Chapter 8

INCORPORATING DISASTER RESILIENCE INTO DISASTER RECOVERY

INTRODUCTION

Natural disasters disrupt communities. They destroy property, force people out of their homes, close businesses, suspend normal routines, and sometimes take lives. Often, natural disasters rearrange the landscape by tossing buildings, upending roads, toppling trees, reshaping rivers, scattering debris, and rendering a community unrecognizable to its residents. Under these unsettling conditions, communities feel isolated and helpless, and there is tremendous pressure from residents, property owners, and businesses to put things in order, to rebuild the community back the way it was before—assuming that is even possible.

Natural disasters also create opportunities for action. State, and in some cases federal, agencies will converge on the stricken community to assist with the rebuilding effort. Outside money may be available to undertake projects that were previously considered infeasible financially, such as elevating a damage-prone road, relocating a police station, or floodproofing a sewage treatment plant. Damaged or destroyed buildings, roads, and utilities can be rebuilt in safer locations or built to be more damage-resistant. And perhaps most importantly, the community will be focused, at least temporarily, on its own vulnerability and the need to take decisive action.

Timing is critical. In the immediate aftermath of a disaster, a community will be faced with key decisions that will have long-term consequences on its vulnerability to future disasters, with no time for extensive research or prolonged deliberations. This is why it is so important to have a hazard mitigation plan in place to guide the recovery effort. The plan can provide the framework to make informed decisions in an environment of chaos, uncertainty, and expediency. It can help keep decisionmakers focused on the ultimate goal of creating a more sustainable, resilient community. And it can help establish priorities for action.

Some communities have learned to roll with Nature's punches by placing buildings and key infrastructure out of harm's way. That is, they are resilient. For example, after severe flooding in the spring of 1997, the cities of Grand Forks, North Dakota, and East Grand Forks across the river in Minnesota, decided to reduce flood risks by acquiring floodprone properties, building a levee to protect properties that could not be moved, and establishing a minimum setback

distance from the Red River. The combined effort of the two cities resulted in the acquisition of over 1,000 homes and the creation of a 2,200-acre greenway along the river. Plans call for the development of parks, open space, athletic fields, cultural and educational areas, and the restoration of floodplain habitat (see Chapter 5 on Economic Vitality for more information about the communities' recovery from the Red River flood).

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Resilient communities bend but don't break when disaster strikes. One way for a community to become more resilient is to mitigate the impacts of natural hazards. Hazard mitigation—a technical term for reducing risks to people and property from natural hazards—includes both structural measures, such as flood control levees and landslide barriers, as well as nonstructural measures, such as land use regulations that restrict construction in earthquake fault zones or in floodplains. Mitigation includes not only avoiding additional development in vulnerable areas of a community, but making existing development in hazard-prone areas safer. In general, hazard mitigation involves the following three principles or actions:

- Making new buildings and infrastructure located in hazard-prone areas more damage-resistant and resilient through the use of building codes, design standards, and construction practices and, to safeguard existing development, through protective devices such as dams, levees and seawalls (structural mitigation), if relocation is infeasible.

- Avoiding development in hazard-prone areas by steering new development to less risky areas—that is, to keep buildings out of harm's way in the first place—and by relocating damaged buildings to safer areas after a disaster.

- Protecting natural areas like wetlands, floodplains, forested areas, sand dunes, and other ecological elements that can absorb and reduce the impacts of hazards.

(Godschalk et al., 1999)

Some Benefits of Hazard Mitigation

Saves lives and property and reduces vulnerability to future hazards	By implementing a mitigation strategy such as moving people and buildings out of harm's way, a community can save lives and reduce property damage from future disasters—an opportunity that is often lost in the rush to build back to pre-disaster conditions.
Speeds recovery	By reducing damage to buildings and infrastructure, a community can minimize economic and social disruptions and bounce back quicker after a disaster strikes.
Demonstrates commitment to improving community health & safety	A mitigation strategy demonstrates a community's commitment to safeguarding its citizens and protecting its economic, social, and environmental well-being.
Facilitates post-disaster funding	By identifying and prioritizing projects before the next disaster, communities will be in a better position to obtain post-disaster funding.

Hazard mitigation and disaster resilience go hand-in-hand. A community that follows these three mitigation approaches and also makes use of hazard and other types of insurance that are available will be more resilient the next time disaster strikes. It will bounce back faster.

RECOVERY STRATEGIES TO BUILD A DISASTER-RESILIENT COMMUNITY

Building a disaster-resilient community can start during disaster recovery. A community can start with the *situations* that exist after a disaster, pick and choose among the *options* for making itself more disaster resilient and among the implementation *tools* available to help pursue each of those options. Combining these, the community can develop *strategies* that are specially tailored to its own needs. The Matrix of Opportunities in Chapter 1 shows some of the options a recovering community could use to enhance its disaster resilience while it tends to disaster-caused predicaments. The situations and options shown on the matrix, and the tools listed below, are not exhaustive; rather, they are meant to give an idea of the range of possibilities. Likewise, the sample strategies below suggest ways in which some options and disaster-induced situations could be combined to help a community become more resistant to natural disasters. Notice how each of the strategies suggested below uses one or more of the options listed on the Matrix of Opportunities under the fifth sustainability principle, "Incorporate Disaster Resilience/Mitigation."

Situation: Damage to transportation facilities
Roads often lie directly in the path of natural hazards, and as a result, damage is common. For example, roads get washed out by hurricanes, inundated by floods, buried by landslides and torn apart by earthquakes. Repairs are expensive.
Recovery Strategies to build Disaster Resilience:

- Rebuild to improve resistance to damage. Older transportation facilities can be upgraded to more modern standards that make them more resistant to damage from floods, earthquakes, and other risks.
- Relocate, where feasible. In some cases, transportation facilities could be relocated or rerouted around hazard-prone areas.
- Reduce adverse impacts caused by such facilities. For example, certain roads and highways in eastern North Carolina acted as dams during Hurricane Floyd, obstructing the flow of floodwaters and causing extensive flooding of nearby areas.
- Examine the impact of such facilities on encouraging development in hazard-prone locations. Widening roads may only stimulate additional development in risky areas.

Situation: Damage to public facilities
Public facilities such as schools and community centers often serve as emergency shelters after disaster strikes. Unfortunately, these facilities themselves may suffer damage from natural disasters.
Recovery Strategies to build Disaster Resilience:

- Protect against future damage by making such facilities more resistant to damage. For example, elevate buildings above the flood height or build a berm to help keep out floodwaters.

OPTIONS FOR IMPROVING DISASTER RESILIENCE

- Make buildings & infrastructure damage-resistant.
- Avoid development in hazardous areas.
- Manage stormwater.
- Protect natural areas.
- Promote & obtain hazard and other insurance.

- Relocate to a less vulnerable area.
- Avoid building new public facilities in hazard-prone areas.

Situation: Damage to utilities
Utilities are extremely vulnerable to natural disasters. Fallen trees can down power lines, earthquakes can tear apart water or gas lines, and floods can inundate wastewater treatment plants. Protecting utilities from damage can minimize the economic and social disruptions caused by natural disasters.
Recovery Strategies to build Disaster Resilience:

- Safeguard power lines from damage by fallen trees by putting the lines underground.
- Move water or gas lines out of harm's way. For example, re-route utility lines around earthquake fault zones or floodplains.
- Protect existing facilities from damage, for example, by constructing berms around sewage treatment facilities located in floodplains.
- When planning to install new lines, identify the location of hazard-prone areas and try to avoid them.
- Build redundancy into the system. For example, be able to shift water or wastewater treatment capacity to treatment plants not located in hazard-prone areas.
- Develop plans to contain and treat spills from existing gas or wastewater treatment lines that may be damaged by natural disasters.

Situation: Damage to homes and businesses
Homes and businesses may suffer direct or indirect damage from natural disasters. For example, wildfires may consume houses, or a hurricane may knock down power lines, putting businesses out of commission temporarily and leaving homes in the dark.
Recovery Strategies to build Disaster Resilience:

- Buy out or relocate damage-prone properties. Acquiring or relocating homes or businesses located in hazard-prone areas, particularly structures that have been damaged repetitively, can help reduce the public costs of disasters, which include emergency services, evacuation, emergency shelters, debris removal, and the loss of tax revenues.
- Acquire vacant, hazard-prone property. Buying vacant property and prohibiting its development permanently reduces the risk of damage to those properties while providing additional open space, wildlife habitat, and recreation areas.
- Rebuild according to modern building codes; upgrade the local code if necessary. Typically, older buildings not built to modern standards are the ones that suffer the most from natural disasters. When rebuilding, make sure that structures comply with modern building codes that specify how to make buildings more resistant to damage from hurricanes, floods, wildfires, wind, or earthquakes. Educate builders about hazard-resistant provisions in the codes.

Protecting Water Service in Des Moines, Iowa

During the 1993 Midwest floods, the city of Des Moines, Iowa's water works was inundated by floodwaters, which caused extensive damage and knocked the plant out of commission for 11 days. Over 250,000 customers were without water service. In addition, the business community was devastated. Only a few businesses in the city closed due to direct flood damage, yet more than 40% had to close temporarily until water service could be restored. Even those that did not rely on water for production or operation were forced to close for health, sanitation, and fire safety reasons. The result was a loss of staff productivity and sales. Tax revenues to the city were down as well.

In all, although it costs $14 million to repair the damage caused by flooding, the city suffered an estimated $300-400 million in business losses.

In response, the Des Moines Water Works is constructing a smaller water treatment facility at another location. This facility will meet growing water demands and serve as a backup for the main plant, when the next flood occurs.

Situation: Damage to natural resources
It is hard to put a dollar figure on damage to natural resources. How much is a floodplain worth? Natural systems provide numerous benefits, such as wildlife habitat, open space, recreation, and mitigating the impacts of certain natural hazards. Damage to natural resources has real consequences for wildlife and for human settlements.

Recovery Strategies to build Disaster Resilience:

- Relocate and prohibit land use activities that are not safe for hazard-prone areas. Unsafe land use activities include animal waste lagoons, animal production facilities, septic systems, hazardous waste facilities, junkyards, and sewage treatment plants.

Minimizing Floods by Protecting Wetlands and Floodplains

One of the oldest examples of using the natural capacity of floodplains to control floods is the Charles River Project in Massachusetts. The Charles River winds 80 miles from central Massachusetts to Boston Harbor. Rather than spend an estimated $100 million for additional structural controls (a flood control dam was built in 1977), the U.S. Army Corps of Engineers instead decided to rely on existing wetlands along the river to control flooding. The agency purchased 3,250 acres outright, and acquired easements on 4,680 acres at a total cost of $10 million, which was only 10% of the estimated cost of constructing another dam. Not only do the wetlands reduce flood hazards, but they continue to provide wildlife habitat, outdoor recreation opportunities, and capture sediment and pollutants to improve water quality.

(Faber, 1996, p. 18)

Buyout in St. Charles County, Missouri Proves its Worth

St. Charles County, Missouri, which sits at the confluence of the Missouri and Mississippi rivers, was hit hard by the 1993 flood. Total federal disaster assistance for the county topped $26 million. After the flood, the county purchased 1,374 flood-damaged properties in the 100-year floodplain, including 560 single-family homes and three mobile home parks with a combined total of 814 mobile home pads. When floodwaters rose again in 1995, causing serious flooding, about 1,000 families already had been moved to higher ground. This time, federal disaster assistance to the county totaled only $283,094, a 99% reduction compared to 1993. The difference can be attributed in large part to moving the vast majority of repetitively damaged properties out of floodprone areas.

- Maintain and restore mitigation functions of the natural environment. The natural environment can help mitigate the impacts of natural hazards. For example, wetlands and floodplains slow down and absorb excess water during storms, then slowly release the stored water, thus reducing flooding downstream. Similarly, dunes help protect inland areas from the onslaught of storm-driven waves, and dense forests on steep slopes can reduce the risk of landslides.

Throughout eastern North Carolina, Hurricane Floyd's floodwaters engulfed sewage treatment plants, breached hog waste lagoons, and drowned hundreds of thousands of chickens, turkeys, and pigs. Oil and gas seeping from flooded junkyards were added to the mix, as were hazardous chemicals from flooded Superfund sites. Nearby rivers ran brown and oily with the toxic, fetid runoff.

- Protecting natural areas keeps people and buildings out of the path of natural hazards and maintains the natural capacity of the environment to attenuate disasters. In addition, protecting natural areas serves other purposes, such as preserving open space and wildlife habitat.

Tools for Implementing Disaster Resilience

Communities vary in their financial, political, and institutional capacity to implement a hazard mitigation plan. Some communities have a variety of planning and investment tools at their disposal while others are more limited. Some of the more common tools and techniques for increasing the resilience of a community are summarized below. The tools are divided into two groups: regulatory and nonregulatory. Most of these techniques have their greatest effectiveness at mitigating losses if they are implemented before a disaster. However, the recovery period may provide opportunities for initiating their use or strengthening them.

Regulatory Tools

Local governments have developed a variety of regulatory techniques such as zoning, impact fees, and subdivision exactions, to protect natural areas, including areas vulnerable to natural hazards. For example, some communities use their subdivision regulations to protect open space. Typically, such regulations require developers to set aside steep slopes, wetlands, floodplains, or other sensitive lands. Sometimes developers will be granted higher densities in return for the set-asides. Some of the more common regulatory measures used by local governments are summarized below.

Zoning. Zoning is the most common form of land use control available to local governments. It divides land into separate land use districts or zones and establishes the uses (e.g., residential, commercial, open space, or industrial) as well as the density of development allowed in each zone. The simplest and probably the most common approach to limiting the number of people and buildings in hazard-prone areas is to reduce the allowable density, or downzone an area, either by increasing the minimum lot size or reducing the number of allowable dwelling units permitted per acre.

TOOLS FOR DISASTER RESILIENCE

- Zoning
- Subdivision regulations
- Transfer of development rights
- Limiting public investment in hazardous areas
- Relocation out of hazardous areas
- Increasing public awareness of hazards
- Land acquisition
- Preservation of natural floodplain, coastal, wetland, and other functions
- Retrofitting
- Warning and preparedness
- Insurance

In areas where stringent restrictions are politically infeasible, zoning preserves some economically viable use of land and therefore generally avoids an unconstitutional taking of land. The weakness of using zoning to reduce a community's vulnerability to natural disasters is that it only affects new development, rather than existing buildings. Also, zoning's inherent flexibility is one of its primary weaknesses as a tool for protecting hazard-prone areas. For example, the zoning for a parcel of land can be changed through variances, special use permits or rezonings.

Subdivision regulations. Subdivision regulations govern the division of land into smaller parcels for development or sale. Traditionally, subdivision regulations focused on the physical aspects of a proposed development: the arrangement of lots, the size and layout of streets, and the provision of stormwater facilities. Gradually, the regulations evolved to encompass the fiscal impacts of new development as well, ensuring that a community's facilities and services will not be overburdened by new development (Platt, 1996). Many local governments impose exactions on new subdivisions. For example, as a condition of approval, developers may be required to "dedicate" land for schools or for open space. Developers may pay a fee in lieu of donating land to the municipality. A typical subdivision requirement might call for a 50-foot setback of developed land (a buffer) from a stream or wetlands, or it might prohibit development on steep slopes (Porter, 1997). Thus, subdivision regulations could be used to require minimum setback distances from lands vulnerable to natural hazards, or to set aside such lands as open space.

Some jurisdictions allow developers to cluster homes in one portion of a subdivision while leaving a large portion of the site undeveloped. That is, by rearranging the density of each development parcel, less than half of the buildable land will be consumed by lots and streets and the rest can be preserved permanently as woodlands, meadows, farms, or wetlands. This would result in the same number of houses as in a conventional subdivision, but the houses would be grouped closer together to protect natural areas, including floodplains, steep slopes, and other hazard-prone areas.

Transfer of development rights. While not as common as zoning or subdivision regulations, transferrable development rights or TDRs are used in numerous communities to protect certain lands from development. Transfer of development right programs, which treat the right to develop land as a commodity separate from the land itself, work as follows. A local government identifies an area it wants to protect, say, undeveloped property in a floodplain or landslide-prone area. This area becomes the *sending* area from which TDRs can be purchased from willing landowners. Property owners in the sending area are awarded a set of development rights based on the value or acreage of land. The government then identifies an area, usually where it would like growth to occur, as a *receiving* area for these development rights. By purchasing TDRs from landowners in sending areas, developers typically can build at higher densities in the receiving areas than would otherwise be allowed by zoning. Landowners who sell TDRs in sending areas typically are prohibited from developing their land.

Transfer of development rights can be used as a relatively low cost means of protecting sensitive lands. But TDRs is a complex system, which makes it difficult for planning staffs to implement and for landowners to understand and accept. Often it is unpopular with residents in the receiving zone, who are subject to development at densities higher than otherwise permitted by existing zoning. Perhaps most importantly, without strong development pressure in the receiving areas, there may be no market for the development rights.

Using TDRs to protect Farmland in Maryland

Montgomery County, Maryland, located just northwest of Washington, D.C., operates one of the most successful transfer of development rights programs in the country. In the early 1980s, the county adopted a TDR program to help stem the loss of agricultural lands. It designated large chunks of agricultural lands as rural density transfer zones that serve as the "sending" areas for the TDR program. The county downzoned this area from 1 dwelling per five acres to 1 dwelling per 25 acres. Landowners in this zone can sell development credits based on the original zoning.

The county then amended its general plan to allow higher density development, through the use of TDRs, in designated "receiving" areas. When a landowner sells the development rights for a parcel, a restrictive easement that permanently limits development is placed on the deed.

Credits sell for about $10,000–$12,000. For developers, the added cost for the credits is more than offset by the increase in allowable density in receiving areas. So far, over 4,300 credits have been transferred and over 35,000 acres of farmland have been protected by the TDR program

(Johnston and Madison, 1997, p. 369)

Nonregulatory Tools

Nonregulatory tools can be equally as effective as regulations. Many rely on the market to determine whether and where development will occur. Some, such as limiting public expenditures, can be implemented at virtually no cost to a local government. Others, such as acquisition, can be quite expensive. Some of the more common nonregulatory tools are summarized below.

Limiting public investments in hazard-prone areas. Development in hazard-prone areas can be discouraged simply by withholding or restricting government spending for infrastructure in such areas. For example, a local government may choose not to extend roads or water and sewer lines into undeveloped floodplains or into an earthquake fault zone. The expenditure limitation is based on the premise that government spending for infrastructure encourages development in these areas and that removing the subsidies will discourage development, presumably by making it too expensive. This approach not only helps use existing services more efficiently, but can also reduce the pressure to develop in risky areas. The concept is similar to that of urban growth boundaries, beyond which infrastructure will not be extended, at least in the near future.

Acquisition of hazard-prone lands. Probably the best way to protect hazard-prone lands is simply to buy them, either outright in fee simple or as an easement. The purchased land can then be set aside permanently as public open space. As mentioned previously, voluntary buyouts, which include purchase of vacant property, purchase and relocation of existing structures, or purchase and demolition of damaged structures, have become a major new focus in the Federal Emergency Management Agency's (FEMA's) overall strategy to reduce flood losses.

Buying properties that lie in the path of natural hazards often is cheaper in the long run than other forms of mitigation, plus it can serve multiple objectives, such as providing open space. Still, acquisition is expensive, especially in areas where property values are high, such as along the coast. Acquisition expenses include not only the cost of purchasing property, but program administration, property maintenance, and liability expenses as well. Small governments may

1993 Midwest Flood Boosts Federal Buyouts

The flood of 1993 devastated communities in the upper Midwest. Missouri was hit hardest, sustaining an estimated $3 billion in damage. In the wake of that flood, voluntary buyouts, which include purchase of vacant property in floodplains, purchase and relocation of existing structures, or purchase and demolition of flood damaged structures, became a major focus in the federal government's strategy to mitigate flood losses. Since 1993, the Federal Emergency Management Agency has purchased, from willing sellers, approximately 17,000 properties in 36 states and one territory and acquired easements on approximately 400,000 acres of floodprone farmland in 14 states. Property owners were paid pre-flood fair market value for their homes. Many state and local governments have developed successful programs to purchase floodprone properties.

(National Wildlife Federation, 1998)

lack sufficient resources to develop and implement an acquisition program. Federal funds are available for acquisition of damage-prone properties, primarily through the Hazard Mitigation Grant Program (HMGP).

The Federal Disaster Assistance Act (Stafford Act) provides funds authorized by the federal government and made available by FEMA for a cost-share program to states after a Presidentially declared disaster. These funds can be used for acquisition. The HMGP provides 75% of the funds while the states provide 25% for mitigation measures through the post-disaster planning process. The state share may be met with cash or in-kind services.

Increase public awareness of natural hazards. People often are unaware that the property they are about to buy is located in a hazard-prone location. Notifying potential purchasers in advance would allow them to make informed decisions about where to live or locate a business as well as take steps to safeguard their property from hazards. Thus, notification relies on the power of the marketplace to take corrective action once full knowledge about hazard conditions is obtained. In California, buyers are notified of an earthquake fault zone presence by real estate agents through a contract addendum at the time of purchase (Godschalk et al., 1998).

Many people are not aware that they live in a hazard-prone area until a disaster strikes. The post-disaster time frame may be a good window in which to pass, for example, a local ordinance requiring disclosure of a hazard at the time of a property sale. As noted in Chapter 2, after one disaster is before the next one, so it is never too late to act.

Retrofitting

Retrofitting means making changes to buildings to make them more resistant to hazards. Relocation and demolition are always mitigation options, but may be unrealistic when the portion of land at risk is large; i.e., in a coastal community or a town along a major fault line. In those cases, making changes to existing buildings may be more practical and cost-effective. Communities that want to retrofit buildings should consider providing economic benefits to residents who are willing to take steps to protect themselves from future hazards.

Four ways to retrofit for the flood hazard are elevation, wet floodproofing, dry floodproofing, and the construction of levees or floodwalls. Elevation means raising the building so that the lowest floor is above the flood level. Under the National Flood Insurance Program, a home is required to be elevated or relocated if it is damaged in a flood to 50% or more of its pre-flood market value. Wet floodproofing makes uninhabited parts of a house resistant to flood damage when water is allowed to enter during a flood. Dry floodproofing is sealing a house to prevent flood waters from entering. Levees and floodwalls are barriers built to prevent flood waters from entering. Other things that homeowners should consider doing are raising electrical and heating, ventilation, and air conditioning (HVAC) systems, anchoring fuel tanks, and installing a sewer backflow valve.

For seismic hazards, the main retrofit activities are bracing cripple walls and bolting sill plates to house foundations. Residents should also be encouraged to anchor tall items in their homes as well as valuable ones like computers. For new construction, there are other engineering methods to prevent seismic damage to buildings, but retrofitting for these design components can be

difficult and expensive. The National Earthquake Hazards Reduction Program is charged with the development and enhancement of provisions to minimize structural damage and loss to life due to earthquakes. More information on seismic retrofitting can be obtained from FEMA, which administers the National Earthquake Hazards Reduction Program..

For areas prone to coastal storm surge and hurricanes, several practices can be applied to existing construction. Hurricane straps, metal fasteners that attach the roof of a building to the walls, can reinforce a building's capacity to withstand severe winds. Shutters are one of the most basic methods for preventing damage and can be easily attached to existing homes and businesses. In coastal areas where flooding is a concern, elevation is highly recommended. Wind-resistant windows, wind- and hail-resistant shingles, and hurricane-resistant doors are also available.

Tornado retrofitting is similar to hurricane retrofitting in many ways. The goal of tornado retrofitting is to reduce the "uplift" effect of strong winds. Straps to attach a roof to the walls are helpful, as are wind-resistant shingles, windows, and doors. Garage and entrance doors should be reinforced. In addition, trees and yard materials that could become wind-borne in a tornado should be removed. Finally, residents may consider constructing "safe rooms," rooms that are reinforced, safe places to wait out a storm. FEMA publishes several how-to books to assist in the construction of safe rooms. Many states, including Arkansas, Mississippi, Hawaii, Iowa, and Oklahoma, have adopted safe room initiatives.

Warning and Preparedness

A warning system is a vital component of mitigation, because it allows both evacuation of people at risk and an additional window of time in which to take last-minute measures to secure property.

In deciding on a warning system, a community should consider such factors as what will happen to the warning system if the power is out, whether the warning system reaches all residents, and how it will promote the use of the system in the community so that people know what to do when a warning is issued.

Existing warning systems include the Emergency Alert System (EAS), which is a national system that can broadcast warnings via television and radio; the Radio Broadcast Data System, used for FM broadcasts; National Oceanic and Atmospheric Administration (NOAA) Weather Wire Service (NWWS); NOAA Weather Radio, which broadcasts to owners of radio transmittal devices designed for the system; Emergency Managers Weather Information Network (EMWIN); the Internet Weather Information Network (IWIN); and the Advanced Weather Information Processing System/Local Data Acquisition and Dissemination (AWIPS/LDAD). Some municipalities also use sirens. The National Science and Technology Council recently summarized many of the issues associated with choosing and implementing warning systems (Working Group on Natural Disaster Information Systems, 2000).

Insurance
Insurance is available for flood, earthquake, and wind hazards. Insurance is a useful means of sharing hazard risk and providing for financial assistance when natural disasters occur.

The National Flood Insurance Program (NFIP) provides flood insurance to residents in floodprone communities that have enacted certain land use restrictions to mitigate the effect of future flooding. In order to make residents in a community eligible for flood insurance, the community must be a member of the program. The NFIP state coordinator can determine whether a community is a member in good standing and, if not, determine what steps to take to make a community eligible.

Earthquake insurance is available through several different insurance companies as an add-on. However, because of the high damage associated with earthquakes, the insurance can be very expensive. In California, the California Earthquake Authority (CEA), a state-sponsored, private-public partnership, provides earthquake insurance to homeowners, renters, and condominium owners. It was implemented after the 1994 Northridge quake. Many insurance companies in California offer CEA's insurance, which has a 15% deductible. Californians can also buy earthquake policies outside the CEA.

Wind insurance, like earthquake insurance, is available through several private insurance companies. However, in some hurricane-prone states, it can be difficult or impossible to get coverage. In Florida, the Florida Windstorm Underwriting Association (FWUA), a group of insurers providing hurricane coverage to Florida homeowners who cannot get wind insurance in the regular market because of their hurricane exposure, is regulated by the state and provides insurance to residents. However, wind insurance remains extremely expensive in spite of this public-private partnership.

PURSUING STRATEGIES FOR DISASTER RESILIENCE

Once the recovery ideas—or strategies—are identified, the community will need to explore them through a systematic process in order to decide on the best approach, select feasible tools, locate technical assistance, formulate details, plan for action, find funding, get approval, and move toward implementation.

How are the disaster resilience strategies suggested above–and others that local planners and decisionmakers brainstorm— carried out? Developing and implementing a hazard mitigation plan is probably the best way a community can reduce its vulnerability to natural disasters.

A good process for developing a hazard mitigation plan is the 10-step process described in Chapter 2. In addition, a hazard mitigation plan should:

- Be linked with land use plans, subdivision regulations, building codes, stormwater management plans, and the capital improvement plan. The capital improvement plan could include a strategy to protect public facilities from disruptions, for example through seismic retrofitting of public buildings such as schools or fire departments.

- Anticipate all hazards faced by the community, such as floods, hurricanes, earthquakes, tornados, high winds, and wildfires.

- Address multiple objectives in order to incorporate other principles of sustainability, such as creating a more livable community, protecting open space or wildlife habitat, enhancing economic vitality, and promoting social equity, and providing for future generations. For example, buyout programs in Arnold, Missouri, and Darlington, Wisconsin, took buildings out of the path of floods and used the resulting open space to connect their river corridors to existing greenways and trail systems (Schwab, 1998). Care should be taken that mitigation actions do not undermine other aspects of sustainability, thus detracting from the community's "holistic recovery."

- Focus on the long term. The plan should reduce risks for the future, rather than simply return the community to pre-disaster condition.

- Be internally consistent. That is, reducing risk to one type of natural hazard should not increase risks to others. For example, elevating homes to reduce their vulnerability to floods may make them more susceptible to earthquake damage. These factors need to be weighed so that overall risk is reduced, for the long term.

Building Disaster Resilience During the 10-Step Recovery Process

Even if the community does not have or create a formal hazard mitigation plan, strategies for disaster resilience can be carried out in the context of the overall disaster recovery. Within the 10-step process described in Chapter 2, the following activities in particular will help ensure that disaster resilience is improved during a community's disaster recovery.

Actions to take during Step 4, Assessing the hazard problems.

To reduce the risk of natural hazards, a community will need to determine its present and future susceptibility by conducting a vulnerability assessment. Vulnerability is a measure of the risk or likelihood of various types and strengths of hazards occurring in the area, and the amount and quality of development in that area.

Assessing a community's vulnerability involves identifying areas of greatest risk, conducting an inventory of those areas, putting these areas on a map, identifying existing policies that may reduce vulnerability, and setting priorities for action. These procedures are summarized below.

First, identify the hazards that threaten the community (e.g., floods, earthquakes, wildfires) and prepare a map delineating the vulnerable areas. Is the community subject to frequent flooding or hurricanes? Are earthquakes common? Which areas suffer the most? Some of these areas may already have been mapped. For example, Flood Insurance Rate Maps (FIRMs) delineating floodplains are available for most communities under the NFIP. Identifying and mapping the areas that are most vulnerable can help guide policies and prioritize mitigation actions.

Identifying future areas of risk is more problematic. Boundaries of hazard-prone areas can change over time. For example, an increase in the amount of impervious surfaces (roads, driveways, parking lots) in a watershed could lead to increased stormwater runoff, which in turn could cause flooding in areas formerly considered outside the floodplain. Use current growth or land use patterns to predict how boundaries of hazard-prone areas might change over time.

Second, conduct an inventory of people and properties in vulnerable areas. Estimate the number of people and buildings, and the value of those buildings, located in the hazard-prone areas, and the number of people and buildings that will be there in the future if current growth and land use patterns remain unchanged. The Community Rating System of the NFIP gives points for an assessment of the impact of flooding on a community if it includes an inventory of the number and types of buildings subject to the hazards identified in the hazards assessment.

Third, prepare a map showing areas and facilities at risk. Highlight on the map the areas of highest risk and the critical facilities, major employers, repetitively damaged structures, and infrastructure in those areas. Particularly vulnerable neighborhoods and facilities, such as a low-income neighborhood or a housing facility for senior citizens, should be identified. Areas prone to flooding that are not included on the FIRM should be marked on the map. Areas subject to other hazards should also be identified. Maps can identify boundaries of natural hazard areas such as floodplains and pinpoint the location of vulnerable buildings or facilities.

Actions to take during Step 5, Evaluating the problems.

Use this window of opportunity to analyze policies, programs, and ordinances that may affect vulnerability. A community's existing policies and programs may, either intentionally or not, increase or decrease its vulnerability to natural hazards. Use the Matrix of Opportunities from Chapter 1 as a starting point to examine whether continuing those policies in the recovery period will worsen vulnerability, or whether changes can be made to minimize future risks. For example, extending water and sewer lines into floodplains will encourage development in those areas, while a plan for a greenway or open space in earthquake fault zones could preclude development there.

Communities should identify current policies that weaken hazard mitigation efforts and those that strengthen them, including land use plans and regulations, subdivision regulations, open space policies, transportation plans, and stormwater management plans. In addition, a community should identify areas where new policies are needed to reduce current and future risks of hazards.

Actions to take during Step 6, Setting goals and objectives.
Once it has identified and inventoried vulnerable areas and determined whether existing policies will increase or decrease vulnerability to natural hazards, a community can begin to set goals based on priorities for mitigating the threats posed by such hazards. The priorities should be based on the other principles of sustainability as well as upon traditional criteria such as cost-effectiveness (number of people, houses, or jobs protected per dollar invested), savings in tax revenues, and whether the action will achieve multiple objectives. Again, mitigation measures should not be adopted in isolation. All the risks to which the community is susceptible, and all the principles of sustainability, should be considered before goals and objectives are set. This prevents mitigation actions from undermining other aspects of a holistic recovery, and vice versa.

Action to take during Step 7, Exploring all alternative strategies.
Use multi-objective mitigation to link with other aspects of the community recovery. Consider all of the sustainability principles in the formulation of recovery plans for mitigating hazards. Consolidate economic, social equity, quality of life, and environmental perspectives.

Comprehensive Flood Mitigation in Napa County, California

In 1965, the Corps of Engineers was authorized to build a flood control project in Napa, California. The project called for constructing concrete walls along 11 miles of the Napa River. Local citizens who opposed the project forced the issue onto a ballot initiative. In 1976 and again in 1977, voters turned down the project, on the grounds that it would be too costly and would destroy the river.

In the mid-1980s, after a severe flood, the Corps proposed a scaled down version of the project, lining only about 6 miles of the river with concrete. But the project languished in the face of stiff opposition.

Finally, after a huge flood struck the city in 1995, the county put together a coalition of state, federal, and local agencies as well as citizen and special interest groups to try to develop a solution to Napa's flooding problems. The result was a $175 million flood control project that includes both structural and nonstructural measures. The structural component involves widening the river to increase its capacity, moving the levees farther back from the river, and constructing a floodwall to protect the most vulnerable residential properties. The nonstructural component involves acquiring floodprone properties and restoring wetlands along the river.

The county has plans to purchase about 350 parcels, primarily commercial and industrial, in the floodplain. Thus far, it has purchased six properties and is negotiating to purchase another twelve.

To pay for its share of the project—an estimated $50 million for the buyout alone—county residents approved a ½ cent sales tax increase, which is expected to raise about $7 million per year, over 20 years. The county also received about $5 million from the Federal Emergency Management Agency to help fund the buyout.

Choose from the opportunities identified under Step 5, the goals and objectives set in Step 6, and the options and tools described in this chapter. Expand and tailor them to meet a community's concerns. Be sure that the potential impacts of each alternative on other aspects of sustainability within the community are analyzed.

Actions to take during Step 10, Implement, evaluate, and revise.
Some ways to monitor and evaluate disaster resilience are discussed in the next section.

MONITORING DISASTER RESILIENCE

It is difficult to measure the success of hazard mitigation efforts. Why? Because for an valid measurement to occur, a community would have to compare damage incurred with and without the hazard mitigation actions. And the events being compared would have to be of the same strength, duration, and location. This seldom occurs.

Other indicators are available, however, to estimate the effectiveness of the hazard mitigation strategy—that is, whether the community has increased or decreased its vulnerability to natural hazards. In addition to measuring a community's progress toward achieving its mitigation goals, the indicators also can be used to set performance goals for a community, e.g., reducing the percentage of homes in the floodplain by 10% per year. Finally, the indicators can help build support for mitigation programs by showing tangible benefits. Several indicators for improving the resilience of homes, businesses, critical facilities, and the natural environment are shown in the box on the next page.

CONCLUSION

Communities vary in their vulnerability to natural hazards and in their capacity to mitigate their impacts. Some face risks from several types of natural hazards, such as earthquakes, landslides, and wildfires, while others suffer primarily from a single type of hazard, such as flooding. Some are subject to seasonal hazards that occur in relatively predictable areas, such as wildfires in the west or Nor'easters along the Atlantic coast, while in other communities, disasters can strike anytime. Also, communities vary in the amount of development that has occurred in hazard-pronelocations and in their approach to mitigation, e.g., structural or nonstructural. Thus, each community is unique, and its approach to addressing the threat of natural disaster varies considerably.

Most communities will remain vulnerable to one type of natural hazard or another. Natural disasters provide an opportunity for communities to become more sustainable—to rebuild and redevelop homes, businesses, critical facilities and infrastructure in a manner that they will be less vulnerable to future disasters. To do so requires communities to implement policies and programs that (1) make structures in hazard-prone areas more damage-resistant, (2) avoid development in hazardous areas, and (3) protect natural areas that can reduce the impacts of natural disasters. This is the essence of hazard mitigation.

Checklist for Measuring Community Resilience to Natural Disasters

Housing

- ☐ Fewer households living in unsafe areas
- ☐ Fewer repetitively damaged structures
- ☐ Increase in number of households with insurance against natural hazards

Businesses

- ☐ Fewer businesses in unsafe areas
- ☐ Fewer repetitively damaged structures
- ☐ Increase in number of businesses with insurance against natural hazards

Infrastructure and critical facilities

- ☐ Critical facilities (hospitals, police and fire stations, schools, etc.) relocated to safe areas or protected against damage from natural hazards
- ☐ Fewer repetitively damaged facilities
- ☐ Infrastructure (roads, bridges, sewage treatment plants, water treatment plants) relocated to safe areas or protected against damage from natural hazards

Natural Environment

- ☐ Unsafe land use activities (junkyards or chemical storage facilities) relocated from areas prone to natural hazards. New unsafe uses prohibited in such areas
- ☐ Commercial or industrial facilities in hazard-prone, environmentally-sensitive areas have undertaken mitigation measures to reduce the likelihood of the release of hazardous materials
- ☐ Wetlands, floodplains, dunes, and coastal zones protected from development or damage

(North Carolina Division of Emergency Management, 2000)

Mitigation is an ongoing process, and few communities can claim that they are completely free from the risk of natural disasters. Some small communities, such as Pattonsburg, Missouri; Grafton, Illinois; and Soldiers Grove, Wisconsin have come close, because they have relocated themselves to higher ground, out of the path of floodwaters. In most other places, however, particularly in large cities that were settled along rivers or ports or in earthquake-prone areas, relocation of all vulnerable properties is not feasible. It is possible, however, to reduce a community's vulnerability.

When disaster strikes, a mitigation plan can help guide the recovery effort toward increased resilience to future disasters. The plan can help forge a common vision on how to make the community, including its businesses, more resilient and sustainable. And the plan can help ensure that community decisions about the type and location of future growth consider the impacts of natural hazards.

By integrating mitigation concepts into governmental activities today, a community can reduce its vulnerability to natural hazards and avoid much more costly losses from tomorrow's disasters. The time, energy, and resources invested in mitigation could significantly reduce the demand for future dollars by reducing the amount needed for emergency recovery, repair, and reconstruction after a disaster. That is, it could make a community more sustainable, by safeguarding the environment, protecting the local economy, and promoting greater equity.

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Godschalk, D.R.; Beatley, T.; Berke, P.; Brower, D.J.; and Kaiser, E.J. 1999. *Natural Hazards Mitigation. Recasting Disaster Policy and Planning*. Washington, D.C.: Island Press. 575 pp.

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National Wildlife Federation. 1998. *Higher Ground: A Report on Voluntary Property Buyouts in the Nation's Floodplains*. Washington, D.C.: National Wildlife Federation.

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Porter, Douglas. 1997. *Managing Growth in America's Communities*. Washington, D.C.: Island Press.

Schwab, Jim; Topping, Kenneth C.; Eadie, Charles C.; Deyle, Robert E.; and Smith, Richard A. 1998. *Planning for Post-Disaster Recovery and Reconstruction*. PAS Report No. 483/484. Chicago, IL: American Planning Association. 346 pp. Abstract available at **www.planning.org/apapubs/details.asp?Num=1178**. [accessed September 21, 2001]

Working Group on Natural Disaster Information Systems, 2000. *Effective Disaster Warnings*. Washington, D.C.: National Science and Technology Council, Committee on Environment and Natural Resources.

WHERE TO FIND MORE INFORMATION

Training Courses and Workshops

Federal Emergency Management Agency, Emergency Management Institute, Higher Education Project Courses. Emmitsburg, MD. **www.fema.gov/emi/edu/aem_courses.htm** [accessed June 15, 2001] Contact: (301) 447-1233 or email Barbara Johnson: barbara.l.Johnson@fema.gov

- "Building Disaster Resistant and Sustainable Communities." Course developed by Raymond Burby. **www.fema.gov/emi/edu/bldcomm.htm,** [accessed June 15, 2001] This course introduces the concepts of sustainable development, resilient communities, and smart growth. Public and private sector planning are discussed. The last quarter of the class focuses on topics of resilience, including financing resilience projects, creating resilience among vulnerable populations, and creating resilience for specific hazards.

Federal Emergency Management Agency, Emergency Management Institute, National Emergency Training Center. Emmitsburg, MD. **www.fema.gov/emi** [accessed June 15, 2001] (301) 447-1035.

- "Introduction to Mitigation." Independent Study Course. Federal Emergency Management Course IS393.
  At the end of the course, the student should be able to: explain the rationale for mitigation and its function as a component of emergency management; define the principles, purposes, and priorities of mitigation; describe mitigation measures that are applicable to local hazard risk problems; summarize responsibilities and resources for mitigation; and outline mitigation planning considerations.

- "Integrated Emergency Management Courses for Specific Communities." Federal Emergency Management Agency Courses E930/S390, E931/S391, E932/S932.
  These courses place emphasis on community response and short-term recovery issues. They are tailored to fit the community and are based on a selected hazard type. The courses use classroom instruction, planning sessions, and exercises to allow for structured decisionmaking in a learning, yet realistic, environment. A key outcome is to assist with making the transition from response to short-term recovery. The three classes offered are: E930/S390 IEMC/Community Specific/All Hazards: Response and Recovery; E931/S931 IEMC/Community Specific/Hurricane: Response and Recovery; and E932/S932 IEMC/Earthquake: Response and Recovery.

- "IEMC/All Hazards: Recovery and Mitigation." Federal Emergency Management Agency Course E901/S901.
  This course emphasizes recovery and mitigation and is conducted for two types of audiences. The course places public officials and other key community leaders in a simulation that begins after a disaster has affected the community.

- IEMC/Earthquake: Recovery and Mitigation." Federal Emergency Management Agency Course E911/S911.
  This course is similar to the above "All Hazards" in its format, but focuses specifically on earthquakes.

- "IEMC/Hurricane: Recovery and Mitigation." Federal Emergency Management Agency Course E906/S906.
  This course is similar to the above "All Hazards" in its format, but focuses specifically on hurricanes.

- "Multi-Hazard Building Design Summer Institute." Federal Emergency Management Agency Courses E329, E330, E331, and E333.
  These courses are intended to provide up-to-date technical information on building design for the faculty of engineering or architectural colleges. It is intended that faculty members incorporate this information into their curriculum in order to train the architects and engineers of the future in the proper approaches to mitigating natural hazards. Four courses include: Flood Protective Design (E329), Earthquake Protective Design (E330), Wind Protective Design (E331), and Fire Safety Design (E333).

- "Retrofitting Flood-Prone Residential Buildings." Federal Emergency Management Agency Course E279/G279.
  This 2-day course is designed to provide engineering and economic guidance on retrofitting existing one- to four-family residential structures situated in floodprone areas. Subjects covered include an introduction to retrofitting, regulatory framework, controlling parameters, building assessment, and design practices. There is also a 1-hour unit on economics and a final exam.

- "Seismic Retrofit Training for Building Contractors and Inspectors." Federal Emergency Management Agency Course G225.
  This 8-hour course demonstrates methods to retrofit residential structures to reduce seismic damage. Students are shown methods of properly tying a structure to a foundation and using connectors to strengthen its frame. Topics covered include earthquake basics, shear walls, foundations, connections, and miscellaneous elements in construction. In addition, liability issues for contractors are discussed throughout the course. The manual is designed to be an on-site reference tool for contractors.

Organizations

Association of State Floodplain Managers.
The Association of State Floodplain Managers is an organization of professionals involved in floodplain management, flood hazard mitigation, the National Flood Insurance Program, and preparedness, warning and recovery. The ASFPM represents the flood hazard specialists of local,

state, and federal government, the research community, the insurance industry, and the fields of engineering, hydrologic forecasting, emergency response, water resources, and others.
See **www.floods.org** [accessed July 23, 2001]

Center of Excellence for Sustainable Development.
The CESD website is a project of the Denver Regional Office of Department of Energy's Office of Energy Efficiency and Renewable Energy. Since 1995, the CESD website has offered users access to comprehensive resources on community sustainability. It is an excellent source for resources on sustainable development.
See **www.sustainable.doe.gov** [accessed June 29, 2001]

Disaster Resistant Communities Association.
This web site includes recent news stories about communities that have implemented pre-disaster mitigation plans and Project Impact.
See **www.hazmit.net/PIAssoc/PIHome.htm** [accessed June 15, 2001]

Federal Emergency Management Agency (FEMA).
FEMA is the federal agency responsible for preparing for and responding to disasters in the United States.
See **www.fema.gov** [accessed July 23, 2001]

Institute for Sustainability and Technology Policy. *Directory of Policy Journals in Transport, Urban Planning and Sustainability.*
Over 50 journals are described to help academics, professionals, and students research many topics related to this field. Each journal is described including a link to the site where the journal may be found on the internet. Some journals have access to online articles.
See: **wwwistp.murdoch.edu.au/research/journal/** [accessed July 13, 2001]

Network of State Hazard Mitigation Officers.
This web site is a link to state hazard mitigation officers and an online source of information for hazard mitigation officers.
See: **www.hazmit.net/index.htm** [accessed June 15, 2001]

Videos, CD-ROMs, and DVDs

Stand Up to the Flood: Get Your Home in Shape. Association of Bay Area Governments. 1999.
Contact the Association of Bay Area Governments at: P.O. Box 2050, Oakland, CA 94604-2050. Phone: (510) 464-7900; fax: (510) 464-7970; or see **www.abag.ca.gov** [accessed September 14, 2001]

Flood Mitigation Planning: The First Steps. Association of State Floodplain Managers (ASFPM). 2000.
Contact ASFPM at **asfpm@floods.org** or see **www.floods.org** [accessed September 14, 2001]

Mitigation Revitalizes a Floodplain Community: The Darlington Story. Wisconsin Department of Natural Resources. 1997. Madison, WI.
This is a splendidly produced videotape about the efforts of a small rural Wisconsin community to reverse the effects of neglect and disinvestment in its historic downtown area caused by repeated flooding and economic change. Using a multi-objective planning and management strategy, officials and citizens, in partnership with government agencies and private entities, identified six goals: 1) preserve the historic character of the downtown; 2) restore community pride; 3) acquire and relocate commercial properties at risk; 4) elevate and flood proof commercial and residential structures; 5) stimulate investment downtown; and 6) pursue tourism as an economic strategy. The video follows the mitigation process from early meetings through floodproofing and relocation. Produced by the Wisconsin Department of Natural Resources. 27 minutes. 1997. Available free from Wisconsin DNR, P.O. Box 7921, Madison, WI 53707-7921; (608) 264-9200.

Rhineland Relocation Project. Booneslick Regional Planning Commission. n.d. Produced by Video Production Company for the Booneslick Regional Planning Commission and others.
For availability, contact the Booneslick Regional Planning Commission at (314) 456-3473 or the Economic Development Administration in Jefferson City, Missouri at (314) 751-4146.

Quality Redevelopment of Eastern North Carolina. Horizon Video Productions. 2000. Durham, NC.
This 20-minute video was produced by the state in the aftermath of Hurricane Floyd to introduce and educate local and state officials about the "better ways" available to recover from the disaster and at the same time address other local concerns such as environmental quality, economic vitality, housing, sense of community, business and job opportunities, and disaster mitigation. It introduced a framework espoused by the state for sustainable community action and features the governor explaining the tenets of "quality redevelopment" and how it can—and did—benefit North Carolina communities and help ensure a better future for the state's citizens. Available from North Carolina Department of Emergency Management, 1830-B Tillery Place, Raleigh, NC 27699; (919) 751-8000; fax: (919) 715-9763.

Taking the Initiative. Federal Emergency Management Agency, Emergency Management Institute. 2000. Emmitsburg, MD.
This 20-minute video shows how a neighborhood, two small towns, and a business owner took responsibility for and got organized to adopt sustainability principles and techniques in coping with hazards. The three separate instances, all in California, illustrate participatory processes, taking initiative, looking at the economic benefits of hazard mitigation (in one case, elevating a restaurant), incorporating livability components into a flood protection measure, and protecting the local environment and habitat. This video is available from the Emergency Management Institute at 1-800-238-3358. Ask for the "Disaster-Resistant Jobs" video.

The Link Between Sustainability & Disaster Resistant Communities. Slide show produced by the U.S. Department of Energy and the Federal Emergency Management Agency. **www.sustainable.doe.gov/disaster/impact** [accessed July 23, 2001]
This slide show explains the concept of sustainable redevelopment and gives examples of redevelopment in three communities: Soldiers Grove, Wisconsin; Valmeyer, Illinois; and Arkadelphia, Arkansas.

Community Vulnerability Assessment Tool. New Hanover County, North Carolina. NOAA Coastal Services Center.
Before communities can develop effective hazard mitigation strategies, they must first identify their hazard risks and assess their vulnerability to the impacts of those hazards. This CD-ROM includes a method for conducting a community-wide vulnerability assessment. A tutorial steps the user through a process of analyzing physical, social, economic, and environmental vulnerability at the community level. The foundation for the method was established by the Heinz Center Panel on Risk, Vulnerability, and the True Cost of Hazards.

Planning for Natural Hazards: Oregon Technical Resource Guide. Oregon Natural Hazards Workshop. 2000. University of Oregon: Oregon Natural Hazard Workshop.
The purpose of the guide is to help Oregon cities and counties plan for and limit the effects of threats posed by natural hazards." More information is available on-line at **www.uoregon.edu/~onhw/text/projects/tfeatured.html** [accessed June 22, 2001]

Books, Articles, and Papers

Association of State Floodplain Managers. 1996. *Using Multi-Objective Management to Reduce Flood Losses in Your Watershed*. Madison, WI: Association of State Floodplain Managers. 72 pp. Abstract available at **www.floods.org/PDF%20files/PUBSLIST.pdf**. [accessed September 21, 2001]
This publication documents the results of a multi-year project, funded by the Environmental Protection Agency and conducted by ASFPM, to explore planning and implementation techniques for multi-objective watershed management. It provides a general introduction to multi-objective management and the planning process that helps a community select the flood-loss reduction measures most suitable to its situation. It explains how to define problems and goals, build partnerships, combine needs and solutions creatively, and begin formal implementation procedures. Both riverine and coastal flood watersheds are examined. Much of the document focuses on multi-objective management planning details, involving subjects such as fish and wildlife issues, water supply, housing improvement, transportation and lifelines. Preparation of a M-O-M plan involves problem definition, involvement of non-local groups, and public and official acceptance of the plan.

Bay Area Regional Earthquake Preparedness Project. 1990. *Putting the Pieces Together: The Loma Prieta Earthquake One Year Later*. Oakland, CA: Bay Area Regional Earthquake Preparedness Project. 253 pp.
This report grew out of a conference held to determine the lessons learned from the Loma Prieta earthquake and its aftermath. The conference examined preparedness and mitigation efforts before the quake, political and management issues of disaster response, recovery and reconstruction programs, and mitigation activities since the event. Among the numerous topics addressed in the volume, separate chapters are given to seismological and geological considerations, geotechnical aspects, the performance of lifelines, buildings, and transportation systems and the implications for future design of these elements, effective emergency management, emotional and psychological aftereffects, economic impacts, emergency public information and the media, the restoration of lifelines, emergency medical services, business recovery, and housing reconstruction.

Beatley, Timothy and David Brower. 1997. *Hazard Mitigation in Florida Following Hurricane Andrew*. Natural Hazard Working Paper No. 13. Chapel Hill, NC: University of North Carolina, Center for Urban and Regional Studies. 61 pp.
This case study examines the impacts, activities, and lessons learned from Hurricane Andrew. The report describes the extent and nature of the damage the storm caused, along with Florida's susceptibility to hurricanes. It describes the pre-storm status of the region's planning and mitigation framework, then documents the major recovery and reconstruction activities that have transpired since the storm, including the post-storm mitigation projects and expenditures, changes to building codes, and design charrettes that examined alternative rebuilding strategies. Among the major policy issues that emerged from the study are: the appropriate role of the state mitigation plan, the appropriateness of mitigation choices made following Andrew, the limited mitigation options in South Florida, and the benefits and limitations of Florida's system of comprehensive planning and growth management.

Berke, Philip R. and Timothy Beatley. 1992. *Planning for Earthquakes: Risk, Politics, and Policy*. Baltimore, MD: John Hopkins University Press. 228 pp.
The authors examine the experiences of 260 earthquake-prone communities across the U.S., paying particular attention to three areas of especially high risk: Palo Alto, California; Salt Lake City, Utah; and the lowlands of South Carolina, including Charleston. They address issues that include citizen safety, determining and maintaining the structural integrity of old and new buildings, mapping, and land use, and also discuss alternative seismic hazard reduction measures and local earthquake mitigation programs. They conclude with a set of recommended activities for implementing local programs and building public support while involving federal and state governments. It is recommended that major stakeholders in the development of mitigation strategies should be involved with the planning process from the beginning.

Berke, Philip R. and Jack Kartez. 1994. *Sustainable Development as a Guide to Community Land Use Policy: A Conceptual Framework*. HRRC Publication 37P. College Station, TX: Texas A&M University, College of Architecture, Hazard Reduction & Recovery Center. 25 pp.
This paper provides a conceptual definition of "sustainable development," which many have argued is a vague phrase that threatens to become an unmanageable cliche. The authors explore how "sustainable development" can be used to describe the common good in land use and development and present a set of principles for land use policy formation. Principles for land use policy that the report identifies are: 1) include public participation in the decisionmaking process; 2) build consensus through conflict resolution mechanisms; 3) build local decisionmaking on a realistic capacity to carry out policies; 4) recognize local rights to devise rules for guiding human settlement patterns; 5) land use policy must work in harmony with nature and recognize the limits of ecosystems; 6) the built environment should be in harmony with people's needs and aspirations; 7) realistic land use policy must be able to alleviate local poverty and account for the least advantaged; 8) polluters, or culpable parties/corporations, must pay for the adverse affects they have imposed on ecosystems; and 9) responsible regional planning needs to be promoted.

Berke, Philip and David Godschalk. 1996. *Hazard Mitigation in California following the Loma Prieta and Northridge Earthquakes*. Natural Hazard Working Paper No. 14. Chapel Hill, NC: University of North Carolina, Center for Urban and Regional Studies. 59 pp.
This report documents a case study conducted almost six years after the Loma Prieta quake and one and one-half years after Northridge. The strengths and weaknesses of the California 409 Plans are identified, state and federal mitigation planning and implementation processes are reviewed, and local mitigation examples are drawn from San Francisco, Berkeley, Watsonville, and Los Angeles and Ventura counties. One finding was that present mitigation systems (policies and institutions) will not be adequate to mitigate the impacts of a future major earthquake catastrophe. Two recommendations were that California should pursue a coordinated, interdisciplinary effort to further the understanding of earthquake prediction and of earthquake impacts and should reinvigorate efforts to mandate local multi-hazard mitigation planning before and after a disaster.

Burby, Raymond J., ed. 1998. *Cooperating with Nature: Confronting Natural Hazards with Land-Use9 Planning for Sustainable Communities.* Washington, D.C.: Joseph Henry Press. 356 pp. Available at **www.nap.edu/catalog/5785.html.**
This volume focuses on the breakdown in sustainability—the capacity of the planet to provide quality of life now and in the future—that is signaled by disaster. The book takes a historical approach to the explain why land use and sustainability have been ignored in devising public policies for natural hazards. The authors provide suggestions and a blueprint for the future.

Burby, Raymond J., Timothy Beatley, Philip R. Berke, Robert E. Deyle, Steven French, David R. Godschalk, Edward J. Kaiser, Jack D. Kartez, Peter J. May, Robert Olshansky, Robert G. Paterson, and Rutherford H. Platt. 1999. "Unleashing the Power of Planning to Create Disaster-Resistant Communities." *Journal of the American Planning Association* 65 (Summer).
Human suffering and losses of lives and property in natural disasters can be reduced with appropriate planning for hazardous areas. However, the authors of this paper assert that federal policies addressing these problems have yet to recognize the importance of planning as the cornerstone of effective local hazard mitigation. In fact, federal programs make planning more difficult, the authors suggest, because they encourage the intensive use of hazardous land and shield local governments and private decisionmakers from financial losses in the disasters that inevitably follow. To unleash the power of planning for hazard mitigation, federal policies must be revised so that they help build local understanding of risk, commitment to hazard mitigation, and support for planning.

Bush, David M., Rodney Priddy, Kathie Dixon, and Orrin H. Pilkey. 1991. *Principles of Property Damage Mitigation and the Impact of Hurricane Hugo*. Durham, NC: Duke University, Department of Geology, Program for the Study of Developed Shorelines. 167 pp.
Prepared as a field-trip guide for the study of damage caused by Hurricane Hugo along the Carolina coast, this report is designed to educate readers about the many effects of hurricanes on seashores and to encourage a new way of thinking about hurricane recovery. It tries to show that simply cleaning up and rebuilding should make way for more active steps to enhance and preserve the protective capabilities of the natural setting. It also suggests principles of reducing

hurricane-caused property damage given expected sea-level rise, barrier island migration, and increased storm severity, and encourages environmentally sensitive approaches to hurricane mitigation. The document contains an account of pertinent hazard mitigation legislation and hazards research, a matrix of mitigation options, a general description of the shoreline affected by Hugo, and detailed descriptions of various sites included in the field trip.

Federal Emergency Management Agency. 1997. *Project Impact Guidebook. Building a Disaster Resistant Community*. Washington, D.C.: U.S. Government Printing Office.
This guidebook is designed to help communities protect residents, organizations, businesses, infrastructure, and stability and growth of the economy as much as possible against the impact of natural disasters before they happen.

Federal Emergency Management Agency. 1997. *Report on Costs and Benefits of Natural Hazard Mitigation*. Washington, D.C.: Federal Emergency Management Agency. 52 pp.
A long-standing question for those who work to reduce the impacts of natural hazards is whether mitigation is worth the time and expense. Specifically, are the costs required to reduce or eliminate the impacts of natural hazards substantially less than the benefits they provide? This report reviews the benefits that can accrue to different segments of society from mitigative measures, the costs that can be incurred by undertaking mitigation activities, and the analyses needed to evaluate the cost-effectiveness of these measures. The document has 16 case studies across the United States and demonstrates their efficiency against several types of natural hazards, as well as the effectiveness of other mitigation tools. The studies include seismic retrofitting of lifelines in Tennessee, reinforcement of highway bridges in California, historic preservation and community development in Wisconsin, mitigation in hospitals in California, reduction of business interruption costs in Iowa, seismic retrofitting in Los Angeles public schools, wind shutter protection in Florida, acquisition and relocation of floodplain structures in Missouri, regulation of unreinforced masonry buildings in Los Angeles, land-use and building regulation along the coasts of Florida, land-use and building requirements in floodplains, and seismic retrofitting to avoid business disruption. The cases include both public- and private-sector initiatives.

Federal Emergency Management Agency. 2000. *Planning for a Sustainable Future: The Link Between Hazard Mitigation and Livability.* FEMA Report 364. Washington, D.C.: Federal Emergency Management Agency. 40 pp. Available at **www.fema.gov/mit/planning_toc2.htm**. [accessed September 21, 2001]
This booklet is about hazard mitigation, disaster resilience, sustainable development and livability, and describes the linkages among these concepts. It shows how communities that undertake hazard mitigation planning become more disaster resistant and reap further benefits. Hazard mitigation links disaster resilience to broad community objectives of economic health, social well-being, and environmental protection.

French, Steven P., Arthur C. Nelson, S. Muthukumar, and Maureen M. Holland. 1996. *The Northridge Earthquake: Land Use Planning for Hazard Mitigation*. NSF Grant Number CMS-9416458. Atlanta, GA: Georgia Institute of Technology, College of Architecture, City Planning Program. 160 pp.
Land use planning for seismic safety has been mandated in California for more than 20 years. The 1994 Northridge earthquake, which significantly impacted 19 local jurisdictions, provided a

unique opportunity to assess the effectiveness of this planning as a mitigation strategy. The authors found that planning had a small but measurable effect in reducing earthquake damage. In particular, the hazard delineation and public awareness components of the plans were the most strongly related to lower damage levels. Additionally, a disproportionate amount of damage occurred in areas that were previously identified as likely to experience liquefaction, and communities that had undertaken detailed mapping of these areas experienced less damage than those that did not. The report initially discusses the role of land use planning in natural hazard mitigation, then provides a setting for the Northridge quake. The pre-earthquake policy framework is reviewed, and local land use plans in effect are overviewed. The final chapter suggests ways to improve the effectiveness of land use planning for hazard mitigation.

Geis. D.E. 2000. "By Design: The Disaster Resistant and Quality of Life Community." *Natural Hazards Review* 1(3):151-160.

According to Geis, the present approach to designing and building communities is inadequate and is inflicting great and growing harm–physically, environmentally, socially, economically, and emotionally–that we can no longer tolerate. The disaster resistant community concept, the first step toward creating quality-of-life communities, was created specifically to provide a new way of thinking. A number of basic questions need to be addressed. What are disaster-resistant communities? Why are they important? What are the benefits? What is the relationship between a disaster-resistant community and a sustainable quality-of-life community? And, most importantly, how do we go about creating them? This article provides the answers to these questions so that the concept can be better understood and used to its fullest potential.

Godschalk, David and Timothy Beatley. 1996. *Hazard Mitigation in Iowa Following the Great Midwest Floods of 1993*. Natural Hazard Working Paper No. 10. Chapel Hill, NC: University of North Carolina-Chapel Hill, Center for Urban and Regional Studies. 31 pp.

The report examines how the Stafford Act influenced recovery in eight localities in Iowa. Questions explored include: What constitutes mitigation? Who is in charge after a disaster occurs? What good is the 409 (Stafford) Plan? Who pays for disasters? Other topics considered include grant administration accountability, equity issues, the promotion of sustainable communities, and problems caused by confusing rules and guidance.

Godschalk, D.R., T. Beatley, P. Berke, D.J. Brower, and E.J. Kaiser. 1999. *Natural Hazards Mitigation. Recasting Disaster Policy and Planning*. Washington, D.C.: Island Press. 575 pp.

This book describes and analyzes the way that hazard mitigation has been carried out in the United States under the Robert T. Stafford Disaster Relief and Emergency Assistance Act. The authors determine how the requirements of this law, establishing a national system for hazard mitigation, have worked in practice and how they might be made to work better.

Kundzewicz, Zbigniew W. 1999. "Flood Protection—Sustainability Issues." *Hydrological Sciences–Journal–des Sciences Hydrologiques* 44(4): 559–571.

Several types of technical infrastructure used globally for flood protection have been criticized in the context of sustainable development because they close off options for future generations and introduce unacceptable disturbances in ecosystems. Large structural flood defenses like dams, levees, storage reservoirs, and embankments are often listed in this category. This article examines the means of coping with floods in the sustainability context. The premise is that, although some

flood protection is necessary to the present generation to attain a fair degree of freedom from disastrous events, it must be done in such a way that future generations are not adversely affected. Various measures, or tests, of the sustainability of structural and nonstructural flood mitigation approaches are reviewed. Among them are questions about the fairness, reversibility, potential for landscape rehabilitation, and risk of various approaches; the extent to which consensus and/or participatory decisionmaking was incorporated into the planning; the magnitude of the marginal environmental impact; and the efficiency of existing and proposed projects. The author concludes that a change in paradigm is needed because a flood protection system guaranteeing complete safety is an illusion; an attitude of "living with floods" is more sustainable than a hopeless striving to combat floods.

Mileti, Dennis S. 1999. *Disasters by Design*. Washington, D.C.: The Joseph Henry Press. 351 pp. Available at **books.nap.edu/catalog/5782.html**. [accessed September 21, 2001]
This book is a summary volume of the Second National Assessment of Research on Natural Hazards with the formal mission of summarizing what is known in the various fields of science and engineering that is applicable to natural and related technological hazards in the United States, and making some research and policy recommendations for the future. It summarizes the hazards research findings from the last two decades, synthesizes what has been learned, and outlines a proposed shift in direction in research and policy for natural and related technological hazards in the United States. *Disasters by Design* is intended for a general audience, including policymakers and practitioners.

Mittler, Elliott. 1997. *An Assessment of Floodplain Management in Georgia's Flint River Basin*. Boulder, CO: University of Colorado, Institute of Behavioral Science, Natural Hazards Research and Applications Information Center. 190 pp.
On July 3, 1994, Tropical Storm Alberto struck the Florida panhandle and proceeded northeast before stalling just south of Atlanta, Georgia, inflicting over $1 billion in damage. The flood provided an opportunity to identify and document the successes and failures of state and local floodplain management programs and activities. The author assessed the impact of federal, state, and local floodplain management activities on losses in the Flint River Basin, paying particular attention to the impact of the National Flood Insurance Program (NFIP) and local floodplain management efforts. He examines previous floodplain studies; evaluates the political situation affecting flood recovery in each community; examines federal, state, and local responses to the disaster, concentrating on recovery plans and the use of hazard mitigation programs to reduce future flood losses; analyzes the effectiveness of the NFIP; and offers a series of findings and recommendations based on the relatively successful recovery programs he found.

Nanita-Kennett, Milagros. 1994. *Urban Redevelopment and Earthquake Safety.* Tallahassee, FL: Florida A&M University, School of Architecture. 143 pp.
Urban renewal or redevelopment has been employed by federal, state, and local governments to promote the creation of public infrastructure and regulate the development process. However, earthquake safety programs have never been a part of this process, despite evidence that many cities are broadly vulnerable to the hazard. If these programs could be successfully integrated, seismic safety and protection could be greatly increased with reasonable effort and cost. The author examines this topic by addressing urban decay and earthquake risk; the redevelopment

process; the urban environment, including building codes, land use, and infrastructure; federal earthquake programs; local government programs; and the integration of various aspects of redevelopment. In addition, she provides case studies of Charleston, South Carolina; Memphis, Tennessee; Salt Lake City, Utah; and Santa Rosa and Santa Cruz, California.

National Wildlife Federation. 1998. *Higher Ground: A Report on Voluntary Property Buyouts in the Nation's Floodplains*. Washington, D.C.: National Wildlife Federation.
The National Wildlife Federation is dedicated to restoring landscapes, including natural wetlands, floodplains, and habitat of species that thrive along rivers and streams. *Higher Ground* focuses onefforts to restore floodplains through voluntary property buyouts and relocations of homes and other structures from high-risk flood zones and presents a detailed analysis of National Flood Insurance Program (NFIP) data. It includes sections on the history of buyout programs in the U.S. and the 1993 Midwest floods, an analysis of repetitive losses in the NFIP, and conclusions and recommendations.

North Carolina Emergency Management Division and Federal Emergency Management Agency. 2000. *Hazard Mitigation in North Carolina: Measuring Success*. Raleigh, NC: DEM.
To accelerate the institutionalization of hazard mitigation in North Carolina, the North Carolina Emergency Management Division established the Hazard Mitigation Planning Initiative, a long-term program to build local capacity to implement mitigation policies and programs in communities across the state. Through a series of case studies, this study documents losses avoided as a result of the implementation of a wide range of mitigation measures, including elevations and the acquisition and relocation or demolition of floodprone properties.

Reddy, Swaroop. 1992. *A Study of Long Term Recovery of Three Communities in the Aftermath of Hurricane Hugo*. HRRC Monograph 9B. College Station, TX: Texas A&M University, College of Architecture, Hazard Reduction Recovery Center. 171 pp.
The objectives of this report—a doctoral dissertation—included: 1) to determine the factors that explain the successful adoption of hazard mitigation measures during recovery, 2) to develop a conceptual understanding of the problems inherent in the adoption of mitigation during disaster recovery, and 3) to gain an understanding about the influence of pre-storm institutional regulations on mitigation during the recovery period. The major findings were: the stronger and greater the presence of eight implementation factors in a community, the greater the successful adoption of mitigation measures; local institutional involvement is essential in the successful adoption of mitigation; there is a strong link between development management and hazard mitigation; a strong link also exists between the protection of coastal resources and coastal hazard mitigation; and the existence of strong pre-storm institutional regulations help local jurisdictions promote the adoption of mitigation during recovery.

Schwab, Jim, Kenneth C. Topping, Charles C. Eadie, Robert E. Deyle, and Richard A. Smith. 1998. *Planning for Post-Disaster Recovery and Reconstruction*. PAS Report No. 483/484. Chicago, IL: American Planning Association. 346 pp. Abstract available at **www.planning.org/apapubs/details.asp?Num=1178**. [accessed September 21, 2001]
This document helps community leaders and planners educate their constituents on how informed decisions and choices can affect the rebuilding process and yield a safer, more sustainable community. This report introduces planners to their roles in post-disaster reconstruction and

recovery, and provides guidance on how to plan for post-disaster reconstruction side by side with all other players involved. A key theme throughout this report is to rebuild to create a more disaster-resilient community. The report contains many references to technical resources.

U.S. Department of Agriculture and U.S. Department of the Interior. 1996. *Federal Wildland Fire Management Policy and Program Review Implementation Action Plan Report–May 23, 1996*. Washington, D.C.: U.S. Dept. of Agriculture. 33 pp.

This report describes methods for implementing the recommendations contained in a prior report on federal wildland fire policy. It outlines specific actions to be enacted immediately, such as developing fire management plans for all areas subject to wildland fires, developing research programs, and requiring appropriate treatment of fuel hazards created by resource management and land use activities. The report also discusses items that require a long-term commitment, such as the use of a planning system that recognizes both fire use and fire protection as inherent parts of natural resource management, long-range management objectives, and standard criteria to assess suppression and support requirements.

Western Governors' Association. 1996. *Wildland/Urban Interface Fire Policy Action Report*. Denver, CO: Western Governors' Association, 1996. 9 pp.

Many state governors believe that a comprehensive revision of fire policy regarding the wildland/urban interface is critical to preventing future loss of life, property, and natural resources. Hence, the members of the Western Governors' Association offer a blueprint for improved management of the wildfire hazard that plagues western states. The governors recognize that, as western populations continue to move into wildland areas, the risk increases, and that, although low-intensity fires are often beneficial to the forest environment, intense fires are destructive to plant and soil systems.

Wilhite, Donald, Deborah A. Wood, and Kelly Helm Smith. n.d. *Planning for a Sustainable Future: The Case of the North American Great Plains*. IDIC Technical Report Series 95-1. Lincoln, Nebraska: International Drought Information Center.

The participants at this symposium addressed the complex economic, social, and environmental issues facing the Great Plains region in anticipation of climate change in the years to come. In addition to essays on sustainable development and global change policies, the volume contains four case studies that deal with sustainable land use, education and research agendas, the Groundwater Guardian Program, and the use of reverse engineering to enhance the lessons learned over the past eight decades. Also included are focus group reports on agricultural production, land and water resources, human and community resources, biological resources and biodiversity, and integrated resource management.

Wright, J.M. and J.L. Monday. 1996. *Addressing Your Community's Flood Problems. A Guide for Elected Officials*. Madison, WI: Association of State Floodplain Managers, Inc. and the Federal Emergency Management Agency. 38 pp.

This document was prepared to help elected officials plan and take action to prepare their communities for floods.

Additional Reading

Beatley, Timothy. 1995. *Promoting Sustainable Land Use: Mitigating Natural Hazards Through Land Use Planning*. HRRC Publication No. 133A. College Station, TX: Texas A&M University, College of Architecture, Hazards Reduction & Recovery Center. 6 pp.

Beatley, Timothy. 1996. *National Trends and Future Directions in Hazard Mitigation Policy: The Elements of a New Paradigm*. Natural Hazard Working Paper No. 6. Chapel Hill, NC: University of North Carolina, Center for Urban and Regional Studies. 97 pp.

Faber, Scott. 1996. *On Borrowed Land: Public Policies for Floodplains*. Cambridge: MA: Lincoln Institute of Land Policy.

Federal Emergency Management Agency. 1987. *Reducing Losses in High Risk Areas: A Guidebook for Local Officials*. FEMA 116. Washington, D.C.: U.S. Government Printing Office.

Federal Emergency Management Agency. 1995. *Mitigation. Cornerstone for Building Safer Communities*. The Report of the Mitigation Directorate for Fiscal Year 1995. Washington, D.C.: U.S. Government Printing Office. 83 pp.

Federal Emergency Management Agency. 1997. *Multi Hazard Identification and Risk Assessment. The Cornerstone of the National Mitigation Strategy*. Washington, D.C.: U.S. Government Printing Office.

Godschalk, David R. and Edward J. Kaiser. 1996. *Lessons from Six Mitigation Case Studies*. Natural Hazard Working Paper No. 15. Chapel Hill, NC: University of North Carolina, Center for Urban and Regional Studies. 10 pp.

Godschalk, David, Richard Norton, Junko Peterson, Craig Richardson, and David Salvesen. 1998. *Coastal Hazards Mitigation: Public Notification, Expenditure Limitations, and Hazard Areas Acquisition*. Chapel Hill, NC: Center for Urban and Regional Studies.

Johnston, Robert and Mary Madison. 1997. "From Landmarks to Landscaped: A Review of Current Practices in the Transfer of Development Rights." *Journal of the American Planning Association* 63(3):369.

Missouri State Emergency Management Agency. 1995. *Out of Harm's Way: the Missouri Buyout Program*. Springfield, Missouri: Missouri State Emergency Management Agency.

National Park Service, 1996. *Floods, Floodplains and Folks: A Casebook for Managing Rivers for Multiple Uses*. Washington, D.C.: U.S. National Park Service.

Platt, Rutherford. 1996. *Land Use and Society: Geography, Law, and Public Policy*. Washington, D.C.: Island Press.

Porter, Douglas. 1997. *Managing Growth in America's Communities*. Washington, D.C.: Island Press.