CONGRESS OF THE UNITED STATES
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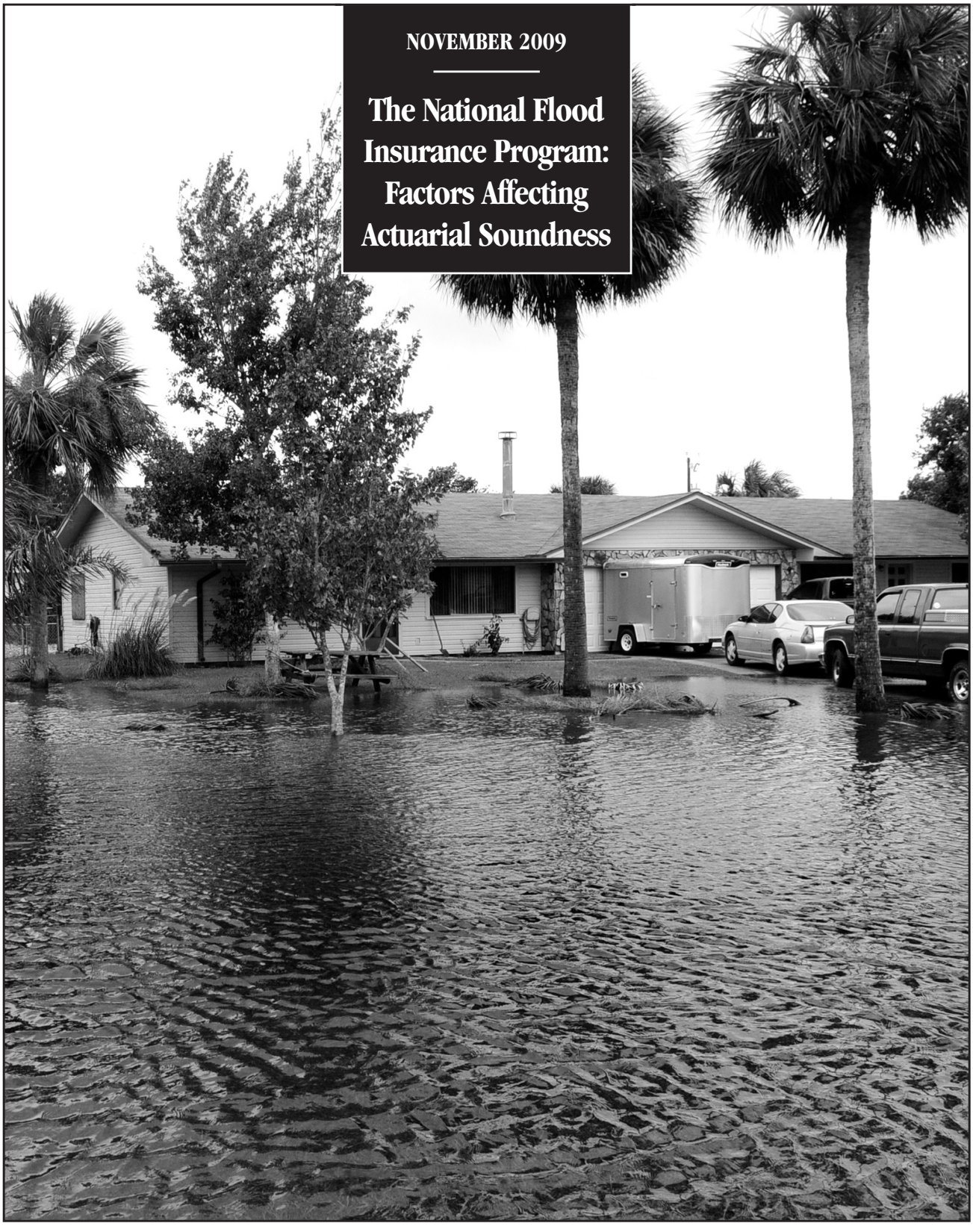
PAPER

NOVEMBER 2009

The National Flood Insurance Program: Factors Affecting Actuarial Soundness



Pub. No. 4008

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Note

The cover photograph shows a home in Bird Island, Florida, threatened by flooding from Tropical Storm Fay in August 2008. (Federal Emergency Management Agency/Barry Bahler)

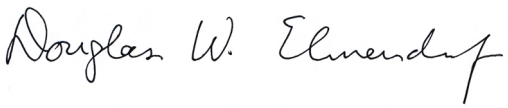
Preface

The vast majority of homes and small commercial buildings that are insured against flood damage in the United States are covered by the National Flood Insurance Program (NFIP), which is administered by the Federal Emergency Management Agency (FEMA) in the Department of Homeland Security. Although the flood insurance program had been largely self-sustaining in the past, it had to borrow about $17 billion from the federal Treasury to pay claims after the catastrophic hurricanes of 2005. That borrowing has highlighted questions about the program's financial health, including the actuarial soundness of the premium rates charged on policies that are not explicitly subsidized and the cost of paying claims for properties that have suffered multiple flood losses.

This Congressional Budget Office (CBO) paper—prepared at the request of the Ranking Member of the Senate Committee on Banking, Housing, and Urban Affairs—explains how FEMA sets "full-risk" (actuarially based) premium rates for the flood insurance program. The paper then discusses various reasons for concern that those rates may not be adequate to cover the total expected costs associated with the program's full-risk policies. The report also addresses other aspects of the NFIP, including the impact of insured properties that have flooded more than once and the U.S. market for flood insurance from private companies. In keeping with CBO's mandate to provide objective, impartial analysis, this report makes no recommendations.

Perry Beider of CBO's Microeconomic Studies Division wrote the paper, under the guidance of Joseph Kile and David Moore, with contributions from Craig Cammarata (formerly of CBO), Robert Shackleton, and David Torregrosa. Thomas Hayes and many other staff members at FEMA provided most of the information and data on which this analysis is based. Bruce Bender of Bender Consulting Services provided helpful information about private companies that offer flood insurance. Kim Cawley, Robert Dennis, Daniel Hoople, Jeffrey Kling, and Allison Percy of CBO offered useful comments on various drafts of the paper, as did Kevin Bingham of Deloitte Consulting, Gerald E. Galloway of the University of Maryland, and Howard C. Kunreuther of the University of Pennsylvania. (The assistance of outside participants implies no responsibility for the final product, which rests solely with CBO.)

Chris Howlett edited the manuscript, and Leah Mazade proofread it. Judith Cromwell prepared early drafts. Maureen Costantino prepared the report for publication and produced the cover. Lenny Skutnik produced the printed copies, Linda Schimmel coordinated the print distribution, and Simone Thomas prepared the electronic version for CBO's Web site (www.cbo.gov).



Douglas W. Elmendorf
Director

November 2009

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The National Flood Insurance Program: Factors Affecting Actuarial Soundness

Introduction and Summary

The main source of insurance against flood damage in the United States is the National Flood Insurance Program (NFIP), administered by the Federal Emergency Management Agency (FEMA). Some 21,000 communities, covering about 98 percent of the U.S. population, participate in the program. Almost all buildings in participating communities are eligible to be insured through the NFIP, except for structures that are built entirely over water or largely below ground. Certain buildings, such as those with a mortgage from a federally regulated lender, must be insured if they are located in areas at high risk of flooding, though compliance with that requirement is incomplete. In all, the NFIP had 5.6 million policies in force as of July 31, 2009, with a total insured value of $1.2 trillion and total annual premiums of $3.1 billion.[1]

The program encompasses three main activities:

- Offering insurance for flood risks—coverage is available in amounts up to $350,000 for residential properties ($250,000 for the structure and $100,000 for the contents) and up to $1 million for nonresidential properties ($500,000 each for the structure and contents);
- Mapping flood hazards—for each participating community, FEMA creates a flood insurance rate map that documents areas at risk of flooding; and
- Setting minimum requirements for building codes and floodplain management practices in participating communities.

Together, those components of the NFIP address the interrelated goals of reducing exposure to flood damage, allowing floodplains to play their natural beneficial roles, making it easier for flood victims to recover when damage occurs, and reducing federal costs (by charging premiums for flood insurance rather than providing disaster aid after a flood at no charge to the recipients).

Most NFIP policies are issued at "full-risk" premium rates that FEMA considers actuarially sound—that is, sufficient on average to cover the total flood claims and administrative costs for those policies based on the agency's maps and its estimates of the frequency of different size floods. However, for more than 1 million policies—about one-fifth of the total—premium rates are explicitly subsidized. Those policies mainly cover older structures in areas at high risk of flooding.

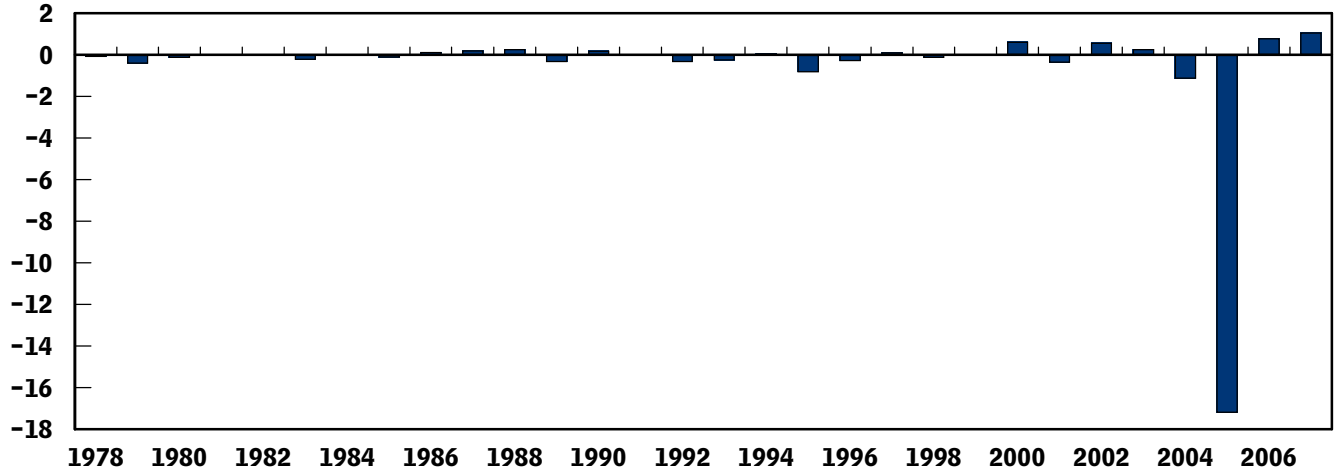
The subsidized policies give the NFIP a built-in actuarial deficit, which the Congressional Budget Office (CBO) currently estimates at about $1.3 billion per year. That actuarial deficit was somewhat obscured for many years by the program's operating results. In 2005, however, the NFIP experienced an unprecedented volume of claims resulting from Hurricanes Katrina, Rita, and Wilma. Total payments on those claims were greater than the total for all of the program's previous years combined and

1. Figures are from Federal Emergency Management Agency, *Community Status Book Report: Nation* (October 14, 2009), available at www.fema.gov/cis/nation.pdf; personal communication from Dan R. Spafford of FEMA, June 19, 2007; and Bureau Net, National Flood Insurance Program, "Policy Statistics Countrywide as of July 31, 2009," available at http://bsa.nfipstat.com/reports/1011.htm.

Figure 1.

The NFIP's Net Profit or Loss on Insurance Operations, 1978 to 2007

(Billions of nominal dollars)



Source: Congressional Budget Office based on Thomas L. Hayes and D. Andrew Neal, *Actuarial Rate Review: In Support of the Recommended May 1, 2009, Rate and Rule Changes* (Federal Emergency Management Agency, National Flood Insurance Program, August 2009), Exhibit B1, available at www.fema.gov/library/viewRecord.do?id=3742.

Notes: NFIP = National Flood Insurance Program.

These data exclude the federal policy fee paid by policyholders and the expenses covered by the fee. The data also exclude about $1.5 billion in payments for principal and interest on the program's debt since 2005.

led the NFIP to borrow about $17 billion from the Treasury, an amount roughly equal to the program's net loss on insurance operations for that year (see Figure 1).

The 2005 loss highlighted a number of factual and policy questions about the NFIP's financial position. This CBO paper addresses two sets of factual questions.

First, does evidence suggest that the program's full-risk premium rates are actuarially sound, or does it suggest that those rates implicitly carry hidden subsidies from taxpayers?

Historically, the NFIP's full-risk premiums have been too low to cover the flood claims and administrative costs of the policies insured at those rates. Even before the 2005 hurricanes, the program's total claims and expenses on full-risk policies since 1978 exceeded its total premium income from those policies by about 5 percent. Taking into account the large 2005 losses, cumulative costs on those policies are almost twice the size of total income from the policies. That experience does not directly imply that current premium rates are too low, however, because rates have risen over time and because the frequency of future catastrophic years like 2005 is highly uncertain. In part because of that uncertainty, CBO does not have enough information about the current distribution of flood risks to calculate whether the present full-risk premiums are actuarially adequate.

Analyzing the methods that FEMA uses to set the full-risk rates does not yield definitive answers either. Some aspects of those methods tend to contribute to an actuarial surplus—the primary one being the additional 10 percent that FEMA includes in the rates in high-risk areas (20 percent in some high-risk coastal areas) as a safety margin for uncertainty. Other aspects of the agency's rate-setting methods tend to contribute to an actuarial deficit. FEMA is not reviewing its flood maps every five years as required by law, and some older maps do not reflect significant changes in local conditions that tend to increase the risk of flooding, such as coastal erosion, increases in sea level, land development, and reductions in the capacity of river channels. In addition, evidence suggests that climate change has increased the risk of flooding from rivers and perhaps also from coastal storms, making FEMA's models of flood frequencies out of date. Those issues may warrant attention regardless of the overall adequacy of the program's full-risk rates.

Second, to what extent are the NFIP's losses attributable to properties that have experienced multiple floods? How is FEMA responding to the risks posed by such properties?

Currently insured repetitive-loss properties (RLPs)—defined by FEMA as properties that have been the subject of two or more flood-claims payments greater than $1,000 apiece in any 10-year period—account for 2 percent of current policies and 3 percent of current premiums but about 12 percent of total claims since 1978. More than half of the roughly 71,000 RLPs that are now insured have had only two losses leading to such payments, and their experience may reflect random chance rather than truly above-average risks. However, about 23,000 RLPs nationwide have been the subject of at least four claims payments while insured, and 10,000 of those properties have prompted six or more payments.

FEMA's approach to reducing the cost of repetitive-loss properties focuses more on taking steps to mitigate the worst flood risks—such as elevating, relocating, flood-proofing, or demolishing properties—than on charging higher premiums for flood insurance. Indeed, more than half of the policies covering RLPs in high-risk areas have rates that are explicitly subsidized. Policies covering RLPs in low- to moderate-risk areas do have higher average premiums than non-RLPs in those areas (because they are ineligible for the lower-priced "preferred-risk policy" rates that FEMA charges on most policies in those areas). Even those higher average rates, however, are not based directly on the claims experience of individual properties or of repetitive-loss properties as a whole.

Actuarially Sound Versus Subsidized Premium Rates

When lawmakers created the NFIP, they faced a trade-off in deciding whether the premiums charged for flood insurance should be actuarially sound—that is, high enough to cover the full expected value (the average of all possible outcomes, weighted by their probabilities) of flood claims and administrative expenses for the insured properties—or subsidized. Premiums that were actuarially sound would be unattractively high for many properties that were built before the extent of their flood risk was documented, especially for properties that face repeated flooding. High premiums for such properties might discourage communities from joining the NFIP. Conversely, subsidized premiums would produce a cumulative deficit for the NFIP, meaning that the program would not be self-sustaining. Lower premiums could encourage more property owners to buy flood insurance and thus help reduce federal spending on disaster aid after floods. But total federal costs related to floods could increase if the NFIP's cumulative deficit exceeded the savings on disaster aid. (For more information about other federal programs related to flood prevention or recovery, see Box 1.)

Subsidies in the NFIP

The decision that lawmakers incorporated into the NFIP's founding legislation, the National Flood Insurance Act of 1968, was to subsidize the premiums charged for policies covering certain structures in high-risk flood areas. (Subsidized rates also apply to policies covering only the contents of those structures.) Program designers expected that the subsidized structures would be replaced over time as they became damaged or aged past their useful life. The proportion of policies that are subsidized has indeed gradually declined, but it is still about one-fifth.[2] More than 90 percent of those policies are for structures that were built before their community's flood insurance rate map (FIRM) was created or before 1975, whichever is later.[3] Such properties remain eligible for the so-called pre-FIRM subsidy if they are bought or sold, but they lose that eligibility if they experience flood damage worth at least 50 percent of their value or if improvements are made that increase their value by 50 percent or more.

2. Thomas L. Hayes and Dan R. Spafford, *Actuarial Rate Review: In Support of the May 1, 2008, Rate and Rule Changes* (Federal Emergency Management Agency, National Flood Insurance Program, August 2008), p. 34, available at www.fema.gov/library/viewRecord.do?id=3430.

3. About 8 percent of subsidized policies cover properties in four other categories: properties in communities for which flood maps have not yet been completed; properties subject to coastal flooding that were built between 1975 and 1981, when FEMA incorporated new information about wave heights and revised its new-construction standards; properties that will have flood protection when a structural project such as a levee is completed, provided that the project is currently at least 50 percent complete; and properties in areas that are protected by flood-control structures that FEMA now deems insufficient, provided that there is a repair or upgrade plan in place that meets specific standards.

Box 1.

Other Flood-Related Federal Programs

The National Flood Insurance Program (NFIP) is one of many federal programs, both within and outside the Federal Emergency Management Agency (FEMA), that focus on preventing floods or helping people recover from flood damage. FEMA administers several grant programs that offer funding to state, local, and tribal governments for planning and carrying out flood-mitigation projects.[1]

Two of the FEMA programs apply to all types of natural disasters:

- The Hazard Mitigation Grant Program provides funding to states that have experienced an event that the President has officially declared a major disaster. The amount of funding is determined as a percentage of the total sum allocated for public and individual assistance after the disaster.
- The Pre-Disaster Mitigation Program awards funds primarily on the basis of a nationwide competition for proposed projects and planning activities.

Three other FEMA programs focus specifically on mitigating flood risks:

- The Flood Mitigation Assistance Program allocates funding to states on the basis of how many NFIP policies and repetitive-loss properties they have.
- The Repetitive Flood Claims Grant Program focuses on states and communities that do not participate in the Flood Mitigation Assistance Program because they lack the required matching funds or the capacity to manage the activities.
- The Severe Repetitive Loss Program allocates funds mainly on the basis of the number of severe repetitive-loss properties in each state.[2]

1. For an overview, see Federal Emergency Management Agency, *Mitigation Grant Programs Fact Sheet* (April 2009), available at www.fema.gov/library/viewRecord.do?id=2065, and *FY 2010 Hazard Mitigation Assistance Unified Guidance* (June 2009), available at www.fema.gov/library/viewRecord.do?id=3649. The effectiveness of projects funded by FEMA to mitigate risks from floods, earthquakes, or windstorms (including hurricanes) is discussed in Congressional Budget Office, *Potential Cost Savings from the Pre-Disaster Mitigation Program* (September 2007).

2. Repetitive-loss properties (RLPs) are ones that have been the subject of at least two flood-claims payments exceeding $1,000 apiece in any 10-year period. The Severe Repetitive Loss Program focuses on the subset of RLPs that are residential properties and have prompted at least four claims payments of more than $5,000 each, or two or more payments that together exceed the property's value, with at least two of the payments occurring within 10 years of each other.

Continued

Box 1. **Continued**

Other Flood-Related Federal Programs

FEMA also provides recovery aid to public and private entities affected by Presidentially declared disasters. Funds for individuals—which are currently capped at $30,300 per household (an amount that is adjusted annually for inflation)—may be used for things such as temporary housing, home repair, moving and storage costs, and medical expenses. However, most federal disaster assistance to individuals and businesses takes the form of low-interest loans from the Small Business Administration (SBA). The loans are available in the event of a disaster declaration by the President or the SBA. The availability of both FEMA grants and SBA loans depends on Congressional appropriations.

From the point of view of flood victims, NFIP coverage has three advantages over federal disaster aid. It is available in larger amounts than the individual assistance from FEMA; it covers events that are not the subject of a disaster declaration; and unlike SBA loans, flood-claims payments do not have to be repaid. However, NFIP coverage requires premium payments, and benefits are limited by the terms of the insurance policy.

Flood insurance and disaster assistance both serve the basic purpose of helping flood victims recover. Thus, the two approaches substitute for each other to some extent—indeed, one of the rationales for the NFIP is that it helps reduce the demand for disaster assistance. Conversely, the expectation that aid will be provided in the event of a flood (whether by the government or by other entities, such as the Red Cross) may decrease the demand for NFIP coverage. That effect is an example of the broader problem that disaster assistance lessens the economic incentives to reduce one's exposure to disaster losses—in other words, it subsidizes risky behavior. Various features of the NFIP attempt to limit the adverse effects of that subsidy: Participating communities must meet the program's minimum requirements for floodplain management and building codes, and the owner of a property in a high-risk flood zone who receives federal disaster aid after a flood must buy and maintain NFIP coverage to remain eligible for assistance after a future flood.

Besides FEMA and the SBA, other federal agencies involved in flood prevention or recovery include the Army Corps of Engineers, which builds levees and other flood-control structures, and the Department of Agriculture, whose Federal Crop Insurance Program covers farmers against losses from floods, pest infestations, droughts, and other natural disasters.

On average, the premiums charged for subsidized policies are about 35 percent to 40 percent of their full-risk level, FEMA estimates.[4] The actuarial shortfall that results from those subsidies (currently about $1.3 billion a year) has drawn greater scrutiny following the program's unprecedented losses in 2005. Previously, the NFIP had been able to cover its costs, borrowing relatively small amounts from the Treasury on a few occasions to pay claims and then quickly repaying the loans with interest. But the $17 billion it borrowed from the Treasury in response to the surge in claims from the 2005 hurricanes is more than five times the program's annual income from premiums. The NFIP can pay interest or even repay principal on that debt when it experiences a year with low claims; indeed, it has made $2.9 billion in interest and principal payments since 2005. Nonetheless, it is very unlikely to be able to retire the debt without substantially raising premiums. The debt grew to $19 billion by the end of fiscal year 2009, and given the actuarial deficit built into the NFIP, that figure can be expected to continue growing over the long term. Even if the program managed to generate large surpluses during an extensive run of low-claims years, using those surpluses to retire the debt instead of accumulating them as reserves would make it more likely that the program would have to borrow again in the future.

Subsidized rates for flood insurance have implications not only for the federal budget but also for the expected amount of flood losses. The program's explicit subsidies lower the cost of living in high-risk properties. Moreover, they undermine the incentives for policyholders to carry out mitigation measures—such as flood-proofing or elevating properties—because the subsidized rates are not affected by such measures.[5] The explicit subsidies do not encourage development in risky areas because they are not available for new construction. However, any implicit (that is, unacknowledged) subsidies that may exist in the full-risk rates if FEMA underestimates the actual risk of flooding may lead to excessive development in risky areas. (The same may be true for the expectation that disaster assistance will be available after a major flood; see Box 1.)

Besides explicit and possibly implicit subsidies from taxpayers, a third type of subsidy in the NFIP is the "cross-subsidy" to some policyholders from others who are charged premiums above their full-risk rates (see Appendix B). If cross-subsidies completely balance out, they do not create financial risk for taxpayers. But like the other types of subsidies, cross-subsidies distort the perceived riskiness of the properties involved. Moreover, the rates that are raised to provide cross-subsidies may discourage some potential policyholders from buying coverage.

The Meaning of "Actuarial Soundness"

Actuarial soundness and actuarial adequacy are common concepts in the insurance industry, but their specific definition can vary depending on the context. In this report, both terms refer to the ability of premiums to cover the expected value of flood claims and administrative costs, and the NFIP is considered subsidized by taxpayers to the extent that premiums fall short of that amount. Those definitions do not account for any economic value associated with the risk that is transferred from policyholders to taxpayers, but they are consistent with the current cash-based treatment of the NFIP in the federal budget.[6]

4. Hayes and Spafford, *Actuarial Rate Review,* p. 4. That estimate assumes that if full-risk premiums were charged for those policies, they would include proportionately higher allowances paid to the private insurance companies that sell and service almost all NFIP policies under FEMA's Write Your Own (WYO) program. (Of the $3.1 billion in total premiums for policies in force as of July 31, 2009, about $0.9 billion went to WYO companies.) However, FEMA and the companies might agree not to increase the WYO allowances proportionately because there would be no proportional increase in actual sales expenses. In that case, premiums for subsidized policies would not have to rise as much to reach the full-risk level. Under the polar opposite assumption that the total allowance would remain constant, current subsidized premiums would be about 55 percent to 60 percent of their full-risk level, on average, rather than 35 percent to 40 percent. Regardless of the assumption about the allowances, the effect of subsidized rates on the funds available to the NFIP to pay claims—and hence on the program's actuarial balance—is the same.

5. Even when premium rates are actuarially sound and incentives are undiminished, policyholders may fail to take cost-effective mitigation measures because they perceive the risk of flooding as too small or too distant in time, or they consider the measures unaffordable. For example, see Howard C. Kunreuther and others, *At War with the Weather: Managing Large-Scale Risks in a New Era of Catastrophes* (Cambridge, Mass.: MIT Press, 2009), pp. 256–261.

6. The federal budget displays the operations of insurance programs on a cash basis. Federal loan programs, by contrast, are presented on a credit reform basis. Under credit reform, the costs of a loan program (excluding administrative costs) are measured by the discounted present value of any subsidies in the loans' interest rates and the expected defaults. For federal insurance programs, no explicit estimate of the annual subsidy from taxpayers—even on the flood insurance policies that are explicitly priced below the full-risk level—appears in the federal budget.

The definition of actuarial soundness used here has three noteworthy implications:

- The NFIP must cover not only costs directly related to insurance policies and claims but also costs for flood insurance studies, floodplain management, and administrative personnel. The Omnibus Budget Reconciliation Act of 1990 directed FEMA to charge policyholders a fee to cover those and other implementation costs of the program.[7] Currently, that fee is $35 per year for most policyholders and yields about $140 million annually.[8] The rule that policyholders be charged for implementation costs has one current exception: The Map Modernization program, a multiyear effort to convert FEMA's flood maps to digital form, is funded mainly from separate appropriations. This CBO paper focuses on FEMA's methods for estimating the costs of claims; it does not explore the accuracy of FEMA's estimates for other administrative or program costs.

- Proposals to increase the amounts or types of coverage available under the NFIP (for example, by raising policy limits or offering coverage for wind damage) and pricing the additional coverage to recover its full costs would not improve the program's actuarial soundness as defined here. Successfully implementing such proposals would reduce the program's actuarial deficit as a percentage of its premium income—a factor that would be relevant to a private insurer because it could reduce the risk of bankruptcy. But doing so would not directly decrease the NFIP's actuarial deficit as measured in dollars.[9] That deficit can be decreased in only two ways: by reducing the extent to which some coverage is sold at premiums below the full-risk level or by increasing the extent to which some coverage is sold at premiums above the full-risk level (that is, by increasing cross-subsidies from some policyholders to others).

- Rates that were actuarially sound as defined here would not be high enough, in general, to allow private insurers to compete with the NFIP. Unlike the NFIP's rates, actuarially sound premiums in the private sector need to reflect the cost of capital—that is, to compensate investors for the use of their funds and the risk they are accepting. Nonetheless, some flood insurance in the United States is provided by private insurers, generally in ways that complement rather than substitute for coverage offered under the NFIP (see Box 2).

An Overview of the NFIP's Full-Risk Rates

In setting full-risk (or actuarially based) premium rates for flood insurance, FEMA groups together properties in geographic zones based on the risk of flooding. For each zone, the agency estimates the expected annual flood losses on an insured property as a percentage of the property's value, using data (where available) on floodwater flows, water heights, and damage from water at that height and taking into account estimated probabilities of very large floods that have not yet occurred. FEMA then determines premiums on the basis of those expected losses, after adjusting for deductibles and other factors. Between 1978 and 2004, the total amount of premiums that the NFIP collected on full-risk policies roughly equaled the total amount of claims it paid. But claims from hurricanes in 2005 have left the program with a large debt.

Geographic Zones

The methods that FEMA uses to calculate full-risk rates vary by zones—areas shown on the agency's flood insurance rate maps that are defined by the degree or type of flood risk and the amount of information available.

7. 42 U.S.C. 4014, 104 Stat. 1388-24.

8. Hayes and Spafford, *Actuarial Rate Review*, pp. 15–16. The federal policy fee is $13 for policies written at preferred-risk rates in low- and moderate-risk areas. For condominium policies, the fee depends on the number of units in the building. The fee is not considered part of the premium for the purpose of calculating the allowance paid to Write Your Own companies.

9. Expanding the types of coverage sold by the NFIP could have other benefits, however. To the extent that the new types of coverage were not already provided by private insurers, they could help alert property owners to the risks they face and reduce federal spending for disaster assistance. Adding coverage for wind damage, which is part of standard homeowner's insurance, could potentially reduce claims-adjustment costs and possibly improve the NFIP's actuarial balance (if allegations that claims adjusters report some wind damage as flood damage are true). However, adding wind coverage would entail significant administrative costs. And setting actuarially sound premiums could be difficult, particularly if the policyholders who shifted from private or state wind coverage to federal coverage were disproportionately those whose properties were at higher risk.

Box 2.

Flood Insurance from Private Companies

Private firms provide relatively little flood insurance in the United States, and information about private flood insurance is spotty. What is known, however, is that private companies rarely compete directly with the National Flood Insurance Program (NFIP). Most private policies address special needs that the NFIP does not serve as well or at all.

One market for private flood insurance consists of property owners who need coverage above the amounts available in the NFIP (a maximum of $250,000 for a residential structure, $100,000 for its contents, and $500,000 each for a nonresidential structure and its contents). For example, private insurers dominate the market for flood coverage on large commercial properties (excluding those that are self-insured). Data on that coverage are not readily available, in part because such insurance is typically provided as part of some broader coverage—either overall commercial insurance, often using the NFIP limits as the deductible, or "difference in conditions" coverage that insures against losses from a variety of disasters. For residential properties, a 2008 survey by an industry consulting firm indicates that in that year, 13 private sources offered "excess-layer" policies to insure residential properties against flood damage above the amount covered by a primary policy (whether from the NFIP or elsewhere). Those private sources consisted of seven companies that issue the policies they sell and six brokerage firms that represent other companies, mostly Lloyd's of London.[1]

Primary flood coverage for residential properties was available from three companies and three brokerages, according to the 2008 survey. The companies selling their own flood policies focused on clients with high net worth for whom they were already writing homeowner's insurance; such coverage was offered only for homes in areas at low-to-moderate risk of flooding. Some of the policies sold by brokers were for properties on coastal barrier islands where NFIP insurance is prohibited under the Coastal Barrier Resource Act or in communities that did not participate in the NFIP. Other policies were sold in conjunction with excess-layer coverage on high-value homes.

1. Bruce A. Bender, "Alternatives to the NFIP" (unpublished table, Bender Consulting Services, May 2008). Homeowners typically have fewer than 13 private companies to choose from, however, and some have none at all. Some of the companies do not offer flood coverage in all states, and most of them are selective about the properties they insure, rejecting those that face the highest risks.

Continued

The labels used on the FIRMs have changed over time. Today, the major categories are A zones, V zones, and Zone X:

- A zones include all 100-year floodplains—that is, areas where the risk of flooding is thought to be at least 1 percent annually—with the exception of areas designated as V zones.
- V (for "velocity wave action") zones are coastal areas in 100-year floodplains where waves add at least three feet to the water level that would be reached during a 100-year flood in the absence of wave action.[10]
- Zone X includes essentially all areas outside 100-year floodplains. (The exceptions are areas where no analysis of flood hazards has been conducted. Such areas, which are labeled Zone D, are rare and account for very few properties insured by the NFIP.)

FEMA divides the A and V zones into a variety of subcategories, which are described in Appendix A.

Properties covered by the NFIP are concentrated in coastal areas. In a sample of 20,000 properties that

10. The definition of V zones reflects the fact that "a three-foot wave generally carries enough energy to break a wall panel away from a floor to which it has been nailed"; see Federal Emergency Management Agency, *Managing Floodplain Development Through the National Flood Insurance Program* (undated), p. 3-25, available at www.fema.gov/library/viewRecord.do?id=2108.

Box 2. Continued

Flood Insurance from Private Companies

The best-studied segment of the U.S. market for private flood insurance is the market for policies that mortgage lenders buy on behalf of homeowners who are required to carry flood insurance but have not purchased it themselves. That requirement applies to any property in a 100-year floodplain that carries a mortgage from a federally regulated lender or a mortgage that is insured or purchased by Fannie Mae, Freddie Mac, or another government-sponsored enterprise or federal agency. Although lenders can choose to purchase such coverage from the NFIP, they rarely do so, according to a report by the RAND Corporation. Instead, they typically buy private insurance policies that have certain features tailored to meet the lenders' needs: For example, policies purchased from private insurers take effect on the date the lender sends a letter to a homeowner noting the requirement for flood insurance coverage.[2] Using data from various sources for different periods from mid-2004 to early 2006, the RAND study estimated that private insurers had roughly 130,000 to 190,000 lender-placed residential policies in effect at any one time, compared with the NFIP's 5 million or so residential policies. The number of lender-placed residential policies written during a year may be much higher than the above range, however, because few of those policies remain in effect for a full year. Property owners, to whom the costs of the policies are passed on, typically replace them with less expensive coverage from the NFIP.[3]

The fact that the market for private flood insurance is small does not indicate that the NFIP's full-risk premium rates are too low to cover the flood risks and associated administrative costs. Private insurers must set their rates high enough to cover their cost of capital (including reserves for losses incurred but not yet reported), and that cost would be influenced by the high variability of flood losses. Thus, the NFIP's rates could be actuarially sound as the term is used here and still be too low for private insurers to compete with them.

2. A lender can also buy an automatic coverage endorsement that allows the insurance to take effect even earlier—for example, on the date the lender refers the property to a tracking firm for verification of its flood insurance status; Lloyd Dixon and others, *The Lender-Placed Flood Insurance Market for Residential Properties* (Santa Monica, Calif.: RAND Corporation, 2007), pp. 25–28.

3. Ibid., pp. xiv, xv, 31.

FEMA analyzed for CBO (including those insured at both subsidized and actuarially based rates), about 40 percent were in zip codes containing at least one V-zone property. However, only 1 percent were in the V zones; the rest were far enough from the shore not to be susceptible to damage from three-foot waves during a 100-year flood.[11] Thus, the A zones and Zone X contain nearly all of the properties insured at full-risk rates (the A zones currently account for half of full-risk policies, and Zone X accounts for just under half). Even if coastal properties lie outside the V zones, they may face higher flood risks, on average, than their inland counterparts, for reasons discussed below.

11. Congressional Budget Office, *Value of Properties in the National Flood Insurance Program* (June 2007), p. 4.

Estimating Expected Losses

Expected losses for properties in 100-year floodplains (A and V zones) are generally calculated using three types of information:

- Local data on the frequency of floodwater flows of different sizes;
- Representative topographic profiles to convert floodwater flows to water heights (which are greater, for any given volume of water, in a narrow valley than on a broad plain); and
- Damage functions that specify the percentage damage a given depth of flooding does to a particular type of structure. (The functions differ by zone type because

properties in V zones are subject to wave action and damage to piers and pilings below the lowest floor.)

Analyzing local data on floodwater flows is complicated by the relatively short historical records of floods that exist in some inland areas. FEMA has concluded that when its analytic methods use data with short records, it underestimates flood risks. All else being equal, that factor tends to make the mapped boundaries of 100-year floodplains too small and to understate the risks within the mapped floodplains. To compensate for the latter bias, FEMA includes an adjustment in calculating the A-zone rates. However, the adjustment factors have not changed since the 1980s, although additional data have been collected and maps have been updated, and they are now likely to be incorrect. (For details about FEMA's correction for short historical records, see Appendix A.)

FEMA uses the three types of information listed above to produce tables for properties in A and V zones that show expected percentage losses as a function of a structure's type and of its elevation relative to the 100-year flood (known as its base flood elevation). The tables may be revised annually as FEMA updates the damage functions to reflect its most recent experience with claims.

For properties outside 100-year floodplains (in Zone X), two different sets of full-risk premium rates are used. Roughly one-fourth of the structures insured at Zone X rates are covered under so-called standard rates and three-fourths under the rates for preferred-risk policies. Preferred rates are available for a property in Zone X that is not grandfathered (see below) and whose past and present owners have received no more than two payments of NFIP claims or federal disaster aid—and no more than one payment exceeding $1,000—for floods that damaged the property. Specific combinations of structure and contents coverage and specified amounts of contents-only coverage are available, and the premiums are determined by the professional judgment of FEMA's actuaries on the basis of claims experience.

For the Zone X properties insured at standard rates, FEMA uses estimates of expected annual losses to determine premiums, as it does for properties in the A and V zones. However, the agency has no set of estimated probabilities of floods of all sizes for Zone X to use in estimating expected annual losses. Instead, it extrapolates the expected losses for properties insured at standard rates from the average losses observed to date on those properties by assuming that the ratio of expected to observed losses is the same as in the main A zone. FEMA's analysts make that calculation with and without the losses from 2005 and use their professional judgment to combine the two results. (The agency has commissioned a study to provide recommendations on the appropriate treatment of the 2005 experience.)

Roughly 20 percent to 25 percent of Zone X standard policies cover properties that are actually located in an A or V zone—that is, within a 100-year floodplain. Those properties were grandfathered at the Zone X standard rate by FEMA after they were remapped from Zone X into a high-risk zone. The agency allows such grandfathering partly to hasten the incorporation of new information into communities' floodplain management efforts by reducing property owners' opposition to the revised flood maps. To the extent that flood losses on the grandfathered properties are higher than those on "true" Zone X properties paying the standard rate, the grandfathered properties are cross-subsidized by the other standard ratepayers, because the higher losses on the grandfathered properties contribute to the observed damages on which FEMA bases its standard rates. Such grandfathering may not undermine the actuarial soundness of the NFIP as a whole. But the burden of funding the cross-subsidy may discourage owners of some Zone X properties that are ineligible for preferred-risk rates from buying or maintaining coverage. (That effect grows larger as the percentage of grandfathered properties increases.)

Translating Expected Losses into Premium Rates

Once it has estimated the expected losses for properties of various types and elevations in each flood zone, FEMA converts those estimates into premium rates by using certain adjustment factors. Four of its general adjustments are noteworthy:

- All premiums in 100-year floodplains are increased by a contingency-loading factor of 10 percent in the A zones and 20 percent in the V zones. Contingency loads are commonly used in the insurance industry to provide a safety margin for uncertainty—such as the uncertainty about the assumed frequencies of catastrophic floods.[12] FEMA's current contingency loads

12. The premium income attributable to contingency loads is not directed to any separate reserve fund for catastrophic events. It simply increases the funds available to pay claims and expenses.

were increased from 5 percent in the A zones and 10 percent in the V zones; they remain under review.

- The Community Rating System (CRS) gives discounts to policyholders in communities that take additional steps to reduce flood hazards. In implementing that system, FEMA scales up its base (undiscounted) rates by a factor calculated to offset the discounts and thus keep the CRS program as a whole revenue neutral.[13] Tailoring the rates more specifically to a community's level of risk should help reduce cross-subsidies among communities. Even if the CRS creates new cross-subsidies because some of the discounts overstate the effectiveness of the credited activities, it probably has little effect on the overall actuarial soundness of the flood insurance program.[14]

- As needed, FEMA reduces the rates it would otherwise charge to avoid annual increases of more than 10 percent. The 10 percent cap is specified in law, and FEMA staff interpret it to mean that the premiums for a given combination of flood zone and structure type should not rise by more than that amount. FEMA also interprets the cap as indicating that annual increases in specific rates—such as the rate for single-family residences in the main V zone that lie one foot above the base flood elevation and are insured to 60 percent of their value—should not exceed 10 percent by more than a few percentage points.

- As necessary, FEMA also raises the rates it would otherwise charge to ensure that it covers its estimated fixed costs on each policy. For instance, the agency's published rates for coverage of a single-family residence do not go below 24 cents per $100 for the basic layer of coverage (up to $50,000) or below 8 cents per $100 for coverage above that layer.

Other adjustment factors that FEMA uses in converting estimated losses into premium rates—such as for deductibles, loss-adjustment expenses, and underinsurance—reflect standard practices in the insurance industry.[15] (More specifics about FEMA's rate-setting methods are provided in Appendix A.)

In most recent years, FEMA has made an additional adjustment in the rates for full-risk properties in coastal zones, scaling up the rates determined by the above methods as much as possible within the constraints of the 10 percent cap.[16] Those increases are FEMA's response to a combination of two factors: coastal erosion and the cap itself. As discussed in more detail below, erosion increases flood depths in coastal areas relative to the depths shown on flood maps. Thus, policies on structures in an area subject to coastal erosion tend to become increasingly underpriced as time passes since the last remapping. Moreover, because development tends to be denser the farther one goes from the shoreline, the number of properties affected by such underpricing increases over time as erosion continues to claim the less developed shore land.

FEMA staff expect the erosion problem to grow to the point where the premiums charged in V zones would have to rise much more than 10 percent per year to keep pace. Because the cap will preclude such increases if it remains in force, FEMA is raising current rates above the levels it believes are necessary to cover today's risks in order to prefund future risks and allow for higher rates in the future.

13. The discounts range from 5 percent to 45 percent and are determined according to a system of points awarded for various types of risk-reduction activities. FEMA estimated that in 2006, CRS communities accounted for two-thirds of NFIP policyholders, and their average discount was 13 percent. Those figures imply that the base rate from which discounts are taken was scaled up by about 9.5 percent.

14. If anything, the CRS program may have a small positive impact: If it induces communities to reduce their exposure to flood hazards in ways beyond those captured in FEMA's rate-setting models, claims payments by the NFIP could decline without a corresponding decrease in premium income.

15. A structure is underinsured if it is insured for less than its full value. All else being equal, $100,000 of coverage on a $200,000 structure costs FEMA more in claims payments than does $100,000 of coverage on a $100,000 structure. The reason is that the same event generally causes similar proportions of damage to both structures, and hence, the dollar costs will be higher for the more costly structure. In the NFIP, underinsurance can affect the value of a flood claim. Damage to a single-family dwelling that is a principal residence and is insured for at least 80 percent of its full replacement cost (or to the maximum amount available under the NFIP) is valued on the basis of replacement cost. Damage to a structure that does not meet those criteria is valued on the basis of replacement cost minus physical depreciation at the time of the loss.

16. FEMA applies the same scaling factor to all full-risk V-zone rates. Therefore, it holds the average increase below 10 percent if necessary to avoid increases in specific rates that it considers too far above 10 percent.

Table 1.

The NFIP's Experience with Full-Risk Policies, by Risk Zone

(Billions of dollars)

	A Zones	V Zones	Zone X	Total
		1978–2006 (Full period of data)		
Number of Policy-Years	28,710,924	442,585	24,834,155	53,987,664
Number of Claims	225,072	7,225	263,574	495,871
Gross Premiums	6.5	0.5	5.6	12.6
Gross Claims and Expenses	13.8	0.5	9.9	24.2
Net Profit	-7.3	*	-4.3	-11.6
Net Adjusted Profit[a]	-6.9	0.2	-5.6	-12.3
		1978–2004 (Omitting catastrophic losses of 2005)		
Number of Policy-Years	24,565,935	362,880	21,727,759	46,656,574
Number of Claims	138,736	5,149	215,547	359,432
Gross Premiums	5.2	0.3	4.6	10.2
Gross Claims and Expenses	4.8	0.3	5.6	10.7
Net Profit	0.4	*	-0.9	-0.5
Net Adjusted Profit[a]	1.3	0.2	-2.1	-0.5

Source: Congressional Budget Office based on data from the Federal Emergency Management Agency.

Notes: NFIP = National Flood Insurance Program; * = between -$50 million and $50 million.

V zones are coastal areas subject to waves of three feet or more during a 100-year flood; A zones consist of all other coastal or inland areas within 100-year floodplains; and Zone X comprises areas outside 100-year floodplains.

a. Net adjusted profit is the cumulative profit from past years adjusted for inflation and for changes in the number of policies and the mix of policies by zone, but not for changes in premium rates (other than inflation). Net adjusted profit represents the cumulative profit or loss in real dollars that the NFIP would have experienced if it had insured the current number and mix of policies each year at historical premium rates (adjusted for inflation). Adjusted profit does not provide a direct measure of the soundness of current rates, however. Some past rates were significantly lower than current rates, especially in the early years of the period.

Premiums Versus Claims Over Time

Historically, premium income from the NFIP's full-risk policies fell short of the total costs of those policies even before the catastrophic losses of 2005. Between 1978 and 2004, premiums for such policies totaled $10.2 billion in nominal dollars, while claims and expenses totaled $10.7 billion (see Table 1). The result was a loss of $0.5 billion over that period on policies with full-risk rates. Adding in data for 2005 and 2006 brings total premiums to $12.6 billion and total claims and expenses to $24.2 billion. Thus, with the large losses of 2005 factored in, the NFIP ran a loss on full-risk policies over the whole 1978–2006 period of $11.6 billion in nominal dollars or $12.3 billion adjusted for inflation and for changes in the number and mix of policies.[17] The latter measure corrects for the effects of general price inflation and program growth that would otherwise make later years more important than earlier years to the NFIP's actuarial performance during that period.

On the surface, the program's loss over the 1978–2006 period might suggest that the full-risk premiums were only about half as large as needed. However, those figures cannot be taken at face value in evaluating the adequacy of the actuarially based rates because flood losses on the scale seen in 2005 are expected to recur much less often

17. The adjustment for inflation uses cost factors provided by FEMA. The mix of policies refers to their distribution by zone and, for Zone X, by rate class (standard or preferred-risk policies).

than once in 29 years. (The true "return interval" is highly uncertain, but future catastrophes on that scale are far from impossible: A sufficiently powerful storm striking Miami or Houston could lead to even larger losses for the NFIP.)

Moreover, the profit figures shown in Table 1 are backward-looking and thus do not provide direct evidence of an actuarial shortfall in current rates. Specifically, the figures are not adjusted for changes in premium rates other than inflation, so they reflect FEMA's experience with the rates it charged (in nominal or real dollars) over the years, not the results it would have gotten with current rates. Many premiums were much lower in the first several years of the period than they are today: roughly 50 percent lower for the A zones, on average, and one-third to two-thirds lower for Zone X (although that may reflect differences in the amount of coverage as well as in the premium rates). With the early years of that period omitted, the NFIP ran an adjusted net profit of $0.6 billion on its full-risk policies over the two decades from 1985 to 2004.

Although Table 1 cannot settle the question of the actuarial adequacy of the program's full-risk premiums, it does provide some useful insights. One notable fact is that more claims have been paid on fewer total policy-years in Zone X (outside 100-year floodplains) than in the A zones (within those floodplains). The rate of claims in the A zones is less than 1 per 100 policies per year, in part because of the building codes and floodplain management practices adopted by participating communities, which are designed to reduce the rate of flood damage. In contrast, the claims rate in Zone X is over 1 percent per year for the full 1978–2006 period and nearly that high without 2005 and 2006. One reason is that a small fraction of those policies cover properties that are actually inside a 100-year floodplain: They have been remapped into an A or V zone but remain classified as Zone X because they have been grandfathered to stay eligible for coverage at Zone X premiums, which are generally lower. The high claims rates for that zone also suggest that the floodplain boundaries on FEMA's maps may tend to be too small. That is particularly likely for floodplains in communities with short historical records of floods (see Appendix A).

The table also highlights the fact that, to date, the NFIP has not lost money on properties in V zones, even after the four hurricanes that struck Florida in 2004 and the unprecedented losses of 2005. That result reflects the narrow definition of V zones: Only a small share of properties in coastal areas are thought to be subject to storm waves of three feet or higher in a 100-year flood. Thus, the limited data available suggest that if the NFIP has any problem adequately pricing the risks of coastal flooding, the problem is concentrated not in the V zones but in the A and X zones in coastal areas.

Issues Regarding the Soundness of the NFIP's Full-Risk Rates

CBO cannot determine whether the full-risk premiums currently used in the flood insurance program are actuarially adequate on the whole. Some aspects of FEMA's rate-setting methods tend to promote an actuarial surplus on the full-risk policies, whereas others tend to produce a deficit. The historical data are insufficient to support a more definitive conclusion, particularly because estimates of the frequency of catastrophic floods are so uncertain and because flood risks may be changing over time. Over a period of 30 years, the full-risk premiums could be adequate or too high and still yield occasional deficits and even large cumulative debts after rare catastrophic floods. Conversely, those premiums could be too low and still yield surpluses in most years. One would need to analyze data spanning many decades (or even centuries, if the distribution of floods is changing over time) to distinguish between those two cases with confidence from the data alone.

Analysis of FEMA's rate-setting methods identifies some aspects that err on the side of creating an actuarial surplus. Of those, probably the most important are the contingency loads (safety margins) included in the premiums for properties in 100-year floodplains: 10 percent in the A zones and 20 percent in the V zones. The fact that V-zone rates are set higher than they would be otherwise in anticipation of future increases in erosion risk also tends to create a surplus in the short run—although FEMA expects those rates to be inadequate in the future when the rise in erosion risk outpaces the 10 percent annual limit on rate increases. A third possible source of surplus is overcompensation for bias in estimates of risks

in areas with short historical records of floods (see Appendix A).[18]

Despite those factors, FEMA's full-risk rates may be too low overall because the agency uses some outdated or incomplete information in its rate-setting—specifically, in its maps of areas at risk of flooding and its models of flood frequency and severity. Many flood maps are too old to reflect recent erosion of coastlines, decreases in permeable ground area because of wetland loss and economic development, or increases in sea level. FEMA's policy of grandfathering properties in a previous zone or elevation class can also be seen as a case of basing rates on information that is out of date. Moreover, FEMA's models of flood frequency and severity may understate actual risks because they do not reflect the effects of global climate change. (Less important, the models also neglect the effects of storm-water flooding—flooding from water that has not yet entered a river, stream, or other channel—and the damage caused by debris carried by floodwaters.)

The factors mentioned above that tend to create an actuarial surplus in FEMA's full-risk rates offset the financial effect of the weaknesses in the flood maps and models to some unknown degree—partially, fully, or more than fully. Even in the unlikely case that the two sets of factors exactly balance each other out for the program as a whole, the effects on rates paid by individual policyholders will not all balance out. Rather, the result will be hidden cross-subsidies, with some policyholders paying more than the actuarially fair level for their coverage and others paying less. Other cross-subsidies in the NFIP are more easily identified (see Appendix B). In particular, properties grandfathered at Zone X standard rates and those in areas that are classified as Zone X because they are protected by levees or other flood-control structures (notwithstanding their additional risks from failure of those structures) are both cross-subsidized by other Zone X policyholders. In both cases, the higher risks faced by those properties contribute to the observed damages that FEMA uses in determining the Zone X standard rates for all properties. That full averaging of the higher and lower risks makes the net impact on the program's actuarial balance small or zero. (Grandfathered properties in the A and V zones are not directly cross-subsidized and do contribute to a shortfall, as explained at the end of the next section.)

Of course, actuarial soundness—that is, avoiding an implicit subsidy from taxpayers—is not the only goal set for the NFIP. The program is also intended to reduce flood losses and federal costs for disaster assistance and to facilitate recovery when floods occur. On those terms, the information gaps that lend a downward bias to the rates could be problematic even if the rates are not too low overall because of cross-subsidies. As noted above, rates that are below the actuarially fair level can lessen incentives for policyholders to reduce their flood risks (whereas rates above that level, serving as a source of cross-subsidies, may discourage some potential policyholders from buying coverage). At the same time, rates that are too low actuarially can also encourage communities to participate in the NFIP and thereby reduce federal disaster aid.

Outdated Flood Maps

In general, topographic information that is not up to date lends a downward bias to estimates of flood risks and thus contributes to the likelihood of an actuarial shortfall. By law, FEMA is required to review all of its flood maps on a five-year cycle; to date, it has not met that requirement, at least partly because it has lacked the resources to do so. Keeping the maps relatively current will be easier once FEMA completes its multiyear Map Modernization program, in which the agency is both updating maps and switching them from paper to digital form. The digitized maps can be made available over the Internet and are more precise and less costly to update.

How current are the maps used in the NFIP? Different estimates measure currentness in different ways. According to the Government Accountability Office (GAO), 50 percent of the program's roughly 106,000 maps were more than 15 years old in April 2008, and another 8 percent were 10 to 15 years old.[19] For its part, FEMA says

18. In addition, a problem identified by the Government Accountability Office with the quality of the data that FEMA uses in deriving the damage functions could contribute to an upward bias in flood premiums. See Government Accountability Office, *Flood Insurance: FEMA's Rate-Setting Process Warrants Attention*, GAO-09-12 (October 31, 2008), pp. 14–16, 35, 43; also see Appendix A of this CBO report. In the absence of a comprehensive review of all of the data used in the NFIP, however, CBO does not infer too much from this one known problem, which could be offset (or reinforced) by other data-quality issues.

19. Government Accountability Office, *Flood Insurance: FEMA's Rate-Setting Process Warrants Attention,* p. 18.

that "68 percent of the nation's population has already received updated maps that meet, exceed, or at least approach the map quality targets of Map Modernization," and another 27 percent of the population has updated preliminary maps (those not yet approved by the local communities).[20] For purposes of actuarial soundness, the share of the population covered by up-to-date maps is more meaningful than the percentage of maps themselves, so GAO's figures may overstate the extent of the problem associated with outdated maps. However, FEMA's figures focusing on map quality do not address the concern that older maps fail to reflect changes over time in geographic factors that may tend to increase flood risks. Moreover, FEMA staff report that the majority of coastal maps are based on outdated analyses and some were drawn under an earlier set of specifications for analyzing the particular characteristics of coastal flood hazards.[21]

One factor that causes older maps to understate flood risks is shoreline erosion. When FEMA updates a map of an area subject to such erosion, the mapped flood depths take into account the erosion that could occur during a significant storm; accordingly, the insurance premiums are higher than they would be without the erosion risk. Once such a storm occurs and causes erosion, however, the mapped coastline and flood depths are no longer accurate. According to a 2000 study conducted for FEMA by the Heinz Center, losses of 50 to 100 feet of shoreline over 30 years (or 20 to 40 inches per year) are "fairly common" on the coasts of the Atlantic Ocean and the Gulf of Mexico.[22] The study estimated that without additional measures to protect coasts, about 25 percent of structures within 500 feet of the Atlantic, Pacific, Gulf, or Great Lakes shoreline and outside major cities—or about 87,000 structures in all, assuming no new development—will be lost to erosion within 60 years. At the projected rates of erosion, about 10,000 of those structures will be lost within 10 years. Using observed participation rates in the NFIP, the study estimated that costs to the program for erosion losses to insured properties would average about $80 million a year over 30 years (or about 5 percent of 1999 premiums), with costs rising over time.

For now, however, NFIP premiums may be high enough to cover the risks associated with the cumulative erosion expected between one map review and the next. FEMA staff have indicated that the agency does not have legal authority to base premiums on such erosion risks. Instead, FEMA has been raising rates on all properties in V zones as a rough substitute for targeting the specific areas with high erosion risks. Between 2000 and 2008, full-risk rates in the V zones rose by 78 percent.[23] (For more discussion of erosion risks in the NFIP, see Appendix C.)

Another factor that makes flood maps outdated is the loss of wetlands. In coastal areas, wetlands serve as natural buffers to storm surges, and in inland areas, they can reduce the extent of downstream flooding. As an example of their disappearance, coastal Louisiana loses an area of wetlands about the size of Manhattan each year, primarily because of levees, jetties, canals, and subsidence (land sinkage).

Even when it does not displace wetlands, ongoing development—particularly increases in the ground area

20. Ibid., p. 44. FEMA also says there that "Older maps are not always outdated." Within the 68 percent figure, 21 percent of the population is covered by maps that meet or exceed two FEMA standards: the floodplain boundary standard, which is aimed at ensuring that flood maps match the topographic data on which they are based (taking those data as given), and the engineering analysis standard, which says that maps should reflect flood data and engineering analyses that are new or have been updated or validated as adequate for current use. Maps for the other 47 percent of the population satisfy at least part of either the floodplain boundary standard or the engineering analysis standard. See National Research Council, Committee on FEMA Flood Maps, *Mapping the Zone: Improving Flood Map Accuracy* (Washington, D.C.: National Academies Press, 2009), pp. 19–20. For the purposes of this report, CBO assumes that the data on which FEMA bases its flood maps and premium rates were measured and recorded accurately. However, the National Research Council study discusses many sources of uncertainty and possible error in the maps. For example, topographic data from the National Elevation Dataset of the U.S. Geological Survey, obtained from airborne and land surveys, is often used in FEMA's approximate studies of river flooding in lower-risk areas, but the uncertainty surrounding those data is about 10 times greater than called for by FEMA's accuracy standards (ibid., pp. 30, 36).

21. Information received from FEMA staff during a meeting on October 3, 2007, and in an e-mail dated December 22, 2008.

22. H. John Heinz III Center for Science, Economics, and the Environment, *Evaluation of Erosion Hazards* (report prepared for the Federal Emergency Management Agency, April 2000), p. 115, available at www.heinzcenter.org/publications/#majorreports. Erosion affects the NFIP not only by hastening the obsolescence of flood maps but also by increasing the expected damage for a given storm and a given distance from structure to shoreline.

23. Hayes and Spafford, *Actuarial Rate Review*, pp. 18, 22.

covered by roads, buildings, and other impermeable surfaces—reduces the natural environment's ability to absorb or delay water flows during storms and floods. That issue is illustrated by the results of a study, commissioned by FEMA, that looked at selected river segments in four communities and examined the effects of planned development on the damage expected from a 100-year flood. The study found that planned development would increase expected damage to *current* buildings and their contents by about 20 percent in the studied area of Fort Collins, Colorado; by roughly 100 percent in parts of Mecklenburg County, North Carolina, and DuPage County, Illinois; and by more than 1,200 percent in the studied area of Harris County, Texas.[24] Those areas are not intended to represent the nation as a whole: They were selected for their potential for significant development. Moreover, the estimates assume that development occurs without any mitigation efforts, such as on-site retention of storm water (which is required in three of the four jurisdictions studied). Even so, the examples provide qualitative evidence that development can have an impact on the depth and coverage area of river flooding. The relevance of those case studies is supported by the view of representatives of the Association of State Floodplain Managers, who told CBO that the "vast majority" of FEMA's older maps understate current flood risks, in part because of increases in impermeable surface area.[25]

Yet another factor that affects the topographic information shown on FEMA's maps is climate change. As the global climate warms, sea level rises because of the thermal expansion of seawater and the loss of ice sheets in Greenland and Antarctica. The ongoing rise in sea level shortens the useful life span of flood maps of coastal areas. (Climate change may also affect the frequency and severity of floods. Those effects are discussed in the next section.) According to a working group of the Intergovernmental Panel on Climate Change, "There is strong evidence that global sea level gradually rose in the 20th century and is currently rising at an increased rate, after a period of little change between AD 0 and AD 1900."[26] From 1961 to 2003, sea level rose at an average rate of 1.8 millimeters (mm) per year. During the last 10 years of that period, from 1993 to 2003, the average rate was about 3.1 mm per year, although it is unclear whether that higher rate marks an increase in the long-term trend.[27] Even a small rise in sea level can move shorelines significantly inward, depending on the local terrain: In South Carolina's low country, for example, one vertical inch corresponds to roughly 200 horizontal feet. Besides moving shorelines, higher sea level also increases storm surges and erosion hazards.

FEMA staff acknowledge that outdated maps—particularly in areas subject to coastal erosion—pose a problem for the actuarial soundness of the flood insurance program.[28] The agency has created a five-year plan for flood mapping and public awareness of flood risks. Among its goals are ensuring that all populated coastal areas have updated flood-hazard data and that data for 80 percent of all flood hazards are new, updated, or still valid.[29] FEMA estimates that the plan's goals could be achieved with annual appropriations of $220 million through fiscal year 2014. FEMA staff are less concerned about maps' being outdated because of man-made changes in floodplains, such as new bridges and culverts, partly because federal regulations require communities that participate in the NFIP to report to FEMA on "physical changes affecting flooding conditions" no later than six months "after the

24. Neil C. Blais and others, *Managing Future Development Conditions in the National Flood Insurance Program* (report prepared for the Federal Emergency Management Agency, October 2006), available at www.fema.gov/library/viewRecord.do?id=2596. CBO calculated the percentage changes using the estimates shown in Tables 4 through 11, pp. 33–58.

25. Personal communication, October 24, 2007.

26. Nathaniel L. Bindoff and others, "Observations: Oceanic Climate Change and Sea Level," Chapter 5 in *Climate Change 2007: The Physical Science Basis* (Cambridge, England: Cambridge University Press, 2007), pp. 387–388, available at www.ipcc.ch/pdf/assessment-report/ar4/wg1/ar4-wg1-chapter5.pdf.

27. Sea level has continued to rise at a high rate since 2003 "largely due to the growing contribution of ice loss from Greenland and Antarctica"; see Katherine Richardson and others, *Synthesis Report from "Climate Change: Global Risks, Challenges and Decisions, Copenhagen 2009, 10–12 March"* (Copenhagen: University of Copenhagen, 2009), p. 10, available at http://climatecongress.ku.dk/pdf/synthesisreport.

28. The statements by FEMA staff referred to in this paragraph are from a meeting with CBO staff on October 3, 2007, and e-mails dated December 22, 2008, and October 23, 2009.

29. Federal Emergency Management Agency, *Risk Mapping, Assessment, and Planning Multi-Year Plan: Fiscal Years 2010–2014* (March 16, 2009), available at www.fema.gov/library/viewRecord.do?id=3587.

date such information becomes available."[30] The agency produces an average of about 2,000 Letters of Map Revision per year to incorporate information on significant changes.

In the case of grandfathered properties, FEMA has up-to-date map information but chooses not to use it in setting premiums. FEMA staff say that most cases of grandfathering probably involve properties that were outside the 100-year floodplain and have been remapped inside it but are still paying Zone X standard rates rather than an A-zone or V-zone rate. Some cases, however, involve A-zone properties that would have moved to a V zone, or A- or V-zone properties that would have remained in the same zone but been reclassified at a lower elevation. Assuming everything else is the same, those lower-elevation properties generally face higher flood risks than predicted by FEMA's models for the A and V zones. (The exceptions are cases where the lower elevation is still well above any level that floodwaters are likely to reach.) Because the "excess" flooding that those properties experience does not affect the models—and thus does not feed back into higher rates for all properties in those zones, as it does in Zone X—they may contribute to an actuarial shortfall.

Climate Change

Besides raising sea level, climate change could adversely affect the NFIP through such mechanisms as more severe rainstorms and increased hurricane activity. A June 2008 report on climate change that summarized and synthesized many previous scientific studies provided evidence of trends in rainfall that could increase losses from river flooding.[31] It also offered some evidence of adverse trends in hurricanes. FEMA has begun studying the implications of climate change for the NFIP and expects to complete its analysis in early 2010.[32]

Effects on Rainstorms. On the basis of several studies, the June 2008 report concluded that it is "highly likely" that rainfall from severe rainstorms has increased in recent decades. One of the studies found a 50 percent increase over the past century in the number of days with more than four inches of rain in the upper Midwest. Another of the studies found statistically significant upward trends in the amount of rain falling on the rainiest days (specifically, those in the top 0.3 percent of the distribution) in the South, Midwest, and upper Mississippi regions. The report's authors also analyzed 100 years of data on total precipitation over 90-day periods, which is relevant to efforts to predict the likelihood of major widespread (rather than localized) floods. They found that 90-day periods with total precipitation in the top 5 percent of the distribution occurred 20 percent more often in the past 25 years than in earlier 25-year periods.[33] Some scientists, however, argue that the evidence available to date does not show that climate change is affecting river flooding.[34]

Effects on Hurricanes. Researchers generally agree that hurricane activity has been greater in recent years than it was from 1970 through 1994 (when the number of hurricanes reaching the United States was low by historical standards) and that risks remain higher in the near

30. 44 C.F.R. 65.3.

31. U.S. Climate Change Science Program and the Subcommittee on Global Change Research, *Weather and Climate Extremes in a Changing Climate—Regions of Focus: North America, Hawaii, Caribbean, and U.S. Pacific Islands* (June 2008), available at www.climatescience.gov/Library/sap/sap3-3/final-report/default.htm.

32. Government Accountability Office, *FEMA's Rate-Setting Process Warrants Attention,* p. 46.

33. U.S. Climate Change Science Program, *Weather and Climate Extremes*, pp. 46–50.

34. For example, see R.M. Hirsch, "Flood Flows and Climate Variability and Change in the U.S.: An Exploration of the Literature, Theory, and Long-Term Flood Records" (abstract H111-01, American Geophysical Union, Fall 2008 meeting), available at www.agu.org/meetings/fm08/waisfm08.html; and William S. Logan and Laura J. Helsabeck, *Research and Applications Needs in Flood Hydrology Science: A Summary of the October 15, 2008, Workshop of the Planning Committee on Hydrologic Science* (Washington, D.C.: National Academies Press, 2009).

term.[35] For example, one researcher estimates that the Power Dissipation Index for tropical storms—a measure that reflects the storms' frequency, intensity, and duration—tripled over the 30 years from the early 1970s to the early 2000s for hurricanes in the North Atlantic.[36] Globally, the percentage of storms in a five-year period rated as category 4 or 5 on the Saffir-Simpson scale more than doubled over roughly the same 30 years, from 16 percent in the 1970–1974 period to 36 percent in the 2000–2004 period.[37]

The key question for the NFIP, however, is not whether hurricane risks are higher in the near term (because of cyclical factors that may be well-represented in the decades of historical data underlying FEMA's models). What matters for the NFIP is whether climate change has increased hurricane risks in the long term, averaged over cyclical ups and downs. There is less agreement on that question.[38] On the one hand, data for the North Atlantic from 1950 through 2005 show a very strong correlation between the Power Dissipation Index and sea surface temperatures, and several studies have concluded that those temperatures have risen partly because of greater concentrations of greenhouse gases in the atmosphere. Moreover, statistical analysis suggests significant increases in the number of North Atlantic hurricanes if the initial year of the period analyzed is between 1881 and 1921, suggesting that a long-term trend is at work. On the other hand, hurricane counts were also high between 1851 and 1871, and no strong trends are found in analyses that include those years. Nor is there evidence of a trend in the number of hurricanes that make landfall in the United States.[39]

One possible explanation for that lack of clear evidence is that climate change has had only a negligible impact, if any, on hurricane risks in the United States. Temperatures in the North Atlantic—where hurricanes striking the U.S. Atlantic and Gulf coasts form—have risen by about 0.67 degrees Celsius (1.2 degrees Fahrenheit) since 1906, researchers estimate. They attribute just over 40 percent of that increase to global warming.[40] A review of studies suggests that for each rise of 1 degree Celsius in average sea surface temperature, wind speeds of the strongest hurricanes increase between 1 percent and 8 percent, all other things being equal.[41] The destructive power of a hurricane grows with the cube of the wind speed, so the increase of 40 percent of 0.67 degrees Celsius attributable to global warming translates to an increase of about 1 percent to 7 percent in the destructive power of storms. That effect is relatively small, and it could be less important than a second, offsetting impact of climate change on hurricane formation: an increase in vertical wind shear (changes in wind speed or direction as altitude changes). Vertical wind shear tends to prevent weak disturbances

35. Annual hurricane rates for three periods covering 1930 through 2006 are shown in a report by the catastrophe modeling firm Risk Management Solutions, *The 2006 RMS Expert Elicitation and Atlantic Hurricane Activity Rates Update* (white paper, November 2006), p. 3, available at www.rms.com/Publications/60HUActivityRates_whitepaper.pdf. Among the scientific papers that find an increased risk of hurricanes in the near term are Lennart Bengtsson, "Enhanced Hurricane Threats," and Stanley B. Goldenberg and others, "The Recent Increase in Atlantic Hurricane Activity: Causes and Implications," both in *Science*, vol. 293, no. 5529 (July 20, 2001), pp. 440–441 and 474–479. After the 2005 season, Risk Management Solutions raised its estimates of hurricane losses across the Gulf Coast, Florida, and the Southeast by 45 percent, and its estimates of losses in the Mid-Atlantic and Northeast coastal regions by 25 percent to 30 percent, relative to those derived from averages for the 1900–2005 period. The other two leading catastrophe modeling firms—AIR Worldwide and EQECAT—also increased their estimates of losses, though by smaller amounts; see Howard C. Kunreuther and Erwann O. Michel-Kerjan, *Climate Change, Insurability of Large-Scale Disasters and the Emerging Liability Challenge,* Working Paper No. 12821 (Cambridge, Mass.: National Bureau of Economic Research, January 2007). Similarly, the companies that rate the financial strength of private insurers have raised their standards for the amount of capital that property and casualty insurers (whose policies generally cover wind damage but not flood damage) must hold against catastrophic risks.

36. Kerry Emanuel, "Increasing Destructiveness of Tropical Cyclones Over the Past 30 Years," *Nature*, vol. 436 (August 2005), pp. 686–688. The Power Dissipation Index is defined as the cubed estimated maximum sustained surface wind speed at six-hour intervals, summed over all tropical cyclones occurring in a given year.

37. P.J. Webster and others, "Changes in Tropical Cyclone Number, Intensity, and Duration in a Warming Environment," *Science*, vol. 309 (September 16, 2005), pp. 1844–1846.

38. Congressional Budget Office, *Potential Impacts of Climate Change in the United States* (May 2009).

39. U.S. Climate Change Science Program, *Weather and Climate Extremes*, pp. 5–6, 56–61, 96.

40. Greg J. Holland and Peter Webster, "Heightened Tropical Cyclone Activity in the North Atlantic: Natural Variability or Climate Trend?" *Philosophical Transactions of the Royal Society,* vol. 365 (1997), pp. 2695–2716.

41. U.S. Climate Change Science Program, *Weather and Climate Extremes*, pp. 6, 110.

from intensifying into hurricanes and may limit the intensity of storms that have already formed.

Another possible explanation for the current inconclusive evidence is that climate change is already having an important impact on hurricane risks in the United States but more data must accumulate before that effect can be confirmed statistically.[42] In that view, the influence of climate change is being obscured for now by the high variability of hurricane events from year to year and by large-scale quasi-periodic oscillations in weather patterns that influence hurricane activity in the United States, such as El Niño, West African monsoons, and perhaps the Atlantic Multidecadal Oscillation.[43]

If the various effects of climate change on hurricane risks do not neutralize each other, their net impact could become more pronounced over time as carbon dioxide and other greenhouse gases continue to accumulate in the atmosphere. Most global climate models indicate that sea surface temperatures and maximum wind speeds will continue to rise in the future.[44] Many also anticipate increases in accompanying rainfall in some areas. William Nordhaus has estimated that if the atmospheric concentration of carbon dioxide (or its equivalent in other gases) doubled, the mean effect would be to roughly double expected U.S. losses from hurricanes—an increase of about $8 billion in 2005 dollars.[45] Moreover, applying a recently developed analytic technique to results from climate models indicates that global warming could reduce the frequency of hurricanes worldwide but increase their frequency off the southeastern coast of the United States.[46] That analysis also concluded that the intensity of hurricanes could increase in some locations, including the North Atlantic. However, even if climate change had no significant effect on the number or intensity of hurricanes reaching the United States, it would still increase flood risks in coastal areas through its effect on sea level.

Private Insurers' Response to Climate Change. Some support for the view that climate change may have a significant impact on flood risks, now or in the future, comes from the concern seen among private insurers who provide coverage for flood or wind damage in areas subject to hurricanes (see Box 2 on page 8). For example, a coalition of insurance companies, environmental groups, and other organizations recently issued a report on risks to U.S. coastal communities that said, "Changing climatic conditions pose an unprecedented threat to U.S. coastlines. . . . Current flood, shoreline and inundation maps, used for land use and infrastructure planning and mortgage due diligence, do not accurately reflect current risks, let alone future risks."[47] A 2006 report from insurer Lloyd's said, "Insurers should plan for increased flood risk in areas expected to suffer greater rainfall."[48]

42. Available data are particularly scant in the case of hurricanes that make landfall in the United States because those storms represent a small fraction of all North Atlantic hurricanes. Summarizing the state of knowledge, the U.S. Climate Change Science Program's report says, "It is very likely that the human-induced increase in greenhouse gases has contributed to the increase in sea surface temperatures in the hurricane formation regions. . . . However, a confident assessment of human influence on hurricanes will require further studies using models and observations" (*Weather and Climate Extremes*, p. 97).

43. The Atlantic Multidecadal Oscillation is an ongoing pattern of long-duration changes in sea surface temperatures in the North Atlantic. Its significance is under debate: Compare National Oceanic and Atmospheric Administration, Atlantic Oceanographic and Meteorological Laboratory, "Frequently Asked Questions About the Atlantic Multidecadal Oscillation" (January 13, 2006), available at www.aoml.noaa.gov/phod/d2m_shift/amo_faq.php; and M.E. Mann and K.A. Emanuel, "Atlantic Hurricane Trends Linked to Climate Change," *Eos*, vol. 87, no. 24 (June 13, 2006), pp. 233–241, available at http://holocene.meteo.psu.edu/shared/articles/MannEmanuelEos06.pdf. Climate change could have an impact on the large-scale oscillations themselves, but any such effect is highly uncertain at present.

44. Swiss Re, *Influence of Global Warming on Tropical Cyclones, Hurricanes, and Typhoons* (Zurich: Swiss Reinsurance Company, October 2006).

45. That estimate does not account for any accompanying rise in sea level. See William D. Nordhaus, *The Economics of Hurricanes in the United States*, Working Paper No. 12813 (Cambridge, Mass.: National Bureau of Economic Research, December 2006).

46. Kerry Emanuel, Ragoth Sundararajan, and John Williams, "Hurricanes and Global Warming: Results from Downscaling IPCCC AR4 Simulations," *Bulletin of the American Meteorological Society*, vol. 89 (March 2008), pp. 347–367, available at ftp://texmex.mit.edu/pub/emanuel/PAPERS/Emanuel_etal_2008.pdf.

47. The group included Fireman's Fund, Lloyd's, and Travelers insurance companies, reinsurer Swiss Re, and the Reinsurance Association of America. See H. John Heinz III Center for Science, Economics, and the Environment and Ceres, *Resilient Coasts: A Blueprint for Action* (2009), pp. 3–4, available at www.ceres.org/Document.Doc?id=435.

48. Lloyd's, *Climate Change: Adapt or Bust* (London: Society of Lloyd's, 2006), p. 17, available at www.lloyds.com/NR/rdonlyres/38782611-5ED3-4FDC-85A4-5DEAA88A2DA0/0/FINAL360climatechangereport.pdf.

What private insurers are already doing to respond to the effects of climate change is largely unknown. For a 2007 report, the Government Accountability Office contacted representatives of 11 large property casualty insurers; all 11 said their firms were using models that predicted greater frequency and intensity of hurricanes in the near term, but they did not attribute those effects to climate change.[49] Two industry sources told CBO that some private flood insurers have tightened their eligibility criteria for various combinations of reasons, which may include climate change. However, a representative of a firm that produces flood maps in Europe told CBO that the company does not yet have enough data to justify specific changes to its models of flood frequency and severity.

Options to Address Concerns About the NFIP's Full-Risk Rates

Various lawmakers and interest groups have proposed changes to the policies governing the NFIP. Some proposals would address the sources of actuarial weakness that CBO has identified; others would not.

With regard to the problem that FEMA's older maps may understate the damages expected from a given weather event, possible responses include providing more funds to speed the agency's Map Modernization program or to shorten the interval between map reviews once the modernization effort is completed. Updating flood maps more often would allow the rates charged on new policies to reflect more-current floodplain boundaries and base flood elevations. (Under FEMA's present grandfathering policy, new information would not alter the rates charged on existing policies.) Another option would be to let FEMA base its rates not on currently observed conditions—such as land use, location of shoreline, and so forth—but on the average conditions expected between one map review and the next.

FEMA is conducting an analysis to address whether its estimates of flood frequencies are too low because they do not account for the effects of climate change. The agency hopes to finish that analysis early next year. Depending on the conclusions of the study, it may seem worthwhile to establish a regular periodic review so that FEMA can stay abreast of the latest research findings on climate change.

To address concerns about FEMA's ability to respond quickly to new data showing higher flood risks, the 10 percent cap on annual premium increases could be lifted. At present, the cap is rarely a binding constraint on the rates that FEMA's actuaries would choose to set to cover current flood risks. As explained above, current rates in the V zones are actually higher because of the cap than they would be otherwise. However, lifting the cap could help improve the NFIP's financial position in the future if FEMA's analysis of the effects of climate change indicates a need for large increases in some rates or if erosion leads to rapid growth in the risks to coastal properties.

Another concern is the grandfathering of properties that otherwise would have moved from a regular 100-year floodplain (A zone) to an area subject to velocity wave action (V zone) or that would have been reclassified at a lower elevation relative to the base flood. Lawmakers could address that issue by prohibiting such grandfathering. Alternatively, they could require FEMA to track the premium income lost through that practice and offset it by raising rates elsewhere, thus creating a cross-subsidy.

Grandfathering properties that had been in Zone X could also be prohibited, but doing so would have little or no impact on the NFIP's actuarial balance, because those properties are already cross-subsidized. The same is true of policy actions to reduce the residual risks to properties protected by levees (see Appendix B) or to adjust the floodplain boundaries on FEMA's maps to correct for small-sample bias in communities with relatively short data records (see Appendix A).

Some other common proposals also would not address the sources of actuarial weakness in the NFIP's rates. An example is proposals to expand the program's coverage—for instance, by raising coverage limits or by adding coverage for wind damage. Proposals envision offering the additional coverage at actuarially neutral rates, but meeting that goal would be difficult, as it is for the program's current coverage. Raising coverage limits, for instance, would disproportionately affect properties in coastal states; therefore, the actuarial balance of the premiums

49. Of the 11 firms, six attributed the changes to the Atlantic Multidecadal Oscillation and five did not specify any causes; Government Accountability Office, *Climate Change: Financial Risks to Federal and Private Insurers in Coming Decades Are Potentially Significant*, GAO-07-285 (March 2007), p. 32.

would be particularly sensitive to any weakness in FEMA's modeling of hurricanes.[50] Even if the premiums for the new coverage were actuarially fair, the program's overall actuarial balance would remain the same in dollar terms.[51]

A full analysis of policy options for the NFIP is beyond the scope of this report, and it should be noted that actuarial soundness is not the only goal policymakers have set for the program. Even from the standpoint of federal spending, the effect of the program depends not only on its own financial position but also on its interaction with federal disaster assistance: The more properties that are adequately insured by the NFIP, the fewer applications will be filed for disaster assistance from FEMA or low-cost loans from the Small Business Administration after the President declares a flooding disaster. Quantifying the extent of that effect is one of several research goals that could help inform future policy choices about the NFIP (see Box 3).

Beyond its federal fiscal impact, the NFIP is important for its effects on environmental protection, public safety, and economic efficiency. Expanding floodplain boundaries where needed to correct for small-sample bias would be desirable on some of those grounds, because applying the program's minimum-elevation requirements for new construction as well as other land-use standards would decrease future flood damage. Reducing cross-subsidies could also be beneficial if policyholders reacted to rates that reflected their properties' true risks by taking cost-effective actions to mitigate those risks. In both cases, however, the benefits could be reduced if participation in the program fell.

NFIP Properties That Have Experienced Multiple Floods

Another concern that some observers of the NFIP have raised is the impact of insured properties that have flooded more than once. Such properties are responsible for only a small share of claims paid by the NFIP, but they impose a disproportionate burden on the program's finances.

The Number and Effects of Repetitive-Loss Properties

About 71,000 properties insured by the NFIP as of January 31, 2009, meet FEMA's definition of repetitive-loss properties—that is, they have been the subject of two or more flood-claims payments greater than $1,000 each in any 10-year period.[52] Nearly 32,000, or 45 percent, of those RLPs have prompted three or more such payments while insured by the program, and a few thousand have had losses leading to least 10 payments (see Figure 2). Properties with the largest numbers of claims payments typically experience minor damage, such as ruined carpeting, each time. Thus, of the almost 23,000 properties that have prompted at least four payments, only about 10,000 meet FEMA's criteria for a severe repetitive-loss property (SRLP)—that is, they have been the subject of at least four payments of more than $5,000 each, or two

50. According to the Government Accountability Office, 36 percent of NFIP policies for residential structures carry the maximum coverage of $250,000. That share is above 50 percent in six coastal states and the District of Columbia and is 41.5 percent in Florida, which accounts for almost 40 percent of NFIP policies nationwide. See Government Accountability Office, *Information on Proposed Changes to the National Flood Insurance Program*, GAO-09-420R (February 27, 2009). Many of the policyholders who carry the maximum coverage from the NFIP would benefit from higher coverage limits. Those few who carry additional private insurance above the limits—so-called excess-layer coverage—would have the opportunity to replace some or all of it with additional federal insurance, which could be expected to cost less (see Box 2 on page 8). Policyholders without supplemental insurance would be able to increase the total coverage on their property; many would presumably choose to raise their coverage up to the new limits or the value of their property, whichever was less. Increasing the limits might also affect the market for private primary (or first-dollar) flood insurance. However, many properties carrying that coverage are ineligible for NFIP insurance or are insured for $1 million or more.

51. New coverage priced at break-even premiums would affect the program's actuarial balance in percentage terms: Relative to total premiums, any actuarial deficit (or surplus) would be smaller. For private insurers, adding new types of coverage that are not too highly correlated with existing coverage (which these might well be, especially in the case of increased coverage limits) is beneficial. Thanks to "the law of large numbers," such a change reduces the variability of companies' losses and thus the relative amount of capital they must maintain to keep the risk of bankruptcy below some acceptable threshold. For the NFIP, which does not rely on its own capital to sustain operations, the relevant figure is the annual expected loss (or gain) in dollar terms, not in percentage terms.

52. The data analyzed in this section were provided to CBO by FEMA.

Box 3.

Questions for Further Research on the Demand for Flood Insurance

If the premium rates charged on some or all groups of policies in the National Flood Insurance Program (NFIP) are too low to cover their expected costs, raising those rates would improve the program's actuarial soundness and lessen the need for future borrowing from the federal Treasury. Raising rates, however, would have other effects that can be described in qualitative terms but are not well understood quantitatively. Improved answers to the following questions could help the Congress make more informed policy decisions about the NFIP:

- To what extent would raising premiums reduce the number of policies in force or the amount of coverage per policy?
- To what extent would raising premiums increase expected losses per policy by disproportionately reducing the demand for coverage of lower-risk properties?
- To what extent would raising premiums lead to greater mitigation—for example, by encouraging policyholders to elevate their properties or move to less risky locations?
- To what extent would raising premiums increase federal costs for disaster assistance?

There are few empirical studies of the demand for flood insurance, and none of them provide definitive answers. The best available evidence suggests that raising premium rates by 10 percent lowers the number of policies by 1 percent and the amount of coverage per policy by 9 percent. However, those estimates were derived from an analysis of aggregate state-level data from 1984 through 1993.[1] Thus, they do not reflect the effects of the changes made by the National Flood Insurance Reform Act of 1994 to the requirement for flood coverage of certain structures in high-risk areas. (Under that law, federally regulated mortgage lenders and government-sponsored enterprises such as Fannie Mae and Freddie Mac must put NFIP premium payments in escrow for any loan that has an escrow account for other purposes.) Moreover, the degree to which premium rates affect the demand for flood insurance may be different at the current rates than it was during the 1984–1993 period.

Another study used 1997 NFIP data on 62 coastal communities in 16 counties to analyze the percentage of properties covered in each community. It did not find statistically significant evidence that the average price of NFIP insurance has any effect on the extent of coverage, perhaps because most covered properties were subject to the mandatory-purchase requirement.[2] A third study was commissioned by the Federal Emergency Management Agency to analyze the potential effects of eliminating the explicit subsidy for structures built before their community's flood insurance rate map was created. However, the methodology of that study focused on surveying structures in a nationwide sample of communities with high-risk flood zones; it did not include any new analysis of how the demand for flood insurance is affected by price, instead relying on a single 1983 report by the Government Accountability Office.[3]

1. Mark J. Browne and Robert E. Hoyt, "The Demand for Flood Insurance: Empirical Evidence," *Journal of Risk and Uncertainty*, vol. 20, no. 3 (2000), pp. 291–306.

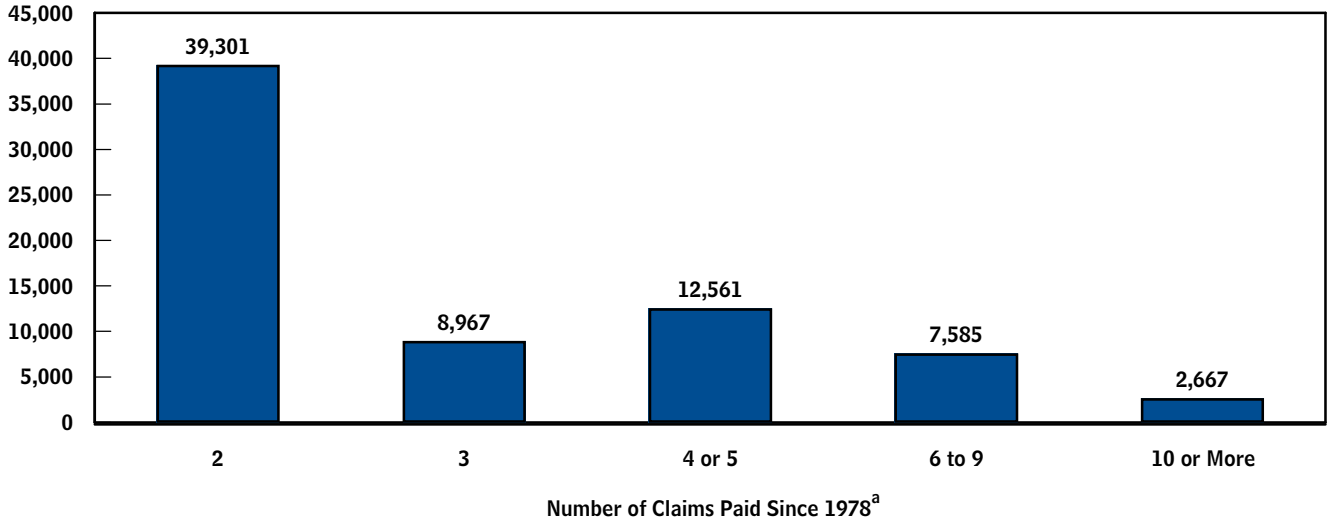
2. Craig Landry and Warren Kreisel, "Modeling the Decision to Buy Flood Insurance: An Empirical Analysis for Coastal Areas" (paper presented at the American Agricultural Economics Association annual meeting, Tampa, July 30–August 2, 2000), available at http://purl.umn.edu/21880.

3. PricewaterhouseCoopers, *Study of the Economic Effects of Charging Actuarially Based Premium Rates for Pre-FIRM Structures* (report prepared for the Federal Emergency Management Agency, May 14, 1999), available at www.fema.gov/library/viewRecord.do?id=2555. The 1983 report used in that study was General Accounting Office (now Government Accountability Office), *The Effect of Premium Increases on Achieving the National Flood Insurance Program's Objectives,* GAO/RCED-83-107 (February 28, 1983). Also see Congressional Budget Office, letter to the Honorable Rick A. Lazio regarding CBO's review of a study of the economic effects of charging actuarially based premium rates for federal flood insurance, September 22, 2000.

Figure 2.

Currently Insured Repetitive-Loss Properties, by Number of Claims Paid

(Number of properties)



Source: Congressional Budget Office based on data from the Federal Emergency Management Agency as of January 31, 2009.

a. Includes only payments that exceed $1,000.

or more payments that cumulatively exceed the property's value.[53]

The 71,000 currently insured RLPs are covered by a total of about 110,000 policies, or 2 percent of the 5.6 million NFIP policies nationwide (see Table 2).[54] RLPs account for 3 percent of current NFIP premiums, indicating that the rates on individual policies tend to be 50 percent higher than the national average. However, currently insured repetitive-loss properties account for 12 percent of the total number of claims paid by the NFIP since 1978 and 16 percent of total claims payments (in nominal dollars). SRLPs have an even more disproportionate impact on the program's actuarial balance: They represent just 0.3 percent of current policies and 0.5 percent of current premiums, but 3 percent of claims and 5 percent of payments since 1978.

Looking only at the losses to date on currently insured RLPs may understate the significance of the repetitive-loss problem. Over time, the current set of properties will experience some additional losses, and additional properties will become RLPs. Another way to measure the impact of repetitive-loss properties is to include former RLPs—those that are no longer insured or are no longer considered active RLPs because they have undergone mitigation to reduce their risks. Including those properties raises RLPs' share of total claims since 1978 from 12 percent to 22 percent and their share of total payments from 16 percent to 24 percent.[55]

53. The definitions of both RLPs and SRLPs require that at least two of the payments occur within 10 years of each other. The criteria for SRLPs were originally established for residential properties housing one to four families. They appear in section 102 of the Bunning-Bereuter-Blumenauer Flood Insurance Reform Act of 2004 (42 U.S.C. 4001, 118 Stat. 712), available at www.fema.gov/pdf/nfip/fira2004.pdf. FEMA later used the same criteria to define larger residential SRLPs. Nonresidential properties are not eligible for mitigation assistance under the pilot program created by the 2004 Flood Insurance Reform Act, but the same criteria can be applied to them as well. The roughly 10,000 properties identified here as SRLPs include 8,859 residential properties and 1,195 nonresidential properties.

54. Like other insured properties, RLPs and SRLPs may be covered by more than one policy contract. For example, a rental property may have a contract covering the structure and another covering the contents, purchased by the landlord and tenant, respectively. Moreover, for contracts bought by condominium associations, FEMA attributes one policy to each condo unit.

55. The share of total payments attributable to current and former RLPs was closer to one-third before 2005, a year that was comparatively less catastrophic for RLPs than for NFIP properties as a whole. That year's losses account for one-quarter of total payments to RLPs since 1978 but nearly one-half of payments to all insured properties.

Table 2.

Statistics on Insured Properties with Multiple Flood Claims

	Currently Insured Properties	
	RLPs	SRLPs
Number of Properties	71,081	10,054
Number of Policies	109,842	17,814
Percentage of Current Policies	2.0	0.3
Percentage of Current Premiums[a]	3.1	0.5
Percentage of Cumulative Claims[b]	12.5	3.3
Percentage of Cumulative Claims Payments[b]	15.7	5.1
Percentage of Policies in High-Risk Zones That Are Subsidized[c]	56.2	62.3
Percentage of Policies in V Zones[d]	8.3	9.7

Source: Congressional Budget Office based on data from the Federal Emergency Management Agency as of January 31, 2009, and on Thomas L. Hayes and Dan R. Spafford, *Actuarial Rate Review: In Support of the May 1, 2008, Rate and Rule Changes* (Federal Emergency Management Agency, National Flood Insurance Program, August 2008).

Notes: Repetitive-loss properties (RLPs) are properties that have been the subject of at least two flood-claims payments of more than $1,000 each in any 10-year period. (The numbers shown here for RLPs include severe repetitive-loss properties.)

Severe repetitive-loss properties (SRLPs) are RLPs that have prompted four or more flood-claims payments greater than $5,000 each, or two or more payments that together exceed the property's value. (The numbers shown here for SRLPs include 1,195 nonresidential properties, although such properties are not defined as SRLPs for purposes of mitigation assistance under the pilot program created by the Flood Insurance Reform Act of 2004.)

a. Current premiums are shown because data on cumulative premiums are not available.

b. Cumulative data for January 1, 1978, through January 31, 2009.

c. The analogous figure for the flood insurance program as a whole is 35.4 percent.

d. V zones are coastal areas subject to waves of three feet or more during a 100-year flood. The analogous figure for the flood insurance program as a whole is about 2 percent.

In high-risk zones, RLPs are much more likely than all NFIP properties (56 percent versus 35 percent) to be insured at subsidized rates. That situation reflects the fact that properties eligible for subsidies are older ones that were built before communities joined the NFIP and had to meet the program's standards for building codes and floodplain management. Also, policies on RLPs are about four times as likely as all policies to cover properties in V zones. For SRLPs, the contrasts are sharper still.

The apparent imbalance for repetitive-loss properties between current premiums and cumulative claims, however, cannot be taken at face value as indicating the effect of an individual RLP on the actuarial soundness of the NFIP. A property that has experienced two floods in a 10-year period may indeed be at a higher risk of future flooding, or it may simply have been subject to a run of bad luck despite having an average or below-average level of risk. One cannot assume that the owners of such properties would pay higher actuarially sound premiums any more than one can assume that the owners of properties that have experienced no losses over 10 years face no flood risks. The statistics for SRLPs are more meaningful: A series of four claims payments of more than $5,000 each (or two to three payments that together exceed the property's value) is unlikely to reflect merely a run of bad luck.[56]

FEMA's Treatment of Repetitive-Loss Properties

In dealing with RLPs, FEMA's main focus is on efforts to reduce their risk of future flooding, not on their premiums. NFIP premiums are not based on the loss experience of individual properties, and most RLPs are not targeted for special rates as a group. Although the average premium paid on policies that insure RLPs is higher than in the NFIP as a whole, that is mainly because those policies are more concentrated in the high-risk coastal and

56. To illustrate, the probability that a property with a flood risk of 1 percent per year will experience two or more floods in 25 years is 2.6 percent. But the probability that such a property will flood four or more times over that period is 0.01 percent (1 in 10,000). For six or more losses, the probability is less than 0.00002 percent (2 in 10 million).

Table 3.

Average Annual Premiums, by Risk Zone, for All Properties and for Multiple-Loss Properties

(Dollars)

	All Properties	RLPs	SRLPs
		Full-Risk Premium Rates	
A Zones (High risk: annual flooding probability of 1 percent or more)	430	467	484
V Zones (High risk coastal, subject to 3-foot waves in a 100-year flood)	2,270	1,389	950
Zone X (Low to moderate risk)	394	640	504
		Subsidized Premium Rates	
A Zones (High risk: annual flooding probability of 1 percent or more)	980 [a]	1,140	1,024
V Zones (High risk coastal, subject to 3-foot waves in a 100-year flood)	1,500 [a]	1,506	1,253

Source: Congressional Budget Office based on data from the Federal Emergency Management Agency.

Note: Repetitive-loss properties (RLPs) are properties that have been the subject of at least two flood-claims payments of more than $1,000 each in any 10-year period. Severe repetitive-loss properties (SRLPs) are RLPs that have prompted four or more flood-claims payments greater than $5,000 each, or two or more payments that together exceed the property's value.

a. Approximation based on Thomas L. Hayes and Dan R. Spafford, *Actuarial Rate Review: In Support of the May 1, 2008, Rate and Rule Changes* (Federal Emergency Management Agency, National Flood Insurance Program, August 2008). Subsidized rates are available only in high-risk zones, not in Zone X.

subsidized categories.[57] RLPs' loss experience affects their rates in one case, however: Repetitive-loss properties located in Zone X are ineligible for the discounted preferred-risk policy premiums that apply to most properties outside 100-year floodplains. Thus, RLPs in Zone X are insured at premium rates well above average for their area (see Table 3).

Conversely, among properties in V zones that are insured at full-risk rates, RLPs and SRLPs pay premiums that are much lower than average. That situation may result from the greater prevalence of condominium policies among multiple-loss properties; such policies can be less costly because the risk is shared among a larger number of owners.[58]

An RLP's risk of future flooding may be mitigated in several ways: by elevating the structure; by acquiring the structure, relocating or demolishing it, and converting the land to open-space uses; and, in some cases, by dry flood-proofing (sealing the exterior walls to prevent water from entering) or building localized physical flood-control measures (levees or floodwalls). FEMA provides grants to help state and local governments reduce flood risks through several programs that have varying eligibilities and requirements, including the Hazard Mitigation Grant Program, the Flood Mitigation Assistance Program, and the Pre-Disaster Mitigation Program (see Box 1 on page 4).

Legislation enacted in 2004 established two additional programs focusing on RLPs: the Repetitive Flood Claims (RFC) Grant Program and the Severe Repetitive Loss Program.[59]

- RFC grants are targeted to state or local governments that lack the financial or managerial capacity to take

57. Even with their discounted rates, subsidized properties in high-risk A zones are subject to higher premiums, on average, than their unsubsidized counterparts are. The reason is that the subsidized properties are at much greater risk because they predate their community's entry into the NFIP, with the accompanying changes in floodplain management and building codes.

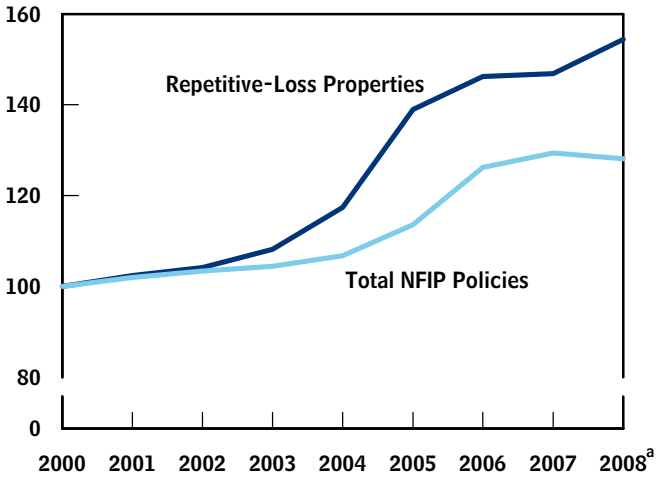
58. Whereas the "policy" and the "contract" are the same thing for most NFIP coverage, when condominium associations purchase contracts, FEMA attributes one policy to each condo unit. Thus, the higher ratios of policies to contracts—3.5 for RLPs and 4.5 for SRLPs in V zones compared with the average of 2.2 for all full-risk policies in those zones—indicates a greater prevalence of condominium policies.

59. See the Bunning-Bereuter-Blumenauer Flood Insurance Reform Act of 2004, 42 U.S.C. 4001, 118 Stat. 712.

Figure 3.

Growth in the Number of Repetitive-Loss Properties and Total NFIP Policies Since 2000

(Index, 2000=100)



Source: Congressional Budget Office based on data from the Federal Emergency Management Agency.

Notes: NFIP = National Flood Insurance Program.

Repetitive-loss properties are properties that have been the subject of two or more flood-claims payments greater than $1,000 each in any 10-year period.

a. Data for 2008 include January 2009.

part in the Flood Mitigation Assistance Program. Those grants do not require any local sharing of costs. Through December 2007, 66 repetitive-loss properties had been mitigated via RFC grants, and another 13 projects had been approved but not completed.

- The Severe Repetitive Loss Program includes both a carrot and a stick. An SRLP insured at subsidized rates can receive mitigation assistance under the program, but if the property owner rejects the mitigation offer, the NFIP premium rises by 50 percent at the next policy renewal and by another 50 percent after each subsequent flood claim, until the full-risk rate is reached. FEMA first issued guidance for the new program in January 2008. As of September 30, 2008, grants had been awarded for mitigation of 168 properties, 132 of them in Texas. Mitigating all of the residential SRLPs in the nation by acquiring them—the typical method for such properties—would cost $1.8 billion (including a nonfederal cost share of 10 percent to 25 percent), according to the Department of Homeland Security.[60] That estimate was based on 8,040 residential SRLPs as of December 2007. The comparable figure for the end of January 2009 is $2.0 billion—nearly 10 times the total appropriations for the Severe Repetitive Loss Program through fiscal year 2009.

Despite mitigation efforts by FEMA and state and local governments, the number of repetitive-loss properties insured by the NFIP has grown by more than 50 percent in this decade: from 45,783 at the beginning of 2000 to 71,081 as of January 31, 2009. Annual growth rates for such properties have been roughly consistent with growth in the total number of NFIP policies, except in 2004 and 2005 (see Figure 3). The more rapid growth of RLPs in those years is largely associated with the effects of the hurricanes of 2004 and 2005. Annual growth is measured as the difference between the number of insured properties that newly meet the definition of an RLP and the number of properties that cease to be insured (because they have been destroyed or abandoned or the policyholder has dropped coverage) or that have undergone mitigation and are therefore not considered active RLPs.[61] The number of properties leaving the active list fell sharply in 2005 and 2006—perhaps because public efforts were focused on short-term cleanup and restoration after the hurricanes rather than on mitigation—but rose again in 2007 and 2008 (see Figure 4).

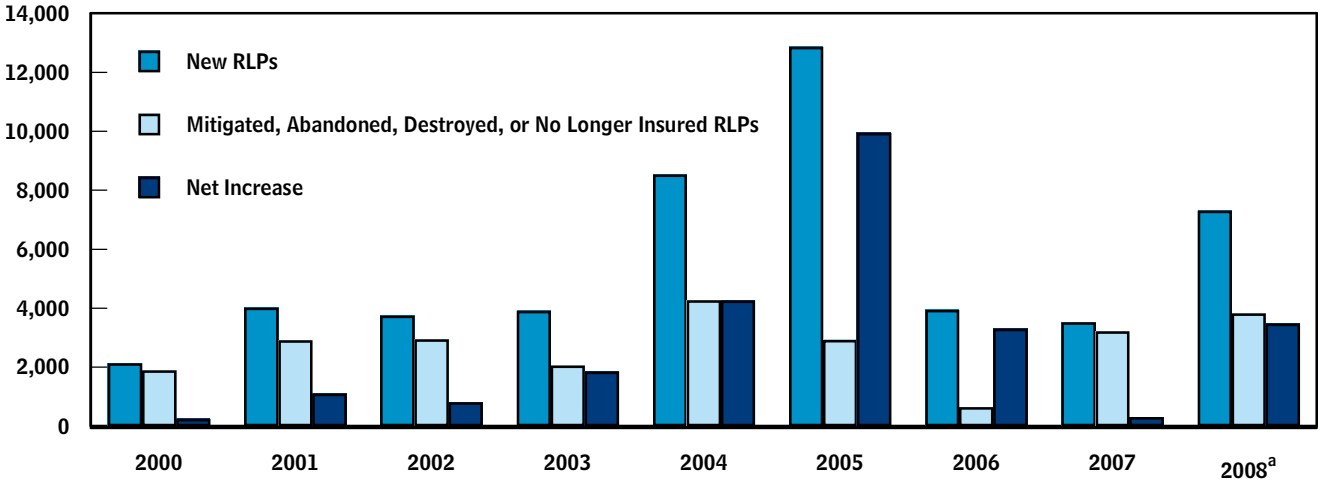
60. See Department of Homeland Security, Office of Inspector General, *FEMA's Implementation of the Flood Insurance Reform Act of 2004,* OIG-09-45 (March 2009), pp. 5, 8, 16; and Federal Emergency Management Agency, "FY 2009 SRL Allocations and Set Aside" (March 9, 2009), available at www.fema.gov/government/grant/srl/fy_2009_srl_allocations_and_set_aside.shtm.

61. A mitigated RLP that experiences a subsequent insured flood loss is put back on the active list.

Figure 4.

Annual Changes in the Number of Insured Repetitive-Loss Properties

(Number of properties)



Source: Congressional Budget Office based on data from the Federal Emergency Management Agency.

Note: Repetitive-loss properties (RLPs) are properties that have been the subject of two or more flood-claims payments greater than $1,000 each in any 10-year period.

a. Data for 2008 include January 2009.

APPENDIX

A

Further Details About the NFIP's Full-Risk Rates

This appendix presents supplementary information about the zone system and rate-setting methods used in the National Flood Insurance Program (NFIP).

Classification of High-Risk Flood Zones

In drawing up its flood insurance rate maps, the Federal Emergency Management Agency (FEMA) delineates three major types of flood zones. Most coastal or inland areas in 100-year floodplains—that is, places where the annual probability of flooding is at least 1 percent—are labeled A zones. However, coastal areas where a 100-year flood would include three-foot waves on top of the storm surge itself are labeled V zones (for "velocity wave action"). Areas outside 100-year floodplains are designated Zone X.[1]

FEMA's rate structure can be more detailed in areas for which it has more information, so the agency breaks down its zone categories further according to the level of analysis it has performed. In the V zones, more than 99 percent of policies with full-risk premiums cover properties in areas for which detailed analyses are available. Under an older rating system, those areas carried various numbers from V1 through V30, but now they are all labeled Zone VE. The relatively few V-zone areas that have been mapped more approximately are labeled Zone V—sometimes referred to as "unnumbered Zone V" to avoid confusion between that label and the larger V-zone category (see Table A-1).

Areas in the A zones are similarly classified according to the level of information available, and FEMA also distinguishes areas that are subject only to shallow flooding. In particular, Zone AE (formerly Zones A1 through A30) refers to areas studied in more detail, and ("unnumbered") Zone A is the label used for areas subject to normal (not merely shallow) flooding that have been mapped more approximately. In addition, Zone AH designates areas where flooding takes the form of shallow ponding—for example, on a plateau where flood waters can reach only one foot before they start spilling off the plateau. Zone AO covers other areas that are subject to shallow flooding, usually in the form of sheet flow (shallow flow over a wide area) on sloping terrain. Among all full-risk policies in those four A zones, roughly 75 percent cover properties in Zone AE, 5 percent in Zone A, and 20 percent in Zone AH or AO.[2]

As discussed below, FEMA uses models to set full-risk rates for policies that cover properties in Zones VE and AE, where it has more-detailed information about flood risks. The agency has less-detailed information about risks in Zones V, A, AH, and AO, so its rate setting for those areas relies more on professional judgment. For the relatively few properties in unnumbered Zone V, FEMA's actuaries determine premium rates on a case-by-case

1. The very few areas for which FEMA has not yet analyzed flood hazards are labeled Zone D.

2. FEMA uses two other labels in the A-zone category, but all of the properties in those areas are insured at subsidized rates rather than full-risk ones. Zone A99 and Zone AR refer to areas where the annual chance of flooding will be less than 1 percent upon completion of a structural flood-control project, such as a levee. Zone A99 designates an area where a new project is under way and more than half finished. Zone AR designates an area where an existing flood-control project is now considered insufficient and where the schedule and plan for making repairs or upgrades meet specific standards.

Table A-1.

Distribution of Full-Risk Flood Insurance Policies by Zone

Major Zone	Subzone	Description	Share of Full-Risk Policies (Percent)
V		Coastal areas subject to waves of three feet or more during a 100-year flood	
	VE	V-zone areas mapped using detailed methods	1.3
	V (or "unnumbered V")	V-zone areas mapped using approximate methods	*
	Total V		**1.3**
A		All other coastal and inland areas in 100-year floodplains	
	AE	A-zone areas mapped using detailed methods	37.2
	A (or "unnumbered A")	A-zone areas subject to more than shallow flooding and mapped using approximate methods	2.2
	AH, AO	Areas subject to shallow ponding (AH) or other shallow flooding (AO)	10.6
	Total A		**50.0**
X	(No subzones)	Areas outside 100-year floodplains	**48.8**

Source: Congressional Budget Office based on estimates for 2008 to 2009 in Thomas L. Hayes and D. Andrew Neal, *Actuarial Rate Review: In Support of the Recommended May 1, 2009, Rate and Rule Changes* (Federal Emergency Management Agency, National Flood Insurance Program, August 2009), p. 35.

Note: * = less than 0.05 percent.

basis.[3] For unnumbered Zone A, three sets of rates are used. One set applies to buildings whose position relative to the base flood elevation (BFE)—that is, the height of water reached during the local 100-year, or base, flood—has been certified.[4] A second set of rates applies to structures for which the elevation relative to the adjacent grade (ground level) is specified. A third set applies to buildings for which no elevation information is available. FEMA's actuaries calculate those three sets of rates using Zone AE rates as a benchmark. For example, the BFE-rated schedule is somewhat higher than the comparable schedule in Zone AE, and the adjacent-grade-rated schedule assumes that the ground level is two to three feet below BFE. For areas subject only to shallow flooding (Zones AH and AO), actuaries use a different set of rates; for any given type of structure, those rates depend only on whether the structure is certified as lying above the community's BFE.

The Role of Representative Topographic Profiles

Ideally, the full-risk rates charged in Zones AE and VE, where FEMA has the most detailed information, would reflect not only each structure's type and its location

3. Case-by-case rating is also used for properties in A or V zones that were built after the community's flood insurance rate map (FIRM) was created and that lie below the base flood elevation. Such properties are very rare because communities that participate in the NFIP must implement zoning rules and building codes that require all new (post-FIRM) structures in the identified 100-year floodplains to be built at or above the base flood elevation. Thus, post-FIRM properties that do not meet that requirement can exist only through implementation errors or enforcement problems.

4. More precisely, the base flood is the one for which the annual probability of a flood *that large or larger* is 1 percent. Similarly, the 10-year flood is the one that has a 10 percent (1/10) chance of occurring or being exceeded in any given year.

relative to the base flood elevation but also its local topography. Depending on local conditions, structures at the same elevation relative to BFE—and hence exposed to roughly the same depth of water (if any) in a 100-year flood—may face different risks from floods of other sizes. For instance, a house that is one foot above BFE may be safe from all floods smaller than a 300-year event if it is located in a broad, shallow floodplain, where the water does not rise much higher in a rare large flood than in a more common small one. Conversely, a house located one foot above BFE in a narrow, steep valley, where the difference in water heights between rare and common floods is greater, may suffer damage in all floods larger than a 130-year event.

Basing flood insurance rates on each structure's local topography is not currently feasible, however, because of the information requirements and administrative complexity involved. Instead, FEMA uses estimates of average topographic conditions to set uniform nationwide rates for Zone AE and for Zone VE. The agency derives those rates by averaging six representative topographic profiles, summarized by "probability of elevation" (PELV) curves. Each PELV curve shows the relationship for a particular topography between flood recurrence intervals (the reciprocals of the annual probabilities) and flood heights, which are expressed relative to BFE (for example, BFE +2 feet). All six curves intersect at the common point (100, BFE)—because the base flood is the 100-year flood by definition—but they differ in how steeply or gradually they slope away from that point. In particular, each curve shows a different height below BFE for a 10-year flood. Indeed, FEMA derived the curves by analyzing the flood exceedence probabilities for a sample of communities whose 10-year floods share the same relative height.[5]

To determine how to weight the six curves in calculating the national averages, FEMA uses state-by-state data on the distribution of 10-year flood heights relative to BFE for some of its insured properties. (Initially, FEMA's maps for the A and V zones showed subzones that indicated the relative height of the 10-year flood at each location, but current maps do not always include that information.) For instance, if 19 percent of the properties for which FEMA has data in a given state are located in places where the 10-year flood has a height of about BFE -3 feet, the agency assumes that the locations of 19 percent of all insured properties in that state fit the topographic profile represented by the PELV curve that includes the point (10, BFE -3).

The PELV curves therefore allow FEMA to reduce its information requirements, generalizing from data on the relative height of 10-year floods to the heights of floods of all recurrence intervals—or conversely, to the exceedence probabilities for floods of all relative heights. Combining the probabilities using each state's share of insured properties and the respective weights for each PELV curve in the state yields a set of average probabilities for the nation as a whole. FEMA can then estimate expected percentage losses for each zone (AE or VE), structure type, and structure elevation relative to BFE by combining those average probabilities of flood heights with a set of damage functions—one for each zone and structure type—that relate the depth of flooding in a structure to an estimated percentage loss. The damage functions are zone-specific because the function for Zone VE takes account of wave action and effects on piers and pilings below the lowest floor.[6]

FEMA bases the damage functions on a combination of models from the Army Corps of Engineers and its average

5. The Government Accountability Office has expressed concern that FEMA has not updated its PELV curves since the early 1980s; see Government Accountability Office, *Flood Insurance: FEMA's Rate-Setting Process Warrants Attention,* GAO-09-12 (October 31, 2008), pp. 13–14, 34. The concern is that the shape of individual PELV curves may have changed in the past 25 years. In other words, although they remain anchored at the same relative heights for the 10-year and 100-year floods, some of them may now curve more or less sharply between or outside their two anchor points than they did before. CBO believes that changes in the precise shape of the six curves are a smaller source of potential error in FEMA's rates than changes in the BFEs themselves and changes in the distributions of the 10-year flood heights relative to BFE (which determine the relative weights of the six curves in the national averages).

6. However, FEMA uses the same damage function for inland and coastal areas in Zone AE. A given depth of flooding tends to do more damage in coastal areas (even outside V zones), so using a single average damage function for Zone AE results in a cross-subsidy. FEMA is currently studying that issue.

claims experience.[7] In calculating its average experience, the agency applies a weight of 1 percent to the data from 2005 and a weight of 99 percent to the average of all other years, on the grounds that the long-duration flooding of 2005 was highly unusual and should not excessively influence future expectations. Because FEMA now has about 30 years of claims data, going back to 1978, those weights have the effect of reducing the impact of the 2005 experience from about 3 percent (1/30) to 1 percent—in effect, treating 2005 as a 1-in-100-year event. The agency has commissioned a study to provide recommendations on the appropriate treatment of the 2005 experience.

FEMA's Correction for Short Historical Records in Zone AE

In some cases, the method outlined above for calculating expected percentage losses underestimates the actual risks: A small-sample bias exists whenever the length of available data is short relative to the return period of the risks being studied. For example, FEMA estimates that for a location with 25 years of data, a 100-year flood estimated without correcting for sample bias can be expected to have a true return interval of 63 years—or, in other words, to have an annual exceedence probability of 1.59 percent (1/63) instead of the intended 1 percent.

The many small samples that exist nationwide include representative numbers of small and large floods. But the errors in estimated flood risks—with some estimates being too high and some too low—do not cancel each other out. FEMA uses flood records and a statistical model of flood flow in a local area to calculate an exceedence probability. Graphically, that probability is a decreasing and concave function of flood flow for rare floods. In FEMA's modeling, areas that have below-average flood experience exert disproportionate influence on the estimated national average probability compared with areas that have above-average flood experience. Intuitively, for a true exceedence probability of 1 percent, for example, estimation errors from small samples resulting in low estimates must be between zero and 1 percent, while errors resulting in high estimates may be much greater than 1 percent—and the average of the high and low estimates will be greater than 1 percent. A second but smaller source of bias from short historical records is downward bias in estimates of sample standard deviations.[8]

Since the late 1980s, FEMA has compensated for small-sample bias in its estimates for Zone AE by conducting the above analysis again using a second set of elevation probability curves that incorporate a correction for small samples.[9] Those curves, called PELV(500) curves, assume that the short data records cover 25 years.[10] FEMA combines the results obtained using the two sets of PELV curves; in doing so, it uses weights of 20 percent for the PELV(500) results and 80 percent for the regular PELV results, based on its original estimate that 20 percent of the NFIP's policies were in communities with short records.

If those weights produced the right amount of correction for small-sample bias when FEMA first implemented the approach in the late 1980s, they may be leading to overcompensation now and thus contributing to an actuarial surplus on policies in Zone AE (and by extension in unnumbered Zone A). One reason is that the percentage of the NFIP's exposure that is in communities with relatively short records has declined in the past two decades as the program's policies have become increasingly

7. The Government Accountability Office has also questioned the reliability of the data FEMA uses in deriving the damage functions; ibid., pp. 14–16. It found evidence that many entries in the claims database show a flood depth of zero feet (FEMA's classification for depths of a few inches) not because the adjustors who filed the claims actually reported zero feet but because they reported no depth figure at all. Misattributing damage caused by deeper flooding to shallower flooding, which occurs more frequently, should contribute an upward bias to FEMA's estimates of future claims. However, CBO does not know of any comprehensive review of the data that underpin the NFIP, and the program could have other data-quality problems that have the opposite effect.

8. See Clayton H. Hardison and Marshall E. Jennings, "Bias in Computed Flood Risk," *Journal of the Hydraulics Division: Proceedings of the American Society of Civil Engineers,* vol. 98 (March 1972), pp. 415–427.

9. According to FEMA staff, the need to correct for small-sample bias does not arise in Zone VE because coastal communities tend to have longer records of floods. The correction also does not apply in Zone X because, as mentioned above, rates for that zone are set on the basis of professional judgment, informed by the program's actual experience of losses, not on the basis of estimated event frequencies.

10. See Howard Leikin and Saul Singer, "National Flood Insurance Program Rate Review Process," in *NFIP Interactive Rate Model Documentation* (June 1987), p. 3.

concentrated in coastal areas, where flood records tend to be longer. Another reason is that over the same period, communities with shorter records have accumulated additional data, some of which have been incorporated into FEMA's models when flood maps have been revised.

FEMA's approach to the problem of small-sample bias has some important limitations. First, it creates a cross-subsidy because it raises the rates charged on all Zone AE policies nationwide, not just on those in communities with short flood records. Second, small-sample bias is a factor that shrinks the areas mapped as 100-year floodplains and reduces the estimated depth of flooding in communities with short historical records. All else being equal, in a community that has 25 years of data, what appears to be a 1-in-100 chance of flooding on the basis of those data can be expected, on average, to be a 1-in-63 chance. For such a community, therefore, the mapped 100-year floodplain could actually be a 63-year floodplain, making the annual risk of flooding in Zone X just outside the floodplain boundary not 1 percent but 1.59 percent. Some other factors in FEMA's mapping process, however, also have not been updated for many years.[11] Those factors could exacerbate or offset the effect of the small-sample bias.

Undersized floodplains and underestimated flood depths in communities with short historical records would negatively affect the NFIP's floodplain management goals by reducing the effectiveness of the program's elevation requirements for new construction in 100-year floodplains. Specifically, when floodplains are mapped too small, the requirements do not apply in some areas where they would otherwise; and where they do apply, the requirements are lower than intended.

The mapped errors, however, probably have little or no adverse impact on the actuarial soundness of the NFIP. One reason is that the "additional" floods that affect properties in the mapped A zones because the elevation requirements are too low should be offset (or more than offset) by the higher premium rates that result from the PELV(500) adjustment. As for the properties that lie outside a mapped floodplain even though their true flood risk exceeds 1 percent, they are insured at rates that generally do not cover their full expected costs, but the difference is funded largely or entirely through cross-subsidies from other Zone X policyholders, not taxpayers. As discussed in the main text, the starting point for FEMA's estimate of expected losses for structures insured at Zone X standard rates is the observed losses on those policies (which FEMA then multiplies by the ratio of estimated to observed losses for Zone AE). Therefore, if higher flood risks for properties outside an undersized floodplain lead to greater losses on those properties, they drive up the rates paid by all Zone X standard policyholders. The connection between undersized floodplains and higher rates is less automatic for preferred-risk policies in Zone X, because FEMA's actuaries do not set those rates according to a simple formula. Nevertheless, a connection between greater risks and higher rates is likely to occur over time as the actuaries apply their professional judgment to the available data. (For more details about cross-subsidies in the NFIP, see Appendix B.)

Converting Expected Percentage Losses into Premium Rates

For insured properties in Zone AE, after estimating expected percentage losses using the PELV and PELV(500) curves discussed above, FEMA converts those loss estimates into premium rates by using several adjustment factors. In keeping with standard insurance practices, some of the adjustments take into account administrative expenses, optional deductibles, loss-adjustment expenses, and underinsurance (that is, coverage for less than the full value of the insured property). In addition, FEMA includes a contingency loading of 10 percent to provide a safety margin for uncertainty, and it offsets the discounts given under the Community Rating System (CRS) by scaling the base (undiscounted) rates upward so as to keep the CRS program revenue neutral. Those various adjustment factors, other than the contingency loading, are reviewed by FEMA each year and revised as necessary.[12]

FEMA also adjusts the rates as necessary to keep them between certain lower and upper bounds. Specifically, it ensures that rates do not fall below minimum levels chosen to cover the agency's fixed expenses per policy and

11. For example, guidelines for mapping areas with short historical records specify that regional data should be averaged with local data for part of the analysis (estimating skewness). See Interagency Advisory Committee on Water Data, *Guidelines For Determining Flood Flow Frequency,* Bulletin 17B of the Hydrology Subcommittee (Department of the Interior, March 1982). The primary source for regional data included in Bulletin 17B has not been updated since 1972, which could be causing upward or downward bias.

that average rates for each type of structure do not rise by more than 10 percent a year.

For properties in Zone VE, FEMA uses the same process to convert expected percentage losses into premium rates, with two exceptions. First, it currently applies a contingency loading of 20 percent, not 10 percent. Second, since 2001, FEMA has generally added one more step to scale the rates upward to the extent allowed by the 10 percent cap on annual increases.[13] As discussed in the main text, that extra step is the agency's response to the costs associated with coastal erosion and to the cap itself. Erosion-related costs are expected to rise so rapidly in the future as shorelines continue to move inward, toward areas of denser development, that the 10 percent cap would not allow FEMA's premium income from Zone VE to keep pace. Raising current rates above the levels thought to be sufficient to cover current costs prefunds some of the future risk. It also allows future rate increases to be larger in dollar terms than they would be otherwise because the 10 percent cap will apply to a higher base.

12. Of the factors used in calculating the expected losses themselves, generally only the damage functions that relate water height in a structure to percentage damage change from year to year. FEMA updates those functions annually using actuarial credibility analyses of its accumulated loss experience and studies by the Army Corps of Engineers. FEMA occasionally reviews how its exposure is distributed among the six topographic profiles, on a state-by-state basis, and revises the weights as needed.

13. In practice, the increases may average significantly less than 10 percent. As noted in the main text, FEMA interprets the 10 percent cap on average increases to mean that it should not raise the rates on particular groups of properties by much more than 10 percent. That interpretation can constrain the average increase in full-risk rates in Zone VE because the agency scales all of those rates upward by the same proportion. To illustrate, suppose the previous steps in the rate-setting process would lead to increases of 2.5 percent for 60 percent of the full-risk policies in Zone VE, 6 percent for 30 percent of the policies, and 7 percent for the other 10 percent of the policies, yielding an average increase of 4 percent. Multiplying each of the increases by a scaling factor of 2.5 to achieve an average rise of 10 percent would produce an increase of 17.5 percent on some policies. If FEMA decided that the maximum allowable increase on those policies was 14 percent, then the scaling factor would be 2 rather than 2.5, and the average increase for all policies would be 8 percent.

APPENDIX

B

Residual Risk Behind Levees and Other Cross-Subsidized Risks

A cross-subsidy in insurance coverage exists whenever the rates charged on some policies exceed the expected cost of the claims and expenses on those policies (including the return on capital) while the rates charged on other policies fall below their expected cost. In practice, no insurance program can be completely free of cross-subsidies because insurers cannot collect information on all of the myriad factors that influence the level of risk. When rates are based on past claims, every omitted factor that increases risk creates a cross-subsidy from the policyholders who do not have that factor to those who do (and conversely for omitted factors that reduce risk). In the case of the National Flood Insurance Program (NFIP), unpriced risk factors create cross-subsidies to the extent that they affect flood risks to properties outside 100-year floodplains (that is, in Zone X) or affect the damage caused by a given depth of flooding in any zone—both of which the Federal Emergency Management Agency (FEMA) estimates on the basis of the program's experience.[1]

Cross-subsidies do not necessarily undercut the actuarial soundness of the NFIP, but they can decrease economic efficiency. Policyholders who pay rates that do not fully reflect their risks have less financial incentive to take cost-effective actions to reduce those risks. That effect applies whether or not the reduced rates are cross-subsidized. The other adverse impact of cross-subsidies is that potential policyholders who face premiums that are higher than they would be otherwise may choose to buy less coverage or forgo it entirely. Conceivably, the incentives to reduce or avoid those higher rates could also encourage some property owners to take excessive measures (ones whose costs exceed the expected benefits) to reduce their risks if doing so would lower their premiums.

An important cross-subsidy in the NFIP involves policies that cover properties in areas protected by levees, dams, walls, or other flood-control structures. (For simplicity, such structures are referred to collectively as levees hereafter.) This appendix explains the cross-subsidy to those properties, outlines some options for reducing the risk of flooding in those areas, and briefly reviews the other cross-subsidies in the flood insurance program.

Residual Risk Behind Levees

NFIP premium rates provide a cross-subsidy to policyholders whose properties are in areas protected by levees that have been certified as capable of withstanding a 100-year flood. The cross-subsidy arises because the same Zone X rates apply to those areas as to areas that naturally lie outside 100-year floodplains, even though actual risks in the levee-protected areas tend to be higher.[2]

That difference in risks—called residual risk—occurs for two reasons. First, levees may fail to provide the expected

1. More precisely, such factors create a pure cross-subsidy, on average, over the long run but may result in a mixture of cross-subsidies and taxpayer subsidies in the short run. If the observed losses associated with a particular unpriced risk are below their long-run expected average, then experienced-based premiums do not reflect the full additional risk, and taxpayers implicitly bear some of the risk. That would be the case if, for example, experience before Hurricane Katrina did not reveal the full extent of the residual risk to areas protected by levees.

2. The premium rates distinguish levee-protected areas in two special cases. Explicitly subsidized rates are available for properties that will be considered protected against a 100-year flood when a half-finished levee or other structure is completed. Properties in areas that were protected by structures that FEMA now deems insufficient are also eligible for subsidized coverage, provided the plan and schedule for making repairs or upgrades meet specific standards.

level of protection because they subside (settle), deteriorate from tree growth, or experience other maintenance problems. The NFIP does not require periodic inspection or recertification of levees, and in its remapping program, FEMA has identified many levees that no longer comply with its regulations and should be decertified.[3] Second, even if levees perform as advertised against events up to and including a 100-year flood, the damage that results from a larger flood could be greater than in other nonfloodplain areas—for example, if levees are not just overtopped but breached.

The significance of residual risk for the NFIP is illustrated by the losses that New Orleans suffered from Hurricane Katrina, in which levee failure played a major role. Likewise, Sacramento could experience billions of dollars of losses if a major flood overtopped the levees in California's Central Valley.

Reducing Flood Risks to Areas Behind Levees

The interest of policymakers and analysts in levees and other flood-control structures focuses less on those structures' implications for the NFIP than on the adequacy of the protection they provide. The two issues are related, however. Currently, the NFIP treats areas behind levees built to protect against 100-year floods and areas that naturally lie outside 100-year floodplains the same for regulatory as well as rate-setting purposes. Thus, such levee-protected locales are not subject to the land-use restrictions that apply inside floodplains, and property owners in those areas do not have to meet the mandatory-purchase requirement that would otherwise apply to properties with federally insured or federally regulated mortgages.[4] As early as 1980, FEMA found that communities were building levees to the 100-year standard to avoid those requirements.[5] The result may be to encourage development in risky areas without encouraging mitigation measures beyond the levees themselves.

Some observers have proposed making changes to the NFIP to reduce flood damage in areas behind levees. One proposal would authorize or direct FEMA to take account of residual risk in setting premiums for structures in those areas. Besides improving the actuarial soundness of the NFIP, accounting for that residual risk in premium rates could help make property owners more aware of the limitations of the protection that levees provide. By itself, however, that approach would not affect the regulatory status of the protected areas.

A second option would be to increase the level of protection a levee must provide in order for the protected area to be exempt from the mandatory-purchase and floodplain management requirements. Some U.S. analysts have called for the exemption standard to be increased from 100-year protection to 500-year protection, at least in urban areas.[6]

Other proposals to lessen flood damage in areas protected by levees would not involve the NFIP. An example is the call by some experts for more systematic inspection and maintenance of levees to better ensure that they will perform as designed.[7]

3. Interagency Levee Policy Review Committee, *The National Levee Challenge: Levees and the FEMA Flood Map Modernization Initiative* (September 2006), available at www.fema.gov/library/viewRecord.do?id=2677.

4. Properties inside floodplains are required to carry NFIP coverage if they have a mortgage from a lender primarily regulated by a federal agency or a mortgage that is insured or purchased by a federal agency or government-sponsored enterprise such as Fannie Mae or Freddie Mac. Also, property owners who receive certain types of federal disaster aid after a flood must purchase and maintain NFIP coverage to remain eligible for such assistance after subsequent floods.

5. Gerald E. Galloway and others, *Assessing the Adequacy of the National Flood Insurance Program's 1 Percent Flood Standard,* report prepared as part of the 2001–2006 evaluation of the National Flood Insurance Program (Washington, D.C.: American Institutes for Research, October 2006), available at www.fema.gov/library/viewRecord.do?id=2595.

6. Interagency Levee Policy Review Committee, *The National Levee Challenge*. In the Netherlands, levees and other forms of flood protection are built to protect against 10,000-year storms in coastal areas and 1,250-year floods along major rivers. In Japan, voluntary standards call for protection against 10,000-year events in heavily populated coastal areas and 200-year events in riverside population centers; Galloway and others, *Assessing the Adequacy of the National Flood Insurance Program's 1 Percent Flood Standard*, pp. 69–71.

7. Association of State Floodplain Managers, *Levees: The Double-Edged Sword* (April 17, 2007), available at www.floods.org/PDF/ASFPM_Levee_Policy_Challenges_White_Paper.pdf.

Other Cross-Subsidies in the Flood Insurance Program

Residual risk behind levees has drawn particular attention from policymakers in part because of the catastrophic results of levee failures in New Orleans. However, other cross-subsidies exist under the NFIP's current rate structure.

Besides areas protected by levees, another part of Zone X that faces unpriced above-average risks is 100-year floodplains smaller than one square mile. Those areas are generally included with nonfloodplain locations in Zone X because identifying and mapping such small areas would be prohibitively expensive.[8] Another source of cross-subsidies in the NFIP is the equal treatment of Zone AE properties in inland and coastal areas. Those coastal properties tend to experience more damage for a given depth of flooding (though less than properties in Zone VE, which are exposed to waves of three feet or more during a 100-year flood), but that difference is not factored into premiums. The effect is to raise the estimates of damage as a function of depth that FEMA uses for all Zone AE structures, resulting in a cross-subsidy.

Grandfathering properties at lower rates than they would otherwise be eligible for is another type of unpriced risk—though one driven by FEMA policy rather than by legal constraints or data limitations. Most of the properties that are grandfathered after a flood map is revised are Zone X properties that would have been reclassified into an A or V zone.[9] Continuing to include those properties in the group insured at the Zone X standard rate makes the average losses in the group higher than they would be otherwise, creating a cross-subsidy from owners of "true" Zone X properties. Although such grandfathering encourages the policyholders who provide the cross-subsidy to reduce or drop their coverage (an incentive that grows stronger as the percentage of grandfathered properties increases), FEMA allows grandfathering in order to hasten the incorporation of new information into communities' floodplain management efforts by reducing property owners' opposition to the revised maps.

8. Personal communication, representatives of the Association of State Floodplain Managers, October 24, 2007. In addition, FEMA's rates do not account for the risk of stormwater flooding (flooding from water that has not yet entered a river, stream, or other channel). In Zone AE, stormwater flooding contributes to an actuarial shortfall because such flooding is not included in the modeled flood frequencies on which rates for that zone are based. In Zone X, the result may be a cross-subsidy to owners of properties that are subject to stormwater flooding if they face higher risks overall—for example, if their risks of regular flooding are average and the stormwater risks are on top of that average risk.

9. As noted in the main text, however, some grandfathered properties are A-zone properties that would have moved to a V zone, or A- or V-zone properties that would have remained in the same zone but been reclassified at a lower elevation. Because the "excess" flooding experienced by such properties does not feed back into higher rates for all properties in those zones—as it does for grandfathered properties in Zone X—the result is an implicit subsidy from taxpayers rather than a cross-subsidy.

APPENDIX

C

The Heinz Center's Study of Erosion Risks

Coastal erosion of beaches, bluffs, and cliffs is a complex phenomenon, influenced by both natural factors and human activities. Areas subject to erosion pose two special challenges to the efforts of the Federal Emergency Management Agency (FEMA) to map flood risks. FEMA's maps reflect the fact that such areas may experience more damage from a given storm if it washes away the land beneath buildings' foundations. However, the maps do not reflect the fact that erosion moves the coastline inward, leaving properties closer to shore and hence at greater risk. For example, homes that were previously classified as outside the coastal flood zone—defined as the area exposed to damage from waves of three feet or higher in a 100-year flood—may be exposed to such waves after erosion occurs.

The Scope of the Erosion Problem

In 2000, the Heinz Center produced a study for FEMA on erosion issues in the National Flood Insurance Program (NFIP).[1] The study reached several conclusions:

- NFIP policies cover most erosion damage, but the program does not explicitly include the risk of such damage in its premium rates.[2] Moreover, it does not map existing erosion-hazard areas, so flood insurance maps may be misleading.

- On average, the risk of damage from erosion is almost equal to that from flooding along the Atlantic and Gulf coasts, where losses of roughly two to three feet of shoreline per year are common. In the next 60 years, about 25 percent of homes within 500 feet of the coast (outside major cities, which are well protected against erosion) will be lost nationwide because of erosion-related damage. That estimate translates to about 1,500 homes per year. However, not all coastal regions are subject to erosion, and loss rates vary considerably among communities.

- Over the next 60 years, erosion will cost the NFIP an average of $80 million more per year in claims, assuming no new development, changes in participation rates, or additional actions to protect shorelines. Of that $80 million, the Atlantic coast will account for $70 million and the Gulf coast for $10 million.[3] (Losses on the Pacific and Great Lakes coasts are expected to be fairly small.)

- FEMA estimates that a nationwide program to map erosion-hazard areas would cost about $44 million—or less than $5 million a year over the 10-year useful life of erosion maps. Such mapping would be cost-effective if it discouraged even a small fraction of current development or encouraged mitigation of existing properties.

1. H. John Heinz III Center for Science, Economics, and the Environment, *Evaluation of Erosion Hazards* (report prepared for the Federal Emergency Management Agency, April 2000), available at www.heinzcenter.org/publications/#majorreports.

2. The program's definition of a flood includes "the collapse or subsidence of land . . . as a result of erosion or undermining caused by waves or currents of water exceeding anticipated cyclical levels or suddenly caused by an unusually high water level in a natural body of water"; ibid., p. 45. Excluding wet-weather erosion from NFIP coverage would be impractical because it is usually impossible to distinguish between losses from erosion and losses from flooding in such cases. In contrast, dry-weather collapse of a building because of erosion is not covered under the NFIP.

3. Ibid., Table S.2, p. xxix. Surveys indicate that only about half of the houses in high-erosion areas on the Atlantic and Gulf coasts have flood insurance.

- FEMA has responded to erosion risks by raising rates in all V zones, but those uniform increases create cross-subsidies within the zones from policyholders whose properties do not face such risks.

In principle, the risk of erosion would not be a source of additional costs to the NFIP if maps and premium rates could be updated after each change in a shoreline. In practice, however, flood insurance maps are not revised that often. And even when an area is remapped, FEMA generally grandfathers the existing properties, continuing to insure them at rates that ignore any changes in their zone classification or elevation relative to the base flood level.

FEMA believes it would need authorization and funding from the Congress for erosion mapping before it could impose additional charges in erosion-hazard areas. Lacking such authorization, FEMA began a multiyear plan in May 2001 to increase rates for all policies in coastal zones above currently required levels. Boosting premiums now has two advantages for the agency: It prefunds some future erosion costs, and it provides a higher base from which future premiums can grow at the maximum statutory rate of 10 percent a year. Over the first eight years of the plan, the cumulative increase for full-risk policies in coastal zones averaged 78.2 percent.[4]

Including Erosion Risks in NFIP Premiums

Such large rate increases, and the need for continued increases in the future, heighten questions about the efficiency and fairness of the NFIP's current rate structure. Large cross-subsidies undermine mitigation incentives for policyholders who receive the subsidies and encourage policyholders who provide them to drop out of the program. If the goal were to set actuarially fair rates to protect taxpayers and to keep one class of policyholders from subsidizing another, then erosion risks would be mapped and separately priced.

The Heinz Center's study included estimates of the increases needed to price erosion risks under various approaches that draw the risk classes more or less finely. In particular, the study estimated rates for the following scenarios:

- Replace the existing coastal zones with a new coastal high-hazard zone that includes the current areas plus any areas subject to erosion within the next 60 years.
- Establish a new 60-year erosion-hazard zone, which would overlap but be distinct from the existing coastal zones. (About two-thirds of insured properties in the existing zones do not face erosion risks, according to the study.)
- Establish new erosion-hazard zones that classify the risks more finely, such as one zone for areas subject to erosion within the next 20 years and a second zone for areas expected to erode between 20 and 60 years from now.

The specific estimates from the Heinz study are no longer meaningful because they do not reflect the large rate increases that FEMA has already imposed since 2001. However, the relative magnitudes still help to illustrate the contrasts among the approaches. In particular, the rate increase for a one- to four-family home that would apply in a separate 20-year erosion zone is more than 10 times the increase that would apply if the burden of paying for erosion risk was shared evenly throughout a coastal high-hazard zone: $11.40 per $100 of coverage versus $0.90 (see Table C-1).[5]

The choice of how broadly or narrowly to define risk classes entails a trade-off. On the one hand, average

4. In May 2008, rates for both full-risk and subsidized coastal-zone policies grew by roughly the maximum of 10 percent. Thomas L. Hayes and Dan R. Spafford, *Actuarial Rate Review: In Support of the May 1, 2008, Rate and Rule Changes* (Federal Emergency Management Agency, National Flood Insurance Program, August 2008), pp. 18 and 22, available at www.fema.gov/library/viewRecord.do?id=3430.

5. If the Congress chose to maintain the current proportional subsidies for older properties (primarily ones built before 1975 or before the local community joined the NFIP), those increases in premiums would range from $0.35 to $4.35 per $100 of coverage. CBO estimates that about half of the policies in coastal zones are explicitly subsidized (that estimate is based on Hayes and Spafford, *Actuarial Rate Review*, p. 34). As originally defined by the Heinz Center, the scenario involving two erosion-hazard zones applied the erosion premiums only to new structures (whose owners could decide to build outside the 0- to 20-year erosion zone to avoid the higher premiums there); older subsidized properties would not be affected. The figures used here are for one- to four-family homes. Other types of properties would face analogous increases.

Table C-1.

Illustrative Rate Increases to Price Erosion Risks

(Dollars per $100 of coverage for a 1- to 4-family residence)

	Increase in Unsubsidized Rates		Increase in Subsidized Rates	
Policy Option	For a Residence in a Coastal Flood Zone That Is Not an Erosion-Hazard Area	For a Residence in an Erosion-Hazard Area	For a Residence in a Coastal Flood Zone That Is Not an Erosion-Hazard Area	For a Residence in an Erosion-Hazard Area
Combine Coastal Flood and Erosion Risks into a Coastal High-Hazard Zone	0.90	0.90	0.35	0.35
Introduce an Erosion-Hazard Zone for 0- to 60-year EHAs	n.a.	2.45	n.a.	0.95
Introduce Two Erosion-Hazard Zones				
0- to 20-year EHAs	n.a.	11.40	n.a.	4.35
20- to 60-year EHAs	n.a.	1.75	n.a.	0.65

Source: Congressional Budget Office based on H. John Heinz III Center for Science, Economics, and the Environment, *Evaluation of Erosion Hazards* (report prepared for the Federal Emergency Management Agency, April 2000), Table 6.10, p. 181.

Notes: EHAs = erosion-hazard areas; n.a. = not applicable.

These estimates assume that the National Flood Insurance Program pays 85 percent of damages from hurricanes, that it has overhead costs of 35 percent, and that premiums for subsidized structures are about 38 percent of full-risk rates.

pricing is simpler and distributes the burden of risk more broadly, thereby minimizing the required increases. (According to an estimate in the Heinz study, few people are likely to purchase erosion coverage voluntarily at rates above $5.00 per $100.)[6] On the other hand, pricing that is based on narrow risk classes minimizes cross-subsidies and thus avoids discouraging participation by people whose risks are lower than average. Such pricing also sends the most accurate signals of the true costs of developing or maintaining property in high-risk areas.

Besides charging full-risk insurance premiums, another way to limit erosion risks is by restricting land use. According to the Heinz study, most of the nation's 30 coastal states already impose setback requirements to prohibit new construction close to the shoreline, but the specific requirements vary widely. Seven states define the setback in terms of the area expected to be exposed to the risk of erosion within a certain period (typically 30 years for houses and 60 years for larger structures); other states define it as a certain distance (typically 25 to 100 feet) from some measure of the shoreline.[7] FEMA could set community standards that incorporate erosion risks, as it already does for flood risks. Two other approaches are to spend more money on shoreline-protection measures (such as beach replenishment, dune restoration, and shoreline hardening) or on buyouts or similar inducements to encourage existing owners to relocate.

6. Heinz Center, *Evaluation of Erosion Hazards*, p. 160.

7. Ibid., p. xxxviii.

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