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Potential Cost Savings from the Pre-Disaster Mitigation Program

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REPORT

Potential Cost Savings from the Pre-Disaster Mitigation Program

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Notes

Numbers in the text and tables of this report may not add up to totals because of rounding.

The cover photo shows a house in coastal Mississippi that was elevated using funds from a program of the Federal Emergency Management Agency (FEMA). Several years later, the house was the only one on its street left standing after Hurricane Katrina. (FEMA photo by Robert Harris)

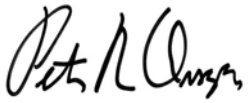
Preface

This document fulfills the requirement in section 209 of the Disaster Mitigation Act of 2000 (as amended by the Predisaster Mitigation Program Reauthorization Act of 2005) that the Congressional Budget Office (CBO) complete by September 30, 2007, "a study estimating the reduction in Federal disaster assistance that has resulted and is likely to result from the enactment of this Act." Staff members of the House Committee on Transportation and Infrastructure and the Senate Committee on Environment and Public Works advised CBO to focus the study on the effects of the Pre-Disaster Mitigation (PDM) program, which was created by section 102 of the 2000 act.

This report examines the extent to which the mitigation projects funded so far by the PDM program might reduce expected losses from future natural disasters, and the extent to which that reduction in losses might translate into lower spending for federal disaster assistance. The analysis uses information about projects funded under the PDM program and builds on the results of a study by the Multihazard Mitigation Council (MMC) of the National Institute of Building Sciences. In keeping with CBO's mandate to provide objective, impartial analysis, the report makes no recommendations.

Perry Beider of CBO's Microeconomic Studies Division wrote this report under the supervision of Joseph Kile and David Moore. Tony Hake, Karen Magnino, Kim Rogers, Cecelia Rosenberg, Shabbar Saifee, and Jody Springer of the Federal Emergency Management Agency provided and helped to interpret the data on PDM projects. Keith Porter of the California Institute of Technology and Adam Z. Rose of the University of Southern California provided information on the methodology and results of the MMC study. Robert Dennis, Peter Fontaine, Arlene Holen, Daniel Hoople, Nathan Musick, Robert Sunshine, David Torregrosa, and G. Thomas Woodward of CBO offered helpful comments on various drafts of this report.

Christian Howlett edited the report, and Kate Kelly proofread it. Maureen Costantino designed the cover. Lenny Skutnik prepared the printed copies, Linda Schimmel coordinated the print distribution, and Simone Thomas prepared the electronic version for CBO's Web site (www.cbo.gov).



Peter R. Orszag
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Summary

Part of the mission of the Federal Emergency Management Agency (FEMA) is to promote steps by communities, businesses, and individuals to reduce their vulnerability to natural disasters. In keeping with that objective, FEMA's Pre-Disaster Mitigation (PDM) program provides grants to help communities plan and carry out projects that are intended to lessen casualties and property damage from earthquakes, floods, hurricanes, and other natural hazards. Since 2004, the PDM program has awarded about $310 million for mitigation projects and roughly $50 million for planning activities. The program is predicated on the idea that mitigation can be cost-effective in protecting people and property from natural disasters.

The Disaster Mitigation Act of 2000, as amended, requires the Congressional Budget Office (CBO) to study the reduction in federal disaster assistance that has resulted and is likely to result from enactment of that law, which created the PDM program.[1] CBO's analysis of the PDM program points to the following conclusions:

- The total dollar value of the expected reduction in disaster losses from the projects funded so far exceeds the projects' costs. The best available information suggests that, on average, future losses are reduced by about $3 (measured in discounted present value) for each $1 spent on those projects, including both federal and nonfederal spending. Significant uncertainty surrounds that estimate, however, and the information available on past projects may not reliably indicate the effectiveness of additional mitigation projects in the future. The benefits of federal spending on such projects could be lower than the benefits of the projects themselves if some of the projects (or other mitigation efforts) would have been undertaken by state and local governments or the private sector in the absence of federal grants. Conversely, the benefits of federal spending could be higher if such spending helps encourage additional mitigation efforts by other parties.

- If federal funding for postdisaster assistance declines in proportion to the decrease in property damage, the existing PDM-funded projects could lower federal spending by an average of roughly $10 million to $20 million per year over the next 50 years, CBO estimates.[2] Such amounts would be small relative to the size of federal disaster aid—which, in the decade before Hurricane Katrina, averaged about $5.3 billion a year from FEMA alone. But those savings would be large enough to make the federal investment of $310 million in the projects cost-effective in budgetary terms.

- Any federal savings from PDM-funded mitigation projects would occur largely in FEMA's disaster relief programs (which are funded from discretionary appropriations) and in its National Flood Insurance

1. The original 2000 law required CBO to complete its study by October 30, 2003 (see Public Law 106-390, 114 Stat. 1571). On October 23, 2003, CBO reported by letter to the Chairmen of the House Committee on Transportation and Infrastructure and the Senate Committee on Environment and Public Works that no cost savings had resulted so far because FEMA had not yet implemented the new program, and future savings could not be estimated because the available data on existing mitigation programs were unreliable. The Predisaster Mitigation Program Reauthorization Act of 2005, which amended the 2000 law, extended the deadline for CBO's study to September 30, 2007 (see P.L. 109-139, 119 Stat. 2649).

2. The amount of disaster aid that the federal government provides may depend not only on property damage but also on deaths and injuries, business interruptions, and other types of losses. However, property damage is used here as a proxy for all disaster losses. Fifty years is a standard lifetime assumed for many mitigation projects.

Program (which ordinarily is not funded through the appropriation process). The savings to the flood insurance program (net of cuts in insurance premiums) would depend on the extent to which the mitigation projects focused on properties that were insured at subsidized rates. Because reductions in discretionary spending for disaster relief would depend on future Congressional action, they could not be counted for scorekeeping purposes as an offset to the costs of mitigation; by contrast, estimated net savings in direct (mandatory) spending for the flood insurance program could be counted as an offset under some circumstances.

Potential Cost Savings from the Pre-Disaster Mitigation Program

Overview of the Pre-Disaster Mitigation Program

Under the Pre-Disaster Mitigation (PDM) program, the Federal Emergency Management Agency (FEMA) makes grants to state, local, and tribal governments for the purposes of raising awareness about disaster risks and reducing future casualties and property damage. The grants focus on two areas: predisaster mitigation planning and the implementation of cost-effective mitigation measures. Planning grants help fund efforts in local communities to identify hazards and prioritize activities to reduce the associated risks. Project grants are used for a variety of initiatives, such as creating "safe rooms" where people can take shelter during tornadoes, retrofitting public buildings to better withstand earthquakes, protecting the operations of gas and electric utilities, and acquiring property to convert flood-prone areas to open space.

The federal government's share of the costs of activities funded with PDM grants can be as high as 75 percent—90 percent for small and impoverished communities—with state or local governments covering the rest of the costs. For the period from 2004 to mid-June 2007, the overall federal cost share for activities funded by the PDM program was 64 percent: $357 million out of $559 million. That $357 million in federal funding consisted of roughly $310 million for 317 mitigation projects and $48 million for 422 planning activities.

The PDM program generally awards grants on the basis of a nationwide competition.[1] For 2007, the program received applications from 47 states, 7 tribal governments, and 3 territories. The applications included 430 "subapplications" from individual communities requesting a total of $292 million—about three times the available funding of $100 million. The selection process involves multiple stages of screening, ranking, and evaluating the subapplications according to various criteria, such as the priority given to a proposal by the state government, the strength of the local community's mitigation efforts, and the "strategy for and identification of appropriate and useful performance measures."[2]

That competitive approach distinguishes the PDM program from FEMA's other major mitigation programs. In the Hazard Mitigation Grant Program, funds are awarded to states that have experienced a Presidentially declared disaster, and the amounts are determined as a percentage of the total funds allocated for postdisaster public and individual assistance. In the smaller Flood Mitigation Assistance program, which is limited to flood hazards, the available funds are allocated using a formula based on the number of properties with flood insurance in each state and the number of insured properties that have experienced multiple flood losses.

1. There are exceptions: For example, in 2007, each state that submitted enough grant proposals that met the eligibility requirements was assured of receiving at least $500,000—potentially removing from competition $25 million of the total $100 million that was available.

2. Federal Emergency Management Agency, *FY 2007 Pre-Disaster Mitigation Program Overview,* available at www.fema.gov/library/viewRecord.do?id=2096. Currently, the criteria used to rank and evaluate projects for funding do not include the ratio of expected reductions in future disaster losses to project costs, although such ratios must be submitted with the applications and are reviewed to screen out any projects whose costs exceed the reduced losses. FEMA staff told CBO that in the early years of the PDM program, the ranking and evaluation process used those ratios directly. That practice was later changed in response to concerns that it led to a bias against applications from smaller communities that did not have the ability to document project gains as thoroughly as larger communities could.

Estimated Reductions in Disaster Losses Nationwide

For mitigation to have any effect on federal disaster assistance, it must reduce the disaster losses that lead to requests for such assistance. Thus, the Congressional Budget Office's (CBO's) analysis of the potential budgetary impact of the PDM program first looked at the extent to which the program has lessened expected losses from floods, earthquakes, hurricanes, tornadoes, and other natural disasters—which is also the program's expected benefit to the economy as a whole.

The best available information indicates that the projects funded under the program have generally been cost-effective. In other words, the discounted present value of their future reductions in disaster losses tends to exceed their total (federal and nonfederal) costs. The mitigation projects funded from 2004 to mid-June 2007 had total costs of nearly $500 million (see Table 1). CBO estimates that the reduction in future losses associated with those projects has a present value of $1.6 billion, for an overall ratio of about 3 to 1.[3] That estimate covers reductions in property damage and casualties; in some cases, it also includes reductions in business interruption and in damage to the environment or historical property. (The sources and limitations of the information underlying the estimates are discussed in the next section.) The PDM program also helped fund $65 million in mitigation planning activities between 2004 and mid-June 2007, but CBO cannot estimate the reduction in losses resulting from those activities.[4]

The 3-to-1 cost-effectiveness ratio for PDM-funded mitigation projects as a whole masks wide variation among different types of projects. Those intended to reduce damage from floods, wind storms, mudslides, and fires had ratios higher than the overall figure. Conversely, mitigation projects that address other severe storms had lower ratios, and those intended to lessen earthquake damage appear to cost more than they are estimated to provide in loss reductions. (Other data, however, suggest that earthquake projects are cost-effective; see the discussion in the next section.)

Although the estimates of loss reductions in Table 1 are shown as specific values, they are subject to significant uncertainty, for at least three reasons. First, the engineering models used to analyze projects' effects necessarily entail various assumptions and approximations. Second, the estimates for projects to mitigate flood, earthquake, and wind hazards are based on analyses of limited samples of projects funded by other FEMA programs, which may not fully represent the entire set of PDM-funded projects of those types. Third, even if the estimates shown in Table 1 are accurate for the PDM projects financed to date, they may not accurately predict the results of future projects. The average cost-effectiveness of projects could fall over time if the rate of spending on mitigation exceeds the rate at which the supply of mitigation opportunities is replenished. Alternatively, average cost-effectiveness could rise over time if disasters increase in frequency.[5]

In interpreting the estimates of cost-effectiveness ratios and loss reductions in Table 1, it is also important to note that those estimates are based on the total effects of the mitigation projects, not the incremental effects (if any) that occur because the projects are partially funded by the federal government rather than fully funded by state or local governments. Those incremental effects depend on the extent to which federal funding substitutes for or stimulates additional spending by state or local governments or the private sector. Given that most of the benefits of disaster mitigation—with the notable exception of

3. The project costs and present value of reduced losses reported here are based on grant applications that used nominal dollars from a number of years, primarily 2002 through 2006. Both sets of figures would be slightly higher if they were standardized to 2006 dollars.

4. Estimates of the effectiveness of mitigation planning and other "process" activities are available in Multihazard Mitigation Council, *Natural Hazard Mitigation Saves: An Independent Study to Assess the Future Savings from Mitigation Activities* (Washington, D.C.: National Institute of Building Sciences, 2005). Although that study is the source of CBO's estimates of the effectiveness of earthquake, flood, and wind mitigation projects, CBO does not consider the estimates for process activities to be persuasive. Measuring the effects of a mitigation plan or other process activity is very difficult because it requires identifying the additional subsequent mitigation projects and practices that would not otherwise have occurred. The authors of the study were not able to conduct new research on the average effectiveness of process activities nationwide; instead, they based their conclusions on a small number of existing estimates, most of which considered the results of combinations of process and project activities, not of process activities alone.

5. An increase in the severity of disasters, if the frequency did not change, could make a given mitigation project more or less valuable depending on the extent to which the increase produced disaster events that exceeded the project's design capacity.

Table 1.

Estimated Reduction in Disaster Losses Attributable to Projects Funded by the Pre-Disaster Mitigation Program

Type of Project (By disaster targeted)	Number of PDM Grants	Total Project Costs (Millions of dollars)[a]	Estimated Ratio of Loss Reduction to Cost	Estimated Present Value of Reduction in Future Disaster Losses (Millions of dollars)[b]
Floods (Including coastal storms)	134	219	4.6	1,010
Earthquakes	64	180	0.9	170
Wind Storms (Including hurricanes, tornadoes, and typhoons)	91	66	4.7	310
Severe Storms[c]	13	10	2.7	30
Mudslides and Landslides	4	9	5.6	50
Fires	9	7	5.1	30
Severe Ice Storms	2	4	2.4	10
Total	**317**	**494**	**3.2**	**1,610**

Source: Congressional Budget Office based on Multihazard Mitigation Council, *Natural Hazard Mitigation Saves: An Independent Study to Assess the Future Savings from Mitigation Activities* (Washington, D.C.: National Institute of Building Sciences, 2005), and data from the Federal Emergency Management Agency.

Notes: The numbers shown here are for the mitigation projects that received grants from the Pre-Disaster Mitigation (PDM) program between 2004 and mid-June 2007. The $494 million in total costs for those projects comprised about $310 million in federal costs and $185 million in nonfederal costs. (The PDM program also awarded 422 grants for mitigation planning activities during that period; costs for those activities totaled $65 million, of which the federal share was $48 million.)

The loss-reduction-to-cost ratios shown here represent the present value of the reduction in future losses because of mitigation projects divided by the projects' total costs. CBO estimated those ratios for flood, earthquake, and wind mitigation projects using estimates from the study by the Multihazard Mitigation Council cited above, and it calculated the estimated loss reductions on the basis of the ratios. For the other types of projects, CBO calculated the ratios on the basis of the loss reductions estimated in PDM grant applications. The two sources of data employed different discount rates to calculate the present value of reduced future losses. At the discount rate that CBO would have used when this report was written, the estimated present value of future loss reductions would be slightly lower for flood, earthquake, and wind projects and higher for the other types of projects (see Box 1 on page 6). The total for all projects would be almost the same, however.

a. Total costs include both the federal and nonfederal shares of projects' costs.

b. Rounded to the nearest $10 million.

c. In some cases, projects in the "severe storms" category could have been classified as addressing flood or wind hazards.

reductions in the cost of federal disaster assistance—occur locally, it is possible that at least some of the projects funded through the PDM program would have been undertaken without it. Some evidence suggests, however, that federal funding may increase total mitigation spending by other parties by raising awareness of the existence of mitigation opportunities and their potential gains.[6] Indeed, stimulating additional spending on mitigation projects is the ultimate purpose of mitigation planning activities, including those supported by PDM grants. Federal project grants may also help elicit spending by other parties through a demonstration effect.

Similarly, the gains shown in Table 1 are not the incremental results relative to those from projects that could

6. Based on case studies of eight randomly selected communities, the Multihazard Mitigation Council concluded that "federal hazard mitigation grants often led to additional or synergistic activities"; Multihazard Mitigation Council, *Natural Hazard Mitigation Saves,* p. 120.

have been funded under FEMA's other mitigation programs. If FEMA would have spent more on the Hazard Mitigation Grant Program or the Flood Mitigation Assistance program in the absence of the PDM program (notwithstanding the three programs' different funding mechanisms), then the incremental reduction in losses would depend on the difference in effectiveness between the PDM program and the others. As discussed below, however, the available data do not allow CBO to judge the relative effectiveness of the three programs.[7]

Basis for the Estimates of Reduced Disaster Losses

In calculating the estimated reductions in disaster losses shown in Table 1, CBO relied on information from two sources: a 2005 study by the Multihazard Mitigation Council (MMC) of the National Institute of Building Sciences (*Natural Hazard Mitigation Saves: An Independent Study to Assess the Future Savings from Mitigation Activities*) and FEMA's data files for individual projects funded under the PDM program.[8] In particular, CBO used results from the MMC study for the three types of hazards addressed in that report—flood, earthquake, and wind—and data from the PDM grant files for the remaining hazards: severe storms, ice storms, mudslides and landslides, and fires. (Those last four categories represent 9 percent of the projects funded and 6 percent of the total project costs shown in Table 1.) As discussed below, however, CBO recalculated the benefit-cost ratios published in the MMC study to reflect two differences in methodology: one concerning the conversion of future effects into a discounted present value and the other concerning the extrapolation of results from a sample of projects to the full set.

MMC Estimates Versus Grant-Application Estimates

The MMC study, which was conducted on behalf of FEMA but independently of it, involved detailed analyses of expected reductions in future disaster losses from 89 mitigation projects funded by FEMA's Hazard Mitigation Grant Program or Flood Mitigation Assistance program between 1994 and 2003.[9] The sample of projects comprised 22 that addressed flood hazards, 42 that focused on wind hazards, and 25 that were intended to mitigate earthquake hazards. Because larger projects were sampled at higher rates, the 89 projects represented just 1.8 percent of all such mitigation projects over the period but accounted for 13.5 percent of the total costs.

Besides the MMC study, another source of estimates of future loss reductions from PDM-funded projects is the individual projects' PDM grant applications. But FEMA staff who oversee the review (and sometimes revision) of the estimates in those applications advised CBO to use the benefit-cost ratios in the MMC study where available, for two reasons. First, that study was more comprehensive in its coverage of effects. It took account of reduced losses in categories—such as losses to the environment, to historic buildings, and in business interruptions—that the PDM applications exclude as a matter of Administration policy or because the applicants often find them too difficult or costly to document. Second, the main tool used in the MMC analysis was a set of engineering-economic

7. A final caveat to the estimates in Table 1 is that they do not reflect any adjustments for the efficiency cost of government fundraising. That cost, called the "deadweight loss," arises in part because taxes distort the incentives that people and businesses face in deciding between work and leisure, between spending and saving, and between various consumption and investment alternatives. Taking that efficiency cost into account, however, would not have a major effect on the outcome of the analysis—in part because some of the gains from disaster mitigation are likely to be reflected in less spending on government disaster assistance in the future, thus reducing the deadweight loss associated with that spending. Estimates of the efficiency cost of federal tax revenues vary widely, but the Office of Management and Budget has identified 25 percent as a standard figure to be used in benefit-cost analyses conducted by or for the Administration. Using that figure, if one assumed that spending on mitigation was financed by additional taxes, that the 25 percent applied not only to federal revenues but also to state and local revenues, and that one-third of the reductions in disaster losses translated into reduced disaster assistance costs by all levels of government (a rough figure based on the analysis described on page 10), then the aggregate ratio shown in Table 1 would be 2.8 rather than 3.2.

8. The National Institute of Building Sciences is a nonprofit, nongovernmental organization chartered by the federal government in 1974. Its goal is to bring together representatives of government, the professions, industry, labor, and consumer interests so that findings on technical building-related matters can be used effectively to improve government, commerce, and industry.

9. A different part of the study used eight randomly sampled communities as the basis for case studies of the cumulative effect of federal mitigation funding, examining factors such as the institutionalization of local mitigation programs and the extent of "synergistic" mitigation activities that are not federally funded. As noted above in footnote 4, the study also estimated the average nationwide cost-effectiveness of mitigation "process" activities, such as planning and education, by type of hazard.

models from FEMA known as HAZUS®-MH (modified or extended in some cases by the study's authors).[10] The HAZUS®-MH models reflect more-detailed and current engineering knowledge about the damage caused by disasters of various strengths (as measured by wind speed, seismic movement, flood height, and so forth) than do the models included in the software that FEMA distributes to grant applicants.[11]

One argument against using the results of the MMC study is that they are based on older data—from mitigation projects funded before the PDM program—and thus do not reflect any effects of the program's national competition in improving the average quality of projects or changing the mix of projects funded to address a given type of disaster. FEMA staff say that the program has not significantly altered the mix of projects by hazard type (or by state) compared with the distributions of projects funded by other programs. However, they believe that the competition helps ensure that the most promising projects are submitted, even though the screening and evaluation process does not focus on cost-effectiveness.[12]

In any event, the differences between the MMC estimates and the grant-application data are significant only for projects to mitigate earthquake hazards. For flood- and wind-related projects, the two sets of estimated cost-effectiveness ratios are similar when expressed in comparable terms—in particular, when the same discount rate is used to calculate the present value of future reductions in losses (see Box 1). Approximate calculations by CBO show that when the estimated ratios in the MMC study, which used a discount rate of 2 percent, are converted to the 7 percent rate used in PDM grant applications, the two sets of figures are within about 15 percent of each other for flood and wind projects.

However, the use of a higher discount rate cannot explain why the application data suggest that earthquake mitigation is much more effective than the MMC analysis would indicate. CBO considers it likely that the "true" average cost-effectiveness ratio for federally funded earthquake mitigation lies somewhere between the 0.9 that results from the MMC study (after CBO's modifications, discussed below) and the 5.0 calculated from the PDM applications.

On the one hand, the MMC figure may be too low: There is no obvious reason why well-chosen earthquake projects could not be cost-effective, or why decision-makers would be less concerned about net benefits in selecting earthquake projects than in choosing flood or wind projects. It is possible that the 25 projects underlying the MMC figure were an unrepresentative sample. The study notes that the reduction in losses from an earthquake project can be sensitive to the number of expected occupants of a particular building and that two of the sampled projects had particularly small estimated effects.[13] On the other hand, the figure based on grant-application data may be too high: FEMA staff cautioned that the earthquake models in its software are being reviewed and could change substantially in the future.

Adjustments to the MMC Estimates

One of the two adjustments that CBO made to the ratios reported in the MMC study for each project category involved recalculating the discounted present value of reductions in future disaster losses. Although the MMC study discounted most types of loss reductions (at 2 percent), it did not discount the value of reduced injuries and deaths; CBO adjusted the MMC estimates to apply the discount rate uniformly to all reduced losses (see Table 2 on page 8). The argument for not discounting reductions in casualties is that saving a life (or avoiding an injury) in the future should be considered just as worthwhile as doing so today. However, that approach implies that given a choice between a current life-saving project and a future project with the same time profile of costs and lives saved, the future project is always preferable because it achieves the same results using future dollars, which have a lower present value than today's dollars. Discounting all effects at the same rate is considered

10. To estimate reductions in environmental and historical losses and some reductions in casualties, the authors used "benefit transfer" methods to adapt results from related studies.

11. FEMA is in the process of reviewing and updating the damage functions used in that software; the revised functions are expected to incorporate more of the engineering information underlying the MMC estimates.

12. See footnote 2 above.

13. Casualties can be a significant share of the losses from earthquakes, which occur with little warning. CBO estimates that reduced casualties accounted for about one-quarter of the overall reduction in losses in the MMC sample of earthquake mitigation projects. That share presumably could have been higher with a different mix of types of earthquake projects.

Box 1.

Discount Rates Used in This Study

The choice of a discount rate—the interest rate used to compute the present lump-sum value of a stream of future income or payments—can significantly affect the attractiveness of investments, such as disaster mitigation projects, whose benefits are realized over many years. The higher the discount rate, the lower the present value of a given reduction in future disaster losses, and hence the smaller the set of projects that can be justified in economic terms. However, different schools of thought exist about how to identify an appropriate discount rate. And even with a particular approach, the appropriate rate can vary significantly over time.

To discount the estimates of reduced disaster losses in this report, the Congressional Budget Office (CBO) would use a real (inflation-adjusted) rate of about 2.5 percent per year, based on yields on the Treasury's 20-year inflation-protected securities when this report was written.[1] (A real rate is appropriate because the future reductions in disaster losses are measured in constant dollars. A nominal rate used to discount benefits measured in inflated dollars would be higher.) Partly on the basis of a 1998 CBO report, the Multihazard Mitigation Council (MMC) used a similar real discount rate, 2 percent, in its study of earlier mitigation projects.[2] In contrast, grant applications for the Pre-Disaster Mitigation (PDM) program use a real discount rate of 7 percent, as required by the Office of Management and Budget, which chose that rate to approximate the real pretax rate of return on an average investment in the private sector.[3]

Recalculating the present value of the estimated loss reduction from a mitigation project requires knowing the project's effective lifetime. The PDM applications assumed a variety of lifetimes for mitigation projects, but the MMC study used only two: 50 years for projects affecting most structures and 100 years for those affecting important structures and infrastructure.[4] CBO does not have the necessary information to convert the PDM estimates to the MMC study's 2 percent discount rate. However, approximate calculations can be made to convert the MMC results to the PDM program's 7 percent rate by assuming some average lifetime between 50 and 100 years. CBO made such a calculation, assuming 50-year lifetimes for the MMC projects. As the table at right shows, the difference in discount rates more than accounts for the difference between the two sources in the estimated effectiveness of flood and wind projects. (That is not the case for earthquake projects; possible reasons are discussed on page 5.)

Ideally, all of the estimates of reduced disaster losses shown in Table 1 on page 3 would be based on a uniform discount rate of 2.5 percent. But CBO does not have enough details about the results of the MMC study or the PDM grant applications to accurately convert the estimates to a different discount rate. However, rough calculations indicate that converting the estimates to a 2.5 discount rate would not

1. See Congressional Budget Office, *Estimating the Value of Subsidies for Federal Loans and Loan Guarantees* (August 2004). The 2.5 percent rate need not hold steady over time. For its August 2007 report *The Budget and Economic Outlook: An Update,* CBO estimated that the average yield on 10-year Treasury notes over the 2008–2017 period would be 5.2 percent in nominal terms—or, after subtracting projected inflation, about 3.3 percent in real terms.

2. See Multihazard Mitigation Council, *Natural Hazard Mitigation Saves: An Independent Study to Assess the Future Savings from Mitigation Activities* (Washington, D.C.: National Institute of Building Sciences, 2005), pp. 8, 32–33; and Congressional Budget Office, *The Economic Effects of Federal Spending on Infrastructure and Other Investments* (June 1998), pp. 12–13.

3. According to the Office of Management and Budget, *Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs,* Circular A-94 (October 29, 1992), 7 percent is the standard real rate to be used for benefit-cost analyses conducted by or for the Administration on "public investments and regulatory programs that provide benefits and costs to the general public."

4. Multihazard Mitigation Council, *Natural Hazard Mitigation Saves,* p. 201.

Box 1.

Continued

significantly change the estimate of total reduced losses for all PDM-funded projects. The estimates for flood, earthquake, and wind projects would decrease by about 10 percent (assuming 50-year effective lifetimes for all projects), and the estimates for the other four categories would roughly double. On net, the estimate of the total reduction in future losses would decline by 3 percent.

Comparing Ratios of Reduced Losses to Costs from the MMC Study and PDM Grant Applications

Type of Project (By disaster targeted)	Ratio from MMC Study as Adjusted by CBO (2 percent discount rate)[a]	Adjusted MMC Ratio with 7 Percent Discount Rate[b]	Ratio Based on Estimates in Grant Applications for Funded PDM Projects (7 percent discount rate)
Floods	4.6	2.0	2.2
Wind Storms	4.7	2.1	2.4
Earthquakes	0.9	0.4	5.0

Source: Congressional Budget Office based on Multihazard Mitigation Council, *Natural Hazard Mitigation Saves: An Independent Study to Assess the Future Savings from Mitigation Activities* (Washington, D.C.: National Institute of Building Sciences, 2005), and data from the Federal Emergency Management Agency.

Notes: MMC = Multihazard Mitigation Council; PDM = Pre-Disaster Mitigation.

The ratios shown here represent the present value of the reduction in future disaster losses because of mitigation projects divided by the projects' total (federal and nonfederal) costs.

a. These ratios reflect the adjustments for uniform discounting and dollar weighting shown in Table 2 on page 8.

b. These ratios were calculated assuming an effective lifetime of 50 years for all projects.

standard practice. For example, it is required in benefit-cost analyses done by or for the Administration.[14]

The second adjustment involved the approach used to summarize the results from the three samples of mitigation projects and extrapolate them to the larger sets of all projects of those types. The MMC study used the unweighted simple averages of the individual ratios for the projects it analyzed. CBO, by contrast, used "dollar-weighted averages," which it obtained by dividing the total savings in disaster losses from each set of analyzed projects by their total costs. In general, dollar-weighted averages are preferable because they reflect the fact that large projects are more important in determining total reductions in losses and because they have a form of internal consistency that unweighted simple averages do not.[15]

14. See Office of Management and Budget, *Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs,* Circular A-94 (October 29, 1992).

15. With dollar-weighted averages, the estimate of total savings in disaster losses necessarily draws closer to the actual figure as the size of the sample approaches the entire set of projects. That is not true for simple averages. Because the sum of a set of ratios generally does not equal the ratio of the sums, the simple average ratio for a "sample" consisting of the entire set of projects would not equal the actual ratio of total savings to total costs except by chance. However, for the MMC study, there is an argument for using simple averages: Because the study disproportionately sampled larger projects, which tend to be less cost-effective, it may be helpful to use simple averages—which give disproportionate weight to smaller projects—in extrapolating the sample results. See Multihazard Mitigation Council, *Natural Hazard Mitigation Saves,* Appendix N.

Table 2.

CBO's Adjustments to the Multihazard Mitigation Council's Ratios of Reduced Losses to Project Costs

Type of Project (By disaster targeted)	Ratio as Reported in MMC Study	Ratio with Uniform Discounting[a]	Ratio with Uniform Discounting and Dollar Weighting[b]
Floods	5.1	5.0	4.6
Wind Storms	4.7	3.6	4.7
Earthquakes	1.4	1.1	0.9

Source: Congressional Budget Office based on Multihazard Mitigation Council (MMC), *Natural Hazard Mitigation Saves: An Independent Study to Assess the Future Savings from Mitigation Activities* (Washington, D.C.: National Institute of Building Sciences, 2005).

Note: The ratios shown here represent the present value of the reduction in future disaster losses because of mitigation projects divided by the projects' total (federal and nonfederal) costs.

a. In this adjustment, CBO applied the MMC study's 2 percent discount rate to the value of reduced injuries and deaths (which the study did not discount) as well as to other types of reduced losses.

b. In this adjustment, CBO used "dollar-weighted averages" rather than the MMC study's unweighted simple averages to summarize the results from the three samples of mitigation projects. CBO's dollar-weighted averages were obtained by dividing the total savings in disaster losses from the set of analyzed projects by their total costs.

In any case, although dollar-weighted and simple averages of the gains from the projects in the MMC sample yield different results for the three categories of hazards, the overall results are very similar. Relative to the estimates based on simple averages, those based on dollar-weighted averages are lower for flood and earthquake projects but higher for wind projects.[16] Using simple averages would have changed the total reduction in future losses reported in Table 1 on page 3 from $1,610 million to $1,650 million and the total cost-effectiveness ratio from 3.2 to 3.3.

16. Evidently, the larger wind projects in the MMC sample tended to have higher cost-effectiveness ratios, contrary to the usual pattern.

Estimated Potential Savings on Disaster Assistance

If future disaster recovery spending by the federal government is assumed to be proportional to disaster losses, the estimates of reduced losses can be used to estimate a potential reduction in that spending. To do so, CBO multiplied estimates of two factors: the reduction in disaster-related property damage and the ratio of federal disaster assistance to property damage. (Of course, the amount of such assistance can be driven not only by property damage but also by deaths and injuries, business interruptions, and other types of losses. The approach taken here, which is similar to that in the MMC study, uses the relative change in property damage as a proxy for the relative change in all disaster losses, because the best available data on losses by the year in which the disaster occurred focus on property damage.) However, the assumptions required in deriving each of those two factors are an unquantifiable source of uncertainty about the estimate of potential savings.

Estimating the Decline in Property Damage Attributable to the PDM Projects

For the different types of mitigation projects funded by the PDM program, CBO estimated the dollar share of overall reductions in disaster losses that reflects reductions in property damage, using various methods:

- For flood and earthquake projects, those shares were calculated directly from information in the MMC study on the sample projects included in that study. Reduced property damage accounts for almost all of the estimated gains from the flood mitigation projects (see Table 3). For earthquake projects, reductions in business-interruption costs and casualties (injuries and deaths) are more prominent. (Reductions in environmental and historical losses are minor in both cases.)

- For wind projects, the MMC study provided enough information to directly calculate the share of total reduced losses that corresponds to reduced casualties—38 percent—but not the shares corresponding to reduced property damage and reduced business interruption. CBO allocated the remaining 62 percent between those two categories in proportion to their unweighted simple-average shares reported in the MMC study.

Table 3.

Estimated Reduction in Property Damage Attributable to Projects Funded by the Pre-Disaster Mitigation Program

Type of Project (By disaster targeted)	Estimated Present Value of Reduction in Future Disaster Losses (Millions of dollars)	Reduced Property Damage as a Share of Reduced Losses (Percent)	Estimated Present Value of Reduction in Future Property Damage (Millions of dollars)
Floods (Including coastal storms)	1,010	97	980
Earthquakes	170	24	40
Wind Storms (Including hurricanes, tornadoes, and typhoons)	310	21	60
Severe Storms[a]	30	86	20
Mudslides and Landslides	50	86	40
Fires	30	86	30
Severe Ice Storms	10	86	10
Total	**1,610**	**74**	**1,190**

Source: Congressional Budget Office based on Multihazard Mitigation Council, *Natural Hazard Mitigation Saves: An Independent Study to Assess the Future Savings from Mitigation Activities* (Washington, D.C.: National Institute of Building Sciences, 2005), and data from the Federal Emergency Management Agency.

Note: The numbers shown here are for the mitigation projects that received grants from the Pre-Disaster Mitigation (PDM) program between 2004 and mid-June 2007. Dollar figures are rounded to the nearest $10 million.

a. In some cases, projects in the "severe storms" category could have been classified as addressing flood or wind hazards.

- For the types of disasters not included in the MMC study—severe storms, mudslides and landslides, fires, and ice storms—CBO assumed that the dollar gains from mitigation were divided between reduced property damage and reduced casualties in proportion to their respective shares of the total savings from all of the earthquake, flood, and wind projects funded to date. Alternative assumptions would yield different estimated shares but would not change the overall estimate of reduced property losses significantly, given the relatively small amount of mitigation funding devoted to those four disaster categories.

Using those data and assumptions, CBO estimated that the first factor—the expected savings on future property damage resulting from the projects funded under the PDM program—has a discounted present value of about $1.2 billion. At a discount rate of 2.5 percent (see Box 1 on page 6), that present value is equivalent to a savings of $42 million per year for 50 years.

Estimating the Relationship Between Property Damage and Disaster Aid

To estimate the other factor—the amount of federal spending on disaster assistance per dollar of property damage from disasters—CBO used the following information:

- Data on FEMA spending for each Presidentially declared disaster from 1960 to 2005;[17]
- Data on annual property losses caused by disasters from 1960 to 2005;[18] and

17. Those data were collected and converted to 2006 dollars by Professor Richard Sylves of the University of Delaware; see Public Entity Risk Institute, "All About Presidential Disaster Declarations," available at www.peripresdecusa.org.

18. See *Spatial Hazard Events and Losses Database for the United States, Version 5.1,* online database (Columbia, S.C.: University of South Carolina, Hazards and Vulnerability Research Institute, 2007), available at www.sheldus.org.

- Data from the MMC study on average annual disaster-related spending by FEMA, the Small Business Administration, and the Army Corps of Engineers.[19]

The data indicate that FEMA's disaster-related spending over the 1960–2005 period was roughly equal to 30 percent of total property damage from disasters over the period. That figure may not remain steady over time, however. For example, larger disasters may receive more federal aid, relative to the amount of damage, than smaller disasters do. Over the 12 most recent years of data (1994 to 2005), FEMA's disaster relief equaled roughly 40 percent of property damage.[20] Scaling up those two percentages to include average disaster spending by the Small Business Administration and the Army Corps of Engineers—which together equal about 13 percent of FEMA's spending, according to the MMC study—yields estimates of 34 percent and 45 percent for total federal disaster spending per dollar of property damage.

Effects on Spending for Disaster Aid

Applying those percentages to the above estimate of the expected reduction in future property damage, CBO calculated that a proportional reduction in federal disaster assistance resulting from the existing PDM-funded projects would amount to about $400 million to $540 million in present value—equivalent to $14 million to $19 million per year for 50 years. Given that the federal share of their costs was $310 million, those projects could lead to a net savings to the Treasury if disaster spending indeed declined in proportion to the decrease in disaster losses.

However, the budgetary scoring of legislation that deals with disaster mitigation programs depends on the nature of the legislation. If the legislation addresses a discretionary program (either reauthorizing appropriations for an existing program or creating a new one), neither the spending for mitigation nor any resulting savings would be counted for pay-as-you-go purposes because they would depend on future appropriation actions.[21] In contrast, direct spending for mitigation programs (provided in authorizing legislation) and any estimated savings in outlays from mandatory programs (but not discretionary programs) could be counted for pay-as-you-go purposes because neither the spending nor the savings would depend on future legislation.

The National Flood Insurance Program is a direct (mandatory) spending program. At present, however, potential reductions in future claims for flood damage to insured properties could not be credited against the costs of legislation to authorize direct spending for mitigation, because those reductions would not be expected to lower the program's outlays relative to current baseline projections.[22] The flood insurance program is currently required to pay nearly $1 billion per year in interest on money it has borrowed from the Treasury, leaving it with insufficient resources to pay the expected level of new claims on a timely basis. Consequently, CBO would assume that mitigation that reduced expected future claims would not decrease outlays but rather would allow the program to reduce its backlog of other unpaid claims. Only when the flood insurance program had unused borrowing authority, which mitigation could allow it to tap more slowly, could the savings be counted for scorekeeping purposes.

19. Multihazard Mitigation Council, *Natural Hazard Mitigation Saves,* p. 140.

20. As a possible alternative to calculating ratios of spending to property damage, CBO performed regression analyses to try to identify a statistical relationship between the two. Because of the variability of the data, however, the results were not precise enough to be useful.

21. That statement applies to authorizing legislation but not to appropriation bills, which are governed by different scoring guidelines.

22. Most policies in the National Flood Insurance Program are sold at rates intended to cover the full risk associated with the insured properties. However, roughly one-quarter of the insured properties are covered at subsidized rates. Mitigation targeting those properties could reduce expected losses to the program, especially because such properties tend to be more vulnerable to flooding than others covered by the program. (The properties eligible for subsidized coverage are older, predating current building codes and floodplain management standards.)