Design of the National Study

The ATC research group examined mitigation conducted for earthquakes, wind, and flood under three FEMA programs: the post-disaster Hazard Mitigation Grant Program (HMGP) and two pre-disaster programs, Project Impact (PI), and the Flood Mitigation Assistance Program (FMA). The overall study addressed five questions:

- What are the net benefits of hazard mitigation to the nation?
- Do these benefits vary across types of hazards and mitigation activities?
- What are the potential savings to the federal treasury from hazard mitigation?
- What is the magnitude of the ratio of the benefits to costs of hazard mitigation activities funded by FEMA when evaluated within a community context?
- What, if any, additional mitigation activities and benefits were stimulated by the three FEMA program activities?

The first three questions were largely addressed as part of a national study of the benefits and costs of FEMA mitigation grants awarded between June 1993 and 2003. Analyses were quantitative and performed on a sample of FEMA-funded mitigation activities selected from the National Emergency Management Information System (NEMIS) database. The basic unit of analysis was the individual FEMA-funded grant. The last two questions were addressed in studies of eight communities that were selected purposively from the NEMIS database. A pilot study of a ninth community also was undertaken. In this case, the unit of analysis was the individual community, although quantitative benefit-costs of individual community grants were also assessed. This paper examines the ways in which these case studies contribute to our understanding of how communities might undertake successful programs to reduce risks from natural hazards.

Results on an Aggregate or National Basis

On average the study team found that the aggregate benefit-cost ratio of FEMA mitigation was about four. That is, every dollar spent by FEMA on hazard mitigation saves the nation about $4 in future benefits. A federal dollar spent on mitigation grants potentially leads to an average savings to the federal treasury of $3.65 in avoided post-disaster relief and increased federal tax revenues.

The more detailed benefit-cost assessments performed for community studies more or less corroborated the above aggregate result. In each of the communities studied, FEMA grants were a significant part of the community's mitigation history. No communities studied developed federally supported grants that taken together had benefit-cost ratios below unity. Benefit-cost ratios by grant, though, varied considerably, as did aggregate benefit-cost ratios by community. Likewise, some perils in the community study (for example, earthquake) had projects with higher benefit-cost ratios for the few communities selected than those in the national study, whereas other perils in the community study (such as floods) sometimes had lower benefit-cost ratios than in the national study. Nonetheless, the community studies corroborated the overall procedures and findings from the national assessment.

Moreover, the community studies often detected additional or synergistic activities. As defined in the next section, these activities can show how FEMA mitigation grants can support, accelerate, or initiate additional risk-reduction activities. These synergistic effects were not identified through quantitative analyses and were only detectable through the conduct of community studies.

Method: Design of Community Studies

After a pilot community study, eight additional communities were selected for in-depth analysis within a multi-case study methodology. The methodology employed three major components: (1) data collection and processing, (2) computation of benefit-cost ratios and the determination of cost-effectiveness for activities with qualitative characteristics, and (3) the identification of synergistic mitigation activities. Data were collected from documents, structured telephone interviews, open-ended on-site field interviews, and archival research. Efforts were made to establish a chain of evidence through triangulation (comparison of multiple, independent sources of evidence), and ordering information chronologically for time series analysis.

Definitions. Considerable time was spent in clarifying definitions. Below are distinctions made between *project* and *process* activities. In addition, three types of synergistic activities or effects are defined: spin-off activities, collateral activities, and spillover effects. As in these community studies, we expect that future community studies might elaborate on how these distinctions clarify community processes in reducing natural hazards risks.

FEMA awarded grants for both *project* and *process* mitigation. *Project activities* involved physical measures to avoid or reduce damage resulting from disasters. These included elevations, relocations, and reinforcement of buildings, lifelines, or other structures to resist or avoid floods, earthquakes, and wind. *Process activities*, in contrast, led to policies, practices, and projects that reduce risk. These included assessing hazards, vulnerability, and risk; conducting planning to identify projects, policies, and practices, and to set priorities; educating decision-makers or others; and facilitating the selection, design, funding, and construction of projects (MMC 2002). Between 1993 and 2003, 90 percent of the FEMA grants in the NEMIS population and 95 percent of costs were for project activities.

Synergistic activities (see Figure 7.1) are the family of activities that reduce risks or increase benefits of risk-reduction activities from floods, earthquakes, and severe winds. The importance of these activities derives from the additional benefits of grants that arise directly or indirectly from their presence. They follow or accompany the award of FEMA mitigation grants or the strong expectation that a grant will be awarded. Synergistic activities are not funded by FEMA and can take the form of spin-off activities, collateral activities, or spillover effects. *Spin-off activities* result from or are enabled by FEMA hazard mitigation grant support directly (an action that would not otherwise have taken place) or indirectly (accelerated timing of an action that would have taken place eventually). *Collateral risk-reduction activities* differ from spin-off activities because FEMA hazard mitigation support had no significant impact on their content or timing. *Spillover effects* include direct and indirect increases in economic activity or value of assets in the more conventional use of the terms *direct* (that is, increase in business activity of new or revitalized enterprises or increase in property value) and *associated indirect* (that is, ripple effects).

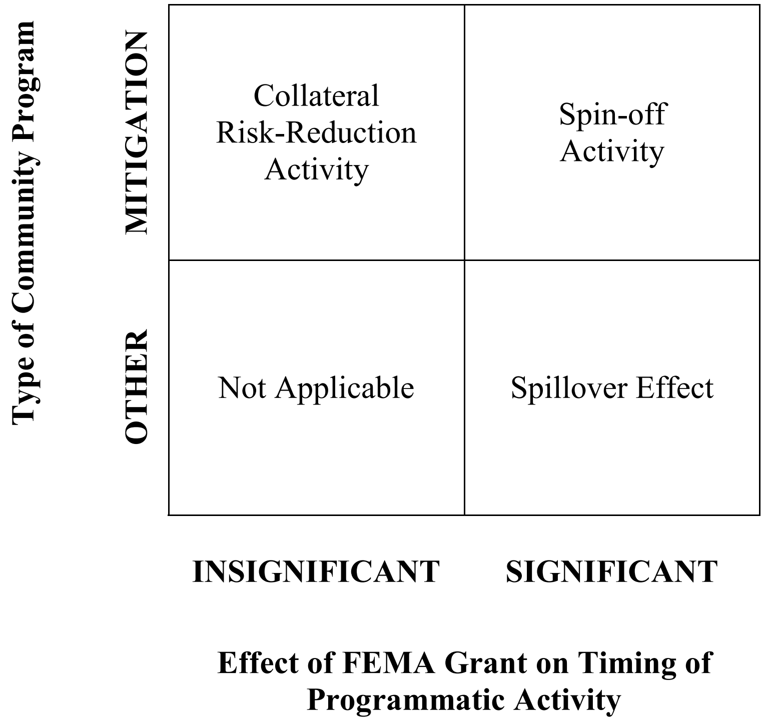

Figure 7.1. Community Activities Following FEMA Grants

Two questions were asked to determine whether an activity was a spin-off. The first question asked was whether there was a high chance that the activity was financed or supported because FEMA provided support or was expected to provide support for another process or project activity. If the preponderance of evidence from telephone interviews, face-to-face interviews, and documents indicated that the answer was “yes,” then the activity was considered a spin-off. If the answer to the first question was “no,” then a second question was asked: Did the FEMA grant accelerate the activity in question? If the answer to the second question was “yes,” then the activity was a spin-off activity. If the answer was again “no,” then the activity could not be a spin-off activity; it, however, could still be a collateral activity.

Spillover effects were determined from more detailed field evaluations of how various types of commercial or industrial activities may have been accelerated or initiated as a result of mitigation grants. For instance, a downtown revitalization project may have been made possible as a result of a grant to reduce natural hazards risks to the downtown area.

Pilot Study. The pilot study community was purposively selected using eight criteria to identify communities that would have received significant FEMA mitigation funds and that had established a robust community mitigation program. To be eligible, potential pilot communities must:

1. Have received at least $1 million from FEMA in mitigation funds from HMGP grants, FMA grants, and Project Impact (roughly 8 percent of the communities in the NEMIS database had received this amount of funding);
2. Be a geographically free-standing city, not adjoining or encompassed by a larger community that had received significant FEMA mitigation funds, or part of a county with many incorporated cities or a large population living in unincorporated areas (to be able to focus on one community and avoid cross contamination);
3. Have a population between 50,000 and 500,000 (a principal city in an SMA must have a population of at least 50,000, and cities exceeding 500,000 are considered megacities);
4. Be riverine flood-prone (by far the most significant hazard in the United States is riverine flooding, and there are more mitigation grants for floods than any other hazard);
5. Have a ranking of 6 or better (1 being best on a scale of 1 to 9) in the Community Rating System (CRS) of the National Flood Insurance Program (NFIP); (the CRS is a voluntary program in which communities agree to adopt and enforce flood regulations in excess of NFIP minimums; the more comprehensive the flood mitigation regulations, the better the CRS rating);
6. Have excellent records relating to its natural hazards mitigation efforts;
7. Have accessible records relating to its natural hazards mitigation efforts; and
8. Have at least one additional exposure either to wind or earthquake hazards.

Only eight communities met criteria 1, 3, and 5, and Tulsa, OK, was the only community to meet all eight criteria.

Eight Communities. Purposive sampling techniques also were used to select eight communities from the NEMIS data set for in-depth study. To be eligible for study, communities must:

1. Have received awards from FEMA where the objective was to mitigate damage from earthquakes, flood, or wind (coastal storm, hurricane, severe storm, tornado, typhoon);
2. Be at high risk of earthquakes, floods, or wind hazard(s);
3. Be a single jurisdiction identified with a legal title as a city, town, borough, village, or county within one of the 50 states;
4. Have received grants for both project and process (includes Project Impact) mitigation activities;
5. Have received awards that summed to $500,000 or more; and
6. Have received no more than 15 grants.

One hundred thirteen communities met criteria 1 and 3 through 6, but only 76 communities were at high risk of at least one hazard.

Communities were sorted and quota limits were set to maximize the probability that the communities selected for study varied in (1) the combination of grants they had received from FEMA (earthquake only, wind only, flood only, earthquake and flood, wind and flood, earthquake, wind, and flood); (2) whether they were at high risk of earthquake, flood, and/or wind; (3) community population (small, 10,000-49,999; medium, 50,000-499,999; large, 500,000 and greater); and (4) FEMA region. Quotas were set for each criterion to ensure that the communities selected represented the population from which they were drawn but did not over-represent any one type of community. For example, 40.7 percent of the communities that had received awards had populations between 10,000 and 49,999 persons, while 49.6 percent had populations between 50,000 and 499,999, and 9.7 percent were 500,000 or more. Quotas were set such that, of the eight communities studied, no more than four were small communities, no more than four were medium-sized communities, and no more than two were large communities.

communities were written on pieces of paper. The 76 pieces of paper were placed in a basket, shaken up, and the first community was drawn. The process was repeated until all communities were drawn. The eight communities selected for analysis are shown in Table 7.1.

Table 7.1. Communities Selected for the Sample by Community Size, Pattern of FEMA Awards Received and FEMA Region.[a]

Pattern of FEMA Awards (Quota Set)	Small Communities (10,000-49,999) (Quota Set: #4)	Medium Communities (50,000-499,999) (Quota Set: #4)	Large Communities (≥500,000) (Quota Set: #2)
Earthquake Only (#2)		Hayward, CA (Region IX) Orange, CA (Region IX)	
Flood Only (#4)	Jamestown, ND (Region VIII)		Multnomah County, OR (Region X)
Wind Only (#2)			
Flood and Earthquake (#1)			
Flood and Wind (#4)	Freeport, NY (Region II)	Tuscola County, MI (Region V)	Jefferson County, AL (Region IV)
Flood, Earthquake, Wind (#1)		Horry County, SC (Region IV)	

[a]Quotas for FEMA Regions were: Region I (#1); Region II (#1); Region III (#2); Region IV (#4); Region V (#2); Region VI (#2); Region VII (#1); Region VIII (#1); Region IX (#3); Region X (#2).

The selection of communities based on random draws guided by quotas ensured that the relatively small number of communities selected for study would represent a full range of conditions, without allowing the researchers to personally "choose" any particular community (that is, "cherry pick").

Data Collection. Data were collected in four phases: pre-interview activities, formal telephone interviews, field visits, and data or information processing. Pre-interview activities included the collection of documents, reports, and other data from FEMA regional offices, state offices of emergency management, libraries, and the Internet that could be used both in benefit-cost analysis and in identifying knowledgeable persons to interview in each community. Persons identified in each community were interviewed by telephone using a standardized interview guide. Respondents were asked about existing hazard mitigation regulations or laws, their knowledge of current natural hazard risks, their knowledge of community hazard mitigation activities, their knowledge of specific FEMA-sponsored mitigation activities and their effectiveness, their knowledge of any partnerships that were key in affecting mitigation for the community, and referral information for other knowledgeable persons in the community. Persons selected for interview were identified both from collected documents and through a process of network sampling. FEMA personnel introduced the research team to one key person in each community. The first telephone interview was conducted with that person who was then asked to provide names of others who were knowledgeable about hazard mitigation in the community. This process continued until no new names were recommended.

Field investigations took place after telephone interviews had been completed and the mitigation grant and Project Impact files had been reviewed. Field investigations had two goals: (1) to find information independent of information contained in the federal and regional files or gathered in telephone interviews, and (2) to identify additional mitigation activities conducted by the communities and additional knowledgeable persons to interview by telephone. The focus of these on-site efforts was on obtaining objective documentation in the form of written documents, compact discs, videos, and other records, rather than on discovering opinions and perceptions.

Analysis. Information from all sources was combined to provide (1) a description of each community, its risk of natural disasters, historical decisions concerning hazard mitigation, and hazard mitigation activities that preceded and followed FEMA grants; (2) a list and discussion of FEMA hazard mitigation grants; (3) a discussion of the project impact if the community had received a Project Impact grant; and (4) an activity chronology to illustrate the temporal relationship of hazard mitigation decisions and activities included in steps 1 through 3. The activity chronology diagram is constructed in two dimensions. The vertical axis (y-axis) is comprised of those factors or elements that generally are associated with hazard mitigation programs. They consist of community participation plans, capacity building, ordinances and regulations, other state and federal grants and programs, FEMA grants and programs, and state laws. The horizontal axis (x-axis) illustrates the chronological relationship between the start of grants for project or process mitigation activities funded by FEMA and the start of other community mitigation activities. This visualization provides a simple means of determining if there is a potential causal relationship between FEMA grants and synergistic community activities.

A benefit-cost analysis was performed on all FEMA-funded activities identified in the community studies analysis. In general, the community studies benefited from the vast amounts of background engineering and science, not available in NEMIS, which assisted in the development of benefit-cost evaluations. Not only did FEMA regional offices and local communities provide considerable help in gathering such background information, they also assisted greatly by providing materials for additional analyses, such as the identification of spin-offs and spill-over effects. The detail often available in the community studies also created disadvantages by, for example, identifying perils (for exmple, storm overflows affecting storm drains, debris flows) and structures (for example, sodium hypochlorite wastewater facility, booster pumps) funded by mitigation grants that were outside the scope of the national study.

Community Descriptions. Descriptions of the selected communities, including the pilot study community, follow.

Tulsa, Oklahoma. Tulsa is located in Tornado Alley, which makes it susceptible to thunderstorms, tornadoes, and floods, generally the result of localized downpours of up to 15 inches in six hours. Historically, the city has flooded often. In the 15 years between 1971, when it joined the National Flood Insurance Program (NFIP) and 1986, Tulsa had floods that resulted in nine presidential disaster declarations, making the city the most flood prone community in the country. Outcries from citizens after each successive flood prompted the city to develop and implement a comprehensive floodplain and stormwater management program that eventually became the model for other cities.

The flood program has a number of important characteristics. In 1974, Tulsa became one of the first communities to purchase severely damaged houses after a flood. It unsuccessfully asked FEMA to pay for part of the cost using Section 1362 of the National Flood Insurance Act funds; however, after a catastrophic 1984 flood, FEMA approved Tulsa's continuing request for 1362 funding, the first time FEMA agreed to financially contribute to acquisitions. When Tulsa first acquired houses as part of its floodplain and stormwater management program, it established permanent earmarked funding sources to pay for small projects, large projects, and maintenance. A stormwater management fee was added to monthly utility bills; a "fee in lieu of detention" was paid by developers to offset downstream impacts of construction; and voters approved bond issues and the use of sales tax revenues to finance various capital elements of the program. The city worked with the Army Corps of Engineers to plan and build structural flood control works to complement non-structural programs like acquisition and adopting stricter ordinances for floodplain management than the minimum required for communities in the NFIP.

Since FEMA established the CRS, Tulsa has led the nation in adopting practices that exceed of NFIP minimums, and consistently has been the highest ranked CRS community in the country. Currently, it is the only community with a "2" rating, and it is likely that it will become the first to be granted the highest "1" rating. Among other things, it plans and evaluates new developments based on total basin urbanization rather than current conditions and stipulates that development can produce no adverse impacts elsewhere.

The success of the Tulsa floodplain and stormwater management program is reflected in the fact that the city has not had a flood that necessitated a presidential disaster declaration since 1986. There are a number of reasons why Tulsa has been successful. First, there have been three generations of floodplain management advocates within the community and city staff; it is unusual to find a program that has been sustained for this length of time. Second, the program includes input from every stakeholder group and gives citizens a prominent role in the decision-making process. Third, the institutionalized program is operated and maintained by the highest ranking officers of the public works department with the support of elected officials. Fourth, the program utilizes private-sector planning and engineering experts to work with and supplement city staff. Fifth, the construction and development communities have partnered with the city to make the program work. As a measure of success, no structure constructed after the city adopted its floodplain management building ordinances in 1979 has ever been damaged by a flood. And sixth, the city sets reasonable goals each year as part of a long-range program that gradually reduces flood risk in accord with its resources and funding opportunities.

Because of its experience with major tornadoes, FEMA established its first safe room demonstration program in Oklahoma in 1999. With pass-through funding initially provided by FEMA to the state and then to Tulsa, Tulsa aggressively encouraged the purchase of safe rooms by current homeowners and the inclusion of safe rooms in newly constructed houses. Building on its experience with floods, Tulsa worked with contractors in starting an initiative that has resulted in safe rooms being included in many new homes. The city has also assisted healthcare facilities and schools construct safe rooms and started a pilot project for the inclusion of safe rooms in low-income housing. As a result, Tulsa is probably one of the most progressive cities engaged in tornado mitigation.

Tulsa’s experience with FEMA hazard mitigation grants has been symbiotic; both parties have benefited from the relationship. The grants have both stimulated and supplemented local activities in Tulsa as well as given FEMA an opportunity to showcase its grants using Tulsa as an early adopter. Unlike the floodplain and stormwater management program, which preceded FEMA involvement, the tornado mitigation program began with the 1999 FEMA safe room grant to the state of Oklahoma. Funds for 100 saferooms were allocated to Tulsa. That grant led to the other spinoff initiatives mentioned above.

Freeport, New York. Originally, a wetlands on the southern shore of Long Island, Freeport was settled as a fishing port, then a weekend retreat for New Yorkers, and finally an urban village for permanent inhabitants. Throughout its history, one thing remained constant: The lowlands of Freeport flooded during lunar high tides, and the city was at risk from storm surge and wind. As a result, some houses flooded more than once a year.

In 1960, residents demanded that the city do something to reduce the constant flooding. The village responded by raising road grade levels and instituting drainage work. Until

1983 the city dealt with flooding sporadically. In 1983, the village began to routinely elevate streets using the revenue from the issuance of general obligation bonds, later from financial grants from the state and federal departments of transportation, and lastly from FEMA hazard mitigation grants. To protect new homes and businesses from floods and wind, Freeport adopted one of the most stringent building codes in the state of New York. It joined the CRS in 1992 and had a rating of 8 in 2001. FEMA's contribution to the city's mitigation plan was a significant infusion of funds that paid for several years' worth of planned street elevations.

While the city appropriated funds to raise streets above the 100-year flood level required by the NFIP, it also received several hazard mitigation grants from FEMA to elevate private structures (assuming the owners paid the local share). By 2003, a significant percentage of the streets and a number of structures in Freeport had been raised, thereby reducing the number of structures that flooded regularly. Private development of the main commercial street, Woodcleft Avenue (also called the Nautical Mile), was an economic consequence or spillover of the city's ability (with FEMA assistance) to reduce flooding. Freeport's involvement with Project Impact strengthened the community's participation in mitigation while also promoting a city flood damage reduction program to raise bulkheads.

Like Tulsa, Freeport has sustained a robust mitigation program for more than 20 years. There are a number of reasons why Freeport has been successful. First, there have been two generations of floodplain management advocates within both the community and the city staff. Second, the village has been proactive in seeking funding for mitigation; it is one of the few communities with a dedicated grant manager. Third, the program is supported by citizens and the business community, both of which have seen their property values increase as a result. Fourth, the institutionalized program is operated and maintained by the highest ranking officers of the public works department and building inspection with the support of elected officials. Fifth, the village tries to accomplish reasonable goals each year by establishing a long-range program that gradually reduces flood risk in accord with its resources and funding opportunities.

Hayward, California. Hayward is a moderate sized city south of Oakland on the east shore of the San Francisco Bay. Its downtown business district straddles the Hayward earthquake fault. The city began to understand its earthquake risk in 1986 after it formed the Hazardous Building Mitigation Task Force (HBMTF) to identify all the unreinforced masonry buildings (URMs) within its boundaries in accordance with the state of California's URM Building Law. As part of its charter, the city asked the HBMTF to create an inventory of all URMs built before 1944, as well as all tilt-up buildings constructed prior to the 1973 building code adoption and all high-occupancy (300 or more persons) reinforced concrete buildings built prior to 1976.

Just before the HBMTF completed its task in late 1989, the Loma Prieta earthquake struck northern California and offered an opportunity for Hayward to apply for FEMA hazard mitigation funds. The city ultimately received mitigation grants to relocate its main fire station, retrofit five other fire stations, and replace its wastewater treatment plant. The city of Hayward also asked the HBMTF to recommend mitigation activities it should undertake. The HBMTF recommended that the city require owners of the URMs and tilt-ups to retrofit their structures. In addition, the city council voted to retrofit all vital city facilities and established an emergency services facilities tax to generate the funds needed to repay general obligation bonds issued for that purpose.

Approximately one year after the Loma Prieta earthquake, Hayward established a comprehensive earthquake mitigation program that was highly successful. According to officials, within five years of program implementation, all but three owners had retrofit URMs, all tilt-ups were retrofit, the city constructed a new city hall on base isolators, all the fire stations were seismically improved, a new and less hazardous wastewater treatment plant was constructed, and plans for the improvement of other city facilities were completed, but not yet implemented. Because of the simultaneous occurrence of the Loma Prieta earthquake and the near completion of the HBMTF inventory of seismically dangerous buildings, it was difficult to separate what the proximal causes of the two retrofit ordinances were. Since the city had not previously enacted any seismic ordinances, we ultimately considered them spin-off activities. Unlike Tulsa or Freeport, which had established mitigation programs prior to their first FEMA mitigation grants, Hayward was just learning what its seismic risk was when the Loma Prieta earthquake made it possible for the city to apply for mitigation grants.

There are several reasons why Hayward was able to turn this opportunity into a successful mitigation program. First, Hayward found out that the city had a manageable problem that could be addressed by the city and cooperative owners of private URMs and tilt-ups. When it enacted retrofit ordinances for the URMs and tilt-ups, there was no opposition. Remarkably, Hayward was then and still is the only community in the United States to mandate that private owners retrofit tilt-up buildings. Second, the city officials were proponents of mitigation, a common characteristic of communities in earthquake country.

All of the communities in our study had some flood risk. Hayward had suffered very little flood damage in its history and considered its risk from flood as low. It joined the NFIP in 1981 and has enacted ordinances to implement building codes that meet the NFIP minimum requirements. From a managerial point of view, the city response to floods has been sound and appropriate to the risk.

Horry County, South Carolina. Horry County is located on the Atlantic Coast about 100 miles north of Charleston. It is relatively flat and filled with wetlands, rivers, and beachfront. Its major cities, including Myrtle Beach, attract about 13 million visitors a year, mostly during the summer months at the height of the hurricane season. Because of its geography and location, Horry County is at high risk from floods and hurricanes and moderate risk from earthquakes.

Horry County is one of the fastest growing regions of the country. Once noted for pine forests that traditionally were harvested for paper products, the county is now undergoing drastic changes as the paper corporations clear the trees and develop numerous