insurance principles just described should make it financially attractive for those at risk to invest in mitigation measures, particularly if the insurance policy is coupled with a home improvement loan so that the up-front costs of the loss-reduction investment are spread over a few years.

Suppose the Anderson family and the Benson family are required to buy a flood insurance policy as a condition for their mortgages. Assume also that the premiums reflect risk (Principle 1). The policy is a 5-year contract with annual premiums stable over this period (Principle 3). If the flood insurance premiums are now higher than before, lower-wealth homeowners could receive an insurance voucher to offset the unexpected increase (Principle 2). The voucher would not preclude homeowners from receiving a premium discount reflecting the reduced losses from future disasters due to investments they make in loss reduction measures.

Suppose the two families are now each offered a 5-year home improvement loan for flood-proofing their homes at an interest rate of 7.5%. Each family now has to decide whether or not to undertake the measure. Recall that both families were reluctant to invest in mitigation measures for different reasons. The Andersons perceived the risk to be below their threshold level of concern; the Bensons faced budget constraints. If flood insurance were required as a condition for a mortgage, then a home improvement loan could encourage each family to invest in mitigation.

The Anderson and Benson families are told that if they invest in mitigation, their annual premium over the next five years will be lowered due to the reduction in expected annual claims that the insurer pays each family—in this case $400 [i.e., $400,000/100] if each family takes a five-year home improvement loan to cover the $1,200 mitigation cost at an interest rate of 7.5%, the annual loan cost will be $290. Thus, there is a net savings to them of $110 (i.e., $400 minus $290) for each of the next five years. From a financial viewpoint, this package should be attractive to both families. The key innovation would be to market the insurance and the home improvement loan together as a package.

**Reframing the Problem of Risk**

Another way to make people want to invest in protection today is to reframe the probability of risk so that people perceive potential future disasters as above their threshold level of concern.

Research shows that simply adjusting the time frame can have a significant impact on people’s perception of the risk. For example, people are more willing to buckle their seatbelts when they are told they have a one-in-three chance of an accident over a 50-year lifetime of driving, rather than a .00001 chance each trip. Similarly, property owners in a flood-prone area are far more likely to take flood risk seriously if instead of
being told the chance of a flood is 1 in 100 in any given year, they are told that it has a greater than one-in-five chance of happening in the next 25 years.21 Such reframed risk information could be provided by insurers, real estate salespeople, and/or local, state, and federal organizations concerned with reducing losses from disasters to encourage investments in risk reduction measures.

Calling attention to the benefits of investing in mitigation measures by focusing on the reduction in losses from a specific storm such as Sandy or Katrina might attract more interest than a general message framed in terms of reducing damage from future hurricanes. Even before 9/11, controlled experiments revealed that consumers are willing to pay more for insurance against a plane crash caused by terrorists than for flight insurance due to any cause, a counterintuitive finding since by definition “any cause” includes a terrorist attack.22

**Encouraging Resilience Through Other Initiatives**

Insurance can be complemented by several other initiatives that should lead families to better protect themselves. **Well-Enforced Building Codes**

Building codes are a key component in ensuring that those residing in hazard-prone areas adopt cost-effective loss reduction measures. Following Hurricane Andrew in 1992, Florida reevaluated its building code standards, and in 1995, coastal areas of the state began to enforce high-wind design provisions for residential housing. The Florida Building Code 2001 edition, adopted in mid-2002, was accompanied by an extensive education and training program that included a requirement that all licensed engineers, architects, and contractors take a course on the new code.23

Hurricane Charley in 2004 demonstrated the effectiveness of the new statewide building code. One insurance company provided the Institute for Business and Home Safety (IBHS) with data on 5,636 policies in Charlotte County at the time this hurricane made landfall on August 13, 2004. There were 2,102 reported claims from the hurricane (37% of all the homeowners’ insurance policies in Charlotte County for this insurer). Figure 2 reveals that homes that met the wind-resistant standards enforced in 1996 had a claim frequency that was 60% less than those that were built prior to 1996. Moreover, this insurer’s average claim for pre-1996 homes was $24 per square foot, compared to $14 per square foot for those constructed between 1996 and 2004, as shown in Figure 3. For a home of 2,000 square feet, the average damage before and after the new building code was implemented would be $48,000 and $28,000, respectively. In other words, the average reduction in claims from Hurricane Charley to each damaged home in Charlotte County built according to the newer code was approximately $20,000.24

IBHS released a new report in 2012 that provided an analysis of residential building codes in the 18 hurricane-prone coastal states along the Gulf of Mexico and the Atlantic Coast. While Florida scored 98 out of 100, other highly exposed states have a long way to go: Louisiana scored 73, New York 60, Alabama 18, Texas 18, and Mississippi 4.25

**Providing Mitigation Seals of Approval**

Homeowners who adopt cost-effective mitigation measures could receive a seal of approval from a certified inspector that the structure meets or exceeds building code standards. This requirement could be legislated or it could be
imposed by the existing government-sponsored enterprises (GSEs; Fannie Mae, Freddie Mac, and Ginnie Mae) as a condition for obtaining a mortgage. Homeowners might want to seek such a seal of approval if they knew that insurers would provide a premium discount (similar to the discounts that insurers now make available for smoke detectors or burglar alarms), particularly if home improvement loans were available for this purpose.

A seal of approval could increase the property value of the home by informing potential buyers that damage from future disasters is likely to be reduced because the mitigation measure is in place. There are other direct financial benefits from having a seal of approval. Under the Fortified ... for safer living program of the Institute for Business & Home Safety, an independent inspector trained by IBHS verifies that disaster-resistance features have been built into the home that exceed the minimum requirement of building codes and may enable the property owner to receive homeowners’ insurance credits in some states.24

Evidence from a July 1994 telephone survey of 1,241 residents in six hurricane-prone areas on the Atlantic and Gulf Coasts provides support for some type of seal of approval. More than 90% of the respondents felt that local home builders should be required to adhere to building codes, and 85% considered it very important that local building departments conduct inspections of new residential construction.26

The success of such a program requires the support of the building industry and a sufficient number of qualified inspectors to provide accurate information as to whether existing codes and standards are being met or exceeded. Such a certification program can be very useful to insurers, who may choose to provide coverage only to those structures that merit such a certificate and/or set premiums that take into account disaster-resistance features of the property.

Providing Local, State, and Federal Tax Incentives

Communities and cities should design their taxation systems to encourage residents to pursue cost-effective mitigation measures. In practice, communities often create a monetary disincentive to invest in mitigation—those who improve their home by making it safer are likely to have their property reassessed at a higher value based on the amount invested in the improvements and, hence, be required 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, California, 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% 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. These measures have an additional external benefit to neighbors by their not being subject to damage from a collapsing house next door.

South Carolina established in 2007 catastrophe savings accounts that allow residents to set money aside to pay for qualified catastrophe expenses. The amount placed in the account reduces the taxpayer’s South Carolina taxable income and, as a consequence, reduces the state income tax that the homeowner has to pay. A homeowner may deduct contributions to a catastrophe savings account to cover losses to the owner’s legal residence against hurricane, rising floodwaters, or other catastrophic wind-storm event damages.27

South Carolina also offers tax credits for retrofitting, allowing individuals to take state income tax credits for costs incurred to retrofit homes. In order to qualify for the tax credit, costs must not include ordinary repair or replacement of existing items. The homeowner may take tax credits for costs associated with specific fortification measures and the required materials. (For more details on this program see http://www.doi.sc.gov/faqs/CatSavingsAcct.htm.)

Encouraging or Mandating Better Zoning

After major catastrophes, there is often pressure at the local level to permit rebuilding to restore economic activity and tax revenue. In addition, residents have emotional ties to their commu-
Local authorities should consider adopting zoning policies that do not permit rebuilding in damaged areas if the likelihood of another disaster is sufficiently high to merit these measures. If rebuilding is permitted, it should be conditional only upon effective mitigation measures and required purchase of insurance, with premiums reflecting risk and vouchers for those needing financial assistance.

The federal government could encourage state governments to undertake cost-effective mitigation and reconstruction measures by denying or limiting the availability of post-disaster financial assistance to communities that fail to adopt and enforce such zoning policies. This might be difficult in the aftermath of a disaster when media coverage and political pressure for rebuilding damage communities are high, as politicians may focus on short-term rewards. Making such policies explicit by law should help them in resisting such pressure.

**Federal Flood Insurance as a Prototype**

The National Flood Insurance Program (NFIP) was created in 1968 to provide flood insurance to homeowners and small businesses given the absence of private insurance. As of December 2012 it had sold more than 5.5 million policies and provided more than $1.28 trillion in coverage. But it had to borrow a total of nearly $27 billion from the U.S. Treasury to meet its claims obligations in the aftermath of the 2004, 2005, 2008, and 2012 hurricane seasons.

An in-depth analysis of the entire portfolio of the NFIP we undertook recently revealed that the median tenure of flood insurance was between two and four years, while the average length of time in a residence was seven years. As depicted in Table 1, of the 841,000 new policies purchased in 2001, only 73% were still in force one year later. Eight years later, only 20% of them were still in place. Surprisingly, homeowners allow their flood insurance to lapse even when they are required to have flood insurance as a condition for a federally insured mortgage. Some banks and financial institutions have not enforced this regulation for at least two reasons: Few banks have been fined, and/or the mortgages are transferred to financial institutions in non-flood-prone regions of the country that have not focused on either the flood hazard risk or the requirement that homeowners may have to purchase this coverage. Only half of those residing in flood-prone areas have flood insurance.

Introducing multi-year flood insurance tied to the structure rather than to the homeowner would ensure that exposed properties are covered over time. Should the homeowner move to another location, the flood insurance policy would remain with the property. Flood insurance should be required on all residences in flood-prone areas to avoid the need for disaster relief following the next major flood or hurricane. Ideally, the cost of insurance could be included in the property tax bill so that this requirement is enforced.

Premiums would be risk-based to reduce taxpayer subsidies, and fixed for a prespecified time period (e.g., 5 years) based on updated flood maps. Low-income homeowners currently residing in flood-prone areas whose premiums increased would be given a means-tested insurance voucher. Homeowners who invested in mitigation measures would be given a premium discount to reflect the reduction in expected losses from floods, whether or not they had an insurance voucher.

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<th>New flood policies-in-force (000s)</th>
<th>2001</th>
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<td>All</td>
<td>841</td>
<td>876</td>
<td>1,186</td>
<td>986</td>
<td>849</td>
<td>1,299</td>
<td>974</td>
<td>894</td>
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**Table 1. Tenure Results: Duration of New NFIP Policies by Year after First Purchase: 2001–2009.**

<table>
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<tr>
<th>Tenure longer than:</th>
<th>1 year</th>
<th>2 years</th>
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<td>73%</td>
<td>49%</td>
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*Source: Michel-Kerjan et al, 2012*
Residences and commercial establishments that have stronger roofs are likely to experience less damage from hurricanes than poorly-designed structures, as highlighted by research by the Insurance Institute for Business & Home Safety’s Storm Lab in Chester County, South Carolina. A full-scale windstorm test demonstration was conducted during which a pair of 1,300 sq. ft., two-story homes were subjected to severe thunderstorm and straight-line wind conditions, including wind gusts of 90 mph to 100 mph. One test house was built to the IBHS FORTIFIED for safer living® standard, while the other was built to conventional construction standards. The conventionally constructed home collapsed when wind gusts reach 96 mph, while the FORTIFIED home remained standing with little damage.

Home improvement loans would encourage investments in cost-effective mitigation measures. Well-enforced cost-effective building codes and seals of approval would provide an additional rationale for undertaking these loss-reduction measures.

The reform of the National Flood Insurance Program in July 2012 (Biggert–Waters Act) provides a starting point for implementing multi-year insurance programs coupled with the other initiatives described earlier. The legislation authorized by FEMA and the National Academy of Sciences to examine ways of incorporating risk-based premiums (Principle 1) and the feasibility of means-tested insurance vouchers (Principle 2).

FEMA is also developing more accurate flood maps to set risk-based rates. The Biggert–Waters Act authorizes $400 million per year for this purpose over fiscal years 2013–2017. For instance, prior to Hurricane Sandy, FEMA was restudying areas of the New Jersey and New York coastlines in order to update flood insurance rate maps (FIRMs). Because existing FIRMs for these areas were developed more than 25 years ago, and updated FIRMs are not finalized, FEMA determined that it is vital to provide near-term advisory base flood elevations (ABFEs) to support reconstruction efforts. Home and business owners suffering damage from Hurricane Sandy in communities adopting these ABFEs will be required to build higher and safer structures. This also means lower flood insurance premiums due to the reduced risk of water damage from future hurricanes.35

Moving Forward

Additional work is needed to design multi-year alternative risk transfer instruments for protection against catastrophic losses. Studies are also needed to integrate insurance with other policy tools such as well-enforced building codes, zoning regulations, tax incentives, and seals of approval to encourage investment in mitigation measures.

One also needs to take into account the impact that changing climate patterns might have on future damage from flooding due to potential sea level rise and more intense hurricanes. There is evidence that federal agencies and other bodies have underestimated the risks of damage from extreme weather events due to climate change.36 Enforcing building codes for all residences in Florida could reduce by nearly half the expected price of insurance under climate change projections, as they are likely to affect hurricane damage and the risk-based price of insurance in Florida in 2020 and 2040.37

Based on these data, the case for making communities more resilient to natural disasters by investing in loss reduction measures now is an obvious one and in the spirit of the recently released National Research Council report.38 Most of the general public is aware that more severe disasters will occur in the coming years. Policy-makers and other experts concerned with the increasing damage and losses from natural disasters are now addressing the question as to how to make the nation more resilient with respect to natural hazards by taking steps to reduce future losses rather than waiting until a disaster occurs.39 Indeed, the urgent need to build more resilient communities is something many other countries around the world face today.40

The challenge facing the country is how to take advantage of the awareness raised by Hurricane Sandy and the five-year renewal of the NFIP to take positive steps today, rather than regretting our inaction after the next hurricane or flood wreaks havoc. Taking these steps today will reduce how much each of us as taxpayers will be asked to pay for disaster relief in the future.41

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We thank our colleagues Karen Campbell, Jeff Czajkowski, Dena Gromet, and Robert Meyer, as well as the
corporate partners of the Wharton Risk Center Extreme Events Project, for insightful comments. Carol Heller
provided helpful editorial assistance. Support for this research comes from the National Science Foundation (SES-1061882 and SES-1062039), the Center for Risk and Economic Analysis of Terrorism Events (CREATE) at the University of Southern California, CRED at Columbia University, the Travelers Foundation, and the Wharton Risk Management and Decision Processes Center.

NOTES
19. To keep the example simple we are assuming that insurance provides full coverage against future losses. In reality there will be a deductible so that the property owner will pay for some of the losses. We also assume reconstruction costs to be stable over time.
23. More recent building codes were established in 2004, then in 2007. See www.FloridaBuilding.org.
27. Tax incentive programs such as this one should encourage homeowners to take out a larger deductible on their insurance policy and contribute more to the Catastrophe Savings Account. In the process they pay lower insurance premiums and lower taxes at the same time. The insurer benefits by having lower claims following a disaster. If many homeowners take advantage of this program by raising their deductible, the insurer’s catastrophic exposure could be significantly reduced.
28. Under the Stafford Act, the federal government covers 75% of the losses to public infrastructure.
35. More details on FEMA’s Advisory Base Flood Elevations (ABFE) program can be found at http://www.region2coastal.com/faqs/advisory-bfe-faq.