United States General Accounting Office

GAO

Report to the Chairman, Subcommittee on Housing and Community Opportunity, Committee on Financial Services, House of Representatives

March 2004

FLOOD MAP MODERNIZATION

Program Strategy Shows Promise, but Challenges Remain

GAO

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GAO-04-417

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GAO Highlights

Highlights of GAO-04-417, a report to the Chairman, Subcommittee on Housing and Community Opportunity, Committee on Financial Services, House of Representatives

Why GAO Did This Study

Flood maps identify areas at greatest risk of flooding and provide the foundation for the National Flood Insurance Program (NFIP) managed by the Federal Emergency Management Agency (FEMA). The maps are used by (1) communities to establish minimum building standards designed to reduce the impact of flooding, (2) FEMA to set insurance rates, and (3) lenders to identify property owners who are required to purchase flood insurance. Nearly 70 percent of all flood maps are more than 10 years old, according to FEMA. In an effort to update its flood maps, FEMA is implementing a $1 billion, 5-year map modernization program. GAO was asked to review the progress of FEMA's map modernization program.

What GAO Recommends

To help ensure that FEMA's map modernization program achieves its intended benefits, GAO is making several recommendations. FEMA should address differences among the communities for which flood maps are being developed—whether those differences arise from different levels of flood risk or different levels of capacity and resources to assist with flood mapping.

www.gao.gov/cgi-bin/getrpt?GAO-04-417.

To view the full product, including the scope and methodology, click on the link above. For more information, contact William O. Jenkins, 202-512-8777, jenkinswo@gao.gov.

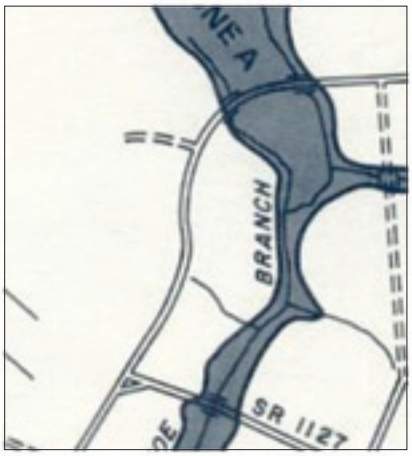
What GAO Found

Through its map modernization program, FEMA intends to use advanced technologies to produce more accurate and accessible digital flood maps available on the Internet. These maps are expected to improve community efforts to reduce the impact of floods, increase property owners' use of flood insurance, and improve community, state and federal efforts to reduce the risks of other natural and man-made hazards.

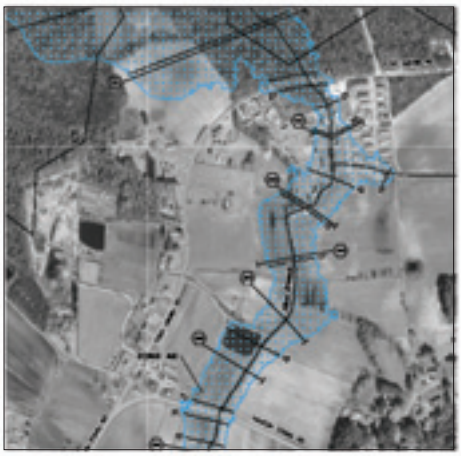
In developing digital flood maps, FEMA plans to incorporate data that are of a level of specificity and accuracy commensurate with communities' relative flood risk. According to FEMA, there is a direct relationship between the types, quantity, and detail of the data and analysis used to develop maps and the costs of obtaining and analyzing those data. Although FEMA ranked the nation's 3,146 counties from highest to lowest risk, it has not yet established data standards that describe the appropriate level of detail, accuracy, and analysis required to develop digital maps based on risk level. Without such standards, FEMA cannot ensure that it uses the same level of data collection and analysis for all communities in the same risk category. Such standards can also help FEMA to target its map modernization resources more efficiently by matching the level of data collection and analysis with the level of flood risk.

FEMA has developed partnerships with states and local entities that have begun mapping activities and has a strategy on how to best work with these entities. However, the overall effectiveness of FEMA's future partnering efforts is uncertain because FEMA has not yet developed a clear strategy for partnering with communities with less resources and little or no experience in flood mapping. By developing such a strategy, FEMA will be better able to identify and use the most effective approaches to engage all of its partners in map modernization.

Comparison of Old Paper and New Digital Map Sections in North Carolina



Paper flood map section



Digital flood map section

Source: North Carolina Department of Emergency Management.

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Abbreviations

CTP	Cooperating Technical Partner
DHS	Department of Homeland Security
FEMA	Federal Emergency Management Agency
GIS	Geographic Information Systems
LIDAR	Light Detection and Ranging
NFIP	National Flood Insurance Program

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G A O
Accountability * Integrity * Reliability

United States General Accounting Office
Washington, DC 20548

March 31, 2004

The Honorable Robert W. Ney
Chairman
Subcommittee on Housing and Community Opportunity
Committee on Financial Services
House of Representatives

Dear Mr. Chairman:

Floods inflict more damage and economic losses upon the United States than any other natural disaster. During the 10 years from fiscal year 1992 through fiscal year 2001, flooding caused over 900 deaths and resulted in approximately $55 billion in damages.[1] Since its inception 36 years ago, the National Flood Insurance Program (NFIP) has combined the development of flood maps to identify the areas at greatest risk of flooding with mitigation[2] efforts to reduce or eliminate flood risks to people and property and the availability of insurance that property owners can purchase to protect themselves from flood losses. To date, the flood insurance program has paid about $12 billion in insurance claims, primarily from policyholder premiums, that otherwise would have been paid, at least in part, from taxpayer-funded disaster relief.

The Federal Emergency Management Agency (FEMA) is responsible for managing the NFIP, including the development of flood maps.[3] Accurate flood maps that identify the areas at greatest risk of flooding are the foundation of the NFIP. The maps are principally used by (1) the

[1]Data are from the U.S. Army Corps of Engineers in cooperation with the National Weather Service.

[2]Mitigation is defined by the Federal Emergency Management Agency as sustained action that reduces or eliminates long-term risk to people and property from hazards and their effects.

[3]Prior to March 2003, FEMA was an independent agency whose Federal Insurance and Mitigation Administration was responsible for managing the flood insurance program. The Homeland Security Act of 2002, P.L. 107-296 (Nov. 25, 2002), transferred FEMA and all its responsibilities to the Emergency Preparedness and Response Directorate within the new Department of Homeland Security. This transfer was effective March 1, 2003. Currently, the Mitigation Division within FEMA is responsible for the flood insurance program, including flood map modernization.

approximately 20,000 communities participating in the NFIP to adopt and enforce the program's minimum building standards for new construction within the maps' identified floodplains, (2) FEMA to develop accurate flood insurance policy rates based on flood risk, and (3) federally regulated mortgage lenders to identify those property owners who are statutorily required to purchase federal flood insurance. Under the National Flood Insurance Act of 1968, as amended,[4] property owners whose properties are within the designated floodplain and have a mortgage from a federally regulated financial institution are required to purchase federal flood insurance. Flood maps can become outdated for a variety of reasons, such as erosion or community growth and development that can affect the drainage patterns of rainwater. Thus, flood maps must be periodically updated to assess and map changes in the boundaries of floodplains that result from community growth, development, erosion, and other factors that affect the boundaries of areas at risk for flooding. According to FEMA, limited funding for flood mapping has resulted in a backlog of outdated maps. FEMA estimates that as of March 2004 nearly 70 percent of the nation's flood maps were more than 10 years old and reflected outdated data that could affect the ability to accurately identify current flood hazard areas.

With congressional support and funding, FEMA has embarked on a $1 billion, 5-year effort to update the nation's flood maps. Recognizing that FEMA is currently in the early stages of its map modernization effort, our objectives for this review were to answer the following questions: (1) How is map modernization intended to improve the accuracy and accessibility of the nation's flood maps? (2) What are the expected benefits of more accurate and accessible flood maps? (3) To what extent does FEMA's strategy for managing the map modernization program support the achievement of these benefits and what, if any, limitations could affect the implementation of the strategy?

To answer these questions, we analyzed available information from FEMA on the program's purpose, objectives, and status and met with agency officials in headquarters and in the regional offices to discuss the program's progress. We also conducted site visits to states and communities that have already begun to modernize their flood maps and interviewed industry organizations such as the Association of State Flood Plain Managers, the National Association of Flood and Stormwater

[4]See 42 U.S.C. 4001 et seq.

Management Agencies, and the National Emergency Management Association. We conducted our work from April 2003 to March 2004 in accordance with generally accepted government auditing standards. See appendix I for more details on our scope and methodology.

Results in Brief

Through map modernization, FEMA intends to produce more accurate and accessible flood maps by using advanced technology to gather accurate data and make the flood maps, and the digital information on which they are based, available on the Internet. For example, displaying map data in digital Geographic Information Systems format permits consistent, accurate display and ready electronic retrieval of a variety of map features, including elevation data and the location of key infrastructure, such as utilities. According to FEMA, nearly 70 percent of the nation's approximately 92,222 flood maps are more than 10 years old, and many of these maps no longer reflect current flood hazard risks because of such changes as erosion and development that can alter drainage patterns and thus the areas at highest risk of flooding. Moreover, since many flood maps were created or last updated, there have been improvements in the techniques for assessing and displaying flood risks.

FEMA expects that by producing more accurate and accessible digital flood maps through map modernization, the nation will benefit in three ways. First, communities can use more accurate digital maps to reduce flood risk within floodplains by more effectively regulating development through zoning and building standards. Second, accurate digital maps available on the Internet will facilitate the identification of property owners who are statutorily required to obtain or who would be best served by obtaining flood insurance. Third, accurate and precise data will help national, state, and local officials to accurately locate infrastructure and transportation systems (e.g., power plants, sewage treatment plants, railroads, bridges, and ports) to help mitigate and manage risk for multiple hazards, both natural and man-made.

FEMA's strategy for managing map modernization is designed to support the expected program benefits, but FEMA's approach to implementing the strategy raises several concerns that could hamper the agency's efforts. FEMA's implementation approach is based on four objectives: (1) establish and maintain a premier data system, (2) expand outreach and better inform the user community, (3) establish and maintain effective partnerships, and (4) achieve effective program management.

- **Establish and maintain a premier data system**: Although FEMA's efforts to establish a new data system could result in more accurate

flood maps and make it easier to access and use the revised flood maps, FEMA has not yet established clear standards for the types, quantity, and specificity of data collection and analysis associated with different levels of flood risk. FEMA has ranked the nation's 3,146 counties from highest to lowest flood risk. According to FEMA, communities at the highest risk of flooding require the most extensive, detailed data and analysis, but the same level of data collection and analysis may not be necessary to create accurate, useful maps for communities with lower flood risks. Defining the level of data collection and analysis for different levels of risk is important because obtaining and analyzing flood map data is time-consuming and expensive, and the more detailed and specific the data, generally the greater the effort and costs required to obtain it. By identifying the types, quantity, and specificity of the data and analysis needed for communities based on their risk, FEMA can better ensure that data collection and analysis is consistent for all communities with similar risk and that it is using its resources efficiently while producing maps that are accurate and useful for communities at different levels of flood risk. FEMA acknowledges the need to develop such standards, but has not yet developed draft standards or included this task into its map modernization implementation plan.

- **Expand outreach and better inform the user community**: FEMA's planned expanded outreach efforts are intended to increase public awareness and obtain community acceptance of the updated flood maps because the updated information could potentially identify changes in floodplain boundaries and, therefore, affect property owners, including whether or not their property's location may require them to purchase federal flood insurance. FEMA's intended outcome for these outreach efforts is to reduce community vulnerability to natural and man-made hazards and increase participation in the flood insurance program. Because FEMA does not have the authority to require that affected property owners take steps to mitigate their properties against flood risks or to ensure that owners whose properties are in the floodplain purchase flood insurance, effective outreach is essential to ultimately achieve these benefits.

- **Establish and maintain effective partnerships**: FEMA's objective for building and maintaining mutually beneficial partnerships is designed to facilitate and support the efficient production and effective use of maps. FEMA recognizes that local, state, and federal agencies, that have been working on mapping activities for years, have the resources and potential to positively affect the quality and quantity of the data collected and improve the way these data are used. In

addition, these partnerships can enable FEMA to leverage its resources and reduce the federal costs of map modernization. FEMA has developed a strategy for partnering with these agencies to encourage greater involvement in map modernization, including the contribution of resources. However, the overall effectiveness of the agency's future partnering efforts is uncertain because FEMA has not yet developed a clear strategy for partnering with communities that have few resources, limited mapping capability, and little history of flood mapping activities.

- **Achieve effective program management**: In March 2004, FEMA awarded a performance-based contract to a single contractor to oversee map modernization that includes performance measures to gauge the success of its efforts. Through a staffing analysis, FEMA has determined that it needs 75 staff with specific, identified skills to effectively monitor and manage the contract and overall map modernization program. As of March 2004, FEMA had hired 1 of the 75 staff, had developed plans to hire or transfer 43 others, but had not yet determine how it would acquire the remaining 31 positions. FEMA has not clearly defined performance measures related to whether (1) the revised maps meet any established standards for accuracy and (2) outreach efforts have been successful in increasing the community and individual awareness and use of flood maps.

To help ensure that FEMA's map modernization program achieves its intended benefits, we make recommendations to the Secretary of Homeland Security to direct the Undersecretary of Emergency Preparedness and Response to address data and analysis standards, partnering with state and local governments, and program management. We provided a copy of our draft report to the Department of Homeland Security (DHS) for comment. In its oral comments, DHS generally concurred with the report's findings and recommendations and provided technical comments that we incorporated where appropriate.

Background

FEMA is the primary federal agency responsible for assisting state and local governments, private entities, and individuals to prepare for, mitigate, respond to, and recover from natural disasters, including floods. FEMA's NFIP has served as a key component of the agency's efforts to minimize or mitigate the damage and financial impact of floods on the public, as well as to limit federal expenditures needed after floods occur.

In 1968, to address the increasing amount of flood damage, the lack of readily available insurance for property owners, and the cost to the taxpayer for flood-related disaster relief, the National Flood Insurance Act of 1968,[5] created the NFIP. Since its inception, the program has sought to minimize flood-related property losses by making flood insurance available on reasonable terms and encouraging its purchase by people who need flood insurance protection—particularly those living in the areas at highest risk of flooding known as special flood hazard areas. The program identifies and maps flood-prone areas in the country, makes flood insurance available to property owners in the nearly 20,000 communities that currently participate in the program,[6] and requires floodplain management efforts to mitigate flood hazards on the part of participating communities.

FEMA's flood maps are one of the basic, essential tools for flood hazard mitigation in the United States. FEMA estimates that the maps are used an estimated 30 million times annually in the private and public sectors. FEMA uses the maps to identify the floodplain boundaries in which flood insurance is required and to set flood insurance rates. Mortgage lending institutions use the maps to determine who is required to purchase flood insurance and ensure that flood insurance is purchased and maintained for these properties. Community planning officials, land developers, and engineers use the maps for designing new buildings and infrastructure to be safe from flooding. See appendix II for more information on the various stakeholders that use and rely upon flood maps.

Flood maps provide the basis for establishing floodplain building standards that participating communities must adopt and enforce as part of the program. For a community to participate in the program, any structures built within special flood hazard areas—also known as 100-year floodplains[7]—that have a 1 percent or greater chance of experiencing flooding in any given year must be built according to the program's building standards whose purpose is to minimize flood losses. A key component of the program's building standards that must be followed by participating communities is a requirement that the lowest floor of the

[5]P.L. 90-448, (Aug. 1, 1968).

[6]Also included are Puerto Rico and the Virgin Islands.

[7]For clarity and ease of discussion throughout the report, we use the term "floodplain" in all discussions where we address the special flood hazard area or 100-year floodplain.

structure be elevated to or above the base flood level—the elevation at which there is a 1 percent chance of flooding in a given year. The administration has estimated that local governments' compliance with the program's standards for new construction is saving over $1 billion annually in flood damage avoided.

Flood maps also provide the basis for setting insurance rates and identifying properties whose owners are required to purchase flood insurance. When the NFIP was created, the purchase of flood insurance was voluntary. To increase the impact of the program, however, Congress amended the original law in 1973 to require the purchase of flood insurance in certain circumstances. Flood insurance is required for structures in special flood hazard areas of communities participating in the program if (1) any federal loans or grants were used to acquire or build the structures or (2) the structures have outstanding mortgage loans made by lending institutions that are regulated by the federal government. Owners of properties without mortgages or properties with mortgages held by unregulated lenders were not, and still are not, required to purchase flood insurance, even if the properties are in special flood hazard areas.

Federal regulations require that FEMA communicate potential changes in flood risk to the public when it decides to initiate a flood mapping study and when it is ready to release preliminary maps. At the beginning of the mapping process, FEMA is required to notify community stakeholders.[8] When FEMA is ready to release preliminary maps, the agency must publish the proposed base flood elevations in the *Federal Register* for public comment and notify the community of the results of the study.[9] When the final map is approved and implemented, FEMA publishes another *Federal Register* notice.[10]

[8]FEMA is required to contact community stakeholders, such as the state coordinating agency and other appropriate community officials, to discuss the scope and methodology for the proposed flood map study. 44 C.F.R. sec. 66.5.

[9]FEMA is required to publish the proposed flood elevations in a prominent local newspaper at least twice during the 10-day period following the notification of the community chief executive officer. Property owners have 90 days from the second newspaper publication to appeal the proposed flood elevations. 44 C.F.R. secs. 67.4, 67.5.

[10]Final flood elevations must be published in the *Federal Register* and copies sent to the community chief executive officer, all individual appellants, and the state-coordinating agency. 44 C.F.R. 67.11.

In the early 1990s, some of the data and information FEMA collected to develop flood maps were becoming available in digital format. In 1994, the President issued Executive Order 12906, which mandated that standards for digital geographic data be applied uniformly across the federal government. Anticipating that electronic data would soon become the standard vehicle for information delivery and in an attempt to make flood map production more cost-effective and efficient, FEMA developed a prototype for a digital flood map.

In 1997, FEMA developed its initial flood map modernization plan that outlined the steps necessary to update the nation's flood maps to digital format and streamline FEMA's operations in raising public awareness of the importance of the maps and responding to requests to revise them. This initial plan and subsequent updates to the plan reflected the recommendations of the Technical Mapping Advisory Council created by Congress and active from 1995-2000. The council provided a number of recommendations which were aimed at making the digital flood map the future method for assessing flood hazard risk and setting federal insurance rates. Recognizing the importance of updating the nation's flood maps, Congress appropriated additional funds in fiscal years 2000-2002. FEMA used these funds to launch its map modernization program through such activities as developing new flood mapping standards and procedures, expanding the Cooperating Technical Partner (CTP) program that recognizes and encourages state and local participation in flood hazard data development and maintenance and developing some digital flood maps. In fiscal year 2003, Congress appropriated $150 million, allowing FEMA to initiate a full-scale update of the nation's flood maps called the Multi-Hazard Flood Map Modernization Program,[11] an effort FEMA expects to take about 5 years and cost about $1 billion. In fiscal year 2004, Congress appropriated an additional $200 million for map modernization, and the administration has requested an additional $200 million for fiscal year 2005 to continue the program. FEMA has established four primary objectives for implementing map modernization: (1) establish and maintain a premier data collection and delivery system, (2) expand outreach and better inform the user community, (3) build and maintain mutually beneficial partnerships, and (4) achieve effective program management. In March 2004, FEMA awarded a performance-based

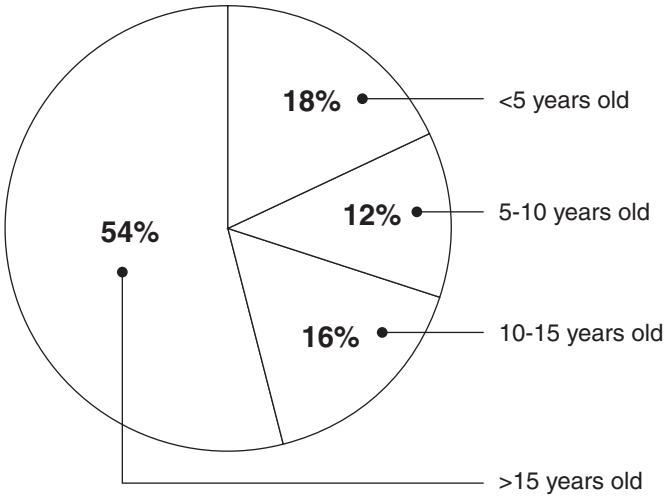
[11]For clarity and ease of discussion throughout the report, we use the term "map modernization" in all discussions where we address the Multi-Hazard Flood Map Modernization Program.

contract for overseeing map modernization that includes contractor performance measures for each of these objectives.

Map Modernization Intends to Use Advanced Technologies to Produce More Accurate and Accessible Digital Flood Maps

Through map modernization, FEMA intends to produce more accurate and accessible flood maps by using advanced technology to gather accurate data and make the resulting information available on the Internet. Currently, many of the flood maps in FEMA's inventory do not accurately reflect the true flood hazard risks because over time, new development and other factors altered watersheds and floodplains faster than the maps could be updated. For the most part, the $35 million to $50 million in annual flood insurance policy fees has been the only source of funding for updating flood maps, and according to FEMA, the agency has not been able to keep the maps updated with the funds available. As a result, nearly 70 percent of the nation's approximately 92,222 flood maps[12] are more than 10 years old and many of these maps reflect inaccurate data, according to FEMA. Figure 1 shows the age distribution of the current map inventory.

Figure 1: Age of the Nation's Current Flood Map Inventory



Source: FEMA.

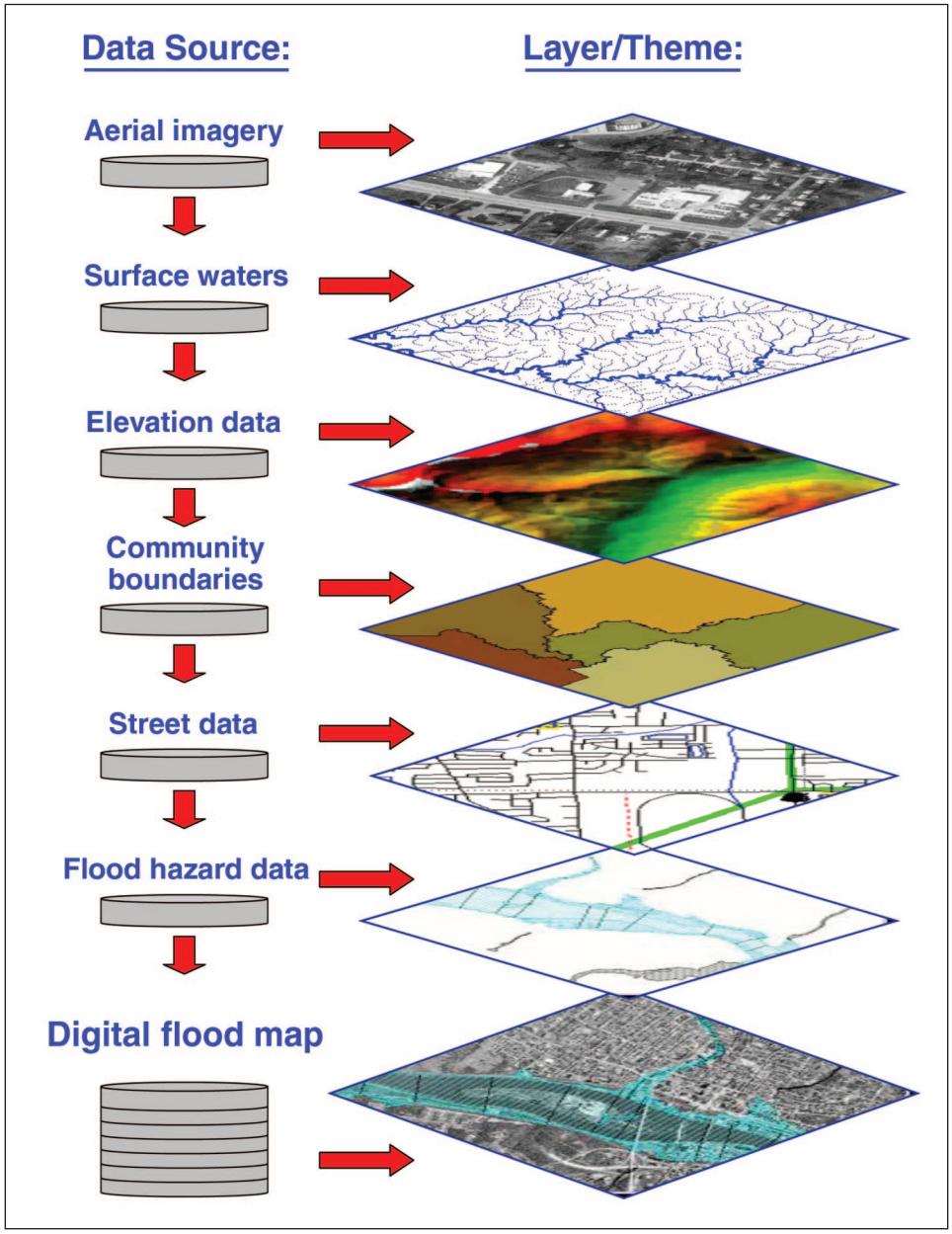
Over time, physical conditions in watersheds and floodplains can change, and improvements in the techniques for assessing and displaying flood

[12]The 92,222 flood maps represent nearly 20,000 communities.

risks are made. FEMA plans to use the latest technology, such as Geographic Information Systems (GIS), to create accurate digital flood maps. GIS technology provides the foundation for achieving FEMA's goals of melding different types and sources of data to create the new digital flood maps and making the new digital flood maps available to a variety of users over the Internet.

The primary function of GIS is to link multiple digital databases and graphically display that information as maps with potentially many different types of "layers" of information. When layers of information are formatted using the same standards, users can potentially overlay various layers of information about any number of specific topics to examine how the layers interrelate. Each layer of a GIS map represents a particular "theme" or feature, and one layer could be derived from a data source completely different from the other layers. For example, one theme could represent all the streets in a specified area. Another theme could correspond to the topography or elevation data of an area, and others could show aerial photography and streams in the same area. These themes are all key elements needed to create flood maps that accurately depict floodplains and can be used to identify properties in these areas. In preparing for full-scale implementation of map modernization, FEMA has established standards and graphic specifications for digital flood maps created with GIS. Figure 2 shows the concept of data themes in GIS for flood maps.

Figure 2: Key GIS Layers or Themes for Digital Flood Maps



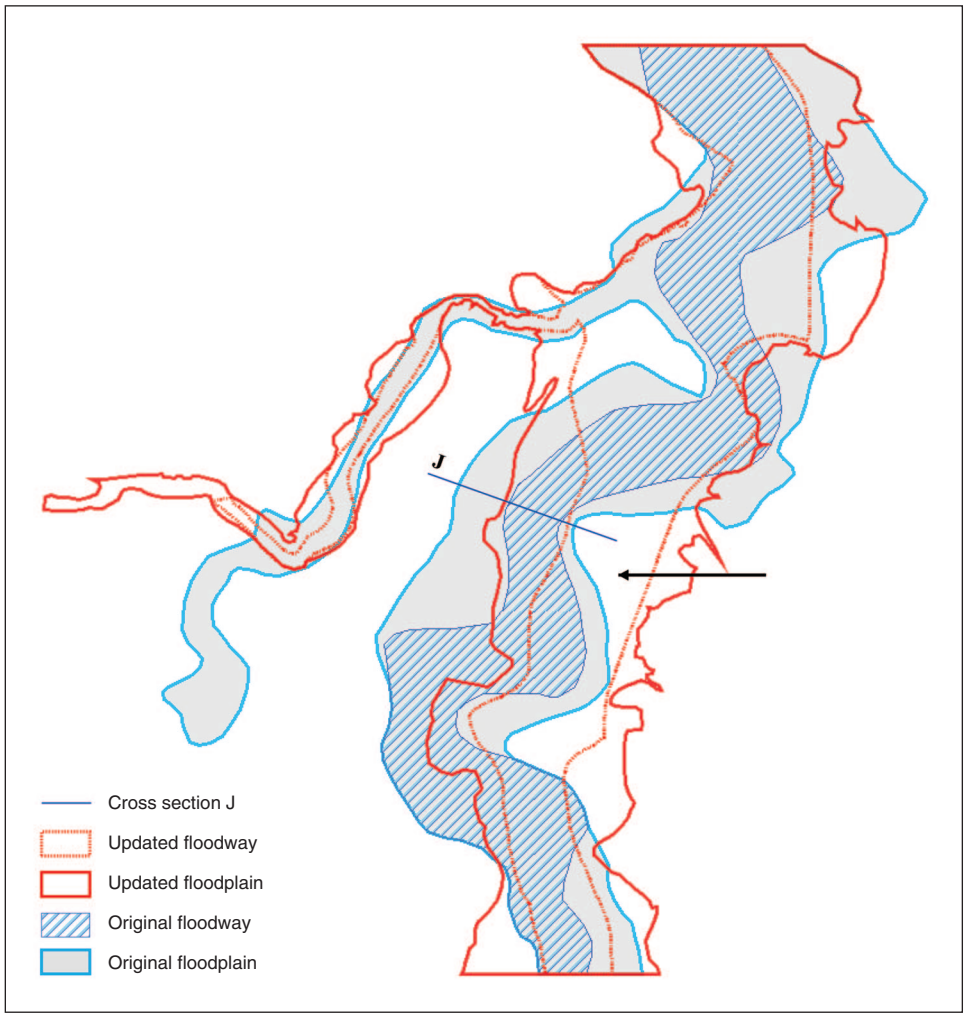
Source: FEMA.

GIS technology also enables the creation of more accurate and accessible maps than would be possible with older mapping methods and technology. The majority of FEMA's flood map inventory was produced using manual techniques that have inherent accuracy and accessibility limitations. For example, in creating traditional paper flood maps, field measurements taken by surveyors would have been transferred by hand to paper base maps. If the paper base map contained any inaccuracies, then the field-survey data could be shown in the wrong place on the final flood map. This would then result in floodplain boundaries being shown in the wrong place.

Douglas County, Colorado

Recent remapping efforts in Douglas County, Colorado, show the accuracy of digital maps using GIS technology compared with paper maps created using manual techniques. As seen in figure 3, some areas (around cross section J) shown outside the floodplain on the original map will be shown in the floodplain based on the updated flood hazard information from a new mapping study using GIS technology. More critically, some areas shown outside the floodplain on the original map will now be shown in the floodway, the most dangerous area of the floodplain (greatest depth, highest flood water velocity). According to FEMA and community officials, the limitations of the manual techniques used to create the original map contributed to the resulting inaccuracy.

Figure 3: Comparison of Original and Updated Floodplain for Plum Creek in Douglas County, Colorado



Source: FEMA and Denver Urban Drainage and Flood Control District.

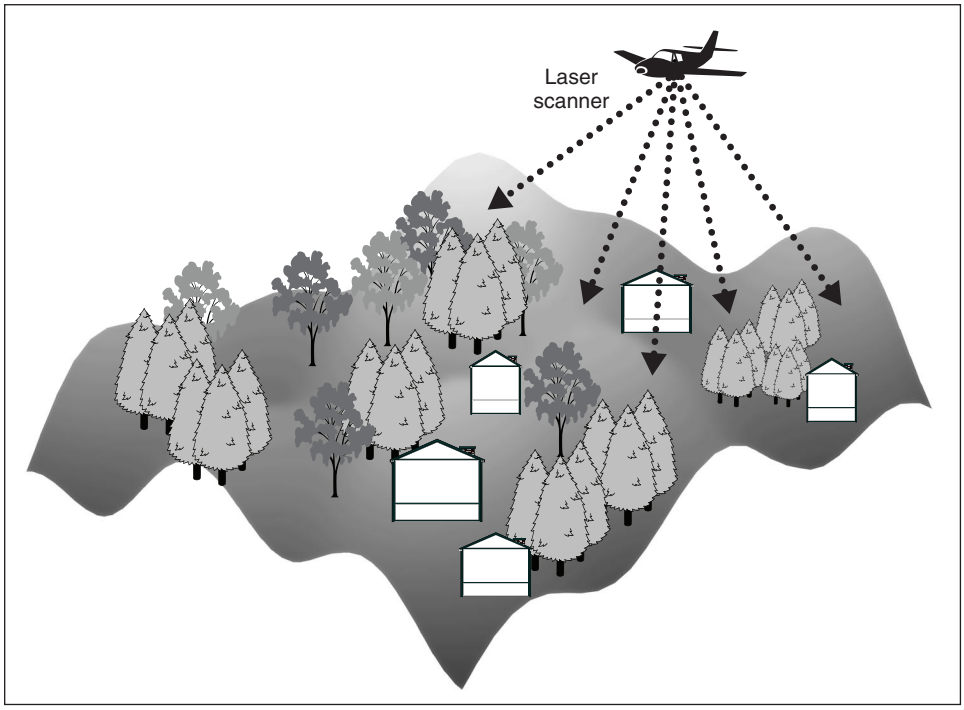
Using GIS technology to create digital flood maps minimizes mapping errors and improves accuracy because each data component (e.g., streams, streets, etc.) would have a common geographic reference system.

By their nature, paper flood maps have limited accessibility as compared with a digital map that can be made available on the Internet. The expansion of Internet connectivity in recent years has substantially

enhanced the potential value of digital maps created with GIS because now it is possible to locate and connect data from many distinct GIS databases to develop analytical information on almost any topic that is associated with physical locations. Digital flood maps created according to FEMA's standards are intended to provide users not only with the ability to determine the flood zone and base flood elevations for a particular location, but also with the ability to access other information like road, stream, and public land survey data. Communities could use this information for a variety of purposes, including decisions on future development and evacuation routes.

As part of map modernization, FEMA has promoted the use of a variety of advanced technologies to improve the accuracy of flood maps. In recent years, for example, where it deems it appropriate, FEMA has promoted the use of Light Detection and Ranging (LIDAR) remote sensing technologies to generate highly detailed, digital elevation data. Elevation data are a key component needed to determine flood risk and identify floodplain boundaries. According to FEMA, for very flat areas where small changes in elevation can have a large impact on where flood plain boundaries are drawn, LIDAR can provide the level of detail needed to accurately delineate these boundaries. Communities can also use detailed, digital elevation data for planning and land development purposes. Figure 4 shows an airplane equipped with laser-pulsing sensors using LIDAR to gather digital elevation data to measure the contours and crevices that determine where floodwaters collect.

Figure 4: Use of LIDAR Technology

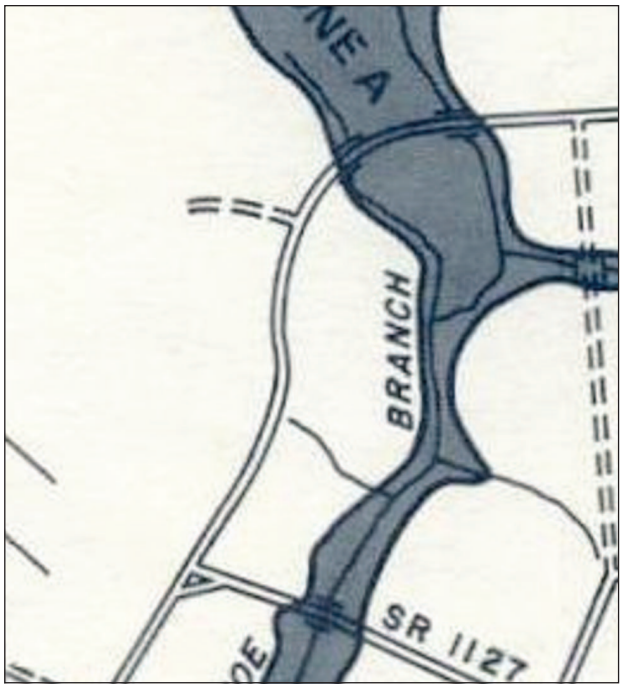


Source: Harris County Flood Control District.

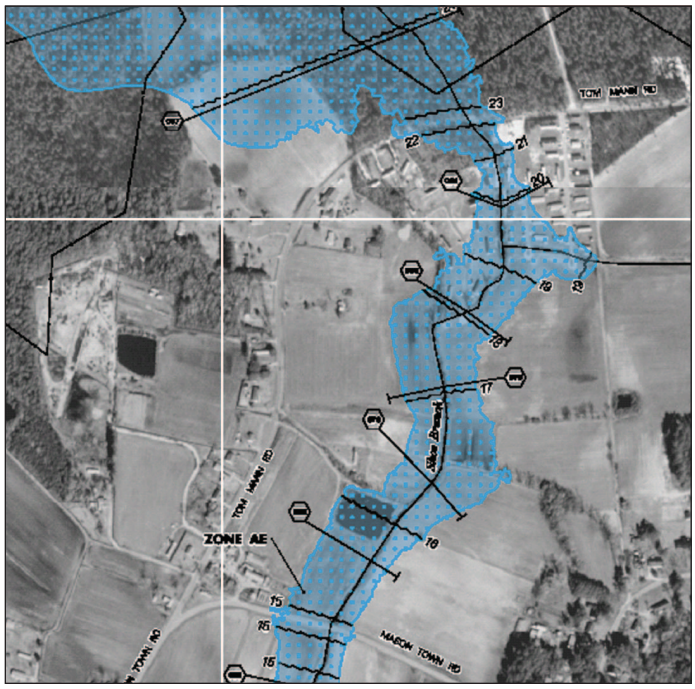
North Carolina's Use of GIS and LIDAR to Develop and Deliver Revised Flood Maps

The state of North Carolina has been utilizing GIS and LIDAR technology to develop new flood maps. As of February 2004, 8 counties had received new effective flood maps, and 28 counties received new preliminary maps, which are now under community review. The state has gathered elevation data through LIDAR for 80 percent of the state. The maps and LIDAR and other data can be freely accessed and downloaded by anyone who has access to the Internet (http://www.ncfloodmaps.com). The state, dependent on continued FEMA funding, expects to have the entire state remapped by 2008. Figure 5 compares a digital flood map section produced by North Carolina with the same area on the original paper map.

Figure 5: Comparison of Old Paper and New Digital Map Sections in North Carolina



Paper flood map section



Digital flood map section

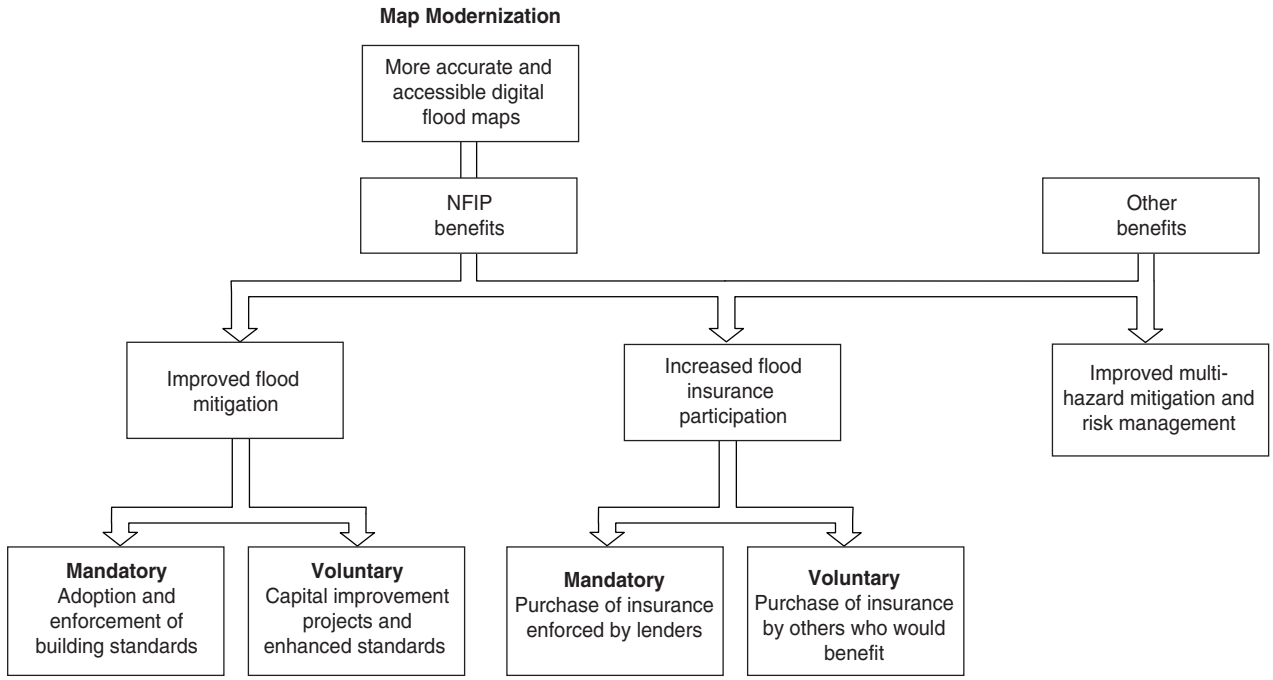
Source: North Carolina Floodplain Mapping Program.

FEMA Expects Map Modernization to Increase the Likelihood Maps Will Be Used for Risk Management

FEMA expects map modernization to increase the likelihood that the more accurate and accessible maps will be used for risk management purposes. Specifically, FEMA expects the new maps to be used to (1) improve flood mitigation, (2) increase flood insurance participation, and (3) improve "multi-hazard" mitigation and risk management capabilities. First, FEMA expects communities to be able to use these new and revised maps to better manage and mitigate flood risk by regulating floodplain development through building codes, ordinances, and regulations. Second, the new maps also have the potential to help increase flood insurance participation because they will more accurately identify those properties that are in the floodplain and whose owners would be required to purchase flood insurance. Compared with the existing paper maps, accessing the new maps through the Internet will make it much easier for lenders to identify property owners who should have flood insurance. In addition, the newly revised flood maps should more accurately identify all

properties in the floodplain, including those whose owners do not have a mortgage or whose mortgage is held by a lender that is not federally regulated. Accurately identifying these property owners should assist FEMA and communities in targeting their outreach about the importance of flood insurance. Third, the data and infrastructure developed by map modernization is also expected to help national, state, and local officials mitigate and manage risk from multiple hazards, both natural and man-made. Accurate digital maps can provide more precise data on such things as the location of hazardous material facilities, power plants, railroads, and airports to state and national officials for planning development as well as to assess internal weaknesses and evacuation routes. (Fig. 6 highlights these expected benefits.)

Figure 6: Expected Benefits of Map Modernization



Source: GAO.

Map Modernization Is Expected to Improve Flood Mitigation

The more accurate and updated flood hazard information produced through map modernization is expected to help improve flood mitigation in participating communities. The NFIP requires participating communities to adopt and enforce building standards based on the floodplain boundaries and base flood elevations when maps are updated. For example, the lowest floor of structures in new construction must be elevated to at least the base flood elevations identified on the maps. FEMA's policy is to monitor communities to ensure that they have adopted building standards that meet the minimum NFIP criteria and to ensure that they are effectively enforcing these standards. If communities fail to establish and enforce minimum NFIP flood plain building standards, FEMA can suspend availability of federal flood insurance.

Communities also may use updated flood hazard data to take actions to mitigate flooding that go beyond adopting the building standards required by the NFIP. For example, communities may use the data from the maps to identify where to conduct capital improvement projects designed to

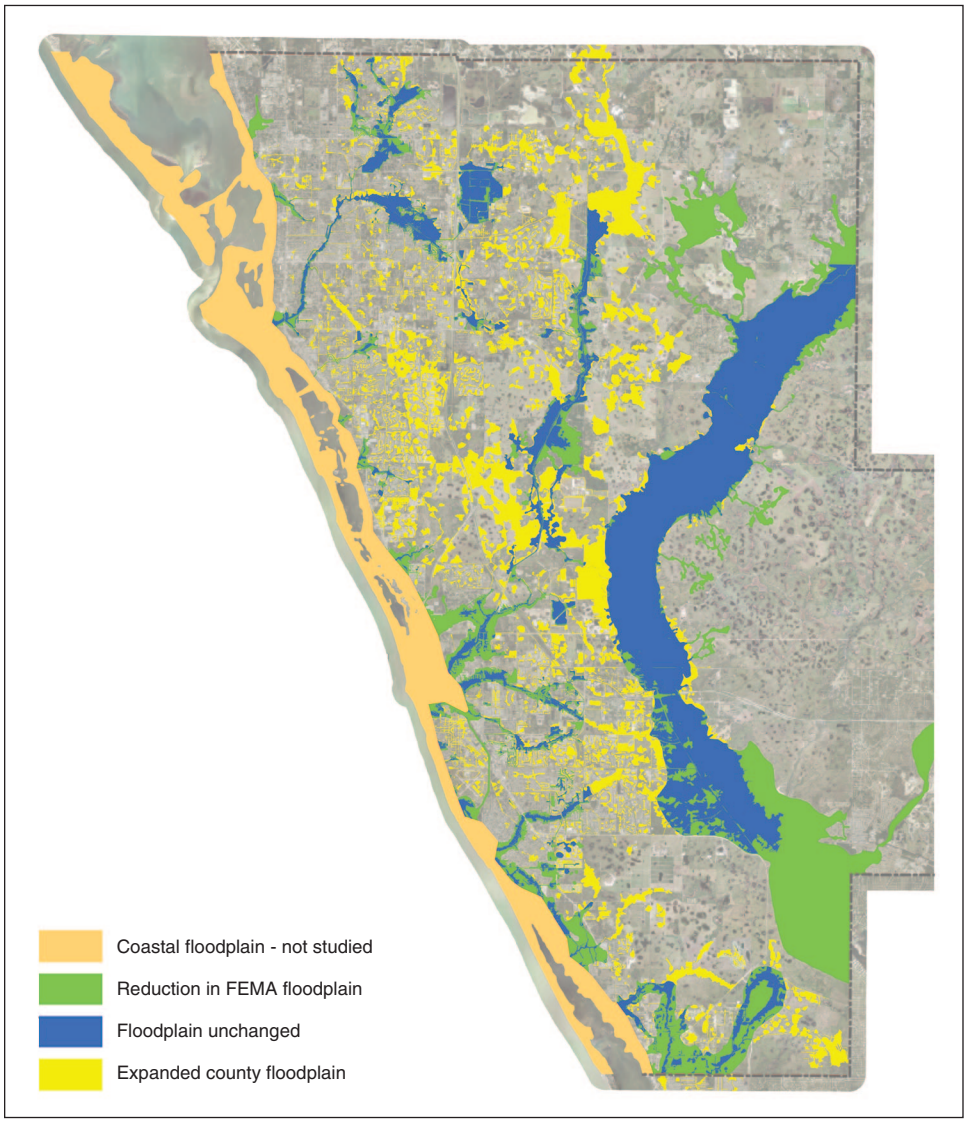
mitigate flooding of structures in the floodplain. In addition, FEMA has established a Community Rating System that provides discounts on flood insurance premiums for those communities that take mitigation actions beyond those required by the NFIP.

Sarasota County's Use of Flood Map Data for Storm Water Capital Improvement Projects

Sarasota County, Florida, is in the process of modernizing its flood maps and has been using the maps and the models behind them to implement stormwater capital improvement projects whose purpose is to mitigate the flood risk for structures now located in the floodplain. These efforts have also resulted in lower insurance premiums for property owners.

In the late 1990s, because Sarasota County officials believed that current maps did not accurately reflect changes to the floodplain that had occurred due to development and other factors, they began an effort to aggressively remap the county's watersheds using GIS and new flood modeling technologies. At the time, the county had experienced several significant flooding events where hundreds of properties not depicted in the floodplain on its 11-year old maps were damaged. Figure 7 shows both the increase and decrease in the floodplain based on the county's remapping efforts.

Figure 7: Comparison of FEMA and Sarasota County Floodplain after Remapping

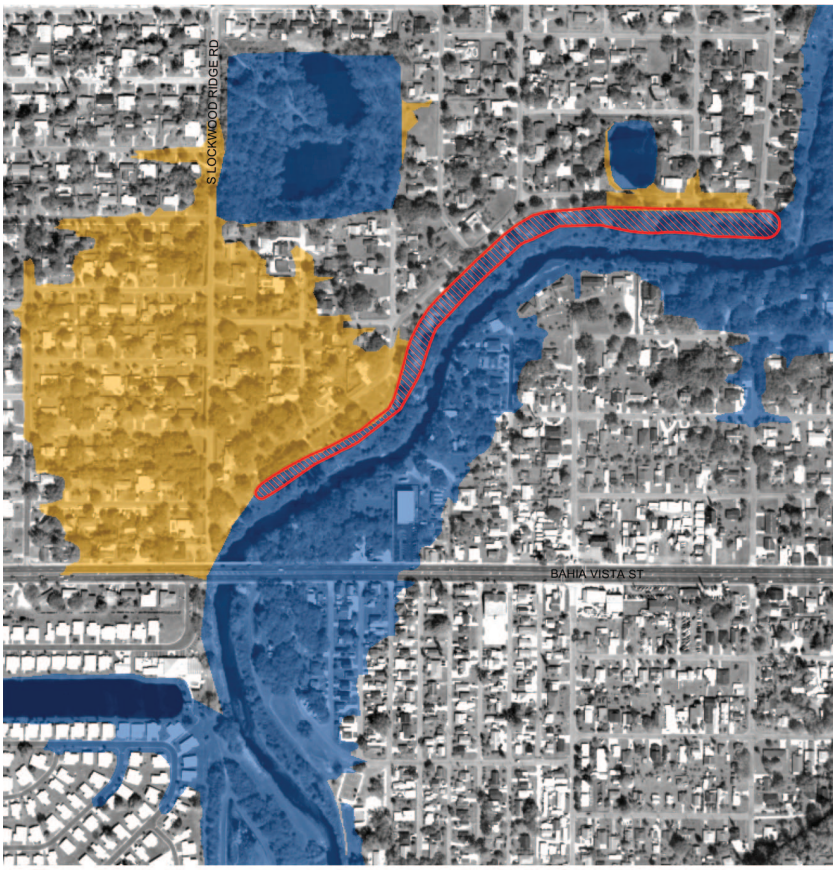


Source: Sarasota County Center for Watershed Management.

The county has been using the maps to implement storm water improvement projects such as retention ponds and levees that are designed to improve drainage and, therefore, alter the floodplain. Ultimately, these projects would result in structures no longer being in the floodplain. County officials estimate that they have reduced the number of structures in the floodplain by 75 percent (from 800 to under 200) through

these projects. According to these officials, the reduction in their Community Rating System rating from an 8 to a 6 was due in large part to their remapping efforts. They estimate that this reduction is saving the community over $1 million a year in flood insurance premiums. Figure 8 shows an example of the impact one such capital improvement project had on the floodplain in Sarasota County.

Figure 8: Impact of Capital Improvement Project on Floodplain in Sarasota County



Bahia Vista/Lockwood Ridge before levee project: 1962 flooding.

Bahia Vista/Lockwood Ridge Levee Project: post project picture.

Levee project

Revised floodplain

Historical floodplain removed by levee project

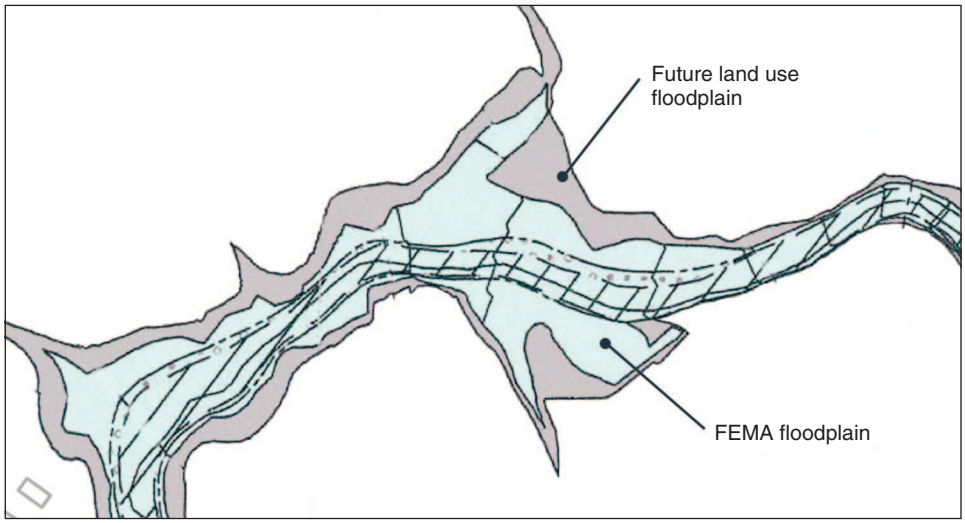
Source: Sarasota County Center for Watershed Management.

Mecklenburg County, North Carolina

Mecklenburg County, North Carolina, provides another example of how communities may use revised maps as a basis for adopting and enforcing building standards that exceed the standards required by the NFIP.

In February 2004, Mecklenburg County, North Carolina, issued final digital maps that not only show the floodplain boundaries and base flood elevations used by FEMA to set insurance rates, but also include local land use maps designed to guide future development. (See fig. 9.) These maps are more restrictive than the FEMA maps, which are used for setting insurance rates. The county uses these maps to require that the lowest floor of all new construction is built an additional foot above the future minimum base flood elevation identified by the map. Engineering and economic studies estimate that this higher standard will save over $300 million in structure and content losses due to future flooding. As in the case of Sarasota County, adopting these higher standards should result in a better Community Rating System rating for the county and reduce insurance rates for property owners.

Figure 9: Expanded Floodplain Boundary for Regulating New Construction in Mecklenburg County, North Carolina



Source: Charlotte-Mecklenburg Storm Water Services.

Map Modernization Is Expected to Help Increase Flood Insurance Participation

Map modernization has the potential to help increase flood insurance participation. The accuracy of the new maps should better identify at-risk property owners who would be best served by obtaining flood insurance whether or not the owners would be required to purchase insurance under the NFIP's mandatory purchase requirement. Moreover, the digital, GIS-based maps should make flood risk information more accessible to a

variety of users such as lenders and community officials who could conduct targeted outreach at these property owners.

Outreach Efforts in Wilson and Johnston Counties, North Carolina

Recent outreach activities conducted during remapping in Wilson and Johnston counties in North Carolina provide an example of the types of information that can be provided to communities and property owners through outreach efforts during map modernization.

As part of its map modernization program, the state of North Carolina holds two meetings. The first meeting is held with the county and community officials and floodplain administrators, and the second meeting is open to the general public. The purpose of the meetings is to provide an overview of the state's program; an outline of flood hazard data changes between the current maps and preliminary revised maps; and guidance on the use of the maps, including how to view and download data from the state's Web site. After the state had completed preliminary studies and maps for Wilson and Johnston counties, community officials used the digital, GIS-based maps to identify structures that are located in the newly identified floodplain. The counties then sent out letters to these property owners that

- notified them that their property was in a floodplain,
- provided a telephone number to call for more information,
- announced upcoming public meetings where the preliminary maps would be discussed, and
- identified the state's Internet site where the flood maps could be viewed (Wilson County).

By providing this information in advance, property owners could know before the meeting whether their property was in the newly designated floodplain. According to community officials, their outreach activities provided the information necessary for the public to become aware of their risk and know what actions could be taken to mitigate these risks.

It is important to note, however, that FEMA, states, and communities do not have the authority to ensure that property owners who are subject to the mandatory purchase of flood insurance requirement actually purchase flood insurance. It is the federally regulated lenders' responsibility to ensure that borrowers purchase flood insurance and that the insurance policy is maintained throughout the loan's life as each new lender

servicing the loan becomes aware that the affected property is at risk for flooding. Furthermore, owners of properties without mortgages or properties with mortgages held by unregulated lenders are not required to purchase flood insurance, even if the properties are in floodplains.

Map Modernization Is Expected to Improve Multi-Hazard Mitigation and Risk Management Capabilities

FEMA expects that the data developed, collected, and distributed through map modernization will help national, state, and local emergency managers mitigate and manage risk posed by other natural and man-made hazards. Accurate digital base maps provide more precise data to state and national officials for planning, such as the location of hazardous material facilities, power plants, utility distribution facilities, and other infrastructure (bridges, sewage treatment plants, buildings, and structures). According to FEMA, map modernization will also support DHS's overall goal to reduce the nation's vulnerability to terrorism by providing GIS data and capabilities to other departmental functions. For example, more accurate information on transportation systems such as railroads, airports, harbors, ports, and waterways should be helpful in assessing internal weaknesses and evacuation routes.

Flood-Inundation Application Developed by North Carolina

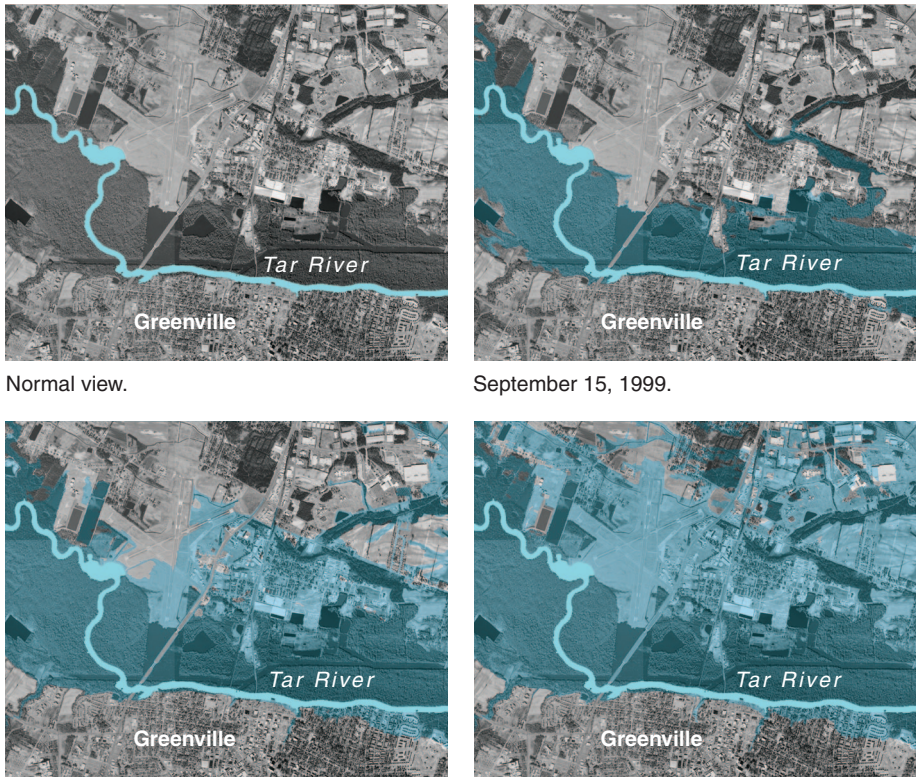
North Carolina's use of information collected during flood mapping to develop a flood-inundation application exemplifies how the data collected through map modernization can be used for other risk management purposes.

Leveraging the work done through the floodplain mapping program, North Carolina is in the process of establishing a real-time flood-inundation and flood forecast mapping Web application that will provide the public with valuable safety information during weather events. During a storm, the application will provide maps and information over the Internet that display which land area, roads, and bridges are inundated by floodwaters. Furthermore, to help ensure that the public is aware of high flood risk areas, the state plans to develop an automated alert network that will utilize different media to notify and warn emergency managers, law enforcement, and the general public. North Carolina is currently working with television broadcasters in the region to broadcast warnings and up-to-date safety information based upon information provided through the Web application. The majority of deaths during Hurricane Floyd, which hit North Carolina in 1999, occurred to individuals driving over flood-inundated roads and bridges. North Carolina hopes that their real-time and forecasted inundation mapping application will help to prevent such deaths during future storm events.

The flood forecasting component of North Carolina's flood-inundation and forecasting application was recently tested during Hurricane Isabel, which struck in September of 2003. Using data collected by North Carolina, the National Weather Service released an experimental Peak Forecast Inundation Web site for predicting the flooding effects of the hurricane. This was a new level of capability for the National Weather Service by forecasting flood-inundation throughout a major portion of the river basin rather than focusing solely on fixed forecasting locations. The implementation of this new flood forecasting technology will greatly enhance North Carolina's flood warning Web application.

Figure 10 shows an example of how the flood-inundation application is intended to work. As floodwaters rise and spread out over the landscape, the flood-inundation application will produce maps to show the extent of flooding and when roads, critical facilities, and other structures will become flooded. The following maps show flooding in Greenville, North Carolina, and are based on flood levels caused by Hurricane Floyd.

Figure 10: Flooding in Greenville, North Carolina, during Hurricane Floyd



Normal view. September 15, 1999. September 17, 1999. September 20, 1999.

Source: North Carolina Floodplain Mapping Program.

Harris County, Houston, Texas

Harris County, Texas, offers another example of how the digital data developed through map modernization could be used to plan for and respond to man-made disasters.

To demonstrate the multi-hazard use of the digital data, community officials showed how a spill response model could be developed to determine the path of a petroleum spill at a Houston area refinery. The model, developed with digital data by a private consultant, uses both elevation data and aerial imagery collected through map modernization to provide officials and emergency response personnel critical information to determine the path of a chemical spill and potentially impacted waterways. This information should provide local officials with valuable

information to aid in their mitigation and evacuation efforts and to protect natural habitats. The figure shows how petroleum at a Houston area refinery would probably flow from specific tanks if ruptured.

Figure 11: Example of Spill Response Model in Harris County, Texas

Source: Harris County Flood Control District.

LIDAR data also provide a basis for three-dimensional modeling of the location of buildings, tanks, and equipment that could be used to determine the optimal location for fire-fighting equipment at the same refinery. The reach of a water jet can be placed against the 3-D model to

determine the extent of coverage and identify obscured structures in the "shadow" of other structures that would limit or block the reach of the water jet. This same 3-D model could also be used in a vulnerability analysis to locate potential targets within a given area that are at risk from gunfire or hand-held rockets.

FEMA's Strategy for Map Modernization Shows Promise, but Challenges Remain

FEMA's strategy for managing map modernization is intended to support the achievement of the expected program benefits of improved flood mitigation, increased NFIP insurance participation, and improved multi-hazard mitigation and risk management capabilities. However, FEMA's approach to implementing the strategy poses several challenges that could hamper the agency's efforts. FEMA's approach is based on four objectives. Two objectives FEMA hopes to achieve through map modernization—building and maintaining a premier data collection and delivery system and expanding outreach and better informing the user community—have the potential to improve the use of flood maps for improved flood mitigation and increased NFIP participation, as well as multi-hazard risk management. The other two objectives—building and maintaining mutually beneficial partnerships and achieving effective program management—are intended to facilitate the achievement of the first two objectives and their intended benefits efficiently and effectively.
Table 1 provides a brief description of FEMA's four objectives for map modernization and the challenges facing implementation.

Table 1: FEMA's Objectives for Map Modernization and Our Observations on the Objectives and Challenges

Objective	Description	GAO Observations
Establish and maintain a premier data collection and delivery system	Create a GIS- and Internet-based system that provides easy access to reliable flood hazard data and other data collected during the mapping process. The system will be available to states and communities to input and use data, therefore, enabling easier and less time-consuming data maintenance and the use of the information for multi-hazard risk management purposes.	FEMA has ranked the nation's counties based on risk. However, FEMA has not yet established data collection and analysis standards for communities with similar risk. Without such standards, FEMA cannot ensure that the level of data collection and analysis is consistent across all communities with similar risk.
Expand outreach and better inform the user community	Raise the awareness of flood map users of their risk of flooding through increased outreach efforts and educate the public on how they can use flood maps and other hazard data to mitigate natural and man-made disasters.	FEMA's outreach strategy is based on a recognition that it has no direct authority to ensure that many map modernization benefits are achieved, but must rely on others—e.g., mitigation efforts by individual property owners and lender enforcement of mandatory flood insurance purchase.
Build and maintain mutually beneficial partnerships	Develop strategies for forming and enhancing relationships with all states and communities resulting in their active participation in the production of flood hazard data. This is intended to help improve the long-term quality of flood data, ensure that the maps meet local needs, and capitalize on local and regional knowledge and resources to achieve the effective production and efficient use of flood maps at a reduced cost to the federal government.	States and communities with limited resources and technical capabilities are likely to pose a challenge to FEMA's ability to fund and implement mapping activities. FEMA has not yet developed a strategy for how to partner with communities that do not have the resources, capabilities, or motivation to initiate and sustain mapping activities.
Achieve effective program management	Develop a flexible program management structure that clearly evaluates the program's performance and identifies continuous improvement strategies to most effectively and efficiently conduct mapping activities that result in high-quality flood maps.	Using current staffing levels, FEMA may be challenged to effectively oversee the contract and the map modernization program. In addition, although FEMA has established measures to assess achievement of its program objectives, its measures for its objectives to develop a premier data system and to expand outreach and better inform the user community are not clearly defined or fully developed.

Source: GAO analysis.

In Its Efforts to Establish a New Data System, FEMA Has Not Yet Established Data Standards for Different Levels of Risk

The goal of FEMA's objective to develop a new data system using the latest technology is more efficient production, delivery and, thereby, the use of flood maps. As discussed previously, FEMA hopes to accomplish this by using geographic information systems technology that provides the foundation for the production and delivery of more accurate digital flood maps and multi-hazard data that is more accessible over the Internet.

In developing the new data system to update flood maps across the nation, FEMA's intent is to develop and incorporate flood risk data that are of a level of specificity and accuracy commensurate with communities' relative flood risks. According to FEMA, there is a direct relationship between the types, quantity, and detail of the data and analysis used for map development and the costs associated with obtaining and analyzing those data. FEMA believes it needs to strike a balance between the relative flood risk faced by individual communities and the level of analysis and effort needed to develop reliable flood hazard data if it is to update the nation's maps efficiently and effectively.

FEMA has ranked all 3,146 counties from highest to lowest based on a number of factors, including, among other things, population, growth trends, housing units, flood insurance policies and claims, repetitive loss properties, and flood disasters. On the basis of this ranking, FEMA established mapping priorities. However, FEMA has not yet established standards on the appropriate data and level of analysis required to develop maps based on risk level. FEMA has historically applied the same minimum standards for all flood maps and supporting data.[13] *FEMA's Guidelines and Specifications for Flood Hazard Mapping Partners* provides guidance for selecting the level of analysis and effort to produce flood hazard data and have generally been used on a case-by-case basis.[14] The guidelines do not specify standards to be used for all mapping projects within a given risk category. Without establishing standards for different categories of risk, FEMA cannot ensure that it uses the same level of data collection and analysis across all communities within the same risk category. These standards could also provide a consistent basis for estimating the costs of developing maps in each risk category. According to FEMA, the agency plans to develop standards that can be applied to different levels of flood risk as part of a 5-year map modernization implementation plan. FEMA expects this plan to be completed by the end of fiscal year 2004; however, at the time of our review, FEMA had not yet developed draft standards or incorporated this task into its implementation plan.

[13]For example, FEMA implemented digital base map standards in 1998 and LIDAR standards in 2000.

[14]These guidelines describe detailed methods of analysis used for high-risk areas and less detailed methods used in low-risk areas.

FEMA's Objective to Expand Outreach Efforts Recognizes the Agency Must Rely on Others to Achieve Map Modernization Benefits

FEMA's objective to expand the scope and frequency of its outreach efforts is intended to increase community and public acceptance of revised maps and use of those maps. Historically, FEMA has only contacted communities when initiating remapping and again when preliminary maps are completed. These expanded outreach efforts reflect FEMA's understanding that it is dependent on others to achieve the benefits of map modernization. For example, under the structure of the NFIP, FEMA is dependent on communities to adopt and enforce FEMA's minimum building standards and on mortgage lenders to ensure compliance with mandatory flood insurance purchase requirements. To expand the scope of its outreach efforts, FEMA plans to involve a wide variety of community participants—e.g., mayors, emergency managers, lenders, property owners, insurance agents, and developers—in the mapping process. To expand the frequency of outreach, FEMA intends to increase community involvement, awareness, and participation throughout the entire flood mapping process. Through a continual education process, FEMA's goal is to inform property owners and others potentially affected by remapping efforts of steps they can take to mitigate the risk of flooding, the types of damage and costs caused by flooding, and the benefits of flood insurance.

According to FEMA, if a community is involved in and understands the map modernization process, the community is more likely to accept and trust the accuracy of the final, revised maps and is more likely to use the maps' hazard data to mitigate natural and man-made disasters. Conversely, if affected property owners do not understand why their communities are being mapped (or remapped) or why their property is now in a flood zone, the unexpected additional expense of new or increased flood insurance premiums can form the basis of significant community opposition to map modernization activities and lead to formal appeals, litigation, and delays in implementing map changes.

We visited several communities that have nearly completed or are engaged in revising flood maps and talked with relevant officials about recent mapping projects and the importance of outreach efforts. The experience of Pinellas County, Florida, shows the potential consequences of a limited outreach effort while the experiences of the Harris County Flood Control District in Houston, Texas, and Hillsborough County, Florida, show the potential benefits of a more expanded outreach strategy.

Pinellas County, Florida

Officials in Pinellas County, Florida, rejected revised flood hazard maps developed by FEMA that raised base flood level elevations and placed

areas in newly established flood zones. According to community and FEMA officials, FEMA did little to communicate with the community and the public during the mapping process. According to FEMA, the agency was only required to inform the community when the remapping project was initiated in 1993 and again after the proposed maps were completed and provided to the community for comment in December 1997. County officials subsequently appealed the preliminary maps. According to local officials, expanded outreach efforts by FEMA throughout this process could have helped the community understand why the county was being mapped and how the new maps reflected the true flood risks of the properties shown in revised flood zones. After working closely with FEMA and mapping contractor officials, the community finally accepted and implemented the maps by establishing new building standards in September 2003.

Harris County, Houston, Texas

The Harris County Flood Control District in Houston, Texas, took steps to expand stakeholder and community outreach by releasing up to date flood hazard map information on its Web site (http://www.tsarp.org). County officials have also worked closely with the local newspaper to release information on the updated flood hazard information to the public. In addition, the county has held individual meetings with the county's 35 flood plain managers to ensure that they understood the new flood maps and were able to convey that information to citizens; hired a public relations consultant to provide guidance on how to better utilize the media to disseminate flood map information; and conducted a poll survey to ascertain public opinion about flood hazard risk and to develop strategies to better convey flood hazard information. County officials also developed several committee groups to relay flood maps information that is audience-specific, such as a technical discussion group that reviews technical issues related to revising the flood maps and verifies methodological assumptions.

Hillsborough County, Florida

Hillsborough County officials have conducted extensive outreach while continuing to work with FEMA throughout the remapping process. To help ensure that insurance companies, real estate agents, county workers, and citizens utilize flood maps in a more efficient and effective manner, a stakeholders outreach coalition was formed in March of 2003. The purpose of this coalition is to create an information campaign for individual property owners and businesses that will be directly impacted by the new maps. The coalition includes representatives from the county's Citizen Advisory Committee, the insurance industry, real estate brokers, builders, lenders, engineers, surveyors, and various county departments. Hillsborough County is working in cooperation with FEMA to have final

maps in late 2004 and create a successful outreach program that could be duplicated throughout the nation.

FEMA's expanded outreach efforts are intended to educate the public of the potential flood risk in communities and to encourage them to take action. Communities that participate in the NFIP are required to establish floodplain management ordinances that require new and substantially improved structures in newly designated floodplains to meet NFIP building standards. However, if a property was not located in the floodplain in the old map, but is in the floodplain in the new revised map, NFIP floodplain management regulations do not require those owners to implement mitigation measures unless they make substantial improvements to the structure.[15] FEMA cannot compel affected property owners to take steps to mitigate their properties against flood risks or to purchase flood insurance. Under current notification requirements, federally regulated lenders, not FEMA, serve as the primary channel for notifying property owners whose mortgaged properties are subject to flood insurance requirements. When property owners seek new financing—through purchase or refinancing—federally regulated mortgage lenders are required to determine if the property is in the floodplain, and, if so, require the purchase of flood insurance. Lenders are not required to monitor map changes or to notify property owners with existing mortgages whose properties are identified in a floodplain by remapping if they are not aware of the change in status.[16]

Nonetheless, if federally regulated lenders become aware of flood map changes that affect properties for which they hold mortgages through FEMA notifications or flood zone determination companies,[17] then they must notify the property owner and require the purchase of flood insurance. The information that must be provided to property owners is

[15]If a community determines that the cost of improvements to a home or business equals or exceeds 50 percent of the market value of the building, the building is considered a "substantial improvement" and must meet the NFIP's minimum requirements.

[16]In making loans, federally regulated lenders are required to ensure that property owners purchase flood insurance if their mortgages are secured by a structure located in a floodplain. Lenders are also required to check the flood hazard status of a property when triggered by statutory tripwires, such as loan renewal or extension.

[17]Many lenders use flood zone determination companies to determine whether properties require flood insurance as a result of loan origination, loan assumption, or map changes. These companies use FEMA flood maps and other data to ascertain if properties are situated in flood zones.

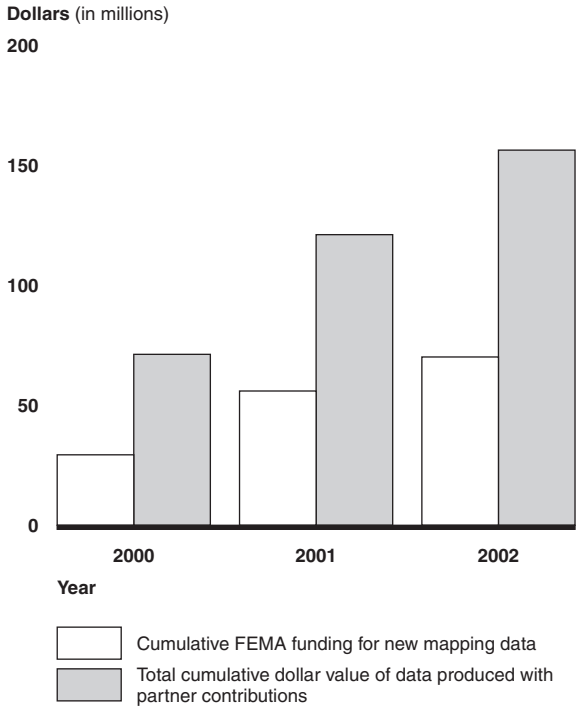
limited to notifying property owners that their structure is in a floodplain, providing a definition of a flood plain, and requiring the purchase of flood insurance if they live in a participating NFIP community. As a result, FEMA's outreach efforts are important for supplementing the formal requirements for notifying communities and property owners of map changes.

FEMA's Strategy for Partnering with States and Local Communities Does Not Include Communities with Few Resources to Assist in Flood Mapping

FEMA's objective for building and maintaining mutually beneficial partnerships is intended to facilitate and support the efficient production and effective use of flood maps. According to FEMA, local, state, and federal partners that have invested resources and assisted in managing mapping activities have the potential to positively affect the detail, accuracy, and quantity of the data collected and improve how these data are used. As part of their strategy for partnering, FEMA provides guidance to the states on how to develop "business plans" that document planned efforts to develop states' and communities' capability and capacity to oversee the collection, analysis, and implementation of flood data in their state and community and to justify funding for these efforts. According to FEMA, 38 states have begun drafting such plans. FEMA intends to use these state business plans to help prioritize its continuing efforts to develop map modernization partners.

Through its Cooperating Technical Partners (CTP) program, FEMA has developed partnerships with a variety of states and communities that have developed their own data and provided their own funds to help update local flood maps. Since 2000, FEMA has leveraged millions of dollars in funding from 171 partners (states and local communities) for producing maps through its CTP program. For example, from fiscal years 2000 to 2002, FEMA used $70 million of its federal map modernization funding along with state and local funds to develop what FEMA has estimated to be more than $155 million worth of new mapping data. Figure 12 compares FEMA's cumulative funding for new mapping data through the CTP program with the total cumulative dollar value of data produced with partner contributions since the program was established in 2000.

Figure 12: Comparison of Cumulative FEMA Funding for Mapping Data with the Total Cumulative Dollar Value of Mapping Data Produced through CTP Program



Source: FEMA.

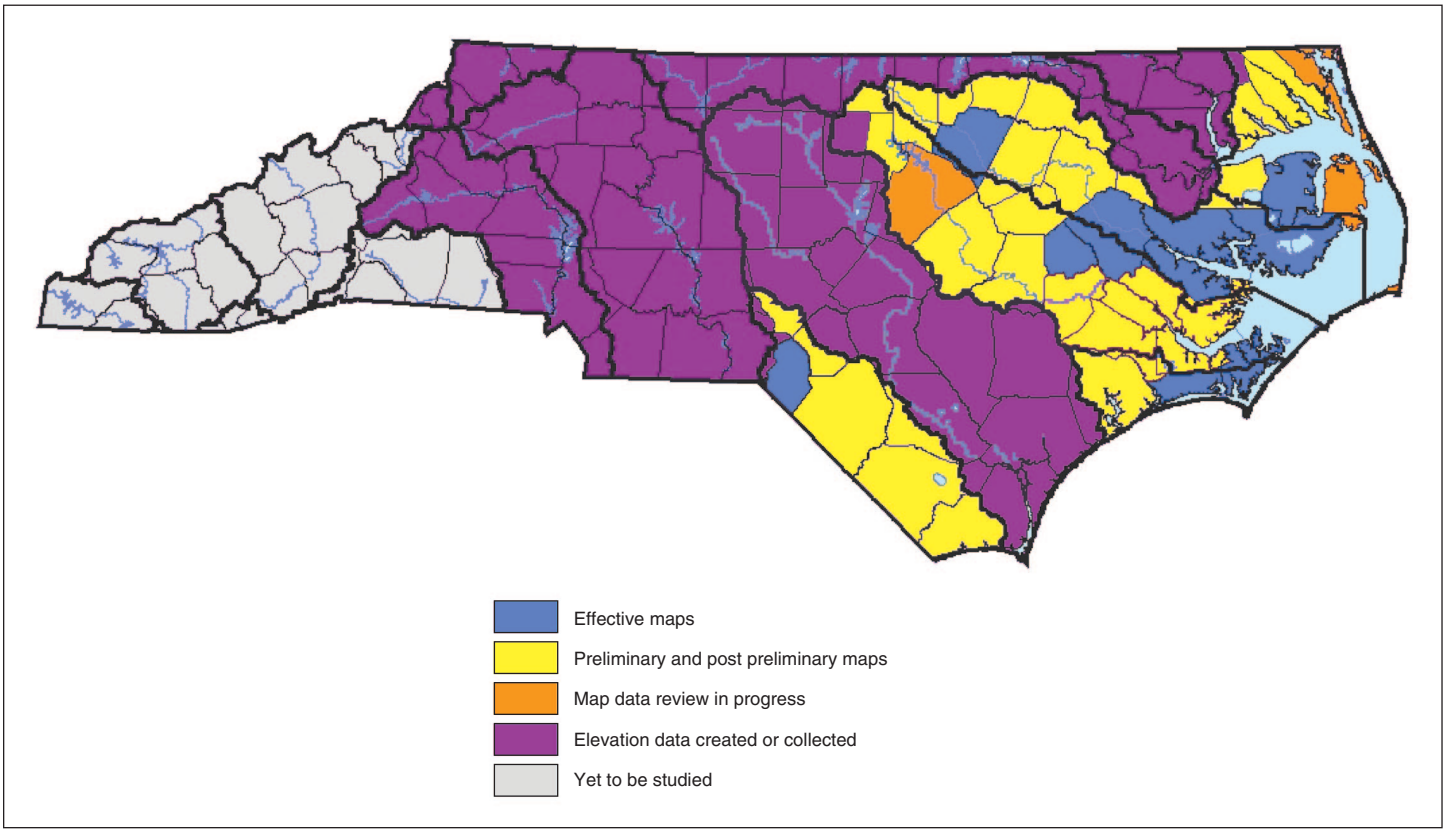
According to FEMA, partnering has other benefits as well. For example, in the long-term, those states and communities with whom FEMA has established partnerships may be more likely to accept final map changes, expand their capabilities, and assume greater responsibility for

periodically developing and incorporating updated flood data, resulting in cost savings to FEMA. FEMA's partnership with the state of North Carolina provides an example of a state assuming greater responsibility for producing and maintaining flood maps.

FEMA's Cooperating Technical Partnership with the State of North Carolina

According to North Carolina officials, the devastating flooding and subsequent damage that occurred from Hurricane Floyd in 1999 led the state of North Carolina to take action to address the limitations of the existing FEMA flood maps. Approximately 80 percent of the homes damaged or destroyed during Hurricane Floyd were not depicted in the floodplain on the state's flood maps. In 2000, North Carolina became the first Cooperating Technical State under FEMA's CTP program, agreeing to assume primary ownership and responsibility of flood maps for all North Carolina communities. Since then, according to state floodplain mapping officials, the state has contributed approximately $41 million towards the overall floodplain mapping program. On the basis of this amount, North Carolina has covered approximately 65 percent of the total cost to date for the remapping effort. To date, 8 counties had received new effective flood maps and 28 counties received new preliminary maps, which are now under community review. (See fig. 13.)

Figure 13: Status of Remapping in North Carolina



Source: North Carolina Floodplain Mapping Program.

Some states and communities with few resources and technical capacities or little history of flood mapping activities are likely to pose a challenge to FEMA's ability to fund and implement mapping activities. For example, we talked with flood management officials in several smaller communities in Montgomery County, Texas; Santa Cruz County, Arizona; and Larkspur, Colorado. These officials said that their communities lacked either the funding needed to develop flood data, the technological capability to develop digital flood data and use geospatial information systems, or, in some cases, the community support needed to conduct mapping activities. One approach for obtaining additional resources, capabilities, and community support would be for FEMA to facilitate coordination with other agencies within the state that have a stake in, or could benefit from, mapping activities. For example, state departments of transportation can

benefit from information in FEMA's geospatial information system, such as elevation data, in developing and implementing state roads and bridges. North Carolina was able to get its state transportation department to help fund the development of elevation data used for flood maps. FEMA has not yet developed a strategy for how to partner with communities that do not have the resources, capabilities, or motivation to initiate and sustain mapping activities. Such a strategy could focus on how to assist these potential partners in garnering community resources and developing technological capabilities, how to coordinate with other agencies in their state, and how to integrate these efforts with FEMA's community outreach efforts to gain community support for mapping activities.

New Program Management Contract Is Performance-Based, but FEMA May Have Difficulty Overseeing the Contract and Measuring Achievement of Program Objectives

In March 2004, FEMA awarded a performance-based contract to obtain assistance from a nationwide mapping contractor to manage tasks associated with the significant expansion of the map modernization program. Unlike many traditional government service contracts, which emphasize inputs rather than outcomes, a performance-based contracting approach gives the contractor the flexibility to determine how best to achieve the outcomes and links payment to the contractor's ability to achieve these outcomes—an approach supported by our past work in federal contracting. Overseeing these types of contracts requires agency staff with the knowledge, skills, and abilities to monitor the contractor's efforts using performance measures that accurately measure agreed-upon outcomes.

FEMA may be limited in its ability to effectively manage the contract, as well as the significant expansion of tasks associated with a five fold increase in funding and related mapping activities that will continue to be performed by agency staff. These tasks include managing grants for many new mapping partners and administering contracts with independent firms to develop and process a significantly larger quantity of flood data to support local efforts. A staffing needs assessment completed by FEMA in December 2003 identifies a need for an additional 75 staff with additional skills, including contracting and program management capabilities. In appropriating fiscal year 2004 map modernization funds, Congress included a provision that would allow FEMA to use up to 3 percent, or $6 million, for administrative purposes. As of March 2004, FEMA had filled 1 of the 75 positions by reallocating existing resources. According to FEMA, it plans to fill another 33 positions using the administrative funding identified in the fiscal year 2004 budget. In addition, FEMA also plans to fill an additional 10 positions by moving staff from other FEMA departments or filling vacancies. However, at the time of our review,

FEMA had not yet established a plan for filling the remaining 31 headquarters and regional positions.

One element of effective program management is establishing performance measures to determine how well FEMA is achieving its map modernization program objectives. FEMA has established performance measures for all four of its program objectives. However, FEMA's measures for two of those objectives that directly support the use of flood maps for risk management—to develop a premier data system and to expand and better inform the user community are not clearly defined or fully developed.

FEMA's principal measure for developing and maintaining a premier data collection and delivery system is the percent of the national population with community-adopted, GIS data-based flood maps. However, this measure does not indicate whether the maps themselves meet any FEMA-established standards for accuracy. As noted earlier, FEMA has not yet defined the minimum level of data collection and analysis for communities with similar risk.

To measure the progress and success of expanding and better informing the user community, FEMA established performance measures related to the percent increase in communities' awareness and use of new maps. FEMA plans to use surveys as the primary means of measuring increased community awareness and use of the new maps. However, FEMA has not yet fully developed an operational definition of how it plans to measure "awareness" or "use," for example, that reflect mitigation steps taken or the purchase of flood insurance. Because the link between revising maps and the use of maps in terms of increased NFIP participation is not direct, we recognize that it may be a challenge to develop a performance measure that accurately reflects the impact on NFIP participation rates of efforts to expand and improve outreach. Nonetheless, without developing such a measure (or measures), FEMA will be less able to ensure that its map modernization program will have resulted in one of FEMA's primary intended benefits.

Conclusions

FEMA's map modernization strategy recognizes the limits of the agency's authority to directly achieve such key intended map modernization benefits as increased, effective flood mitigation efforts and increased flood insurance participation rates by property owners whose properties are within the most hazardous flood areas—those in which there is at least a 1 percent chance of flooding in any given year. At the same time, FEMA recognizes that it has finite resources for completing map modernization

and needs to leverage its resources with assistance from state and local communities. Both the credibility of the maps as accurate and useful and stakeholders' understanding of how the maps can be used to reduce flood risk and flood damage will be instrumental in enhancing the probability that the maps will be used to achieve their intended benefits.

FEMA's outreach strategy for involving stakeholders in map modernization appears to be reasonable. Even with these outreach efforts, the credibility and likely use of the maps can be compromised if there is a perception that similar communities are not treated similarly during map modernization. Establishing and implementing data collection and analysis standards for communities with similar risk can help to assure communities that map development for all communities within the same risk category will be consistent and comparable. Such standards can also help FEMA to target its map modernization resources more efficiently by matching the level of data collection and analysis with the level of flood risk. Similarly, by developing strategies for partnering with state, and local flood management stakeholders with lower levels of capabilities and resources, FEMA will be better able to leverage available resources and identify the most effective approaches to engaging its partners in the remapping process.

To the extent that FEMA does not have appropriate numbers of staff with the requisite skills, it may have limited ability to provide effective monitoring and oversight of its new performance-based contract, whose contractor has been charged with much of the day-to-day work of map modernization that formerly FEMA performed. Finally, in some cases, the performance measures established for the program and the contractor may not be sufficient to permit FEMA to measure whether map modernization is achieving its intended benefits. Without useful operational definitions for its planned surveys to measure map acceptance and use, FEMA cannot reasonably measure and demonstrate whether map modernization has achieved its intended benefits in such areas as community and individual flood mitigation efforts or increased flood insurance purchase rates.

Recommendations

To help ensure that FEMA's map modernization achieves the intended benefits of improved flood mitigation, increased flood insurance participation, and improved multi-hazard mitigation and risk management capabilities through the production of more accurate and accessible flood maps, we recommend that the Secretary of Homeland Security direct the Undersecretary of Emergency Preparedness and Response to take the following four actions:

- Develop and implement data standards that will enable FEMA, its contractor, and its state and local partners to identify and use consistent data collection and analysis methods for communities with similar risk.
- Develop and implement strategies for partnering with state and local entities with varying levels of capabilities and resources.
- Ensure that it has the staff capacity to effectively implement the nationwide mapping contract and the overall map modernization program.
- Develop and implement useful performance measures that define FEMA' s progress in increasing stakeholders' awareness and use of the new maps, including improved mitigation efforts and increased participation rates in purchasing flood insurance.

Agency Comments

We provided a draft of this report to DHS for its review and comment. We met with DHS and FEMA officials, including FEMA's Mitigation Division Acting Deputy Director, to discuss the report. In providing oral comments, DHS and FEMA generally agreed with the report's contents and provided us with minor technical comments, which we have incorporated where appropriate. In addition, DHS and FEMA generally agreed with our recommendations and provided the following comments:

- To address the data standard recommendation, FEMA said that it plans to refine existing standards, in coordination with stakeholders, to ensure consistent data collection and analysis for all communities commensurate with their flood risk.

- To address the recommendation concerning partnering strategies to address varying levels of capabilities and resources, FEMA said that it would continue to collaborate with stakeholder groups to develop an effective strategy to include states and communities with varying levels of capabilities and resources.

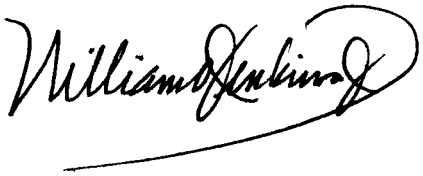
- To address the recommendation to ensure that the agency has the staff capacity to effectively implement map modernization and oversee the contract, FEMA said that it has begun to take steps not only to fill 44 positions for fiscal year 2004, as noted in the report, but is also developing a plan to ensure that additional staffing needs are met in fiscal year 2005 and beyond.

- To address the recommendation to develop and implement performance measures for increasing stakeholders' awareness and use of flood maps, FEMA said that it plans to refine performance measures

for this map modernization objective to make them more useful and quantifiable.

We will send copies of this report to the Secretary of Homeland Security. We will also make copies available to others upon request. In addition, this report will be available at no charge on GAO's Web site at http://www.gao.gov. If you or your staff have any questions about this report, please contact me at (202) 512-8777 or at jenkinswo@gao.gov. Major contributors to this report are listed in appendix III.

Sincerely yours,



William O. Jenkins, Jr.
Director, Homeland Security and Justice Issues

Appendix I: Objectives, Scope, and Methodology

To describe how map modernization is intended to improve the accuracy and accessibility of the nation's flood maps, we interviewed Federal Emergency Management Agency (FEMA) headquarters officials and agency officials in three of the regional offices: Region IV in Atlanta, Georgia; Region VIII in Denver, Colorado; and Region VI in Denton, Texas. To assess the reliability of FEMA's data regarding the number and age of the nation's flood maps, we interviewed officials knowledgeable about the data and the systems that produced them and determined that the data were sufficiently reliable for the purposes of this report. We also reviewed key FEMA documents that describe how map modernization is intended to use advanced technology to improve the accuracy and accessibility of flood maps.

Realizing that map modernization is in the early stages of implementation and information on its impact is limited, we conducted site visits in states and communities that have already begun to modernize their flood maps. To identify potential locations for site visits, we spoke with FEMA Mitigation Division officials and representatives from the following professional organizations: Association of State Flood Plain Managers, National Association of Flood and Stormwater Management Agencies, National Emergency Management Association, and the Mapping Coalition. The selected site visits represent areas that have recently experienced considerable population growth, a high National Flood Insurance Program (NFIP) base, or a high number of repetitive flood loss claims. Over 64 percent of all NFIP policies are located in the states selected for site visits, and over 40 percent of all repetitive loss properties are located in the states in which we conducted site visits.

Our site visits involved reviewing key documents, graphics, and other information related to our reporting objectives. Site visits included the following locations:

- Hillsborough, Sarasota, and Pinellas counties of Southwest Florida
- Maricopa County, Arizona
- State of North Carolina
- Mecklenburg County, North Carolina
- Harris County, Texas
- State of Colorado

To describe the expected benefits of map modernization, we interviewed FEMA officials in their Mitigation Division in Washington, D.C., and obtained documents and graphics from FEMA officials describing the benefits the agency expects to result from map modernization activities.

We also interviewed state and local officials on the potential multi-hazard benefits of map modernization and obtained documents and graphics illustrating the expected benefits.

To determine the extent to which FEMA's strategy for managing the map modernization program supports the achievement of the expected benefits of more accurate and accessible maps, we first reviewed previous documents published by FEMA and others on map modernization. Throughout our review, we remained in constant contact with FEMA officials in their Mitigation Division to monitor the development of FEMA's prioritization of fiscal year 2003 funded mapping projects and the implementation of the overall map modernization approach.

To identify areas where FEMA's implementation of map modernization is limited, we gathered and synthesized the experiences and challenges identified through documentation and interviews provided from various sources, including:

- FEMA headquarters and regional officials;
- site visits and selective review participants;
- professionals in the Association of State Floodplain Managers, National Association of Stormwater Management Agencies, the National Emergency Management Agency, and Arizona Association of Floodplain Managers; and
- private industry representatives in the fields of flood zone determinations, engineering, technology and program consulting, real estate sales and development, and home mortgage lending.

We also conducted additional research to determine whether limitations existed in FEMA's implementation of its outreach approach for its map modernization program. We obtained information on the roles and responsibilities of FEMA and lenders to communicate changes in flood hazard status. We also reviewed and synthesized applicable laws, regulations, and guidance regarding notification of flood hazard risk to identify all parties designated to inform property owners of changes in the flood hazard maps. We interviewed FEMA mapping and insurance officials, state, community, and National Flood Determination Association officials as well as conducted site visits to ascertain information on current processes for communicating changes in flood hazard status. Additionally, we interviewed FEMA's general counsel to obtain the agency's position on statutory requirements for notification of property owners after remapping.

To further analyze the strengths and limitations of FEMA's implementation approach, we also reviewed FEMA's Inspector General's reports related to flood mapping and reviewed our previous work and guidance in the areas of performance-based contracting and performance measurement that relate to the objectives of map modernization.

The information regarding deaths and damages due to floods was considered background information and was not verified. We conducted our review from April 2003 through March 2004 in accordance with generally accepted government auditing standards.

Appendix II: Users of Flood Maps

The principal stakeholders that use FEMA flood maps and the nature of their use are described in this appendix.

State and local floodplain managers/community planners: use flood maps to make floodplain management decisions for each of the nearly 2 million development permits issued for new structures nearly 20,000 NFIP participating communities that have maps. They are responsible for establishing and enforcing land-use and construction ordinances that comply with minimum NFIP standards.

Insurance companies and agents: use flood maps to determine actuarial rates for flood insurance policies. Private insurance companies that sell NFIP-backed flood insurance use the flood maps to determine the proper premium rate for a flood insurance policy. There are approximately 250,000 new policies rated and sold each year.

Lenders: use flood maps to determine the flood risk status of mortgaged properties at loan origination and through the entire life of the mortgage. Each of the 10 to 15 million federally related mortgage transactions each year requires that the flood maps be consulted to determine whether the structure secured by the loan is located in the floodplain on the current flood map.

Flood zone determination companies: use flood maps to determine property locations relative to flood hazard areas on behalf of mortgage lenders that typically contract this service to companies with expertise in making flood zone determinations and the capability to make many determinations quickly.

Individual property owners: use flood maps to better understand their flood risk status.

Land developers: use flood maps to assist in designing developments that are safe from flood hazards.

Surveyors: use flood maps to prepare elevation certificates for structures. These help owners determine their flood risk by comparing the mapped flood elevations to the building's lowest floor elevation.

Engineers: use flood maps when designing flood mitigation projects and to site and design new buildings and infrastructure.

Real estate professionals: use flood maps to determine the flood risk status of properties in the community.

State and local disaster and emergency response officials: use flood maps to prepare for all disasters, issue hazard warnings, and implement emergency response activities and aid in the rebuilding and reconstruction phases.

Other federal agencies: use flood maps in implementing Executive Order 11988, Floodplain Management, for federal actions proposed in or affecting floodplains.

Appendix III: GAO Contacts and Staff Acknowledgments

GAO Contacts

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Staff Acknowledgments

In addition to those named above, Mark Abraham, Leo Barbour, Mark Braza, Grace Coleman, Christine Davis, Michelle Fejfar, Brian James, Kirk Kiester, and Meg Ullengren made key contributions to the report.

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