



## **NATURAL HAZARD MITIGATION SAVES: An Independent Study to Assess the Future Savings from Mitigation Activities**

**Volume 1 – Findings, Conclusions, and Recommendations**

## THE MULTHAZARD MITIGATION COUNCIL

The *Multihazard Mitigation Council (MMC)*, a council of the National Institute of Building Sciences (NIBS), was established in November 1997 to reduce the total losses associated with natural and other hazards by fostering and promoting consistent and improved multihazard risk mitigation strategies, guidelines, practices, and related efforts. The scope of the Council's interests is diverse and reflects the concerns and responsibilities of all those public and private sector entities involved with building and nonbuilding structure and lifeline facility research, planning, design, construction, regulation, management, and utilization/operation and the hazards that affect them.

In recognition of this diversity, the Council believes that appropriate multihazard risk reduction measures and initiatives should be adopted by existing organizations and institutions and incorporated into their legislation, regulations, practices, rules, relief procedures, and loan and insurance requirements whenever possible so that these measures and initiatives become part of established activities rather than being superimposed as separate and additional. Further, the Council's activities are structured to provide for explicit consideration and assessment of the social, technical, administrative, political, legal, and economic implications of its deliberations and recommendations. To achieve its purpose, the Council conducts activities and provides the leadership needed to:

- ◆ Improve communication, coordination, and cooperation among all entities involved with mitigation;
- ◆ Promote deliberate consideration of multihazard risk reduction in all efforts that affect the planning, siting, design, construction, and operation of the buildings and lifelines systems that comprise the built environment; and
- ◆ Serve as a focal point for the dissemination of credible information and sage counsel on major policy issues involving multihazard risk mitigation.

### MMC Organizational Members

American Forest and Paper Association, Washington, D.C.; American Institute of Architects, Washington, D.C.; The American Red Cross, Washington, D.C.; Association of State Dam Safety Officials, Lexington, Kentucky; Association of State Floodplain Managers, Inc., Madison, Wisconsin; Consortium of Universities for Research in Earthquake Engineering, Richmond, California; Council on Natural Disaster Reduction/American Society of Civil Engineers, Reston, Virginia; Earthquake Engineering Research Institute, Oakland, California; Factory Mutual Insurance Company, Norwood, Massachusetts; French and Associates Ltd., Park Forest Illinois; GE Global Asset Protection Service, Hartford, Connecticut; IBM, Woodland Hills, California; Institute for Catastrophic Loss Reduction, Toronto, Ontario, Canada; International Code Council; Johns Hopkins University Applied Physics Laboratory, Laurel, Maryland; Multidisciplinary Center for Earthquake Engineering Research, State University of New York at Buffalo, New York; National Fire Protection Association, Quincy, Massachusetts; National Fire Sprinkler Association, Patterson, New York; National Institute of Standards and Technology, Building and Fire Research Laboratory, Gaithersburg, Maryland; Natural Hazards Center, University of Colorado, Boulder; Portland Cement Association, Society of Fire Protection Engineers, Bethesda, Maryland; State Farm Fire and Casualty Company, Bloomington, Illinois; Tennessee Building Officials Association, Murfreesboro, Tennessee; The Thornton - Tomasetti Group, Inc., New York, New York; Zurich U.S., Schaumburg, Illinois

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*The Multihazard Mitigation Council,  
a council of the National Institute of  
Building Sciences*

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Prepared with funding from the Federal Emergency Management Agency of the U.S. Department of Homeland Security by the Multihazard Mitigation Council of the National Institute of Building Sciences with the assistance of the Applied Technology Council

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### ***In Memoriam***

*The Multihazard Mitigation Council wishes to acknowledge James M. Delahay, PE, for his contributions to the Applied Technology Council's research/analysis efforts and his significant contributions to the profession of structural engineering and the nation's codes and standards development efforts. The built environment and all those who use it have benefited tremendously from his work.*

## PREFACE

The National Institute of Building Sciences through its Multihazard Mitigation Council is pleased to submit this report to the Congress of the United States on behalf of Federal Emergency Management Agency (FEMA) and the Department of Homeland Security. This report presents the results of an independent study to assess the future savings from hazard mitigation activities.

This study shows that money spent on reducing the risk of natural hazards is a sound investment. On average, a dollar spent by FEMA on hazard mitigation (actions to reduce disaster losses) provides the nation about \$4 in future benefits. In addition, FEMA grants to mitigate the effects of floods, hurricanes, tornados, and earthquakes between 1993 and 2003 are expected to save more than 220 lives and prevent almost 4,700 injuries over approximately 50 years. Recent disaster events painfully demonstrate the extent to which catastrophic damage affects all Americans and the federal treasury.

The MMC Board wishes to acknowledge the efforts of its subcontractor, the Applied Technology Council (ATC), and the dedicated, innovative, and painstaking work of the ATC research team. The MMC Board also recognizes the Project Management Committee established to oversee the project on its behalf. The committee members spent countless voluntary hours reviewing study materials and providing guidance to the MMC subcontractor conducting the data analysis effort, and the MMC Board thanks them very much for their extraordinary contribution of time and expertise. The MMC Board also is grateful to the superb MMC staff and its project management consultant, who worked closely with the Project Management Committee and served as technical liaison with the ATC researchers. Further, the MMC wishes to thank the FEMA personnel and state and local officials who provided data and other information for analysis in this study. The MMC also wishes to express its gratitude to FEMA for having the confidence in the Council to give it the independence needed to conduct the study and prepare this report and especially to Maria Vorel and Margaret Lawless of FEMA for their insight and support.

*Brent Woodworth*  
*Chair, Multihazard Mitigation Council*



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# OVERVIEW

The Multihazard Mitigation Council (MMC) of the National Institute of Building Sciences (NIBS) conducted this independent study to quantify the future savings from hazard mitigation activities in response to a mandate by the House Appropriations Committee, Subcommittee for the Veterans Administration, Department of Housing and Urban Development, and Independent Agencies of the 106<sup>th</sup> Congress (House Report 106-161):

The Committee recognizes that investing in mitigation will yield reductions in future disaster losses and that mitigation should be strongly promoted. However, an analytical assessment is needed to support the degree to which mitigation activities will result in future “savings.” Therefore, the Committee directs FEMA to fund an independent study to assess the future savings from the various types of mitigation activities.

The study was based on a detailed work plan formulated by a team of experts established by the MMC Board. Although funding for the study was provided by the Federal Emergency Management Agency (FEMA), the study was conducted independently of FEMA. The study assumptions were generally conservative — that is, where appropriate, parameters and methods were chosen to produce lower estimates of future savings. Sensitivity analyses on key variables indicate the results are robust. More than 50 national experts in a wide variety of disciplines participated in the project. Study methods and results were reviewed by two separate groups of independent experts on an ongoing basis. (See the list of participants at the conclusion of this report.)

The study was structured to quantify the future savings (in terms of losses avoided) from hazard mitigation activities related to earthquake, wind, and flood funded through three major natural hazard mitigation grant programs (the Hazard Mitigation Grant Program, Project Impact, and the Flood Mitigation Assistance Program).<sup>1</sup> Two types of mitigation activity were addressed: “project” mitigations, which include physical measures to avoid or reduce damage from disasters (such as elevating, acquiring, or relocating structures threatened by floods and strengthening structures to resist earthquake and wind forces) and “process” mitigations, which include activities that lead to policies, practices, and projects that reduce risk and loss (e.g., assessing vulnerability and risk, educating decision-makers, and fostering adoption of strong building codes).

The study involved two interrelated components:

- The first component estimated the future savings from FEMA mitigation grant expenditures using a statistically representative sample of FEMA-funded mitigation

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<sup>1</sup> The Hazard Mitigation Grant Program, which assists states and communities in implementing long-term hazard mitigation measures following presidentially declared disasters; Project Impact, which supported pre-disaster mitigation programs from 1997 to 2001; and the Flood Mitigation Assistance Program, which funds state and community measures to reduce or eliminate the long-term risk of flood damage to buildings, manufactured homes, and other structures insurable under the National Flood Insurance Program (NFIP).

grants so that results could be generalized for the entire population of FEMA mitigation grants. The unit of analysis for this component was the individual FEMA-funded grant.

- The second study component assessed the future savings from mitigation activities through empirical research on FEMA-funded mitigation activities carried out in community contexts. The community studies were both quantitative and qualitative and examined mitigation activities in a purposive sample of communities. The community studies examined all FEMA mitigation grants received by the selected communities since the programs began in 1988. It provided insights into mitigation effectiveness by exploring how mitigation activities percolate throughout the community in the form of synergistic activities — mitigation efforts that would not have occurred had it not been for the original FEMA grant. The unit of analysis was the individual community. These communities were blindly selected to represent predetermined demographic categories.

Both components employed common methodologies based on benefit-cost analysis to the extent possible. HAZUS<sup>®</sup>MH was used to estimate direct property damage from earthquake and hurricane wind. Supplemental methods were used to assess direct property loss from flood and tornado, business interruption loss for utilities, environmental and historic preservation benefits, and process mitigation activities.

Benefits were defined as losses to society avoided. The benefits considered in the analysis included:

- Reduced direct property damage (e.g., buildings contents, bridges, pipelines)
- Reduced direct business interruption loss (e.g., damaged industrial, commercial or retail facilities)
- Reduced indirect business interruption loss (e.g., ordinary multiplier or “ripple” effects)
- Reduced nonmarket damage (e.g., environmental damage to wetlands, parks, and wildlife and damage to historic structures)
- Reduced human losses (e.g., deaths, injuries, homelessness)
- Reduced cost of emergency response (e.g., ambulance service, fire protection)

Costs considered were taken from the FEMA grants database and included both the federal share of costs and the local match.

The study also estimated the effect FEMA grants on the federal treasury by reducing the amount of federal funds that would need to be spent on disaster response and recovery and avoiding post-disaster tax revenue decreases (and thereby increasing the amount that could be spent on other government programs). Because the savings to the federal treasury include some of the benefits and costs accruing to society as a whole, these federal savings cannot be added to those estimated for society. In accordance with economic theory, federal agency expenditures are made on behalf of society and funded by taxpayers. Consequently, they are viewed as transfers — equal benefits and costs that cancel. As such, the calculation of savings to the federal

treasury from hazard mitigation estimates the funds that could potentially be spent on other federal programs.

A detailed description of the study can be found in Volume 2 of this report, *Supporting Documentation*, which can be downloaded from <http://www.nibs.org/MMC/mmchome.html>. Further, the MMC will maintain all study data collected from FEMA for use by agencies, organizations, and researchers interested in testing the results of this study. Information related to human subjects will be made available in accordance with the requirements of the Institutional Review Board at the University of California, Los Angeles.



## FINDINGS AND CONCLUSIONS

The study results indicate that the natural hazard mitigation activities funded by the three FEMA grant programs between 1993 and 2003:

- Were cost-effective and reduced future losses from earthquake, wind, and flood events;
- Resulted in significant net benefits to society as a whole (individuals, states, and communities) in terms of future reduced losses; and
- Represented significant potential savings to the federal treasury in terms of future increased tax revenues and reduced hazard-related expenditures.

### FINDINGS

#### Grants Have High Benefit-Cost Ratios

The analysis of the statistically representative sample of FEMA grants awarded during the study period indicates that **a dollar spent on mitigation saves society an average of \$4**. The MMC study estimates that societal benefits from FEMA mitigation grants during the period studied yielded a discounted present value of \$14 billion compared to the \$3.5 billion the value of resources employed in the hazard mitigation programs studied. Moreover, sensitivity analyses indicate that these results are robust with respect to assumptions and uncertainties.

#### Community Context Reveals Additional Benefits

The examination of mitigation activities in a purposive sample of eight communities indicates that the benefits calculated for individual grants are conservative because they often foster additional non-federally funded mitigation activities and additional benefits. The community analysis found that **FEMA mitigation grants are cost-effective, often leading to additional non-federally funded mitigation activities, and have the greatest benefits in communities that have institutionalized hazard mitigation programs**. In the communities studied, FEMA mitigation grants were a significant part of the community's mitigation history. The study found the FEMA funded mitigation activities brought about the most additional non-federally funded mitigation benefits if the FEMA grant was of the sort that helped to institutionalize mitigation in communities. Interviewees reported that the grants were important in reducing community risks, preventing future damages, and increasing a community's capability to reduce losses from natural hazards. Most interviewees believed that the grants permitted their communities to attain mitigation goals that might not otherwise have been reached and that the mitigation benefits of the activities funded by the grants went beyond what could actually be measured quantitatively (e.g., increased community awareness, esprit de corps, and peace of mind).

## Savings to Federal Treasury

A separate calculation using estimates from the statistically representative sample of FEMA-funded mitigation grants examined the effect of mitigation grants on the federal treasury. This calculation identified the economic transfers that normally cancel each other out within the overall calculation of net benefits to society from mitigation activities. The analysis found that **a dollar spent from the federal treasury on FEMA mitigation grants potentially saves it about \$3.65**. The present value of potential annual savings to the federal treasury because of the FEMA grants studied is approximately \$970 million compared to an annual budget expenditure on these grants of \$265 million. Thus, a dollar spent on mitigation grants leads to an average of \$3.65 in avoided post-disaster relief costs and increased federal tax revenues. These results are statistically robust as well.

## CONCLUSIONS

Given these findings, the MMC Board of Direction has concluded that:

- **Mitigation is sufficiently cost-effective to warrant federal funding on an ongoing basis both before disasters and during post-disaster recovery.** The nation will always be vulnerable to natural hazards; therefore, it is only prudent to invest in mitigation. In this context, mitigation should be considered in the broadest possible sense to encompass mitigation projects and processes that relate to enforcing strong building codes and land use and zoning measures as well as developing comprehensive plans that will limit disaster-caused damage and promote reduced losses from such things as disruption of utilities and transportation lifelines.
- **Mitigation is most effective when it is carried out on a comprehensive, community-wide, long-term basis.** Single projects can help, but carrying out a slate of coordinated mitigation activities over time is the best way to ensure that communities will be physically, socially, and economically resilient in coping with future hazard impacts.
- **Continuing analysis of the effectiveness of mitigation activities is essential for building resilient communities.** The study experience highlighted the need for more systematic data collection and assessment of various mitigation approaches to ensure that hard-won lessons are incorporated into disaster public policy. In this context, post-disaster field observations are important, and a statistically based, post-disaster data-collection is needed for use in validating mitigation measures that are either costly, numerous, or of uncertain efficacy or that may produce high benefit-cost ratios.

## MMC BOARD RECOMMENDATIONS

The MMC Board of Direction believes that the rigorous study described in this report and the accompanying volume of supporting documentation provides conclusive evidence that natural hazard mitigation activities are of benefit to the nation as a whole and are a cost-effective investment of federal funds. The Board therefore recommends that the federal government:

- Invest in natural hazard mitigation as a matter of policy on an ongoing basis both before disasters occur and through federally funded disaster recovery and rebuilding activities and programs;
- Support mitigation activities that will increase the resilience of communities by increasing knowledge and promoting institutional commitments to mitigation at the local level; and
- Support ongoing evaluation of mitigation by developing a structured process for assessing the performance of buildings and infrastructure after all types of natural disaster and by measuring the benefits that accrue from process mitigation activities.



# PROJECT PARTICIPANTS

## MULTIHAZARD MITIGATION COUNCIL

### Board of Direction

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