Coastal
No Adverse Impact
Handbook

May 2007

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This publication resulted from the cooperation of many people, several of whom provided case study examples and intense reviews. The initial drafts were developed by Mr. Mark Mauriello, Co-chair, ASFPM Coastal Issues Committee and Ms. Pam Pogue, Chair, Association of State Floodplain Managers (ASFPM).

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INTRODUCTION

Approximately 153 million people (53% of the U.S. population) live in the coastal counties along the United States' Atlantic and Pacific oceans, Great Lakes, and six island territories (NOAA, 2005). By 2015, the population of these areas is expected to increase by another 12 million.

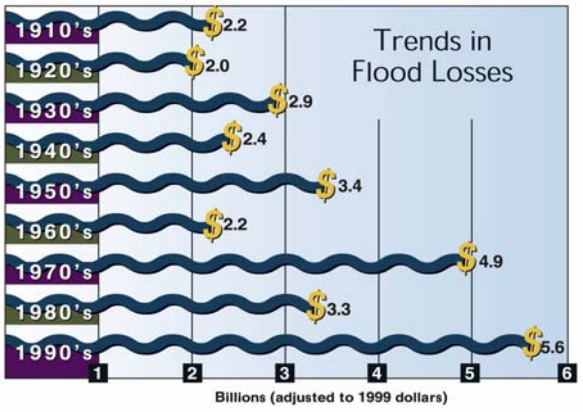
Not only is population density on the coast increasing, but so also is an ever-expanding network of coastal infrastructure and nationally important industries—ports, power plants, petroleum refineries, fishing, and other water-dependent activities.

Yet the margin between the land and the sea is a restless one—a dynamic environment that is at once powerful and fragile, and not the best setting for intensive human development.

> Willard Bascom had a war-like perspective of the struggle between sea and land as he repeatedly rode amphibious Army vehicles through the California surf in the 1940s, learning about the dynamics of breaking waves on the shore in order to help the Allies plan for the future coastal invasion of France.
>
> "The sea attacks relentlessly, marshaling the force of its powerful waves against the land's strongest points. . . . But the land defends itself with such subtle skill that often it will gain ground in the face of the attack. Sometimes it will trade a narrow zone of high cliff for a wide low beach. Or it may use some of its beach material in a flanking maneuver to seal off arms of the sea that have recklessly reached between headlands. The land constantly straightens its front to present the least possible shoreline to the sea's onslaught. When the great storm waves come, the beach will temporarily retreat. . . .When the storm subsides, the small waves that follow contritely return the sand to widen the beach again. Rarely can either of the antagonists claim a permanent victory. This shifting battleground is the surf zone" (Bascom,1980, p. xvi).
>
> A different kind of coastal invasion is now underway in the United States in which people from inland areas, familiar primarily with fixed landforms and fixed boundaries, move as close as possible to the edge of the dynamic sea, build homes and communities, and expect to stay there.

Disaster response and recovery costs have been steadily increasing. Federal efforts to address the problem have had limited success. In the 1930s, the focus was on structural projects, such as levees, dams and river straightening. By the 1960s, people realized a more comprehensive strategy was needed. Managing development in flood hazard areas was as or more important than attempting to control flood waters. The National Flood Insurance Program (NFIP) was developed to address the problem. While the NFIP has resulted in substantially increasing the number of communities that manage development in the floodplain, disaster costs have continued to increase.

By the year 2000, flood damages approached $6 billion annually and the trend of increased disaster costs was continuing into the first decade of the 21st Century. However, the hurricanes of 2005 provided a dramatic wake-up call when three destructive hurricanes (Katrina, Rita, and Wilma) traversed the Gulf of Mexico. Hurricane Katrina alone caused more than 1,300 deaths and more than $120 billion in flood damage. **The Katrina flood insurance claims exceeded all of the flood insurance claims submitted since the inception of the program in 1968.**



The hurricanes of 2005 demonstrated how ill-prepared our society is for the national consequences of dense, inappropriate and poorly constructed development in coastal areas. The NFIP's minimum requirements alone will not reverse the trend because they:

- Do not take to account future conditions (e.g. sea level rise, changing storm patterns or development in the watershed).
- Do not address all hazards (e.g. coastal erosion).
- Do not protect against large flood or storm surge events.

> "The tremendous growth of development and human population in coastal regions is proceeding so rapidly that an increase in the loss of life related to coastal disasters can be expected in the future" (Heinz Center, 2000b, p. xxiv).

To minimize loss of life, damage to property, and degradation of the coastal environment, State and local governments need to adopt a new approach to dealing with the interaction of human beings and the coastal environment that takes into account all aspects of both developed and natural systems.

WHAT IS NO ADVERSE IMPACT?

No Adverse Impact as outlined by the Association of State Floodplain Managers (ASFPM) provides a new and effective coastal management philosophy, and also identifies its legal underpinnings. No Adverse Impact (NAI) floodplain management is essentially a "do-no-harm" policy based on the concept that everyone benefits when the actions of every community or property owner does not adversely affect others.

NAI calls for anticipating the potential negative effects of any development or flood-control action on other people, their property and on the coastal environment itself. Such negative effects could be direct, such as causing shoreline erosion on the adjacent property. Or negative effects could be indirect, such as undermining the economic value of a fishery or altering the filtration capacity of an estuary.

Going beyond federal standards, which are simply minimum measures, No Adverse Impact floodplain management provides vision, principles, and tools through which a private

owner, a local community, or a number of adjoining communities can effectively and permanently manage land area within a region.

Most importantly, No Adverse Impact helps States and coastal communities achieve **disaster resilience**: that is, a coastal environment that can withstand an assault and readily recover from it. Such resilience, in turn, contributes to the long-term sustainability of the coastal zone for the enjoyment of all, both now and for future generations.

NAI is an approach by which the action of any community or property owner, public or private, is not allowed to adversely affect coastal resources or the property or rights of others. NAI follows a legal principle that dates back to ancient Justinian (Roman) law: "Sic utere tuo ut alienum non laedas," or "so use your own property that you do not injure others'." NAI creates a strong foundation that reduces community legal vulnerability to "takings" and negligence claims.

> **Disaster resilience** is the capacity of a community that is exposed to hazards to adapt, by resisting or changing, in order to reach and maintain an acceptable level of functioning and structure. Resilience is determined by the degree to which the community is capable of organizing itself to increase its capacity for learning from past disasters . . . (Subcommittee on Disaster Reduction. 2005)

BENEFITS OF NO ADVERSE IMPACT

NAI protects the rights of residents, businesses, and visitors in a local community by requiring that public and private projects be designed and completed in such a way that they do *not*: 1) pose a threat to public safety, 2) increase flood or storm damage to public or private property, and/or 3) increase the strain on municipal budgets by forcing communities to pay for damages resulting from the project. Under NAI guidelines, permits should not be issued for projects if they increase the potential for flooding or erosion on and off site, degrade water quality, or increase potential public service costs for things such as emergency personnel and storm-water management.

NAI strategies can have substantial benefits both for States and for local communities, because they:

Save money: Less damage means less costly post-storm community cleanup, fewer demands on limited public officials' time, and reduced strains on public resources.

Decrease litigation: The principles of NAI have been judicially tested and courts have shown immense deference to regulations that seek to prevent harm. NAI can also help a community avoid potential litigation over ineffectual flood management practices that result in future damage or loss of life.

Reduce conflicts with property owners: NAI doesn't necessarily say "no." It says "yes, if . . ." It is a common-sense approach that seeks to protect everybody's property, and empowers project proponents to develop as long as they eliminate or mitigate the negative impacts associated with their projects.

Reduce damage to public and private property and loss of life: Better planned and designed development and public infrastructure are less likely to cause and suffer damage.

Lower flood insurance rates: The Community Rating System (CRS) is a Federal Emergency Management Agency (FEMA) program that decreases flood insurance rates for residents in communities with effective hazard mitigation strategies. Many NAI strategies qualify for CRS credits. (For more information on CRS credits, see www.fema.gov.)

Increase a community's capacity to bounce back after a storm: Reduced storm damage means less downtime and less costly clean-ups for local businesses.

Clarify a community's land-use objectives: By adopting NAI principles, a local community can articulate overarching goals that help bring consistency and predictability to the permitting process throughout land-use decision and permitting authorities.

Preserve quality of life: With NAI, local planners can help make a community safer while preserving quality of life for its citizens now and in the future. An NAI approach can help ensure that community resources, such as beaches and other public parks and open spaces, are there to be enjoyed by future generations.

No Adverse Impact works for any type of coastline: The coastlines of the United States are diverse, ranging from steep, rocky shores to wide sandy beaches and dunes to grassy marshes and estuaries. NAI provides tools and concepts that can be applied to any coastal setting.

The important natural processes that shape individual coastal areas, the geographic and biological features that result from those processes and the resources that are important to human beings are described in detail in Appendix B and Appendix C of this handbook.

HOW TO USE THIS HANDBOOK

The Association of State Floodplain Managers (ASFPM) and the National Oceanic and Atmospheric Administration (NOAA) have collaborated in producing this handbook on ***No Adverse Impact in the Coastal Zone***. The handbook introduces local officials and concerned citizens to No Adverse Impact concepts, and suggests how a coastal community can use the NAI approach to minimize the risks and maximize the benefits of their coastal environments.

This handbook explains the No Adverse Impact policy, showing specifically how it applies to the nation's coastlines, and gives examples of ways to mitigate coastal risk without unintentionally causing negative consequences. This coastal-zone handbook expands upon on the concepts first explored in *No Adverse Impact—A Toolkit For Common Sense Floodplain Management* (ASFPM, 2003).

The area of interest is the coastal zone delineated by a State's coastal zone management program (see Appendix D). Because State coastal zone management areas include all or parts of coastal watersheds, the NAI concepts apply to more than just the tidal wetlands, shorelines, and adjacent lowlands, but also include riverine floodplains within coastal communities, extending inland from the coast.

"Basis for No Adverse Impact" (Chapter 1) first explains the No Adverse Impact policy and how it fosters disaster resilience and long-term sustainability. Next, it discusses federal, State and local roles in coastal and flood hazard management. After giving an overview of the legal foundations and implications of a No Adverse Impact policy, the chapter tells how NAI can help communities avoid legal challenges to their regulations and management approaches. It then shows how adverse impacts are all too easy to cause—and why minimum federal standards are inadequate for coastal protection. It then discusses why a coastal community should care about activities outside its boundaries, exploring the linkages among coastal communities, the rest of the coastal watershed, and the rest of the United States.

The next seven chapters then discuss the seven basic building blocks that can be used to implement No Adverse Impact principles:

"Hazard Identification and Mapping" (Chapter 2) shows how a community benefits from accurate and detailed maps to guide development of the coastal resource, provide infrastructure, and preserve the natural and beneficial functions, as well as fulfilling other local government activities. It notes that communities can overcome the shortcomings of existing maps by preparing and using supplemental maps that identify additional hazardous areas, to ascertain a more complete picture of the community's risks.

"Planning" (Chapter 3) illustrates how a community can direct and guide future development, including public projects, and thus prevent many problems before they diminish the local quality of life or become actual disasters. Taking an NAI approach, sound planning will result in what most people really want: a sustainable community that meets the needs of the present without compromising the ability of future generations to meet their own needs—all in a process that balances ecological, cultural, historic, and aesthetic values with economic development.

"Regulations and Development Standards" (Chapter 4), shows how regulatory and other techniques can be used to reduce the impacts of intensive development on sensitive coastal areas while also mitigating such coastal risks as floods, sea level rise, and tsunamis.

"Mitigation Measures" (Chapter 5) explains that some mitigation techniques are superior to others, not only for minimizing flood losses but also for minimizing adverse impacts on surrounding properties, communities, and the coastal environment. NAI-level mitigation measures offer the greatest sustainability, lowest lifetime cost, and lowest adverse impacts on neighboring communities and ecosystems.

"Infrastructure" (Chapter 6) tells how a community's roads, bridges, water and power systems, parks, services, and appurtenant buildings can be guided and maintained to minimize adverse impacts. Facilities vital to the community's operation are best steered away from hazardous areas, as coastal floodplains are better suited for parks, greenways, and drainage ways.

"Emergency Services" (Chapter 7) explains how police, fire, and hospital response should be planned and rehearsed well before any potential disaster to protect people and property, so that a coastal disaster does not result in such adverse impacts as fire or oil spills on the community or surrounding areas.

"Education and Outreach" (Chapter 8) suggests especially effective ways of informing the general public, property owners, decision makers, design professionals, and developers about

their community's NAI approach to its coastal features and hazards, about ways of protecting themselves, and about ways in which their actions could affect neighboring communities and ecosystems.

In each of these seven how-to chapters, three levels of protection are discussed, pointing out their strengths and weaknesses:

- The **BASIC** level describes relevant minimum federal requirements, which history has revealed often offer inadequate protection. These measures represent the least a community can and should do to advance the No Adverse Impact approach.
- The **BETTER** level describes additional floodplain management activities often enacted by State and local governments to improve upon federal minimums, which: 1) are tailored to specific situations, 2) provide protection from larger floods, 3) allow for margins of error, and 4) serve multiple purposes—but that still often fall short of full protection.
- The **NAI** level describes techniques that help ensure that coastal development or flood damage reduction measures avoid direct or indirect negative consequences on the surrounding landscape and watershed, private property, and other communities, both now and into the future—and also offer maximum resilience in the face of disasters.

Important note: These three levels are NOT meant to be viewed either as a smorgasbord of choices, or even necessary progression. They merely show historical distinctions. In all cases, the ASFPM strongly recommends that communities adopt the NAI level, because it alone offers private property owners, communities, and States the greatest long-term benefits and least risk.

The Handbook's last chapter, "Using the No Adverse Impact Principle to Develop Coastal Hazard Management Plans" (Chapter 9) presents two example scenarios—one for the Atlantic Coast and one for the Gulf Coast—to illustrate how the NAI approach can be applied to a watershed and a near-shore landscape, and how the approach can fit within existing federal coastal management programs.

The handbook also includes appendices:

Appendix A – Glossary and Acronyms

Appendix B – Coastal Landscapes of the United States

Appendix C – Coastal Processes, Features, Resources and Hazards

Appendix D – State Coastal Zone Boundaries

Appendix E – Legal Questions and Answers

Appendix F – Recommended Reading

Appendix G – Websites

Appendix H – Related Programs

CHAPTER 1. LEGAL BASIS FOR NO ADVERSE IMPACT

The growing populations along the coastal margins of the United States are at risk. They are increasingly vulnerable to storm surge, floods, erosion, and sea level change. Despite the hazards that owners face, property along the U.S. coastline—because of its beauty and its accessibility to beaches—is in high demand.

If people are to safely live at the water's edge, and if fragile shoreline ecosystems are to survive, communities in the 30 coastal States and six island territories need to carefully manage the interrelationship between human uses and natural coastal processes. Existing federal legislation offers some protection. However, with every passing year it has become increasingly apparent that dependence on minimum federal standards will not reverse exposure to hazards. Indeed, exposure to hazards is actually increasing, both as coastal population densities grow and sea level is rising due to climate change. Nor are federal minimums sufficient to ensure that communities can coexist with one another and with natural ecosystems over the long term in a sustainable manner.

> **Sustainability** is the capacity of a community to "meet the needs of the present without compromising the ability of future generations to meet their own needs" (World Commission on Environment and Development, 1987, p. 188).
>
> Sustainability balances ecological, cultural, historic, aesthetic, and economic concerns and does so over the long term. A community working toward **sustainability** will
>
> 1. Maintain and, if possible, enhance, its residents' quality of life.
>
> 2. Enhance local economic vitality.
>
> 3. Ensure social and intergenerational equity.
>
> 4. Maintain and, if possible, enhance environmental quality.
>
> 5. Incorporate **disaster resilience** and mitigation.
>
> 6. Use a consensus-building, participatory process when making decisions.
>
> (Natural Hazards Research and Applications Center, 2001, pp. 1-3)

The No Adverse Impact principles, which are presented as the seven building blocks in this handbook, offer methods that can help a coastal community establish policies and procedures to manage development, growth, operations, and future enjoyment of its beaches and vistas. Moreover, NAI guides a community to manage activities so they do not adversely impact neighboring communities or the natural ecosystem.

At the same time, No Adverse Impact floodplain and coastal management principles help a community reduce its vulnerability to coastal hazards—and recover from natural disasters that

are an inevitable fact of coastal life. In short, NAI principles contribute to the disaster-resilience of a community—a crucial component of overall sustainability and economic vitality.

To understand NAI principles, however, it is first necessary to understand the different roles of federal, State, and local governments. They are all crucial and equal participants. Although the federal and State governments have jurisdiction over certain lands, it is ultimately the local governments of individual communities through which private owners transfer property and obtain permits for developing their land. Local government plays a key role because that is where the land use and zoning decisions are made. Moreover, NAI principles reinforce a fundamental social doctrine: the Public Trust Doctrine. This is explained further below.

FEDERAL, STATE, AND LOCAL ROLES

Public Trust Doctrine

Coastal waters belong to the public. That is the essence of the Public Trust Doctrine observed in the United States today—a principle that dates back to English common law, which has its roots in the Institutes of Justinian, the body of Roman civil law assembled under the direction of the Roman Emperor Justinian in 530 A.D., which read: "*By the law of nature these things are common to all mankind, the air, running water, the sea and consequently the shores of the sea. . . . The seashore extends as far as the greatest winter flood runs up.*" England adopted much of the Roman law that recognized coastal waters and shores as fundamentally public in nature. Over time, doctrine was established to provide ownership of public lands through the king, who held them in trust for the public.

Through colonial charters from the English monarchs, the law of public shorelands and navigable waters came to America. The waterways were so vital for commerce and sustenance that the original 13 States recognized the importance of keeping surface waters within the public domain. The public value of waterways was codified through the development of State constitutions and federal legislation, which declared national interests in navigability, and later, health of the nation's waters.

At the end of the 19th century the U.S. Supreme Court firmly established the Public Trust Doctrine in American jurisprudence, finding that "the ownership of and dominion and sovereignty over lands covered by tide waters, within the limits of the several States, belong to the respective States within which they are found." *Illinois Central Railroad Co. v. Illinois,* 146 U.S. 387, 435 (1892).

The demarcation between public and private ownership along the U.S. coastline varies from State to State. Most States own the land up to the high water mark. In those States, the Public Trust includes mudflats, wet marsh, and wet beach. In addition to navigable waters, the federal government also holds a wide range of coastal areas in public trust.

Under the Public Trust Doctrine, the States and the federal government have an affirmative duty to take the Public Trust into account in the planning and allocation of land and water resources. They also must protect Public Trust uses for the common good, including the protection of recreational and ecological values. Thus, local development decisions must take into account the public interest under the Public Trust Doctrine, as well as coastal landowners' interests in preserving and using their property.

To enhance their roles in protecting public interests, some States have passed legislation giving authority to regional and local governments to regulate stormwater and water drainage management.

Interstate Commerce and Federal Public Trust Responsibilities

The United States of America is a republic of States. The U.S. Constitution defines authorities granted to the national government. Unless explicitly included, authorities remain with individual States. In the U.S. Constitution, States authorized the federal government to address issues associated with interstate commerce. The rivers of the United States were the primary mode of transportation; thus, States deemed that streams that could be navigated to transport goods were under federal sovereign authorities. It is these federal sovereign authorities associated with the Public Trust Doctrine that allows the federal government to erect dams in and construct levees alongside navigable streams.

Early attempts at protecting people and property from flooding emphasized the physical control of water. Disaster costs and human suffering, however, continued to rise even after billions of dollars had been spent.

The National Flood Insurance and Coastal Zone Management Programs

Later, the federal government passed legislation that provides State and local governments with incentives and inducements to use their land use authorities, specifically to reduce flood risks by managing development in their floodplains.

The National Flood Insurance Act of 1968 (P.L. 90-448, Section 1302(c)) provides incentives to local government to manage development in the 100-year floodplain (FEMA, 1997). The National Flood Insurance Program (NFIP), established in that Act, makes flood insurance available for purchase by existing development in the 100-year floodplain (both inland and coastal). In addition, it encourages communities to guide new development away from the 100-year floodplain so as to be less susceptible to flooding. Flood hazards are mapped and in areas where a significant population is at risk, predicted flood elevations, called base flood elevations (BFEs), are established. Existing buildings with their lowest floor below the BFE face a high risk of being flooded. Communities must require that new development be elevated to or above the BFE. In return, existing flood-prone development in the community becomes eligible for federal flood insurance; moreover, the community can receive federal public assistance funding after a “declared” disaster.

The Coastal Zone Management Program, administered by NOAA, has goals and policies similar to and compatible with those of the NFIP. In the Coastal Zone Management Act of 1972 (16 *U.S.C.A.*§1452(2)) Congress declared it to be national policy to do two principal things: to protect the natural resources of the coastal zone, including floodplains, and to manage coastal development to minimize the loss of life and property caused by improper development in areas subject to floods, storm surge, geological hazards, and erosion. States implement coastal management plans through a federally approved coastal zone management (CZM) program . CZM programs promote wise use of land and water resources in the coastal zone; they also promote compatible economic development that gives consideration to ecological, cultural, historic, and aesthetic values.

Upland land use management, rights reserved, and State governments

Although included under the Public Trust Doctrine in the Institutes of Justinian, today's definition of public trust lands does not include "…as far as the greatest winter flood runs up." Today's definition of what is included under federal authorities extends only to the Ordinary High Water Mark (OHWM) or the landward extent of the primary frontal dune.

Yet, coastal hazards actually extend into uplands well beyond where federal flood authorities stop—one example of the inadequacy of relying just on federal minimums for flood-control protection.

When the U.S. Constitution was drafted, the authoring State representatives identifying federal government authorities did not include upland land use management. To further clarify authorities, Congress drafted and States ratified the Tenth Amendment (as part of the Bill of Rights to the U.S. Constitution), which explicitly reserved all rights not given to the federal government to the States.

Therefore, *States alone have the right to determine land uses within their boundaries*. Thus, individual State constitutions and legislation define the land use and water management authorities granted to local and regional governments within each State.

In fact, *only* State and local governments have the land use authorities to manage new development and require flood damage reduction measures in coastal hazard areas. Furthermore, the federal National Flood Insurance Act specifically allows communities to enact measures above and beyond the basic federal requirements for protecting the public interest while making communities more resilient to coastal threats. To address public safety, some States have passed legislation that requires the State to actively regulate activities in all mapped flood hazard areas.

THE LEGAL BASIS FOR NAI AND ADVERSE IMPACTS OF COASTAL DEVEOPMENT

Liability, Takings, and NAI

As mentioned in the Introduction, courts have long followed the maxim *Sic utere tuo ut alienum non laedas,* or "so use your own property that you do not injure another's property." The NAI approach coincides with traditional common law concerning the rights and responsibilities of public and private landowners with regard to the use of land and water.

NAI-based principles help ensure a local community's actions to reduce and/or mitigate coastal hazards are legally defensible. Assessments of the legal ramifications of the NAI approach indicate that if a community takes reasonable precautions, it can reduce its potential for common law liability and for claims of takings (unauthorized taking of private property by public authorities (Kusler, 2004; Thomas, 2005). The NAI approach thus can be effective not only for avoiding or reducing flood losses, but also for averting possible legal challenges over causing or aggravating a real or perceived flood problem. (See Appendix E for the answers to some frequently asked questions about the constitutionality of floodplain, coastal, and wetland regulations and about potential local governments' liability for flood and erosion damage.)

Common Law Liability

Local officials and the attorneys who advise and represent them consistently express concern about the community's susceptibility to lawsuits brought by people who believe that they have suffered property damage from flooding or erosion as a result of public (local government) action or failure to act. Such lawsuits may be based on one or more common law theories of negligence, nuisance, violation of riparian rights, and other claims. The common law is judge-made law dating back more than 1,000 years, concerned primarily with resolving disputes among individuals.

In a typical common lawsuit over flooding, a private landowner damaged by flood waters sues a community, alleging that the community's actions in constructing or permitting development increased flood or erosion damage on his or her property, or that the community failed to remedy the problem or provide warning of it. There are numerous cases describing a variety of circumstances in which such claims are made. The decisions made in those cases vary as well.

The cases show that local governments can protect themselves from liability by taking some reasonable precautions in their planning and projects, particularly public works projects. To reduce potential liability, governments need to avoid future increases in flood heights and velocities. Simultaneously, they need to address pre-existing increases though flood hazard planning and plan implementation.

Taking of Property

"[N]or shall private property be taken for public use without just compensation."

—Fifth Amendment, U.S. Constitution

The takings clause of the Fifth Amendment, also referred to as the just compensation clause, provides that the federal government may not take private property for public use without paying just compensation to the owner. The clause also applies to the States through the Fourteenth Amendment. Just compensation is ordinarily measured in terms of the fair market value of the property that the owner has lost because of the taking. The government may affect a taking in three different ways:

- By physically invading, occupying, or seizing private property;
- By regulating the use of private property; or
- By imposing conditions on the development of private property.

In cases in which the government causes a permanent, physical invasion of private property, it affects a taking *per se* and just compensation must be paid. *Loretto v. Teleprompter Manhattan CATV Corp.*, 458 U.S. 459 (1982). However, a temporary physical invasion in which the public benefit outweighs the harm to the owner does not constitute a taking. *Tahoe-Sierra Preservation Council, Inc. v. Tahoe Regional Planning Agency*, 535 U.S. 302, 319-343 (2002).

When the government is acting as a regulator, it places restrictions on what the owner may do with his or her own property. Although the Supreme Court has accepted that governments must be able to regulate without being hamstrung by the takings clause, it has also emphasized that "if regulation goes too far it will be recognized as a taking." *Pennsylvania Coal*

Co. v. Mahon, 260 U.S. 393, 415 (1922). Although there is no established formula, it appears that regulation may be found to have worked a taking in at least three situations:

- The regulation arbitrarily singles out some persons for disadvantageous treatment;
- The regulation destroys well-founded investment-backed expectations; or
- The regulation strips property of virtually all use or value.

The Supreme Court has noted that takings challenges to zoning laws "have … been held to be without merit in a wide variety of situations when the challenged governmental actions prohibited a beneficial use to which individual parcels had previously been devoted." *Penn Central Transportation Co. v. City of New York*, 438 U.S. at 125 (1978). In short, it is not enough to show that a property owner's expectations have been disappointed. To establish a taking on this basis, the property owner must show that the expectations stemmed from explicit governmental assurances.

The Court has found a *prima facie* taking if a regulation deprives land of all economically beneficial or productive use, so that it must be left economically idle (*Lucas v. South Carolina Coastal Council*, 505 U.S. at 1026, 1029 (1992). In this case the Court also noted that it will be "extraordinary" and "relatively rare" that a regulation will deprive real property of all economically beneficial uses so as to trigger this categorical rule.

Ultimately, where government regulations promote the public benefit and safety and protect resources held in Public Trust, as most floodplain and coastal area regulations do, State and local government officials are on solid footing, provided that the regulations are applied consistently. It is on this basis that No Adverse Impact principles are based.

A No Adverse Impact Vision for the Coastal Zone

In a seaside community, the National Weather Service predicts a record storm. The hurricane makes landfall with its accompanying storm surge, high winds and heavy rains, but no homes or businesses are flooded or damaged by wind, no roads are closed. Waves pound the shoreline, but no structures collapse into the heavy surf or are washed off their foundations. Barrier islands are not inhabited, so they perform their natural function of absorbing some of the storm surge and wave impacts – thus reducing the impact on the mainland. Emergency response teams are not deployed, no citizen is injured, and rescue workers are not put at risk.

When calm weather returns, the community's high-risk coastal floodplains continue to provide open space, parks, recreation opportunities, habitat for wildlife and fish, and hiking and biking trails and add to the quality of life the residents and tourists enjoy. Owners of water-side property do not encroach onto the beach or into near shore waters, so public access for recreation, fishing, and other uses protected by the Public Trust Doctrine is ensured. The direct and indirect consequences of increased growth are mitigated so they do not affect others. Development is done in a manner that does not pass the cost of living near the sea along to other properties, other communities, or future generations.

Adverse Impacts of Coastal Development

Humans cause adverse impacts for themselves and the coastal ecosystem just by being there (e.g., damage to dunes and wetlands, excessive demand on fresh water supply, groundwater contamination, altering flood flows, damage to shoreline etc.). Three sets of adverse impacts are of specific concern: (1) those caused when people try to protect themselves from the coastal zone's natural hazards, (2) those caused on a cumulative basis even when each individual action seems harmless, and (3) those caused when municipal services are extended into vulnerable coastal land, increasing the likelihood of the first two sets of adverse impacts.

Adverse Impacts of Human Responses to Coastal Hazards

When people migrate to and settle in a coastal area, they eventually take it upon themselves to find ways to protect their property and community from natural coastal processes. As one prime example, natural erosion eats away at shorelines that people come to think of as their own, and can undermine development located too close to the water.

For over a thousand years, the "law of erosion" has held that the boundary between public and private land migrates inland as the shore erodes (Titus, 1998). This recognition, however, directly conflicts with the interest of riparian landowners in protecting their investments. The traditional response to coastal erosion has been to attempt to intervene in the natural process—building protective structures to divert wave action, stop erosion at one point, build up the beach at another, and so forth.

Such responses to protect a shoreline against natural erosion, however, can have unintended adverse impacts on other locations and over the long term.

"Shore protection structures are controversial intrusions on the mobile margins of the coast. Such structures interfere with the natural contribution of beach-building material from the erosion of coastal slopes and the movement of that material along the coast. Shore protection structures are considered by some experts to be measures of last resort …" (Pope, 1997)

The four most common coastal protection structures are groins, seawalls, revetments, and bulkheads. All interrupt the natural coastal processes of the sand being eroded from uplands into near shore areas and flowing along the shore in what is known as "littoral drift". Littoral drift provides the sand that replenishes beaches. Interruption of littoral drift by manmade structures can result in "starving" the beach and increasing erosion on down-drift properties.

Some of the most-studied and controversial structures are ones built perpendicular to the shore, which include: **groins, solid piers, and jetties**. By any name, all solid shore-perpendicular structures alter the along-shore movement of sediment, causing sand to build up neighbors' beaches on one side, and worsen erosion on properties on the down-drift side.

Seawalls and **revetments** are structures parallel to the shore intended to prevent storm waves from further damaging or moving the margins of eroding coastal land. Seawalls and revetments attempt to fix in place the edge of the land on a coast that would otherwise be receding, thus protecting fixed structures such as buildings. On a receding shore, however, seawalls and revetments can contribute to the narrowing and eventual loss of beaches on the ocean side of the structures (Pope, 1997). Shore-parallel structures reduce the supply of sediments that builds the beach, while deflecting and increasing wave energy on the remaining beach. Those two adverse impacts thus can increase erosion both at the base of the structure

(which can cause structural failure) and down-drift of it. Along with the loss of the beach, also compromised or lost is the public's right of passage protected by the Public Trust Doctrine. The inter-tidal beach area becomes so narrow that it no longer affords suitable space for walking, fishing, and other public uses.

Bulkheads are walls built on the margin of waterside land to hold the land back from the water. Bulkheads are typically built in bays and along the banks of streams. They reflect waves; thus they will send storm waves onto neighboring properties, more than would most natural shorelines. Along naturally receding bay shorelines, bulkheads can cause the loss of the inter-tidal zone in front of the walls because landward erosion is replaced by vertical erosion in front of the bulkheads.

In addition to the fact that their mere presence causes adverse impacts, many shore protection structures are not well maintained. As they gradually deteriorate and disintegrate, allowing the land behind them to erode, they leave remnants hazardous to people, animals, and navigation. Some coastlines consist of sand with underlying clay layers. When the sand is not being replenished, as the sand is washed away, the underlying clay is exposed. Erosion of the clay bed can then undermine shore-protection structures, hastening their failure. These pieces of failed shore-protection structures join the slow movement of material along the coast. They create a visual blight for neighbors and beach visitors, as well as hazards for swimmers and beach walkers on neighboring properties.

Cumulative Impacts of Coastal Development

A single human activity in the coastal zone may not seem to have much effect on the neighbors' property or on the surrounding landscape. Yet, a series of seemingly small alterations to a beach can have a significant detrimental impact over time.

The potential for cumulative impacts of coastal development is perhaps most easily understood in the example of shore-protection structures. As more people move to the coast and as investments in coastal properties escalate, it is virtually certain that there will be more shore protection structures in the future. A reasonable expectation of future growth in numbers of structures creates a reasonable expectation of significant cumulative impacts from the structures (Supreme Court of Wisconsin 1966, Court of Appeals of Wisconsin 1996).

The construction of one groin, or a pair of groins, to hold a beach captive, deprives the neighbors' beach of sand. The lack of sand leads the neighbors to construct groins on their property to counteract the adverse impacts of the first set of groins. Soon there is a groin "field" altering the processes and appearance of the entire beach.

Bulkheads also have cumulative impacts. As the shoreline length of bulkheads increases along streams and in coastal bays, harbors, or ponds, the extent of wave reflection grows and the reflected wave energy in the water body increases. Moreover, the confining bulkhead perimeter of a coastal water body limits the spillover of surging waters moving inland from the sea. The result: more violent and higher storm surges.

Sand helps form beaches along the coast. But sand comes from erosion of the land. As more and more of the coast become armored to stop erosion, less sand becomes available to nourish beaches. Thus, some of the most significant cumulative impacts of hardened shorelines are loss of the natural shoreline and coastal habitat. Losses of such habitat are occurring along

coastal estuaries, including lagoons, sounds, bays, and streams as well as in the beach, dune, and ridge habitat along the dynamic boundaries of the open coast.

Coastal development also has cumulative adverse impacts on the natural flood-control functions of shorelands. For example, coastal development can degrade the barrier islands, beaches, ridges, and dunes—all of which previously provided natural protection from storm waves. Similar impacts occur when development encroaches on coastal wetlands, lagoons, sounds, bays, and estuaries, undermining their flood storage capacity, ability to filter pollutants, and ability to attract and sustain wildlife.

Extending Services into Vulnerable Coastal Areas

Many adverse impacts originate from the extension of municipal water, sewer, electricity, roads, and other services into sparsely developed coastal lands—areas that may be vulnerable to present and future natural coastal hazards. The provision of such services in the coastal zone sets the stage for property development, which can adversely impact property owners themselves, their neighbors, and the coastal ecosystem. As demonstrated repeatedly after major hurricanes, the catastrophic collapse of bridges, parking ramps, roadways, railroad tracks, and other infrastructure in a severe storm results in effects that cascade throughout not only a coastal community, but throughout an entire region.

The extension of municipal services into vulnerable areas can be reasonably construed by the public as an implicit assurance of the coastal zone's stability and safety. However, municipal planners may not know which areas of a community are vulnerable—or will become vulnerable—as climate change causes sea levels to rise and alters the severity and frequency of storms and floods. Indeed, as expanding and intensified coastal development and investment continues on a collision course with climate change, the long-term sustainability of some coastal neighborhoods and communities is uncertain.

Impacts of Land Use Upstream

Even though communities within the 100-year floodplain feel the major impacts of flooding, development and other activities throughout the entire coastal watershed contribute to accelerated runoff that aggravates the problem. When urban sprawl (subdivisions and commercial centers), industrial activities, or agricultural and forestry practices pave over the natural landscape, rainwater runoff—which no longer can percolate into the soil—increases, sometimes dramatically. With increased runoff, a coastal community is often flooded more frequently.

Construction, agriculture, and forestry practices throughout the watershed may contribute to coastal flooding problems in additional ways. Land cleared for development, used for agriculture, or modified during forest harvests can deliver much more sediment to channels, floodplains, and wetlands - decreasing their ability to store and/or convey floodwaters. At the other extreme, dams and levees trap virtually all sediment, so beaches become starved of sand, and floodplains and wetlands subside because their soils are not replenished.

Transportation networks (highways, roads, ports) encroach into coastal floodways, flood fringes, and wetlands. In addition to facilitating the growth of businesses and residences in high-risk coastal zones, transportation networks negatively affect the natural coastal environment. Communities and landowners drain or fill wetlands, removing the natural floodwater-storage capacity from the entire watershed. Farmers and other property owners clear vegetation that

otherwise normally would reduce flood flow velocities, provide detention, retard erosion, and trap sediment. As a result of developing uplands, homes and businesses along the lower reaches of a river and along the coast may come to suffer more intense and more frequent flooding. Structures built above the BFE and in compliance with NFIP guidelines may now be flooded because of increased flood levels. Channels that once adequately contained normal runoff now reach bank full sooner and exceed their capacity, causing flood prone areas to expand.

In short, development of both uplands and the coastal zone must be carefully planned so as not to unwittingly increase flood hazards, by both increasing runoff and decreasing ecosystems' natural ability to abate the intensity of flooding. This is the motivation behind No Adverse Impact principles, and is also the province of State and local governments, going beyond federal minimums.

Conclusion

Development decisions have effects—negative and positive—that accumulates and persists over time. The standards set and enforced by today's local officials can haunt their successors, just as the unwise development decisions of the past create headaches in the present. Balancing fiercely competing interests among individual property owners, development interests, and the public good is a community's greatest challenge in achieving its No Adverse Impact vision.

In planning coastal development or redevelopment, the Public Trust Doctrine and property rights principle are two issues that frequently compete for consideration. They also provide valuable conceptual and practical tools to bring the NAI vision into focus for a community. Common law liability is a separate but related issue that local governments (as opposed to State or federal) may face. Fortunately, consistent application of NAI principles can dampen the potential for conflicts in all three of these legal areas.

Community decision makers and administrators can apply several of the NAI building blocks (detailed in the next seven chapters) to eliminate or reduce coastal problems. Implementing a NAI policy throughout an entire watershed—not just the coastal zone, but also including the upland regions—can contribute to multiple community objectives and appeal to multiple constituents with different concerns.

By limiting improper development in lowlands, a community reduces the vulnerability of life and property; at the same time, it conserves coastal resources and maintains the natural and beneficial functions of the floodplain and the coastal ecosystem. If State and local floodplain managers reach beyond the just the Basic management level—that is, the federal minimum NFIP requirements—carefully planned development can continue on the uplands of a coastal watershed without increasing downstream flooding and flood damage. To reach this state, communities can implement one or more of the NAI building blocks outlined in this handbook.

CHAPTER 2. HAZARD IDENTIFICATION AND MAPPING

Coastal hazard and floodplain management depend upon information provided by hazard maps and related flood hazard information. Local communities, States, and the private sector need accurate, detailed hazard maps to:

- guide development,
- prepare plans for a community's economic growth and infrastructure,
- maintain the natural and beneficial function of floodplains,
- protect public trust lands and
- protect private and public investments.

Mapping the flood hazards associated with the rivers that flow to the coast is similar to mapping riverine flooding inland. When mapping a riverine flooding hazard, gage data, basin comparisons and flood simulations using engineering computer models are used to predict flood flows. The amount of runoff that will be produced for a range of rainfall events in the watershed that drains to that river and when it will arrive are information needed. The characteristics (slope, cross sectional area, roughness, etc.) of the river determine how high the flood waters will get. These flood elevations are compared to the ground elevations along the stream to map the edge of the floodplain.

On a coastline, tidal records at gages are used in conjunction with engineering models to predict storm surge, wave heights and wave run-up. This information is combined to establish the Base Flood Elevation. Unless they were incapacitated in a hurricane or other storm, these gages include all historic storm surges since the gage has been in operation. Storm surge, wave heights, and how high waves will run-up onto land can vary greatly, depending upon coastal geomorphology and steepness of the adjacent seabed or lakebed. In general, coastal communities bordering a broad, shallow continental shelf, with gently sloping beaches are the most vulnerable to combined effects of storm surge and waves. Communities located in the middle or apex of a large coastal embayment such as the South Atlantic Bight, New York Bight, or Big Bend region in Florida are especially vulnerable due to the ability of the bay to focus surge and wave energy.

Storm surge has historically brought most of the death and destruction during tropical cyclones, and is the primary reason that coastal areas are evacuated as storms approach. In an effort to minimize this potential for loss of life and property, FEMA works with the U.S. Army Corps of Engineers (USACE) and NOAA to create State and regional Hurricane Evacuation Studies (HES). These are developed to help State and local emergency managers make effective evacuation decisions when threatened by tropical cyclones. The Hurricane Evacuation Studies are also used for citing critical infrastructure and planning activities. The NOAA SLOSH model (Jelesnianski, 1992) is the basis for determining which areas should be evacuated. The SLOSH model is run for a large number of storm scenarios (directions, speed, etc.) to determine maximum storm surge for each hurricane category. This scenario-based approach is used to determine traffic clearance times, appropriate American Red Cross shelter locations, and identify the most vulnerable areas.

Under the National Flood Insurance Program (NFIP), the Federal Emergency Management Agency produces flood maps called Flood Insurance Rate Maps (FIRMs). These maps predict the area that will be inundated during a flood event that has a 1% chance of being equaled or exceeded in any given year. Some FIRMs also show areas that may be inundated by a flood that happens less often (i.e. has a 0.2% chance of occurring in any given year).

Along the coast, FEMA uses two categories to distinguish between coastal flood hazards: V Zones and A Zones (see the Glossary). V Zones along the coast are areas where the resulting wave run-up elevations above storm surge are greater than 3 feet. Allowable construction practices in V Zones differ from those in A Zones because of the additional hazards from high-velocity wave action. These more stringent requirements help protect property from the impact of waves and waterborne debris and the effects of scour.

The Coastal A Zone is landward of the V Zone or it may be shown along an open coast where a V Zone has not been mapped. Like the V Zones, Coastal A Zones are subject to wave effects, high velocity flows, scour, or a combination of these effects. Coastal A Zones are areas where the resulting wave run-up elevations above storm surge are between 1.5 and 3 feet. Although the forces in Coastal A Zones are not as severe as in V Zones, they still are capable of damaging and destroying structures. Currently, the NFIP does not map Coastal A Zones and it has not been established as a Special Flood Hazard Area for regulatory purposes.

Areas of moderate or unknown flood risks are called B, C, D, or X Zones on FIRMs (see the Glossary for more detailed information on all of the FIRM zones).

Determining the zone a property is in and the Base Flood Elevation at the building site is necessary to guide construction, with regard to first floor elevations and building construction. The portion of an elevated structure subject to wave attack should have break away walls and adequate piling depths to avoid scour, etc.

FEMA's flood maps also identify some sensitive environmental areas covered by the 1982 Coastal Barrier Resources Act (CBRA). Since the inception of CBRA, Congress has restricted federal expenditures and financial assistance that could encourage development in these areas. Although CBRA does not prohibit privately financed development, it does prohibit federally backed financing for the development of public infrastructure such as roads, bridges, highways, wastewater treatment systems, and utility construction. Federal flood insurance under the NFIP is prohibited. Any building located within a CBRA area that is constructed or substantially improved after October 1, 1983 (or the date of designation for areas added to the system in 1991) is not eligible for federal flood insurance or other federal financial assistance. The same restriction applies to substantially damaged buildings in a CBRA area that are repaired or renovated after those dates.

BASIC: USING THE FIRM TO MANAGE LAND USE

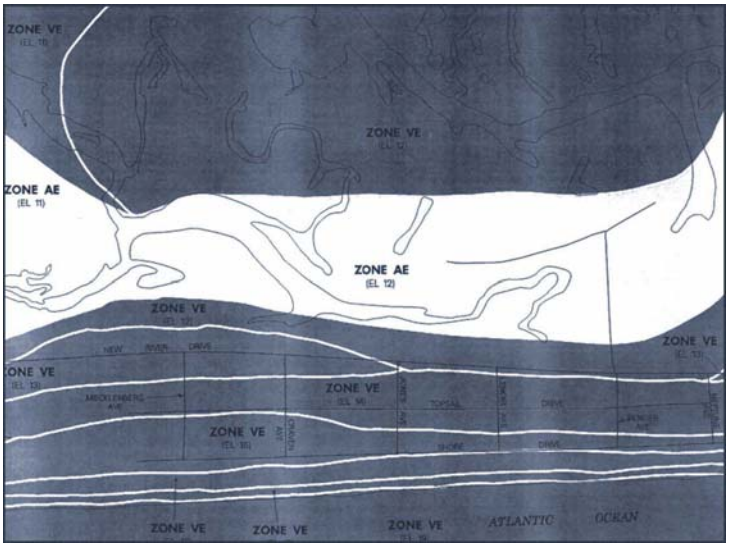
In order for community residents to be eligible to purchase flood insurance and for a community to be eligible for federal disaster assistance, the community must "join the NFIP". This means the community must adopt and enforce a floodplain management ordinance and require that development on lands mapped in the floodplain (as identified on the FIRM) be appropriately located and elevated.

The basic level of floodplain management in coastal areas, therefore, amounts to implementation and enforcement of an ordinance based on the FIRM issued for that community. A community operating at the basic level will apply the NFIP building standards and other requirements in the appropriate flood zones shown on the FIRM, and will monitor and advise prospective development about CBRA restrictions. In addition, communities should:

- Determine if critical facilities such as hospitals, evacuation centers, evacuation routes or police stations are at risk. Critical facilities at risk should be protected from the impacts of flooding – preferably relocated to areas outside the 0.2 % annual chance (500-year) floodplain.

- Purchase flood insurance for any community buildings located in the floodplain.

- Document high water marks and the extent of coastal inundation associated with the most significant historic flood events in the community. FEMA updates Flood Insurance Rate Maps on a regular cycle. Communities should document areas of flooding that presently are not mapped and areas where the community feels the flood hazard maps need to be updated.



Coastal FIRM AE and V Zones

BETTER: USING ADDITIONAL COASTAL HAZARD INFORMATION

FEMA's flood hazard maps are only one piece of the puzzle. FEMA's flood maps do not show areas subject to coastal erosion, Coastal A Zones, locales that are subsiding, places that would be flooded if levees or dams were to fail, or coastal storm surge inundation areas from rarer, intense hurricanes. In addition, other than CBRA-protected areas, they do not show environmentally sensitive areas. A better coastal flood hazard management program therefore will have procedures and requirements to manage development and/or provide information regarding coastal hazards and sensitive environmental areas not reflected on the FIRMs.

The following are selected "better" tools that many coastal communities use:

- Purchase detailed topographic data (e.g., with a smaller contour interval) that can be used to more precisely delineate floodplain boundaries.

- Incorporate Hurricane Evacuation Study category 1-5 storm surge zones, maps of sensitive coastal resources (wetlands, etc.), maps depicting the extent of historic flooding in the community, and maps showing flooding sources not presently shown on their FIRM into your community's Geographic Information System. On the West and East Coasts, the Gulf Coast, Hawaiian Islands, and the Pacific islands, tsunami data should also be obtained.
- Obtain historic aerial photography available for the past 100 years for your community. Contact the State Coastal Management Program to determine if the State has developed maps showing the rate of erosion and/or historic aerial photography on which past shorelines are shown in areas subject to erosion. Some State Coastal Management Programs have established setbacks in the coastal zone to influence new construction practices.

Coastal bluff erosion (Credit: Mike Page)

- Contact the State agency responsible for regulating physical alternations in navigable waters and wetlands to determine if the State has developed maps showing the location of navigable waters or wetlands where State or federal permits for development proposals are needed. Also, communities can map these areas on their own and can require permits for development to protect wetlands. Ecologically sensitive areas can be mapped by the community, or might be available from a State or federal agency.

- Obtain information on subsidence from the U.S. Geological Survey, the State geological survey, and the Natural Resources Conservation Service.

Example of subsidence increase flood hazard, Alaska 1964

- Develop a web mapping application that allows the public to view all community coastal hazard and sensitive coastal resource mapping information in the community. Including this information along with their zoning and parcel maps can assist residents as they evaluate development options.

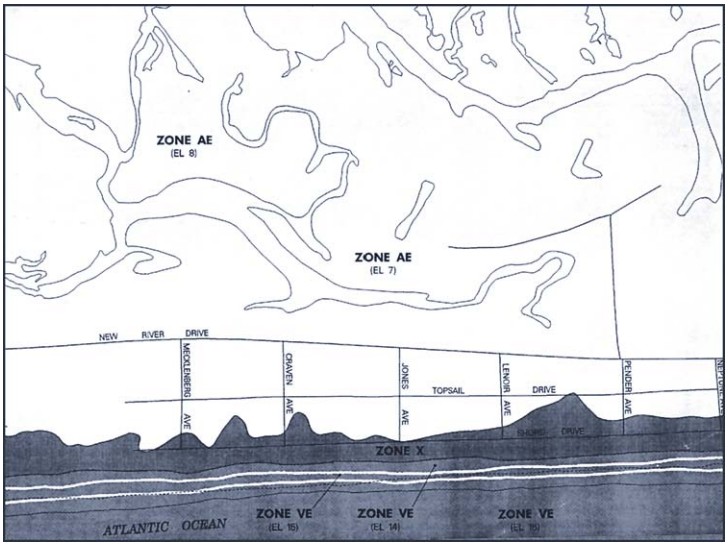
NAI LEVEL: HIGHER MAPPING STANDARDS & NATURAL AND BENEFICIAL FUNCTIONS

Higher Mapping Standards

FEMA's flood maps depict existing flood risks at the time of analysis. No Adverse Impact (NAI-based) hazard management programs develop and use maps that accurately and realistically depict the full range of hazards, now and in the future. By ensuring development is not at risk for the life of the development, the community avoids the adverse impacts of it flooding when the watershed is fully developed or an eroding coastline undermines the structure. Communities using NAI approaches include the following items on their maps to address hazards associated with more extreme events, future conditions and environmental resources:

- Sea level change—Climate change is contributing to a change in the sea level, a problem that is compounded in coastal areas subject to subsidence. Community maps can reflect the anticipated sea level change. (See section on sea level change in Appendix C.)

- Coastal A Zones - Coastal A Zones are areas where the resulting wave run-up elevations above storm surge are between 1.5 and 3 feet. When a community's maps are being updated, they should request that Coastal A Zones be included.



Coastal A Zone

- Tsunamis—a community can get information on its tsunami risk from the U.S. Geological Survey or NOAA.
- Storm Intensity - Taking into account increased storm frequency and magnitude related to climate variation and change. There is a good record of the past 100 years of number of storms and recorded water levels for which to base current coastal flood studies frequency analysis on. If future frequency and intensity of storms change, then the current record will no longer be valid. What we base the 1% chance (100 yr) surge elevation on now will not apply to several decades from now. Adding in a factor of safety to current study process may take into account the potential for future increases in storm frequency and magnitude of surge levels.
- Coastal erosion—Communities can establish a coastal construction control line (CCCL) and prohibit construction of structures seaward of it. One method for establishing the CCCL is to calculate the shoreline erosion rate and then map how the shoreline will look at some year in the future. Accounting for 50 years of erosion should be the minimum. To ensure structures are not at risk for their useful lifetimes, the community would need to account for erosion that will occur over a longer time frame – e.g. 100 years. If buildings and infrastructure are not located far enough from eroding shorelines the buildings, roads, and public utilities are put at risk. Armoring the shoreline in an attempt to slow down the rate of erosion with a hard structure such as a seawall, revetment, or rip-rap should be avoided. In addition to being difficult and expensive to maintain, these structures may adversely impact down drift properties by interrupting the natural littoral flow of sand flow along the shore. As a result beaches "starved" of sand narrow and neighboring properties can experience increased erosion..
- Environmentally sensitive areas—Existing or proposed activities in the coastal zone will be kept from adversely affecting environmentally sensitive areas such as wetlands, barrier islands and beaches, cheniers, critical habitat for threatened and endangered species, submerged aquatic vegetation, shellfish reefs and beds, and mangroves. Along most coasts these areas have been mapped by natural resource or coastal zone management

agencies and are readily available. Communities should consult NOAA's Environmental Sensitivity Atlases and the State's Coastal Zone Management Program, Department of Natural Resources, Department of Fish and Wildlife, Department of State Parks, and/or Department of Environmental Quality/Protection to obtain this information and incorporate it on maps.

- NOAA Coastal Change Analysis Program (C-CAP) – C-CAP is a nationally standardized database of land cover and change information, developed using remotely sensed imagery, for the coastal regions of the U.S. C-CAP land cover products inventory coastal intertidal areas, wetlands, and adjacent uplands with the goal of monitoring changes in these habitats, on a one-to-five year cycle. An immediate objective of C-CAP is to expeditiously complete a national baseline of coastal land cover and change data. Once this baseline is complete, additional dates of imagery will be used to track coastal changes through time. This trend information will give important feedback to managers on the success or failure of management policies and programs and aid in developing a scientific understanding of the Earth system and its response to natural and human-induced changes. This understanding will eventually allow for the prediction of impacts due to these changes and the assessment of their cumulative effects, helping coastal resource managers make more informed regional decisions.

Information Sharing

An important lesson learned from Hurricane Katrina in 2005 (FEMA, 2006a) was the need to improve "communications—the sharing of information." The devastation caused by Katrina was so extensive that first responders had no street signs or local landmarks to get to people needing rescue. Local government offices with mapping information and data sets were destroyed. The private sector generated maps, aerial photography and data that were copyrighted and therefore could not be shared and easily integrated with other maps and data.

Post Katrina damage, Biloxi, MS

An industry standards group called the Open Geospatial Consortium (OGC) has established technical communications standards for improving data exchange. Delivery of geographic information in an "OCG-compliant" manner ensures that data and maps being served up by a web mapping application can be seamlessly integrated with other geospatial data and maps.

Information is further enhanced when communities make their mapping data available through these OGC services without a fee. In the aftermath of a disaster, manual fee and license-based mechanisms to pay for data can substantially slow disaster response. This situation can be improved by establishing open user agreements and employing interoperable data access protocols prior to a disaster. However, they often depend upon the proper people identified in the user agreements being reachable following a disaster. Hurricane Katrina demonstrated that timely contact of the individuals identified in the user agreements may not always be possible.

CHAPTER 3. PLANNING

Communities use planning to direct development and public projects and ensure their land use regulations (zoning) meet the community's needs. When done correctly, planning can prevent many hazard-related problems by directing poorly conceived new developments and post-disaster rebuilding away from dangerous locations. Planning development on the coast requires understanding coastal hazards (See Appendix C). Planning for risk reduction is a key piece of any community's No Adverse Impact (NAI) effort.

Planning embraces a range of activities that communities pursue to direct and guide their future development, including public projects. It is through planning that a community can prevent many problems before they become disasters. Once a community knows the extent of its coastal problems it is better prepared to initiate multi-objective management, an approach that promotes the integration of many community interests, not just hazard reduction or economic development. Sound planning will result in what most people really want—a sustainable community that meets the needs of the present without compromising the ability of future generations to meet their needs. This is all done in a process that balances ecological, cultural, historic, and aesthetic values with economic development.

BASIC: LAND USE PLANNING AND ZONING

Zoning

Local governments derive their authority to zone from State legislatures, either from State constitutions or enabling legislation. Usually, the terms and conditions of the enabling legislation are broad, offering the municipality flexibility in exercising the delegated power because each situation involves unique variables that a State legislature is unable to predict. Municipalities then use this authority for the public good to classify, specify and identify land uses. Zoning regulates development by dividing a community into zones or districts and setting development criteria for each.

Comprehensive Land Use Plans

Comprehensive land use plans define how and where a community should be developed (and where development should not occur). In general, a comprehensive plan has limited authority. Its utility is that it reflects what the community would like to see happen and thus can guide other local activities, such as capital improvements, zoning ordinances, and subdivision regulations. In some States, local comprehensive plans are mandated and in a few States the plan must address natural hazards in conjunction with its development guidelines.

Plans should relate land use to natural hazards by reserving the most hazardous areas such as floodways, V Zones, Coastal A Zones and high erosion zones for parks, greenways, golf courses, wildlife refuges, natural areas, or similar open space. In too many plans, there is no relationship between where development is encouraged and where flooding is likely. As a result, developers expend time and money preparing to build in a flood prone area and then face opposition when they present the project for a permit. Acknowledging floodways and erosion zones as areas that require special attention will result in safer communities.

BETTER: HAZARD MITIGATION PLANS

Risk Analysis and Management

Risk is the likelihood of harm occurring; it is a combination of a hazard with the probability of exposure. Risk exists when there are various outcomes associated with particular coastal hazards' affecting particular coastal properties. Some of those outcomes are adverse impacts on other people, other property, or the environment. (See the section on Adverse Impacts of Coastal Development in Chapter 3.) The NAI principle is intended to avoid, manage, or minimize the element of risk to one's neighbors due to actions taken (or not taken) on riverine and coastal lands.

> Some Useful Definitions:
>
> **Hazard** is the potential to cause harm; it is an intrinsic property of a material or phenomenon. (Tsunamis can be fatal for example.)
>
> **Risk** is the likelihood of harm occurring. It is a combination of a hazard with the probability of exposure. Risks, unlike hazards, can be managed and minimized: a hazard poses a low risk if the chances of exposure are low. (People living miles inland are at less risk for a tsunami because their chance of exposure is lower than those living on the coast.
>
> **Exposure** is a combination of the severity of a hazard multiplied by the duration or extent of contact. The purpose of hazard mitigation is to reduce exposure.

A community should:

- Periodically conduct a comprehensive risk review with tools such as Hazards US (**HAZUS)** in which exposures to every hazard are identified and assessed and the potential impacts of unexpected risks are estimated.
- Develop, recommend, and implement a risk mitigation strategy based on community values and judgments of the prospects for and costs of mitigation. Every option for mitigation should be evaluated.
- Develop, recommend, and implement risk response plans with contingencies that are designed to minimize the probability of adverse impact or contain that impact.
- Analyze residual risks that remain after the impacts are mitigated.
- Regularly monitor and update risk review results as events occur, exposures change, new assumptions appear, and old assumptions change or are discarded.

Risk analysis and management is done at many levels: from an individual homeowner or investor to city government. "As a general rule, risks should not be ignored unless there is absolute confidence that they are trivial. Particular attention and care must be taken with identifying and classifying risks which could have either serious or catastrophic consequences or high expected values, or exceptionally favorable consequences. . . . Risks with catastrophic consequences (even if the probability of occurrence is low) . . . are nearly always worth further study" (U.K. Civil Engineers and Actuaries, 1998, p. 31). Coastal hazards with low probabilities

of occurrence and catastrophic consequences include major hurricanes, and tsunamis. Appendix E lists the websites of organizations that have resource materials to help communities develop a risk management approach.

A comprehensive plan will usually set broad goals and objectives. Special-subject plans provide more detailed guidance on particular aspects of community life or for certain locations in the community. Special-subject plans include, but are not limited to:

- Floodplain management plans,
- Stormwater Management, and
- Hazard mitigation plans.

Floodplain management plans focus on reducing flood damage through the application of both structural and nonstructural techniques (Federal Interagency Floodplain Management Task Force, 1994) and mapping flood prone areas, including those not shown on the FIRM. After a vulnerability analysis (FEMA, 2001b), planners can evaluate various measures to prevent and reduce flood damage and recommend actions for community decision makers. These plans address mapping needs, structures that have suffered repetitive losses, regulatory standards and procedures, acquisition and relocation, outreach and education, and flood protection measures. The purpose of these plans is for the community to agree on an approach to reducing its vulnerability to hazard induced impacts.

Stormwater management plans provide a mechanism for municipalities within the watershed to plan for and manage increased runoff associated with future development and land use changes. The plans include criteria and performance standards for managing urban runoff, and a listing of alternative stormwater management techniques.

Hazard mitigation plans are developed to coordinate actions to reduce injuries, deaths, property damage, economic losses, and degradation of natural resources. These plans expand on the concept of floodplain management by including all natural hazards facing a community, such as hurricanes, tsunamis, tornadoes, earthquakes, landslides, winter storms and areas below dams and behind levees inundated when dams or levees fail. The Disaster Mitigation Act of 2000, requires that communities have an approved all-hazards mitigation plan in place before they may receive post-disaster hazard mitigation grants. The all-hazards plan must show that the proposed mitigation actions (such as guiding development through zoning) are based on a sound planning process that accounts for the risk to and the capabilities of the community. FEMA (2002c and 2003) provides guidance on developing hazard mitigation plans.

Communities can make use of computer models for mapping and visualizing the consequences of storm surge, shoreline erosion, and tsunamis. Scientists and engineers can show community leaders what happens when surge resulting from a storm of selected intensity approaches the coast along different paths. Similarly, shoreline erosion and sediment deposition can be simulated under natural conditions or with structures (jetties, groins, floodwalls, or dredged projects) in position. Tsunami tracks and speed can be calculated and warnings times estimated. Geographic information systems (GIS) can integrate information (e.g., hazards, building locations, emergency evaluation routes, and critical infrastructure) to estimate flood depths, damage, losses, and the magnitude of floods for different storm and development scenarios.

NAI LEVEL: CZM SPECIAL AREA MANAGEMENT PLANS - MULTI-OBJECTIVE MANAGEMENT

NAI-level planning considers the range of ways to reduce or eliminate impacts to others or to the coastal environment that may be caused either by a hazard event or by human responses to the event. If the planning effort is expanded to encompass all community concerns, and if planners are pro-active with the intent of maintaining or building a sustainable community, then broad public support for proposed activities is more likely. A NAI vision has a greater chance of being implemented if the community residents are involved in its development.

Coastal Special Area Management Plans (SAMPs) - Multi-Objective Management

Multi-objective management (M-O-M) plans address flooding, other coastal hazards, and natural resources. A type of multi-objective plan is Special Area Management Plans (SAMPs). SAMPs are broadly defined in the Coastal Zone Management Act (CZMA) as "plans which provide for increased specificity in protecting significant natural resources, reasonable coastal-dependent economic growth, improved protection of life and property in hazardous areas, including those areas likely to be affected by land subsidence, sea level rise, or fluctuating water levels of the Great Lakes, and improved predictability in governmental decision making." SAMPs are appropriate for areas where, due to the multiplicity of authorities, coordination and cooperation is crucial to addressing coastal development on an ecosystem basis. Therefore, SAMPs can be a useful management tool to address difficult resource management issues, including coastal hazards, in a more integrated manner.

Protecting, maintaining, enhancing, and restoring natural coastal barriers (islands, wetlands, dunes and beaches, mangroves, etc.) is a way to avoid some of the negative impacts of coastal storms. It also brings opportunities for healthier coastal ecosystems, and more space for recreation. Beaches are often "economic engines for coastal communities" (Ewing and Pope, 2006). Risk management is most imperative for coastal facilities with functions that affect many people—facilities that can be considered infrastructure (such as sewer systems, water networks, and roads). The range and consequence of risk from coastal hazards should have some influence on the order in which possible risks are addressed, the level of effort spent on risk management, the adopted standard of acceptable mitigation, and community vulnerability to climate change.

This approach avoids adverse impacts by promoting public involvement and coordination of floodplain management with other community concerns, such as economic development, housing, habitat protection, recreation, and water quality. For example floodplain managers think of the floodplain as a hazardous area that poses risks to development. At the same time, environmental organizations see the floodplain as a habitat worthy of preservation. Teachers use floodplain greenways and open spaces as a learning resource—an outdoor laboratory where students can visit and experience habitats and study ecological principles. Finally, the parks or streets department may want a floodplain or shoreline open space to separate pedestrians and bikes from cars and trucks or for recreation.

The M-O-M approach has been proven to garner a larger constituency to support multi-purpose plans and longer-term interest in seeing them implemented. This approach also is helpful when one agency or organization can fund only part of a project, but other agencies can support

other elements. Funding entities often favor projects with multiple components and sources of funding. This is where coordination with other community goals and objectives can pay off.

Sustainability

Far too many land use decisions are made without adequate knowledge and consideration of the long-term economic consequences of those decisions. We do not consider the many hidden costs of developing along a shoreline (The Heinz Center, 2000a). Growing populations borrow against future revenues, while some would argue the quality of life slowly diminishes.

Sustainability is a planning and management concept that addresses the long term. Sustainable development is the challenge of meeting human needs for natural resources, industrial products, energy, food, transportation, shelter, effective waste management, and hazard management, while conserving and protecting environmental quality and the natural resource base essential for future populations. Local resiliency with regard to disasters means that a locale is able to withstand an extreme natural event without suffering devastating losses, damage, diminished productivity, or quality of life and without a large amount of assistance from outside the community (Mileti, 1999, pp. 32-33). Similar concepts include "sustainable development," "smart growth," and "sustainable ecosystems" (see Natural Hazards Research and Applications Information Center, 2001; and the Environmental Protection Agency's smart growth website at http://www.epa.gov/dced/).

Planning for sustainability is all done in a process that balances ecological, cultural, historic, and aesthetic values with economic development. The concept of sustainable development recognizes the relationship among economic growth, environmental protection, and social equity. The synergy of these three goals promotes a healthy economy, a clean environment, and an involved citizenry.

Linear Parks and Greenways

The December 2004 tsunami in the Indian Ocean and Hurricanes Katrina and Rita in 2005 demonstrated the enormous consequences that can result from rare and extreme, but predictable, events. One lesson learned from these disasters is that the unprecedented consequences of rare events can justify actions previously not considered, such as prohibiting residential development in the V Zone or a storm surge zone. The FIRMs show hazards for moderate not worst-case events. The storm surges from these events extended well inland of previously predicted special flood hazard areas (the A or V Zones on the FIRM).

The best way to manage floodplains and coastal hazard areas is to keep them in their natural condition. Both communities and developers are finding that linear parks and greenways that connect the open space areas through a community are becoming more and more popular and help sell new developments. Community plans can identify areas along streams, ocean, and lakes that should be linear parks or greenways. Consequently, hazardous and sensitive part of the floodplain and coastal zone would be developed into useful green space for the community. For example, part of the ocean coastline in Santa Monica, California, is a bluff-top linear park.

CHAPTER 4. REGULATIONS AND DEVELOPMENT STANDARDS

Regulations and development standards, which can be used by communities to reduce damage from natural hazards, work best when using an effective planning process. Proper planning helps ensure a community's rules and standards are properly tailored to fit the coastal landscape, a community's ability and authority, and mitigation of existing problems.

BASIC: NFIP REGULATIONS

The National Flood Insurance Program (NFIP) establishes minimum floodplain management requirements for participating communities. Communities can incorporate these requirements into their subdivision, zoning, and other land use ordinances and building codes or can adopt a separate floodplain management ordinance. NFIP regulations components:

- All development in the Special Flood Hazard Area (the A and V Zones on a FIRM) must have a permit from the community. Development means "any manmade change to improved or unimproved real estate, including but not limited to buildings or other structures, mining, dredging, filling, grading, paving, excavation or drilling operations or storage of equipment or materials" (44 *CFR* 59).
- Development and human habitation in V Zones are discouraged, although not prohibited. Construction in V Zones must be certified by a registered professional engineer or architect. The bottom of the lowest horizontal structural member must be above the BFE and the structure must be built on piles or columns or otherwise properly anchored to resist erosion. Areas below the BFE must have break away walls.

BETTER: HIGHER REGULATORY STANDARDS

The National Flood Insurance Program recognizes that while it helps reduce the risks to development from flood related hazards, it does not make development "safe" from flooding. Regulations that go beyond the minimum requirements of the NFIP are encouraged and higher State and local regulations take precedence over the minimum national NFIP requirements. Most higher community standards receive Community Rating System (CRS) credit (see ASFPM, 2003, pp. 83-87 and available at www.floods.org or see www.fema.gov/business/nfip/crs.shtm).

> Precedence of Higher Standards in NFIP Regulations
>
> Community officials may have access to information or knowledge of conditions that require, particularly for human safety, higher standards than the minimum criteria set forth in … this part. Therefore, any flood plain management regulations adopted by a State or a community, which are more restrictive than the criteria set forth in this part *are encouraged and shall take precedence.* [Emphasis added]
>
> 44 *CFR* 60.1(d)

Coastal A Zones

The *Coastal Construction Manual* (FEMA, 2000a) defines an additional hazard zone – Coastal A Zone – which is not established by the NFIP regulation or shown on FEMA's Flood Insurance Rate Maps. Although the NFIP regulations do not differentiate between coastal and non-coastal A Zones, the *Coastal Construction Manual* recommends that buildings in the Coastal A Zones be designed and constructed to be more resistant to coastal flood forces. The *Manual* describes the Coastal A Zone as that portion of the special flood hazard area of a V Zone, or landward of an open coast without mapped V Zones (e.g., the shorelines of the Great Lakes), in which the principal sources of flooding are highly correlated with coastal winds or coastal seismic activity. Coastal A Zones where the expected wave height exceeds 1.5 feet may therefore be subject to wave effects, velocity flows, erosion, scour, or combinations of these forces. The forces in Coastal A Zones with 1.5 to 3.0 waves are not as severe as those in V Zones but are still capable of damaging or destroying buildings on inadequate foundations. It is advisable to use pile or column foundations (open construction) in any coastal area subject to waves of any size. One of the benefits of building to V-Zone standards is that the reflection and channelization of flow is reduced, thus minimizing erosion and scour around the structure as well as reducing impacts to adjacent properties.

Adopting and Enforcing a Disaster Resistant Building Code

A building code is the minimum acceptable standard used to regulate the design, construction, and maintenance of buildings for the purpose of protecting the health, safety, and general welfare of the building's users.

The purpose of building codes is to build safe buildings, thereby reducing deaths, injuries and property damage. This preserves the built environment, both residential and commercial, reduces public and private disaster aid, and maintains employment in businesses and institutions that otherwise might be forced to close following a catastrophe.

Use Future Conditions for Siting New Development

FEMA's Flood Insurance Rate Maps (FIRMs) show the BFEs and area in the "100 year" floodplain as of when an engineer or coastal scientist analyzed and mapped the hazards. The Flood Insurance Study Report that goes with the FIRM will include the date that the engineering study was conducted. FIRMs newly published often show flooding hazards based on a much older (e.g. 1980s) engineering study.

FIRMs are designed for insuring flood prone property and for siting new development. However, FIRMs have some limitations when used to determine appropriate locations for new development. FIRMs do not show the hazard for the life of the structures being built or even for when the development is occurring. The FIRMs show what the flood hazard was at some time in the past (when the elevations were developed for the FIRM).

> People often say "floods were never this big" or "floods never came this often before." They may be right. Things do change, and unless the community and its people take charge, flooding will get worse.

When new BFEs are being established in your community, request that BFEs and floodplain boundaries based on future conditions be included on the FIRMs. For example, sea level rise, subsidence and increased development in the watershed should be accounted for when developing BFEs and floodplain maps that will be used for land use management.

Coastal Erosion

FIRMs also do not show coastal erosion hazards. Standards that can be placed in local regulatory programs for addressing erosion along shorelines include relocation of threatened buildings, building setbacks, beach nourishment and bio-engineering/stabilization of eroded shorelines. See Appendix C for information on coastal hazards.

Freeboard

The NFIP allows development in the flood fringe if it is elevated above the BFE. In addition, the NFIP allows flood fringe development to constrict flood flows allowing it to raise the BFE a foot. However, the BFE published in the Flood Insurance Study and represented on the FIRM does not reflect that increase. Therefore, even if constructed to NFIP standards, buildings can still suffer damage. In addition, floods can be higher than the base flood elevation for various reasons, including larger storms, ice or debris jams, the cyclic pattern of more intense storms, and sea level rise. Setting higher standards helps address these issues.

Freeboard is an additional height requirement above the base flood elevation. Requiring additional freeboard above the BFE for new development and for existing structures that are being elevated helps offset some of the limitations of the minimal national standards. When constructing a new, elevated building, the additional cost of elevating another foot or two is usually minimal and can result in significant annual savings on flood insurance. Freeboard is the most common higher regulatory standard adopted by States and communities (over half of the communities participating in the CRS receive freeboard credit). Advantages to building with a freeboard include:

- Reduced risk of flood damage;
- Accounting for uncertainties inherent in flood hazard scenarios, modeling, topography, and mapping imitations;
- Significantly lower flood insurance rates due to the lower flood risk for an elevated structure.

Foundation Certification

Without a safe and solid foundation, elevated buildings can suffer damage from erosion, scour, or settling that results from a flood. To prevent this, communities should require property owners to obtain the services of an engineer or architect to certify the adequacy of elevated building foundations or adopt standards for foundation protection.

Inspection of Lower-area Enclosures

Structures that have performed best during coastal storms were those with no or only minimal lower area enclosures. Often owners of coastal-area buildings that are elevated eight feet above grade will enclose the lower area, ostensibly to improve the appearance of the building or to provide a protected area for parking, building access, or storage. The problem is

that, later, this space may be finished to make it suitable for human habitation, greatly increasing the potential for flood damage and interfering with stormwater flow. In addition, stored materials and items can float away in the storm surge, causing damage to adjacent properties. Regulations that limit enclosures below the base flood elevation discourage finishing this space and storing valuable or hazardous items inside.

In a coastal V Zone, the area below all elevated buildings should either be free of obstructions or enclosed only by non-supporting, break-away walls. These walls should be made of open wood lattice or insect screening that will collapse under water loads without causing structural damage to the elevated portion of the building. Structures with no lower area enclosures are more likely to survive a coastal storm. However, coastal property owners often enclose the lower areas to provide additional area for storage.

To ensure owners of coastal-area buildings do not enclose lower areas to create additional living area and/or storage communities should conduct routine inspections. To make this minimum requirement better (or even effective), active local inspections and enforcement are needed. Although yearly inspections may be expensive and politically unpopular, they may be the only realistic way to make sure that program requirements are met. As an alternative, communities can consider placing a non-conversion agreement on the property deed.

Cumulative Substantial Improvement Definition

The NFIP substantial improvement regulations allow each project valued at up to 50% of the building's pre-flood value to be permitted without meeting the NFIP protection requirements. Over the years, a community may issue a succession of permits for different repairs or upgrades to the same structure. This can greatly increase the overall damage potential. To counter this, some communities measure improvements cumulatively, so that when the total value of all improvements or repairs permitted over the years (life of the structure or 10–20 years) reaches 50%, the original building must be protected from flood damage according to the requirements for new buildings. A variation is to have a lower threshold for substantial improvements, that is, less than 50%.

An option to regulating for cumulative substantial improvements is requiring that all additions meet the building protection standards. Additions outside the footprint of the original structure would be elevated (or, for non-residential structures, floodproofed) above the base flood elevation.

Barrier Island Protection

Barrier islands absorb the energy from the open ocean and thereby reduce the wave fetch and protect mainland development and wetlands from wave attack. The submerged aquatic vegetation and mangroves found in association with barrier islands trap sediment, serve as habitat for marine life, add oxygen to the water, and help reduce pollution. In addition, barrier islands are critical habitat for migratory birds and resident species such as pelicans. Based on the premise that flood insurance and other federal benefits may encourage development on these valuable coastal barrier islands, Congress enacted the Coastal Barrier Resources Act (CBRA) (P.L. 97-348). The CBRA designates a Coastal Barrier Resource System (CBRS) within whose boundaries federal incentives for new development are prohibited. The CBRS comprises nearly 200 coastal barrier segments that are neither developed nor in preserved status. Within these areas, the Act prohibits the issuance of new flood insurance coverage and also suspends other

federal assistance for public infrastructure such as bridges, highways, causeways, sewer and water systems, and shore protection projects. Communities should consider not permitting new development and not providing infrastructure in these already designated sensitive areas or in similar areas not protected by CBRA.

NAI LEVEL: RESOURCE PROTECTION & PUBLIC SAFETY

Land Use Management

Most communities adopt master plans and zoning ordinances to guide decisions about land use, density, setbacks, and other development related elements. These ordinances can designate and regulate areas subject to flooding and other coastal hazards and thus incorporate coastal storm hazard mitigation. Among the measures that could be incorporated into regulations are requirements for:

- preserving/conserving areas;
- setting maximum densities for development;
- mapping waterfront setbacks;
- restricting structures between the shoreline and the setback line;
- regulating the type/placement/use of shoreline stabilization structures;
- mandating vegetative coastal buffers rather than bulkheads, seawalls or groins;
- minimizing impervious cover;
- preserving stream corridor and wetland buffers; and
- regulating the size/type of development allowed in erosion/flood-prone areas, e.g., only permit small buildings that can be moved - no schools, hospitals, nursing homes, etc..

Planned Development

One alternative to the usual method of subdividing land into similar parcels is the planned development approach. Under this approach, developers are allowed more flexibility in their design, as long as they meet certain requirements for the zoning district. Communities may provide incentives, such as allowing higher-density development on a portion of the land, in return for setting aside critical habitat or parts of A and V Zones as open space.

Subdivision and similar regulations could allow developers the same or larger number of building sites while preserving the floodway, floodplain, erosion zone, storm surge zone, wetlands, critical habitat, or natural stormwater storage areas for open space. In addition, communities should mandate minimizing impervious cover to reduce runoff (and help mitigate nonpoint pollution).

Planned developments offer an opportunity to include mitigation measures early in their design. Communities can advise developers about the advantages of buffers from coastal hazards and encourage them to evaluate, augment, or take advantage of these protective options.

Protecting Natural Resources in Coastal Landscapes

Coastal zones require management in part because of their economic importance to the nation. However, within coastal watersheds there are conflicting land uses, i.e., intensive development in contrast to the richness, diversity, and sometimes scarcity of resources, such as wetlands, beaches, dunes, barrier islands, estuaries, and coastal waters. Barrier islands, beaches and dunes, wetlands, reefs, and shoals are the "first line of defense" against storms, storm surge, coastal erosion, and flooding. They deserve special attention because of the important, free function they perform. Communities should map these coastal features and protect them from degradation or over-exploitation.

The coastal and estuarine inter-tidal zones provide important habitat. Setback standards establish minimum distances that structures or construction work must be positioned (set back) from lot lines, channels, wetland, or shorelines. Setbacks help prevent development from impinging on fragile areas, protect investments in buildings and structures, may keep buildings from obstructing views, reduce the potential for polluting public waters, prevent disruption to the shoreline, and preserve riparian habitat. The depth of an effective setback would vary from place to place, depending on the characteristics of the shoreline. For example, in erosion-prone areas, it should be deep enough to protect a structure for its expected useful life; in areas of sensitive habitat, it should be enough to allow sufficient vegetation, area, and other resources to sustain the species that need protection.

Vegetated buffer strips protect the banks of the water body from erosion, filter stormwater, provide habitat, protect against storm surge, and trap sediment that in turn may create wetlands. Buffers can be used in conjunction with setbacks. The community regulations can also specify the preservation of natural vegetation within the buffer and prohibit bulkheads, seawalls, and groins in the intertidal zone.

Coastal vegetative buffers can be established and preserved through regulation (wetlands permits, compensatory mitigation, setbacks, or buffers), planning (mitigation banking, a local land use plan, special area management plans) and land and water management (land acquisition, restoration, and enhancement).

Efforts should be made to reduce the erosion rate by building dunes and stabilizing them with native vegetation. Designating walkover paths to the beach and setting aside the dunes for bird nesting areas and wildlife habitat help protect the dunes and vegetation from erosion and trampling.

Under an NAI approach, communities enact stronger standards to protect the coastal landscape. One action a community can take is prohibiting public infrastructure in coastal high-hazard areas, shorelines, or wetlands.

Regulating Fill in the Coastal Zone

A common mitigation action is the use of fill to elevate structures above the Base Flood Elevation (BFE). Use of improper material (e.g. demolition debris) and the filling of valuable coastal resources can occur if the placement of fill is not properly managed.

Communities should require permits for projects where fill is proposed. Community regulations related to fill should clearly define the types of fill covered by their regulations. One

option is to distinguish between fill in the high energy zones of the "open coast" and fill in coastal estuaries and streams that traverse coastal communities to reach the coast. It is important for a community to understand the extent of the public trust lands in their community (see public trust discussion in Chapter 1) and their State's rules regarding fill and/or construction on public trust lands.

Beach fill and beach nourishment can be useful as a coastal erosion response or flood protection measure, as opposed to fill for the sake of replacing eroded material or "extending dry land into the sea" - which would be a violation of the Public Trust Doctrine. The NFIP prohibits the use of fill for structural support of building in V Zones. The NFIP allows the use of fill for landscaping and site grading as long as the fill:

- does not interfere with the passage of floodwaters and debris underneath the building or
- change the flow direction of floodwaters during coastal storms such that adjacent buildings have increased damages.

Coastal barrier islands, beaches and coastal dunes absorb wave energy and thereby could help protect the coastline and wetlands from wave attack. Beach fill and beach nourishment can be used to enhance these natural features provided: 1) proper materials and construction methods are used and 2) other properties or coastal resources are not negatively impacted.

NOAA has developed a web site called "Beach Nourishment: A Guide to Local Officials". The Law and Policy section of the web site has information on avoiding adverse impacts: http://www.csc.noaa.gov/beachnourishment/html/human/law/index.htm.

Coastal estuaries make up 80% of the U.S. coastline. Extreme care must be taken in the placement of fill in these coastal areas outside the high energy zone. Communities should regulate the use of bulkheads often used to enable the placement of fill into environmentally sensitive areas.

By requiring permits for placement of fill and the construction of bulkheads in the coastal zone, communities can:

- provide opportunities for community resident input,
- monitor fill placement to ensure adverse impacts are not occurring, and
- establish regulations that meet community needs to ensure coastal resources are not compromised and other properties are not negatively impacted.

CHAPTER 5. MITIGATION

Mitigation eliminates or reduces the damage that can be done to existing or proposed development or to the coastal environment when natural hazards impact a property or when humans take action in response to that event. According to a Multi-Hazard Mitigation Council report a dollar spent on mitigation saves society four dollars.

Mitigation measures can be either non-structural measures or structural measures. Non-structural measures include changes a community or person can undertake to make property less susceptible to flooding, erosion, or other hazards, such as elevating buildings, using buffers and vegetation, and avoiding development of hazardous areas. Structural measures include levees, floodwalls, seawalls, rip-rap, diversions, groins, jetties, and beach nourishment.

BASIC: COMMON PRACTICES

Structural projects attempt to keep floodwaters away from area inhabited by people or to protect property from coastal erosion. Dams, levees, seawalls, groins and other structural measures often cause the following adverse impacts:

- Disturb the land and disrupt natural water flows, often destroying habitats (for example, levees can isolate wetlands, which are then drained for development);
- Are built to a certain flood protection level that can be exceeded by a larger flood or by overtopping or failure of the structure, causing even more damage than might have occurred without the structure;
- Can create a false sense of security when people protected by a structure believe that no flood could ever reach them so they do not take personal mitigation measures (shown by the levees in New Orleans and along the Sacramento River, and by the March 14, 2006 dam failure on the island of Kauai, Hawaii);
- Require regular maintenance to ensure that they continue to provide protection, something that is often neglected over the years. On structural projects, operation and maintenance are usually the responsibility of local government. (Some levees in southeast Louisiana had subsided and not been raised before Hurricane Katrina overtopped them);
- Are expensive, sometimes requiring capital bond issues and/or cost sharing with local, regional, or State agencies;
- Can divert flood flow onto other properties and reduce the floodplain's storage capacity increasing downstream flood peaks;
- Can alter the timing of flood peaks, causing increased flooding on other properties; and
- Can adversely affect adjacent, unprotected properties by interrupting littoral drift and starving adjacent beaches of needed sediment.
- Loss of life and property, reduced recreational opportunities, degradation of environmental quality, and alteration of traditional coastal uses are some of the detrimental impacts of shoreline erosion and subsequent coastal flooding.

Where coastal or shore protection structures already exist, communities must ensure that either they are properly operated and maintained or removed if they can no longer be maintained.

Breakwater

Jetties

Rip rap

Seawall

Beach Nourishment

Groins

BETTER: HUMAN ADJUSTMENT TO FLOODING

Because of the expense and adverse impacts from flood protection structures, many communities have turned to nonstructural approaches to reduce flood losses. Instead of trying to control water, these techniques focus on altering development practices and how people respond to floods.

The first step in altering development practices can be the development of a comprehensive flood hazard plan to address your community's hazards and risks (See Appendix C for a description of coastal hazards). The plan should provide recommendations to minimize exposure, such as modification to existing zoning maps, building standards and regulations. A major tool for altering development practices is enforcement of the community rules, regulations, and procedures. The lack of enforcement has the domino effect of increasing flood damage. When one property owner is allowed to violate community standards, others follow. This makes it difficult for courts to order compliance because all violations are not treated equally. Cumulative violations increase damage and disaster costs because buildings constructed illegally are more susceptible to flooding and other coastal hazards. Immediate enforcement action, with significant fines, prevents other violations. When the staffs of regulatory programs find illegal revetments, seawalls, groins, or other shore protection structures, the property owner should be required to apply for an after-the-fact permit. Structures that do not meet permit requirements should be removed. Enforcement can also include payments into wetland mitigation banks, fines for illegal activity, and restoration of coastal resources.

Relocation

Relocating a structure inland from the shoreline on higher ground is generally considered the surest and safest way to protect it from coastal flooding. Relocation can also reduce the risk to a community's infrastructure and the risk to first responders. Communities should favor this action to reduce their liability and costs for providing services and infrastructure. Several federal programs are available to help offset the cost of pursuing this option.

Relocating a house (Alaska)

Damaged house, Biloxi

Specialized house-moving companies have the ability to move a structure, even an unwieldy and historic one, as demonstrated by the relocation of the Cape Hatteras lighthouse. The lighthouse, built on a barrier island off the North Carolina coast, was threatened by a gradually encroaching shoreline as the barrier island migrated. The structure was successfully relocated in 1999 to a site about 2,900 feet inland.

Acquisition

However, higher ground and/or moving inland are no guarantee of protection, as victims on the Gulf Coast learned in 2005. The storm surge from Hurricane Katrina exceeded levels thought to represent the ultimate in storm surge by as much as 11 feet and destroyed structures more than a mile from the beach. Acquisition ensures that structures will no longer be potential damage statistics. They also will not become debris that can impact other property nor add to the community disaster recovery costs. The purchased land is usually converted to public open space, such as a park. Acquiring and clearing buildings is also a way to convert a problem area into a community asset, obtain environmental benefits (e.g. wetlands protections) and reduce impacts on others. Coastal areas subject to storm surge, steep slopes, or coastal erosion and for buildings on larger slabs, constructed out of brick or masonry, or too dilapidated to move may be good candidates for acquisition.

Demolishing a house

Damaged structure too large to relocate

Elevation

Elevating an existing building to comply with the local zoning ordinance or to raise it above the most recent storm surge level is often a good on-site protection method. When the first floor of living space is elevated above the base flood, floodwaters don't reach the most damage-intense part of the building. FEMA has developed guidance on elevating buildings on the coast (FEMA, 2005c) and how to ensure the foundations of elevated structures are adequate (FEMA, 2006c). All coastal-area property owners should purchase flood insurance on the structures and their contents. Flood insurance not only reimburses for flood damage, but the standard policy has provisions (called Increased Cost of Compliance coverage or ICC) to cover costs associated with bringing a substantially damaged structure into compliance with current standards. For example, if a NFIP insured structure is below the base flood elevation and is substantially damaged by a flood, this additional funding is available to help pay for elevating the structure.

Pre-Katrina elevation helped to save this house

New Orleans homes with basements

This structure not elevated enough to avoid having a boat being left on its roof by Katrina

Geodesic dome style to resist wind forces

Navigation Channels, Waterways, and Harbors

Flooding from storm surge or tsunami can be amplified when the flood flow is funneled landward from the sea. This can be minimized by increasing the dissipation area available to the flood waters. Communities should prevent in-filling of adjacent wetlands and other low land or even create additional wetlands or lowlands near susceptible land.

Non-structural Shore Protection

Shore protection structures are increasingly being considered a “last resort” for mitigation of erosion (Pope, 1997; USACE, 2002). Non-structural options to be considered before resorting to structures include

- Adaptation to natural coastal processes (by using large setback distances, relocating or acquiring and demolishing threatened buildings, etc.);
- Restoration of natural shorelines (by retaining and nourishing beaches, re-vegetating the shore, conserving or constructing dunes and beach ridges, creating or restoring wetlands, removing failed and failing structures, modifying the ends of structures that must stay to minimize the end effects on other properties and natural resources, etc.); and
- Moderation of erosion (stabilizing coastal slopes, slowing wind erosion, improving existing protective structures, tripping waves, etc.).

If the planning process involves the property owners that need protection, they may well become more supportive of nonstructural measures. Projects that are well planned and involve the public with information have a higher participation rate.

Other Mitigation Measures

Communities can also develop other mitigation measures for coastal property owners, starting with a structural assessment of building vulnerability. Mitigation measures can include anchoring structures to resist flotation, using hurricane clips and similar wall and roof bracings, installing protective shutters on windows and glass doors (FEMA, 1997, pp. 23-25), maintaining and enhancing vegetative cover in riparian corridors, stabilizing dunes with fences and vegetation to reduce erosion and attenuate flood flows, avoiding impervious coverage on the property, avoiding hardening of the shoreline (e.g. the use of retaining walls), and minimizing impacts of any on-site development such as detention ponds. FEMA's Mitigation Best Practices is a web site with a collection of illustrated stories about mitigation projects and activities at http://www.fema.gov/plan/prevent/bestpractices/index.shtm .

Hurricane bracing, MS

For additional information on mitigation success stories, see ASFPM (1999, 2002), Department of Crime Control and Public Safety (1999), FEMA (1997) and FEMA's Mitigation Best Practices

NAI LEVEL: MITIGATING ADVERSE IMPACTS

The No Adverse Impact (NAI) approach advances alternatives for mitigating the negative impacts of coastal development through actions that will probably cost less than would disaster recovery. At the same time, communities should select mitigation measures that contribute to the sustainability of the community and the values and functions of the floodplain, wetlands, and other coastal environments. Some appropriate NAI mitigation measures are:

- Improved management of surface water and groundwater to improve the stability of coastal slopes;
- Slowing shoreline erosion with "hybrid" stabilization techniques, such as a combination of vegetation and geotextile netting. This hybrid technique is more resistant to erosion than vegetation alone in moderate energy environments, and still provides diverse habitat, which rip-rap alone cannot do;

- Slowing wind erosion with vegetation, including trees and shrubs that absorb wind energy;
- Augmenting (or mimicking) natural shoreline defenses, such as near shore shoals and bars;
- Avoiding new development on coastal properties where facilities are likely to be damaged or destroyed or where debris and objects carried from the properties during a storm or flood pose a threat to other persons, services, and structures; and
- Regulating fill on lowlands in proximity to the sea, streams, bays, wetlands, and estuaries.

Non-structural measures can have impacts on other people, their property and natural floodplain functions. Following are some adverse impacts of mitigation efforts identified as BETTER that should be taken into account and mitigated:

- Acquisition and relocation is often done piecemeal, leaving what is called a checkerboard pattern of vacant lots and buildings that either did not qualify for the program or whose owners did not want to move.
- Elevation and floodproofing still leave buildings surrounded by floodwaters during a flood. Occupants often try to ride out the flood or try to get to and from their property during high water, requiring costly police and fire protection.
- If allowed, owner-designed measures, especially dry floodproofing (construction measures incorporated into the design of a building to protecting its utilities and prevent floodwaters from entering the building), may not adequately account for all the forces that floodwaters place on a building. This can result in severe structural damage to the building. The streets, utilities, and other infrastructure that serve an elevated or floodproofed building are still exposed to flood damage and public costs for that damage. It is important to remember that existing buildings should not be protected at the expense of other properties (e.g., through redirected floodwaters or increased flows). Corrective actions must not be allowed to create new flood problems. Dry floodproofing is no guarantee. Storm surge may exceed the design of a structure that was dry floodproofed.

A restaurant in Mandeville, Louisiana, located on the shoreline of Lake Pontchartrain, was dry floodproofed to protect the building from inundation likely to result from heavy rain accompanied by strong southerly wind on the lake. Water from the lake would “push” into the rivers and bayous and prevent the rainwater from draining away, resulting in ponding on the floodplain. The restaurant (estimated value of $700,000) received 6 to 12 inches of floodwater on numerous occasions, resulting in 11 flood claims totaling $94,055. The building was floodproofed with a waterproof membrane covered by bricks for a total project cost of $200,000 (FEMA, 2002c). However, Hurricane Katrina had a storm surge of 6–8 feet across the Mandeville shoreline, far exceeding the protection level of the dry floodproofing in place. The restaurant sustained substantial damage as a result of the Hurricane Katrina storm surge.

Natural Shorelines

Communities can decide to cause no additional adverse impact to the shorelines that are a natural, protective buffer between the storms and tsunamis of the sea and human investments near the shore. Beaches can be maintained and nourished; beach ridges and dunes can be protected, reconstructed, and re-vegetated. Communities can plant vegetation on eroding coastal slopes; restore or create wetlands; remove failed or failing shore protection structures; and restore other natural shoreline features as needed.

Climate Change

The NAI principle can be implemented in a way that builds in some resiliency and adaptability to account for the consequences of potential climate change. Such change seems likely to alter river and coastal processes in a way that will threaten both natural habitat and coastal development. Some anticipated alterations in climate patterns include changes in the frequency and severity of floods, hurricanes, and other coastal storms; more frequent freeze-thaw cycles and less shore ice on northern, temperate shores; and sea level change. At a minimum, communities at the NAI level would incorporate anticipated relative sea level rise within in the next 100 years (the life span of structures built) into the BFEs established for their community. They should plan for the possibility of rapid (or abrupt) climate changes over the span of a decade, as well as more gradual climate changes over several decades to a century.

Water Quality

Communities can construct projects within coastal watersheds that not only reduce flooding but also have water quality benefits as well. Similarly, the agricultural and forestry activities should implement best management practices (BMPs) to minimize runoff in coastal watersheds. State park, recreation, and fish and wildlife agencies should incorporate stormwater detention projects, buffer strips, porous pavement, and vegetative plantings to reduce erosion in and runoff from refuges and management areas, parks, or recreation facilities in coastal watersheds.

State water resource agencies can use Environmental Protection Agency funds (Section 319, Clean Water Act, 33 *USC* 1251) to support demonstration projects and programs addressing nonpoint sources of pollution. The Natural Resources Conservation Service has programs to address nonpoint source pollution and protecting wetlands and riparian habitat through its P.L.-566 Small Watershed Projects (*Catalog of Federal Domestic Assistance* #10.904), the Environmental Quality Incentives Program (*Catalog of Federal Domestic Assistance* #10.912), and the Wildlife Habitat Incentives Program (*Catalog of Federal Domestic Assistance* #10.914). For additional federal programs, see www.cfda.gov and search by agency and sub agency. Conservation and rehabilitation of wetlands and riparian habitat and erosion prevention reduce runoff and contribute to lower flood stages in coastal watersheds.

Monitoring

Monitoring is a vital part of managing the risks of adverse impacts both on neighbors' and one's own property. Monitoring is particularly crucial in this time of changing climate as disagreeable surprises appear one-by-one: unexpected drought, record floods, severe storms, and extreme rainfall events. In order to implement corrective actions, many communities must undertake a monitoring program to justify the expense and effort of corrective actions.

Documenting shoreline position on neighboring properties when shore protection structures are constructed and checking it annually can help ensure the structure is not having adverse impacts on adjacent properties. Video taping development along the coast and in floodplains can help identify development and shoreline modifications that have been constructed without proper permits.

Shore Protection Structures

To avoid adverse impacts, communities should require shore protection structures be: 1) designed and built according to coastal engineering standards and consider potential adverse impacts including minimization of impacts to adjacent properties, 2) monitored for performance and condition, 3) maintained in an as-built condition and 4) modified as needed to minimize adverse impacts.

Groins should be no higher than the beach they are intended to build so that when filled they will pass sand to the down drift coastline. The States of New York and Massachusetts require that groin fields be filled with sand at the time of construction: since the groin is already filled, the natural sand supply can continue to move normally and nourish down drift areas, instead of being captured by the groin. Revetments and seawalls should be located as far as feasible from the normal range of water's edge to protect the land only from the most severe storms and to minimize interactions between these structures and waves during more frequent storms and tidal ranges.

Communities can ban new structures and modify existing structures that are likely to cause storm surges and tsunami waves to be amplified and cause adverse impacts. Although bulkheads and other vertical walls may be needed to some extent in harbors and other waterways, they should be minimized as much as possible, because wave reflection can cause adverse impacts on other properties and on waterway activities. Some measure of wave absorption should be required on new bulkheads if wave reflection would create a problem for others. An absence of grout between rocks or blocks in seawalls, revetments, and groins better dissipates wave energy and allows vegetation to grow. Projects that deflect wave energy can also provide habitat for marine life if nooks and crannies are designed into the structure.

CHAPTER 6. INFRASTRUCTURE

> "Lifelines represent sustainability to the world's economy and health, and the welfare of its more than 6 billion people. Lifelines represent roads, bridges, waterways, ports, airports, dams, gas and liquid fuel pipelines, electrical power, communication, and water and wastewater" (ASCE, 2002, p. iii).

A community's lifelines are its infrastructure—the roads, bridges, water and power systems, services, and buildings that are vital to a community's operation and quality of life. Maintaining these elements is crucial for economic, social and physical well-being.

Infrastructure has influence reaching far beyond the actual facilities. Coastal zones are the locations of oil and gas facilities that produce and distribute energy products throughout mid-America. Coastal harbors support commercial traffic between ocean and inland terminals. Infrastructure connects manufacturing and other businesses with regional, national, and international markets. Electric power generation, water supplies, wastewater treatment facilities, utilities and communication networks serve regional and local businesses and residents. Finally, the transportation network that coastal residents will use to evacuate when needed is likely the primary reason the term "lifeline" was coined. Hurricanes Katrina and Rita clearly illustrated these dependencies and what happens when infrastructure is damaged or destroyed.

Critical facilities (one type of infrastructure) are crucial to the health and welfare of the population and are especially important after extreme hazard events (FEMA, 2001b). If these facilities are flooded or otherwise disabled the community cannot function effectively, lives are lost, and recovery is hampered. This became painfully clear after floodwall failures, overtopping of levees, and storm surge from Hurricane Katrina. For all practical purposes New Orleans, St. Bernard Parish, and parts of St. Tammany and Plaquemines parishes in Louisiana and the southern quarter of Harrison, Hancock, and Jackson counties, Mississippi, were uninhabitable after the hurricanes. Public records were inaccessible or destroyed. Governments were forced to operate from facilities outside their jurisdictions. Structures burned and were beyond the reach of the fire departments because access roads and bridges were either flooded or damaged. Hospitals were unable to continue functioning or provide adequate care for patients.

The interconnectivity of our infrastructure can result in extreme coastal hazards having far-reaching long-term impacts. Coastal communities should adopt higher standards for infrastructure to make it resistant and resilient to coastal hazards. A community also should use the placement of infrastructure to guide or direct development away from the coastal high-hazard zones in order to maintain sustainability and a high quality of life.

BASIC: RESPONSE AND REPLACEMENT

Infrastructure with water-dependent uses must be located in or near the coastal zone. The basic level of management assumes that communities do the minimum to maintain infrastructure and wait to upgrade and repair damaged infrastructure until after a hurricane strikes, shorelines erode, or a tsunami inundates low-lying towns. Historically, elected officials and public administrators are pressured to address the immediate problems of most concern to the public. Governments are also pressured to respond quickly after disasters and are not usually held

accountable for advance preparations. Consequently, many decision makers take a short-range perspective, with a planning horizon that reaches to the next election; a few years in the future.

Complicating local preparations for future disasters is a reluctance to spend public funds for protection against events that may not occur in this lifetime. The recent failure to upgrade the levees and floodwalls protecting the New Orleans region prior to Hurricane Katrina testifies to the death, suffering, and enormous costs that result from taking only the minimum, basic steps for protection infrastructure. In addition, communities must recognize that even well maintained levees can be overwhelmed by flood levels that exceed the levee design level.

Roads, Bridges, Culverts, and Public Utilities

When new developments are built, the communities generally extend services to meet the demand. If a flood problem is reported, such as a washed out culvert, public works crews usually replace it in similar condition at public expense. As a result, flood damage increases as the years go by. Federal Executive Order 11988, Floodplain Management, actually requires new and replacement structures, when federal funding is involved, to be designed and built so as to cause no increase in flood elevations. Communities can avoid this problem by requiring that all replacement structures not increase flood levels. A better approach is to reduce flood levels and erosion.

Bay St. Louis bridge and highway destroyed following Hurricane Katrina

Private Utilities

At the basic level, local governments leave locating, extending, and maintaining services to the utility companies.

Public Property

Unfortunately, in some situations, public buildings damaged in a flood are not protected from the base flood when rebuilt. There are at least two reasons for this. First, the high value of the building means it takes a lot of structural damage to exceed the 50% substantial damage threshold required by the NFIP to require compliance. Second, many communities do not understand that, under the NFIP, public property must meet the same rules as private

development. Often public agencies do not seek or obtain building permits and place infrastructure wherever development occurs, without regard to the flood hazard.

If a public building in the regulatory floodplain is substantially damaged from any cause, its replacement must be protected from the base flood, under the NFIP standards.

BETTER: PROTECTION MEASURES AND PROCEDURES

A community using the better approach inventories the infrastructure exposed to damage from coastal hazards, takes steps to protect it in a timely manner, and sets protection standards for new facilities. Finally, maintenance and replacement programs have formal procedures that account for coastal hazards.

Roads, Bridges, Culverts, and Public Utilities

A community operating at the better level has an inventory and a plan to upgrade/mitigate the risks at their facilities including routine procedures for regularly examining the potential for damage to roads, bridges, culverts, and water or sewer lines. Often a culvert has been sized inappropriately or the road was not designed for high water. At the time of repairs, maintenance, or replacement, culverts should be enlarged and/or realigned to reduce future flood damage. Roads can be raised above the base flood elevation so they remain open for evacuation and response and recovery operations. If development has not yet taken place, roads and public utilities can be used to guide or direct development away from high-hazard areas.

Public Property

An inventory of all public buildings should be made to determine which are exposed to coastal hazards. With support from FEMA, the National Institute of Building Sciences (NIBS) has developed a natural hazard loss estimation methodology (HAZUS) that communities can use to access their hazard exposure. Public buildings at risk should be given a hazard audit to identify low entry points, warning times, and similar factors. Communities using this better approach can use the results of this audit to recommend steps the building owner can take to prevent future damage. At a minimum, a community at the better level should have wind and flood insurance (as well as fire insurance) on all public buildings and facilities in the [mapped] Special Flood Hazard Area and in any other known flood hazard areas.

Whether insurance was required or not, the community risk manager or appropriate office should be consulted about the buildings' exposure to coastal hazards. An "all risk" insurance policy should be verified to determine if it specifically covers damage from flooding, storm (tsunami) surge, storm waves, and shoreline erosion.

> The amount of disaster assistance a community receives for its damaged public buildings is reduced by the amount of insurance coverage (structure and contents) a community should carry on the building REGARDLESS of whether the community is carrying a policy.

Maximum flood insurance coverage amounts available from the NFIP are $500,000 for the structure and $500,000 for contents. After a disaster, public assistance funds will only reimburse a community for flood damages to an uninsured or underinsured building in the

mapped floodplain with structure and/or contents damage that exceeds the amount of coverage that should have been in place. In essence, disaster assistance for public buildings has a very large deductible equal to the NFIP flood insurance policy that should be carried on the building. Communities at the better level do not wait for the disaster to be caught short. They purchase insurance coverage for floods and other natural hazards that might damage or destroy their public buildings.

Buccaneer State Beach

Critical Facilities

Public property often includes critical facilities that should be designed to not be compromised during a flood or hurricane. It is up to local communities to determine which facilities are critical to the community. Examples of critical facilities that many communities identify include:

- Structures or facilities that produce, use, or store highly volatile, flammable, explosive, toxic, and/or water-reactive materials;
- Hospitals, nursing homes, and housing likely to have occupants who may not be sufficiently mobile to avoid death or injury during a flood and that will need emergency services during and following the event;
- Police stations, fire stations, vehicle and equipment storage facilities, and emergency operations centers that are needed for emergency activities before, during and after a flood;
- Access roads and public and private utility facilities that are vital to maintaining or restoring normal services to flooded areas before, during, and after a flood;
- Water supply and waste water facilities that provide for public health and safety;
- Schools and evacuation centers; and
- Power and communications facilities and systems.

As with public property and private utilities, a community at the basic level may not devote any special attention to its critical facilities until after they are damaged. They may have been inventoried by the emergency manager and listed in a disaster response plan. Even if they have practiced mitigation such as elevating a fire station above the base flood, the apparatus may not be operational. If the surrounding streets are flooded, the operations units cannot leave the station.

Determinations of what constitutes critical facilities are also made by federal and State governments, and by corporations responsible for operating such facilities. After Hurricane Katrina, the White House recommended that the federal Department of Homeland Security work with the private sector to finalize an Interim National Infrastructure Protection Plan to better protect and quickly assess the impact of future disasters on critical infrastructure (White House, 2006).

Protecting critical facilities serves several purposes: it reduces damage to vital public facilities, it reduces pollution of flood waters by hazardous materials, and it ensures that the facilities will be accessible and operable during and following most flood emergencies. FEMA 543 is a useful design guide for critical facilities (FEMA, 2006b).

As with publicly owned buildings, it can be well worth the cost to conduct a flood audit to determine ways to protect the facilities through retrofitting or a flood protection project.

A community's emergency manager should help the facilities managers prepare emergency action plans to ensure maximum protection during a flood or other coastal hazard event. Public response efforts should be coordinated with those action plans. For example, early flood warning should give public and private property owners enough time to move hazardous materials or sensitive machinery and equipment to high ground. The better community plans are tied to regular inspections and funding for repairs of any structural protection measures.

> "The disruption of lifelines has a direct impact on the world's regional economies and the health of its citizens. Therefore, it is important that we understand natural hazards, how they can impact lifelines, and what can be done to minimize the impacts when they occur" (ASCE, 2002, p. iii).

NAI LEVEL: PLANS AND ALTERNATIVES

Infrastructure, and the role of infrastructure in facilitating coastal development, has potentially adverse impact on neighbors and on the community. The range and consequence of such impacts should influence how the potential impacts are addressed. It is hard to imagine any more far-reaching impacts from natural coastal hazards than adverse impacts on others who depend upon infrastructure that has become damaged or destroyed. A major effort in following the NAI principle should be to improve the resistance of infrastructure to damage from coastal hazards and improve the resilience of infrastructure so that it recovers quickly when catastrophic events occur. A "liability audit" is recommended to assess situations for potential liability incurred by the providers of infrastructure (see Kusler, 2002).

Infrastructure can be thought of as a web containing sources, nodal points, and lines of linkage. A source may be a manufacturing plant, power plant, or a water treatment plant. A nodal point might be a regional distribution center for a business or a substation for an electric utility.

Highways and power transmission lines are examples of lines of linkage between sources, nodal points, and clients.

The intricate web of infrastructure can be made resilient in absorbing the adverse impacts of small events such as erosion in one location that causes closure of a coastal road. Alternate roads in the area can minimize the temporary disruption of local traffic. However, the adverse impacts of extreme coastal hazards like hurricanes, severe extra tropical storms, and tsunamis become cumulative impacts that cascade through communities and the region. The intricate web of possible interactions in the infrastructure can pose a challenge to those who attempt to improve resistance and resilience and isolate or minimize the unavoidable impacts from extreme events.

One lesson to be learned from the 2004 tsunami in the Indian Ocean and Hurricane Katrina on the Gulf Coast in 2005 is that, the FIRMs reflect moderate not extreme events. One way to reduce or eliminate the exposure of infrastructure to coastal hazards is to relocate facilities out of the hazard area (Pope, 1997). Relocation of roads, power lines, water and sewer lines, pipelines and small buildings may be more common, and more feasible, than relocation of large buildings.

Roads, Bridges, Public Utilities, Public Buildings

Capital expenditures may include acquisition of land for public uses, such as parks, wetlands, or natural areas, and extension or improvement of roads, utilities, channels, and drainage structures. Many communities adopt a capital improvement plan and/or budget that specifies what will be built or replaced in the near future. A community using an NAI approach examines its plans and budgets to ensure that

- Major investments in new fire or police stations or emergency centers (and access to them) are not located in a Special Flood Hazard Area, a surge zone, or along a shoreline subject to erosion. If this is impossible such facilities should be sited where they will be accessible and operable during major (500 year) flood events. Significant protection measures (elevation, floodproofing) should be incorporated as a safety margin for the facilities themselves.
- Public services such as roads, sewer, or utility improvements do not encourage more development in a floodplain or coastal high hazard area. In low-lying areas or on islands where it is not possible to avoid siting emergency facilities in flood hazard areas. Such facilities are elevated and arrangements made with neighboring communities to ensure that emergency services can be provided if some facilities become temporarily inaccessible. Not installing water or sewer lines into a floodplain may not halt development, but it can deter it or result in less-dense development if the buildings must rely on wells and septic systems. Flood impacts, along with pollution impacts of septic systems, must be mitigated.

Parks

The best use of floodplains is generally considered to be open space. Keeping the area natural means no damage from flooding and no adverse impact on others. Communities using the NAI approach expand their ownership or control over open flood prone areas in order to maintain or enhance the natural and beneficial functions of floodplains.

Comprehensive plans and capital improvement programs in these communities ensure that areas subject to flooding now or in the future are preserved as open space by acquisition or purchasing conservation easements. With an easement, the owner may undertake some development and use of the property, but property taxes are reduced or a payment is made to the owner in exchange for an agreement to hold part of the property as open space.

Some areas where storm surge exceeds a selected depth can be identified as very high-hazard zones. Local governments should zone these as open space better set aside for recreational activities, integrated into the nonpoint pollution abatement system, or wetlands.

Areas included in a greenway plan can follow the water bodies and often starts with existing parks. Over the years, lands along the greenway can be purchased or developers can be encouraged or required to dedicate riparian land to connect the open spaces. Often developers view these parcels as undevelopable or too expensive to build on. (See also the regulatory approaches reviewed under "preserving important areas.") The National Park Service and the Urban Forestry Program are two federal programs that will share the costs of creating green space and linking to other green spaces, especially in urban areas. Local governments facilitate Transfers of Development Rights (TDRs) to achieve greenways.

Greenways and waterfront parks in coastal watersheds have an added benefit over other types of open space. They attract people to the water. People learn to appreciate the natural and beneficial functions of the flood prone areas and develop an interest in protecting them. Many State coastal management programs support public access projects in coastal communities. These projects have included: developing public access guides or management plans; installing trails, observation platforms, fishing piers, boat launch ramps and educational signage; and enhancing amenities at existing access sites

Critical Facilities

Under the NAI approach, communities set higher regulatory standards for new critical facilities with the intent of not exposing them to flooding, surge, storm waves, or shoreline erosion. The federal regulations (44CFR60.22) state that "floodplain management regulations adopted by a community should prohibit nonessential or improper installation of public utilities and public facilities in flood-prone areas". Executive Order 11988 requires federal agencies funding and/or permitting critical facilities to avoid the 0.2% (500-year) floodplain or protect the facilities to the 0.2% chance flood level.

At the No Adverse Impact (NAI) level, communities advance their thinking beyond protecting critical facilities to locating them outside the 0.2% (500-year) floodplain entirely. This not only helps ensure critical facilities remain operational but avoids the adverse impacts that construction, improvement, and even protection of these infrastructure facilities will have on other properties, the environment, and natural systems. NAI communities prohibit new critical facilities from the 0.2% chance floodplain unless there is absolutely no alternative (very small low lying community or island) and require existing critical facilities to be protected and accessible during a 0.2% chance flood and that contingency plans—perhaps a mutual support agreement with a neighboring community—are in place. Protection and accessibility could be extended to address surge or shoreline erosion. The Community Rating System provides credits to communities that take these actions.

Guidelines have been developed for owners/operators of oil and natural gas pipeline systems and electric power systems to use in dealing with earthquakes, floods, hurricanes, tornados, windstorms, icing, and ground displacements caused by landslides, frost heave, and settlement (ALA, 2005a; ALA, 2005b). The ASFPM, working with the American Public Works Association, developed a report of case studies that looked at how communities address flood hazards when planning, building and maintaining local road systems (ALA, 2005c). The APA (2005) has published a book on landslide hazards and planning.

There is a National Infrastructure Protection Plan (NIPP) that provides guidance in prioritizing infrastructure for protection (White House, 2006). The White House report notes that there is no supporting implementation plan to carry out protective actions during a natural disaster. The report recommends that the Department of Homeland Security, working with the private sector, revise the National Response Plan and finalize the NIPP to "rapidly assess the impact of a disaster on critical infrastructure…inform Federal response and prioritization decisions and to support infrastructure restoration" (White House, 2006, p. 61). The report also recommends a stronger Infrastructure Support Branch in the National Operations Center of the Department of Homeland Security to "coordinate with critical infrastructure sectors….and develop recommended preemptive and responsive actions to remediate or mitigate the impact of the loss of critical infrastructure" (White House, 2006, p.110).

Risk Management of Infrastructure

Risk management; a practice that is increasingly being applied to infrastructure (ASCE, 2002; ASCE, 2005; ALA, 2005d). Most of the work done to date has addressed flood and earthquake risks. There has been some work on risks from landslides but relatively little on risk management for other natural hazards that affect the coasts (ASCE, 1996). Risk management has been recommended as a standard practice in the design, operation, and maintenance of coastal facilities (Mockett and Simm 2002; Housley and Thompson, 2003). Risk management methods have been developed and used that cover the entire useful lives of facilities and projects of any kind, including infrastructure (U.K. Civil Engineers and Actuaries 1998, 2005).

CHAPTER 7. EMERGENCY SERVICES

> "Although better forecasts and warning processes have helped save lives by providing more lead time to evacuate, the tremendous growth of development and human population in coastal regions is proceeding so rapidly that an increase in the loss of life related to coastal disasters can be expected in the future" (The Heinz Center, 2000a, p. xxiv).

The migration of so many people to the coastal cities and towns of the United States poses an enormous challenge to those planning emergency services in response to coastal disasters. The lack of mass transit in the evacuation of New Orleans ahead of Hurricane Katrina and the freeway gridlock that occurred while evacuating Florida and Texas cities ahead of hurricanes Wilma and Rita vividly demonstrated these challenges.

Providing emergency services are State and local government responsibilities. However, the scope of a disaster and the number of people needing assistance can overwhelm even the most experienced State and local emergency service operations. Along with FEMA, the Coast Guard, National Guard, Army, and Navy can provide critical assistance and have the experience, assets, and capabilities that State, county, and local governments often lack in dealing with large populations. In the aftermath of Katrina, an expanded role for the military in responding to large disasters was suggested. However, the Posse Comitatus Act of 1878 strictly limits the use of American troops within the country (Kaplan, 2005).

Emergency services provide preparedness and response assistance during, and after a disaster. They can involve the federal and State governments, every department of local government, and many non-governmental agencies, like the Red Cross, the Salvation Army, and church groups. Hurricanes Katrina, Rita, and Wilma fulfilled the prophesy of the Heinz Center report and demonstrated that although many people evacuated, others who could leave chose to stay, and many who wanted to leave could not. In metropolitan areas, people live close together on vulnerable coasts and during evacuations strain the existing system of freeways, feeder roads, and auxiliary highways. The White House Report (2006) on how the nation responded to Hurricane Katrina describes some valuable lessons. Local officials, floodplain managers, and coastal zone administrators should review this document in order to reshape or build their emergency services (http://www.whitehouse.gov/reports/katrina-lessons-learned.pdf).

BASIC: GENERIC RESPONSE PLAN

Most communities have a disaster response or emergency preparedness plan. Often these are developed by the county (parish, borough) to provide overall coordination of disaster response and recovery. Larger cities will have an independent disaster planning initiative that includes preparation, response, and recovery elements.

Generic response plans that are not much more than verbatim copies of models developed for guidance purposes have no details on specific threats confronting that community. Model response plans treat all disasters alike and seldom offer directed actions for different hazards or for events of differing magnitude. For example, after a flood, a model plan may recommend convening a committee to determine what steps should be taken and in what sequence. In reality,

action items should be embedded in a community's plan before the disaster strikes. Implementation then becomes the sole focus.

BETTER: MULTI-HAZARD RESPONSE PLAN

Multi-hazard response plans are preferable to single-purpose plans because they force consideration of the interaction of events and agencies. In particular, preparing the plans and practicing them under simulated conditions allows representatives from participating agencies who may infrequently work together to train together. Plans are complete after responsibilities have been assigned and the process tested in realistic simulations.

Two key factors make floods usually easier to anticipate than other hazards:

- Communities usually get some advance warning of a flood; and
- Communities generally know where floods happen based on the Flood Insurance Rate Maps, past flood events and predictions of worst case scenarios (As demonstrated by Hurricanes Katrina and Rita, the inland extent of storm surge or the depth of inundation can exceed the moderate flooding shown on FIRMs and a communities flooding history.).

Because of these two factors, when and where a flood occurs should not be a surprise to local emergency managers. Therefore, a community should have a flood-specific response plan. Emergency managers need not and should not wait for the flood before taking action.

Tsunamis, earthquakes, tornadoes, rapidly developing unusual storms, and massive landslides are much harder to anticipate. On the Great Lakes, rare waves can surge over breakwaters and through marinas (Mortimer, 2005).

The first step in responding to events such as hurricanes; tsunamis that strike the West and East coasts, the Gulf Coast, Hawaiian Islands, and the Pacific islands; and earthquakes from California to Alaska is being aware that they exist. The National Hurricane Center (NHC) issues predicted paths, intensities, and descriptions of potential problems (erosion, surge heights, winds) several days in advance, giving communities time to activate personnel and response plans. Research on warning indicators of impending continental earthquakes continues to improve, and there have been some situations in Asia where devastating earthquakes were predicted weeks to months in advance of their occurrence. In contrast, warnings of impending undersea earthquakes do not occur until after the event has occurred. The Pacific Tsunami Warning Center in Hawaii broadcasts tsunami warnings throughout the Pacific Ocean Basin after rapid analysis of the source and strength of earthquakes detected in the Basin. Both the Pacific Tsunami Warning Center in Hawaii and the West Coast/Alaska Tsunami Warning Center of NOAA/NWS in Palmer, Alaska, can provide inundation zone maps that show potential areas affected by tsunamis and related information as can the State of California and the NOAA office in Seattle, WA.

The time between an earthquake that generates a tsunami and arrival of tsunami waves on the West Coast of the United States can be very short. For example, a tsunami generated by a source in the western Pacific 4,000 miles off the Oregon coast and traveling over average ocean depths would arrive on the Oregon coast in about eight hours. This provides very little time for the Tsunami Warning Center to confirm the location and strength of the earthquake and send out a warning, or for emergency managers on the West Coast to receive the warning and act. For an earthquake generated in the Cascadian Subduction Zone off of the Oregon coast, the travel time for a tsunami to reach the West Coast may be only 5 to 30 minutes—too short a time for an

effective warning to be issued from the Warning Center in Hawaii (Madin 1992; Oregon 2005a and b).

Communities at the better level should have warning systems that may be as simple as a siren. Just as important as the warning is that citizens know what to do. A warning program should have a public information component. For example, people need to understand the difference between a tornado warning (when a basement is a good refuge) and a flood warning (when they should stay out of the basement). People in tsunami risk areas need to be advised to immediately go to high ground when they feel an earthquake.

The National Weather Service established the StormReady and TsunamiReady programs to help local governments improve the timeliness and effectiveness of hazardous-weather-related warnings for the public. Qualifying for this program is a definite step toward improved flood preparedness, and it is also credited by the Community Rating System. www.nws.noaa.gov/stormready.

FEMA Storm Ready logo and local tsunami evacuation sign

Concurrent with threat recognition and issuance of warnings, a community should respond with actions that can prevent or reduce threats to life, health, and property. Typical coastal storm/hurricane response actions and responsible parties include:

- Activating the emergency operations center and securing communications (the chief elected official and emergency manager);
- Providing early warning to certain critical facilities (the dispatcher);

- Changing traffic flow on evacuation routes and closing streets and bridges (police or public works department);
- Providing early warnings to marinas and harbormasters to expedite hauling boats out of the water or relocating them to safer areas (the chief elected official and emergency manager);
- Making evacuation decisions (the chief elected official and emergency manager);
- Providing people with directions to safe emergency evacuation routes away from coastal areas (public works department and the media);
- Providing and publicizing the availability of mass transit for evacuation of people without vehicles (the emergency manager and media);
- Monitoring water levels (the engineering department);
- Holding children at school or releasing them from school (school district);
- Opening evacuation shelters (the Red Cross or other relief organization);
- Providing security for evacuated areas (the police); and
- Informing the public about health and safety precautions (the health department).

Road closed in a storm

The benefit of a good flood preparedness plan is that the appropriate flood response steps are already outlined, responsibility is designated, and the order in which they should be taken is specified. One of the best tools to help predict what will happen is a flood stage forecast map that shows what areas will be affected at specified flood heights. Such a map is prepared on a good topographic map by highlighting areas flooded at different flood levels. Emergency managers should use National Weather Service river forecasts, local gages, projections of flood crests and Hurricane Evacuation Studies to decide when to initiate local emergency plans. (See the websites listed in Appendix E for additional sources of information).

An inventory identifies each structure in the flood hazard area, its first floor elevation, and the flood level at which emergency access to and evacuation from the structure is prevented. Using predicted flood levels and data on specific structures, communities using the better

approach can activate automated phone systems to call specific addresses with warnings to evacuate or take other actions.

NAI LEVEL: PRE- AND POST-DISASTER PREPAREDNESS

A flood response plan that is developed with the No Adverse Impact (NAI) approach is designed to ensure

- That no one suffers harm from implementation of the plan;
- That no one who wants or needs assistance or evacuation will be left behind; and
- That people do not exchange the former insecurity of an impending flood at their home for a new insecurity without shelter as they evacuate or in unsafe shelters because planning was inadequate.

Pre-Disaster

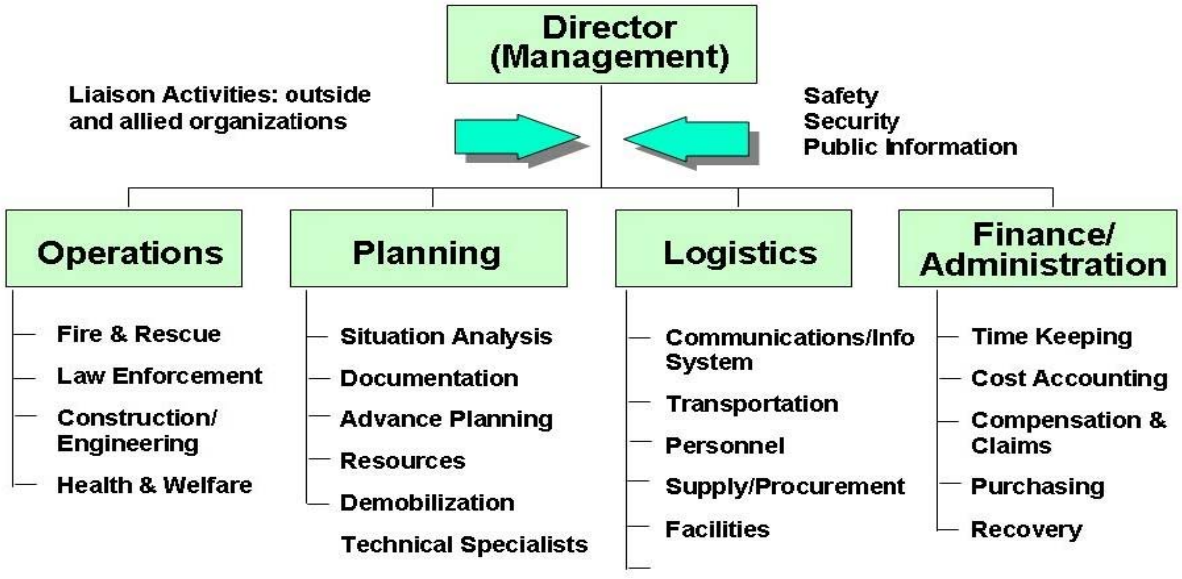
Pre-disaster plans must consider operational steps to reduce adverse impacts during flood response and emergency operations. Sometimes adverse impacts result from efforts to protect properties during a flood. Flood preparedness planning needs to make sure that these actions do not make things worse for someone else. For example, an emergency barrier (often called a temporary levee) will protect one building but divert floodwaters onto other properties in the same way that a permanent levee will.

NAI communities plan their emergency operations in advance. The location, size, and implementation of emergency actions are evaluated to determine if the operations will cause adverse impacts on other people or properties. Emergency action plans are periodically updated to assure that names and contact information are current, and action plans are regularly practiced.

Freeway contra-flow, Hurricane Rita (Houston)

Reducing adverse impacts of floods, as part of a community's multi-hazard response planning effort, is further supported by integration of the National Response Plan (NRP) and the National Incident Management System (NIMS) in local plans. The NRP defines FEMA's central role in coordinating disaster response and recovery when a State requests assistance from the national government. Emergency Support Functions, or ESFs, assign authority for transportation, sheltering, medical services, construction and engineering, communications, and other essential response elements to supporting federal agencies. Under the new National Response Plan, functional coverage for law enforcement and security, long-term community recovery, and public information have been added and the Plan is coordinated with the NIMS concept of Incident Command as an overriding management system. An organization chart showing the relationship between these components, plus a basic diagram for the Incident Command System as an emergency operational template, are included below for reference. Local and State governments needed to have plans complying with the basic ICS requirement of NIMS by March 2006 in order to qualify for FEMA emergency management grant funds.

Incident Action Planning, which reviews and refocuses emergency operations objectives during set Operational Periods, is invaluable for flood operations management and in controlling adverse actions. An Incident Action Plan can identify ongoing risks, determine what resources are required to manage changing events, and assign operational elements to reduce flood impacts. Typically the Incident Action Plan process includes key logistics, operations and management staff under the leadership of the Incident Commander and the Planning Section Chief. Examples of using the ICS planning process to reduce flood impacts include enhancing communication for coastal evacuations or increasing surveillance at landslide-prone areas along the coast.



Post-Disaster

Being prepared for what follows the disaster can help a community take important steps to promote sound redevelopment after a flood. Everyone wants to get "back to normal." The problem is, "normal" means the way they were before the disaster, exposed to repeated damage from future floods. Emergency Support Function (ESF) #14 – Long-Term Community Recovery and Mitigation provides a framework for Federal Government support to enable community recovery (FEMA, 2004b).

This is the time when people are thinking about flooding and when damaged buildings and other facilities could be removed or retrofitted at a lower cost. It is also the time when some disaster assistance funds, as well as FEMA mitigation funds, become available and can best be used to protect buildings and infrastructure from future damage, suffering, and public costs. A community flood preparedness plan should include a plan for post-disaster mitigation procedures that would include:

- Conducting habitability inspections (in addition to safety issues, this is important in determining temporary housing needs);
- Determining which structures are substantially damaged;
- Regulating reconstruction to ensure that the damaged structures meet all code requirements for future flood loss reduction, and revising codes when needed;
- Conducting a public information effort to advise residents about available funding and mitigation measures they can incorporate into their reconstruction plans;
- Evaluating damaged public facilities and incorporating protection measures during repairs;
- Acquiring substantially damaged or repetitive loss properties from willing sellers;
- Preparing or updating a long-term mitigation plan; and
- Applying for post-disaster mitigation funds based on the community's comprehensive mitigation plan.

One new tool that can help a community with substantial damage determinations is FEMA's Residential Substantial Damage Estimator software program, which makes determinations easier and more objective. After large disasters, FEMA can help bring in teams of building code experts to help a community with the many assessments and determinations.

Requiring permits, conducting inspections, and enforcing a community's substantial damage regulations can be very difficult for understaffed and overworked offices after a disaster. It is important to seek ways to supplement building department staffing because if these activities are not carried out properly, not only would a community miss a tremendous opportunity to redevelop or clear hazardous areas, it may be violating its obligations under the NFIP and/or cause additional damage.

Part of planning post-disaster responses involves obtaining interagency "mutual aid" agreements with communities and persons outside the coastal zone in order to ensure that experienced staff (from outside the affected region) are available to help local officials and staffs. *Holistic Disaster Recovery—Ideas for Building Local Sustainability after a Natural Disaster* is a publication that can help with this approach (Eadie et al., 2006).

The same NAI perspective described above needs to be taken in developing emergency response plans for tsunamis, extra-tropical (winter) storms, catastrophic landslides, and other coastal disasters. In planning exercises for such disaster responses, the simulation modeling of storm surges is vital, continues to improve, and needs greater resolution and verification for highly-modified waterways and complex urban landforms. The hazard of the ebb of tsunami water back to the sea needs to be a part of tsunami simulation as well as planning emergency responses to a tsunami.

CHAPTER 8. PUBLIC OUTREACH AND EDUCATION

Perhaps the most effective means of mitigating coastal hazards and protecting sensitive coastal environments is education through outreach. Education and outreach is needed to promote all other recommendations in this manual— to inform the general public, property owners, decision makers, design professionals, educators and developers about their community's hazards (See Appendix C for a description of coastal hazards). It can be used to show people how to protect themselves, and help them understand the ways in which their actions could affect others.

Property owners, residents, and tourists need to be informed of their risk. In addition, community residents need to be provided the opportunity to raise concerns about potential adverse impacts that could be caused by proposed development. Flood, erosion, and vulnerability maps, storm damage surveys, and success stories are useful vehicles by which people come to understand coastal hazards and the ways in which their personal vulnerability can be minimized. Current or prospective coastal property owners should be provided with facts and recommendations about siting, design, and construction practices that will enhance their ability to build a structure that can withstand the forces of moving water and other hazards, without undermining the natural coastal processes, resources, or esthetic quality of the area.

NAI can be called an attitude or a mindset—do not cause an adverse impact on others. It is important that communities convey this message to the public, property owners, decision makers, design professionals, and developers. The fundamental message is "know your community's hazards, learn how to protect against them, and understand that individual and collective actions could adversely affect others and the environment." For example, property owners in subsidence areas should be advised to not build slab-on-grade structures. To help residents survive, they need to know safe places of refuge during a major disaster. Pre-storm preparedness and evacuation practice exercises can help identify education and outreach needs.

BASIC: ANSWER QUESTIONS AND PROVIDE INFORMATION

At a minimum, local officials answer inquiries about the flood, erosion, or other risk to properties and what regulations will apply when developing the property or recovering from a flood. Often when property owners are improving a structure that has been substantially damaged or are requesting a variance from the NFIP standards, they are unaware that they may be building a structure that will be at even greater risk. Nor do they realize that they may subsequently pay higher flood insurance premiums.

Communities make public documents available for review, such as the FIRM and past permit records.

BETTER: COMMUNITY OUTREACH

Local officials go beyond the basic level by making sure that property owners are periodically informed about coastal hazards, the vulnerability of their homes and property, mitigation techniques that will minimize vulnerability, and places to obtain pamphlets and other literature about hazards, mitigation, and the coastal environment. Many of these sorts of information are available in the offices of municipal or county (parish) floodplain administrators. Another source of information is the ASFPM Coastal Issues Committee web page, which can be

accessed via www.floods.org. It contains links to State and federal agencies and professional organizations that can provide information on coastal hazards and mitigation. In addition the NOAA Coastal Services Center offers information on erosion, subsidence, and links to other sources of data (http://www.csc.noaa.gov/rvat). The National Sea Grant website is another good source of State-specific information (http://www.seagrant.noaa.gov). (See Appendix E for websites that provide information on coastal hazards management.)

Additional CRS credit is available for communities who develop a public information strategy and make special effort to contact residents and property owners in the hazardous areas. To get this credit, communities collect or prepare fact sheets and case studies; hold special events like "flood awareness week;" give workshops to nonprofit organizations, professional associations, or the general public; or other similar activities. Additional information on the CRS program is obtained from the State NFIP coordinating agency or community floodplain administrator.

Community leaders plan and prepare for hazardous events before they occur to minimize the impacts and facilitate post-storm recovery. Local officials should increase their public information efforts after destructive storms when lessons are readily apparent and there is a "teachable moment". This is an effective time to promote the benefits of building codes.

Communities show additional data and supplemental maps to complement and clarify the FIRM (e.g., with aerial photographs that show buildings) and depict information such as erosion rates, storm surge zones, historic inundation depths outside the Special Flood Hazard Area (SFHA), and areas where zoning and development regulations apply.

The community gains Community Rating System (CRS) points by using a newsletter or general mailing to notify community residents about the flood hazard and about flood insurance. Outreach projects include:

- Placing brochures in libraries, building supply outlets, convenience stores, or neighborhood hardware stores;
- Mailing notices to property owners in the SFHA or to everyone in the community (e.g. with tax or utility bills) after a disaster to help introduce the idea of floodproofing and identify sources of assistance;
- Locating displays with take-home materials in public buildings or shopping malls;
- Regularly writing articles for daily or weekly newspapers or free tabloids;
- Printing special sections in a newspaper;
- Offering presentations or workshops to neighborhood, civic or business groups;
- Placing information on community, agency, company, or association websites; and
- Promoting support for preservation of natural coastal areas.

NAI LEVEL: EDUCATION

Educational efforts are an NAI strategy because they work toward long-term transformation of people's behavior and understanding about their coastal environment and its hazards and resources. These programs inform city officials and property owners about coastal hazards and responses to the hazards that create adverse impacts on others. NAI education efforts

are used to identify and explain mitigation measures that will reduce the likelihood that legal issues will arise. Educational materials on coastal processes and coastal hazards are available from some of the agencies with websites listed in Appendix E.

Outreach projects provide information to people to make them aware of the hazards and protection alternatives. Education and training can move the process one step further by fostering changes in attitudes and behaviors. Communities should start with their own staff, which then can pass on what they have learned. Working with schools to include coastal hazards in their curriculum can help build a strong foundation of hazard awareness in the community.

Classes offered by the Emergency Management Institute (http://www.training.fema.gov/EMIweb/) and the NOAA Coastal Services Center (http://www.csc.noaa.gov/bins/training.html) can help local government staff to better inform elected officials, the public, educators, real estate agents, insurance agents, and surveyors about ways to mitigate the impacts of coastal hazards. The National Estuarine Research Reserves (NERR) System is a network of 27 areas representing different biogeographic regions of the United States that are protected for long-term research, water-quality monitoring, education and coastal stewardship. The NERR Coastal Training Program and your State coastal management agency outreach and education programs also provide training opportunities for community staff and local decision-makers.

The ASFPM administers the Certified Floodplain Manager (CFM®) program to ensure that floodplain management staff members at local, State, and federal levels are knowledgeable about reducing potential flood losses, and stay up-to-date on the NFIP and other flood programs. Information about the certification program, how to apply, and available training are on the ASFPM website (http://www.floods.org/).

One specific educational tool is the *Coastal Construction Manual* (FEMA, 2000a) prepared by the Federal Emergency Management Agency (FEMA). It can help designers, contractors, and community officials identify and evaluate practices that will improve the quality of construction and reduce the economic losses associated with coastal disasters. Copies of the manual are available from FEMA through its website (http://www.fema.gov/), and FEMA offers a training course on the *Coastal Construction Manual* in two forms: on-site at the Emergency Management Institute (EMI) in Emmitsburg, Maryland (a 5-day comprehensive course) and a 2–3 day "on the road" course tailored to specific communities.

FEMA has produced a series of fact sheets to provide technical guidance and recommendations concerning the construction of coastal residential buildings – *Home Builders Guide to Coastal Construction* (http://www.fema.gov/media/fact_sheets/mitigation.shtm). The fact sheets present information aimed at improving the performance of buildings subject to flood and wind forces in coastal environments. Photographs and drawings illustrate National Flood Insurance Program (NFIP) regulatory requirements, the proper siting of coastal buildings, and recommended design and construction practices for building components, including structural connections, the building envelope, and utilities.

Communities using the NAI-level techniques organize more comprehensive education and outreach initiatives using the expertise of State and federal agencies such as NOAA Sea Grant, State Coastal Zone Management Programs, the National Estuary Research Reserves, the National Park Service, the Environmental Protection Agency, the Natural Resources Conservation Service, and the U.S. Army Corps of Engineers. Communities interested in doing

education and outreach can get support from their regional FEMA office, the State NFIP coordinator, the State Sea Grant program, and the State Coastal Zone Management Program. Staff from these offices may be able to help plan and conduct workshops, write articles for distribution to editors of local newspapers, and provide assistance with other outreach initiatives.

Disclosure of known flood, erosion, or other coastal hazard risks at the time of property transfer is an important educational effort consistent with an NAI attitude. Some States (such as Florida) have disclosure requirements. If a State requires disclosure for property in a flood or coastal hazard area, the seller is required to notify potential buyers of the risks and they can be factored into the purchase decision. If there is a shore protection structure on coastal property for sale, a State disclosure law could also require that prospective buyers be made aware of the issues surrounding such structures—their drawbacks, negative impacts, and the need for monitoring and maintenance. Educational literature from the agencies mentioned above can help sellers avoid transferring known adverse impacts that become unpleasant surprises to buyers.

CHAPTER 9. USING THE NAI PRINCIPLE FOR COASTAL HAZARD MANAGEMENT

This handbook has presented the concept of No Adverse Impact floodplain management and how it can be applied to the coastal area so that a community can build its disaster resilience and help establish long-term sustainability. In this last, final chapter, two fictional scenarios provide a more detailed and in-depth exploration of the applicability of NAI concepts for coastal communities.

The two examples presented in this chapter draw on the No Adverse Impact (NAI) building block information from Chapters 3 through 9. Both examples presume that basic and better floodplain management practices are already in use, so the discussion focuses on possible NAI-level applications. Both examples further assume that there will be an integration of NAI actions into existing hazard-related programs (described in Chapter 4).

For each example situation, there are a series of steps that correspond to the NAI building blocks mentioned in earlier chapters. The sequence of the steps explained here may not correspond to the order warranted in a given situation. NAI is a managing principle, an approach, a more effective way to tackle coastal hazards, not a set of procedures, standards, requirements, or practices (ASFPM, 2003). Both examples show that even projects located miles inland in a coastal watershed can do harm to shoreline neighbors, communities, and ecosystems.

EXAMPLE A: A MUNICIPAL WASTEWATER TREATMENT PLANT

City council members in an east coast city are concerned about the city's aging wastewater treatment plant. The plant sits by a harbor where a river runs to the sea and has little spare capacity for additional growth. During times of river floods or combinations of high tide and extreme storm surge, the plant has experienced some flooding and operational problems due to high water. The city council directs the public works staff to develop recommendations for replacing the wastewater treatment plant and adding enough treatment capacity to accommodate anticipated growth in the sewer service area. The directed planning horizon extends to 2060.

There are three feasible sites for a new wastewater treatment plant:

Site A. An old industrial site in the city next to the harbor. Little site remediation would be required and the site is outside of the existing floodplain.

Site B. An upland site at a higher elevation within the city near the harbor.

Site C. An upland site close to the city and on the coast.

The State and local floodplain managers are concerned that development in the city (including a new wastewater treatment plant) not encroach into the floodplain and be done in a way that lessens the city's vulnerability to future riverine and coastal natural hazard events. The MSD staff and the city floodplain managers are determined that a new or expanded plant neither worsen flood conditions for property owners in the city nor support (through extension of services) development into areas subject to future riverine and coastal hazards. City administrators are concerned about the legal liability implications of the extension of services.

The situation seems made to order for the NAI "do no harm" policy that "requires those who alter flooding conditions to mitigate the impact their actions have on individuals and adjacent communities" (Larson and Plasencia, 2001). City staff developed the following vision statement for the project to expand the plant.

NAI Vision Statement for Expansion of Wastewater Treatment Plant

"The wastewater collection and treatment facilities are adequate to handle the increased load as the service area grows through the year 2060. Adequate treatment continues without interruption and facilities are not flooded or otherwise damaged by anticipated flood events. Existing and new wastewater treatment facilities do not impede riverine or storm surge flood flow, storage, or drainage in the floodplain. Additions to the wastewater treatment plant collector system do not encourage development in areas subject to future hazards from natural riverine and coastal processes including sea level rise, subsidence and coastal erosion."

Hazard Identification and Mapping

The city has a well-documented history of river floods and coastal storms. Floodplain managers prepare a new flood study using future-conditions hydrology based on projections of watershed development. They are aware that the climate is changing and that future floods and storms may be more frequent and more intense than in the past. The staff considers a set of plausible future flood elevations above the base 100-year flood elevations of the National Flood Insurance Program (NFIP), including flooding from storm surges from a Category 5 hurricane approaching the city along various possible storm tracks.

Consultants are hired to help with the hazard evaluation. These consultants use computer models to simulate river flooding, storm surge, wave heights and wave run-up. The simulation models have sufficient resolution to model flow characteristics on individual parcels of land. Storm wave simulation is used to help evaluate the coastal site (Site C). Results are entered in the city's geographic information system (GIS). The influence of expanded existing and proposed wastewater treatment plant buildings on storm surge and flood flow around neighboring buildings and properties in the coastal floodplain is also examined. A range of scenarios is modeled that use various combinations of river flood, storm surge, sea level rise and wave heights. Some scenarios have simultaneous river flood and tropical storm events.

Results of the hazards identification and mapping work lead the staff to conclude that

- An updated watershed development plan is needed to account for changes in land use and climate expected throughout the 21st century;
- The present wastewater treatment plant adversely affects flood flow on adjoining properties during extreme flood and storm surge conditions compared to a baseline situation with no plant on the site. An expanded plant on the site makes the situation worse;
- The former industrial site (Site A) lies within a new floodplain area subject to both river floods and extreme storm surge during some possible Category 5 hurricanes;
- A new treatment plant on Site A would adversely affect flood flow on adjoining properties;

- The present treatment plant is vulnerable to serious flooding from some high intensity hurricanes and other extreme events;
- The upland site (Site B) is not in a future floodplain, based on the assumptions used in this study. A treatment plant at this site is less likely to adversely affect flood flow on adjoining properties;
- Coastal Site C is not likely to be vulnerable to flooding from storm surge and storm wave run-up before 2060. The site is vulnerable to erosion, however, and will need armored shore protection, meticulously maintained at an unknown cost. A wastewater treatment plant at this site is likely to adversely affect neighbors due to interference with sediment transport. Uncertainty about the future frequency and severity of storms as a result of a changing climate raises concerns regarding use of this site.

Planning

Concerns about the wastewater treatment plant are intertwined with many other interests and issues related to growth and sustainability of the city and the surrounding sewer service area. The interests and concerns are public and private, individual and corporate. The city staff creates an advisory committee to help them create a consensus-building, participatory process that considers economic development and ecological, cultural, historic, and aesthetic values in the planning process. The staff uses a multi-objective management (M-O-M) approach with the information from the hazards identification and mapping work to identify all of the hazards, all of the concerned parties, and all of the potentially adverse effects on others. All of the alternative measures to mitigate (avoid or reduce) adverse impacts are identified. As more information is gathered, more outreach is conducted to keep people informed.

The city staff and the advisory committee use sustainability principles in planning for the future of their wastewater treatment plant. Sustainability to them means passing along to the next generation of city managers and residents a plant and collector system they can use for years—not an inherited burden of a dysfunctional system that should have been replaced long before.

The city's principles of sustainability are used with the wastewater treatment plant vision statement to adopt these goals:

- Develop an expandable wastewater treatment system adequate to meet the city's needs until 2100;
- Develop a hazard-resistant wastewater treatment system that maintains performance during extreme weather events as the climate changes;
- Maintain the sustainability of adjoining properties; and
- Identify areas where sewer service should not be provided because of coastal hazards.

All the advantages and disadvantages of the optional sites for a new or expanded plant are considered. All concerns of the community are aired in public forums and in advisory committee meetings.

The city uses risk analysis to determine the threats (and opportunities) that could adversely (or favorably) affect achievement of the sustainability goals for the wastewater treatment plant and potentially affected properties.

The team analyzes

- Floodproofing and expanding the wastewater treatment plant on the present site;
- Building a new wastewater treatment plant on the upland site (Site B) outside of a future floodplain and beyond the reach of a Category 5 storm surge; and
- Building a new wastewater treatment site on coastal Site C.

The risk analysis will continue with the identification of construction and mitigation options and costs, and end with a preliminary judgment about each option.

Regulations and Development Standards

A 0.2% annual chance (500-year) river flood and a 0.2% annual chance storm surge are adopted for all critical facilities in the city exposed to the identified hazards. The city staff did hazard identification, mapping, and planning using a set of future-conditions scenarios for the watershed, harbor, and coast that seem reasonable and defensible as a basis for siting new development. Issues under consideration include:

- How best to create additional flood storage capacity in the watershed upstream of the city and in the coastal floodplain between the city and the sea without damaging important, critical habitat that needs to be preserved; and
- The extent to which the NAI tools of planned development and Transfer of Development Rights are needed to increase flood storage capacity and reduce stormwater runoff in the upstream watershed and increase storm surge capacity in the coastal floodplain.

Acceptance of new development standards by upstream communities will reduce some of the uncertainty about future conditions and help the city staff make risk management plans for the wastewater treatment plant and other critical facilities likely to be positively affected by such flood mitigation efforts.

Mitigation

The hazard identification and risk analyses of the upstream watershed and the four possible wastewater treatment plant sites revealed that the plant's system will have some vulnerability to hazards and that the plant's operation and siting will have adverse impacts on the neighbors at some of the possible sites. The city staff studies how each situation might be mitigated. With the aid of consultants, they investigate

- Mitigation of future flooding of the existing expanded wastewater treatment plant at the existing site;
- Mitigation of future flooding of a new wastewater treatment plant at Site A;
- Mitigation of adversely affected flood flow on properties adjoining the sites during record floods or extreme storm surge;
- Mitigation of erosion that would threaten a wastewater treatment plant at coastal Site C and mitigation of adversely affected sediment transport to distant beaches; and
- The feasibility of establishing a stormwater utility and fee structure to provide funds that can be used to reduce flooding and provide the local match on federal mitigation projects.

The city identifies residual risks that will remain after mitigation measures have been taken. The overall impact of residual risks on the project is estimated. An action plan is drawn up for every option.

Education and Outreach

The consultants prepare displays and help the city staff make presentations to city administration and council members, and in several public forums. One purpose of this work is to make people aware of the situation: the need to do something about the wastewater treatment plant in light of the capacity limitations and the flood and storm hazards facing the city. An equally important purpose is to set the stage for creating a consensus-building, participatory process in deciding what to do about the plant. Education and outreach will play a role in communicating work done during each of the remaining NAI steps as the city staff informs people of options and seeks their support for recommendations to be made.

Infrastructure

Acquisition of land for public purposes in the upstream watershed gains community support as a tool to insure increased flood storage capacity even though it is not likely to be needed for several decades or more. Maintaining or acquiring public or private green space in the coastal floodplain is a favored mitigation option for flood flow impacts that the wastewater treatment plant will have at the existing site and Site A.

The city staff is aware that there may be changes in the tracks, frequency, and severity of storms as a result of climate change. This uncertainty leads them and their advisory committee to recommend adoption of a 0.2% annual chance (500-year) flood and storm surge elevations for the wastewater treatment plant options and for other critical facilities to be modified or replaced in the future. The new standard will be reviewed periodically as more knowledge is gained about climate change and as experience is gained with future extreme events.

Emergency Services

The city reviews the mitigation strategy for each wastewater treatment plant option and determines the emergency response plan needed for each option.

The city staff and the advisory committee evaluate suggestions for improving wastewater treatment plant preparedness for extreme flood and storm events and for recovery from such events. The city begins to participate in the NOAA National Weather Service's StormReady and TsunamiReady programs to improve the timeliness and effectiveness of hazardous weather warnings to emergency responders and the public. The hazard preparedness planning includes pre-planning, post-disaster response, and recovery operations for the plant for each site.

Once a wastewater treatment plant option has been selected, city management establishes accountability for risk management by assigning responsibilities to appropriate staff.

Resources are obtained and training is provided. Risk management becomes a conscious, ongoing part of mainstream management of the wastewater treatment plant. Uncertainty about future development and watershed changes, future storminess, and other aspects of climate change motivates the vigilant monitoring needed for risk management of critical facilities for which the city is responsible.

EXAMPLE B: A COASTAL COMMUNITY ON THE GULF OF MEXICO

A city located on the Gulf of Mexico suffered damage from several hurricanes over the past century but was spared the devastation brought to other Gulf Coast communities by Hurricanes Katrina and Rita in 2005. However, the havoc caused by those hurricanes raised doubts about the city's capacity to prepare for a major hurricane, and recover after it departs.

Critics claim that the city's long-range plan with its implied commitment of city services encourages development into low areas that are vulnerable to hurricane storm surge and storm waves. Concerns have been raised about the city's vulnerability and the long-term sustainability of a significant portion of the city and its surrounding landscape and ecosystem.

A large river flows through the city and a large estuarine wetland to the sea. Barrier beaches, barrier islands, and the wetlands provide some protection from hurricanes. However, the shorelands behind the beaches are developed; the barrier islands have been heavily damaged by hurricanes, and develop is encroaching into the wetlands. The land surface is stable and not subsiding. The river watershed extends upstream into other States, far beyond the influence of the city and region.

The city council requests that city staff study three principal questions:

- **The watershed development plan upstream of the city**: does it account for the possibility of a rapid sequence of storm surge followed by a storm system that stalls out somewhere over the upstream watershed? What changes are needed?
- **The city's development plan in the coastal plain**: does it make the city more vulnerable and less sustainable in the face of major hurricanes than the city is today? What improvements are needed?
- **The city's emergency response plan:** How good is the city's emergency preparedness, resistance to damage, and resilience? Can the city quickly return to full service after a major hurricane? What improvements are needed?

The council appropriates funds and directs the city staff to use the city's long-range development plan as the starting point for the study.

The city staff recruits an advisory committee of community members and a few council members to represent public, business, and private concerns and motivate the community to influence the evaluation and support efforts to implement recommended measures that might be developed. The committee is adamant about avoiding adverse impacts from the combination of human development and natural hazards that were evident after Hurricanes Katrina and Rita. The committee expresses concern about avoiding legal trouble for the city during the aftermath of such a disaster.

The committee is briefed on ASFPM's NAI approach, and recommends that the NAI approach be used. The city staff and the advisory committee develop an NAI vision.

A Community Vision Statement

"The National Hurricane Center forecasts a Category 5 hurricane that is likely to reach our coast and city in three days. The hurricane sweeps ashore. A high storm surge bearing large storm waves batters the coast and reaches into the city. There is no serious injury and loss of life

in our community. Property damage from high wind, flooding, and wave action is substantial but manageable. There is no major harm to neighbors from prior actions or inaction of property owners or the city. City services are interrupted but restored within three days after the hurricane winds have subsided."

Hazard Identification and Mapping

The city staff identifies all natural hazards that the community has experienced and might reasonably expect to experience. The city has experienced river flooding, hurricane storm surge, wind and waves, tornados (with hurricanes), and coastal erosion. The city staff seeks outside help to answer the council's three questions.

One of the consultants hired provides computer simulation modeling of river flood, storm surge, storm waves, and coastal recession for hazard mapping. The city's geographic information system (GIS) is utilized as the spatial and graphical foundation for this work. The models are used to:

- Simulate a nearly simultaneous river flood and hurricane storm surge from a Category 5 hurricane following various possible storm tracks on its approach to the city;
- Help estimate the cumulative impacts on the city's coastal defenses from deterioration of barrier islands, incremental development of the coastal plain, and encroachment on wetlands;
- Help investigate helpful and harmful alterations in storm surge and storm waves from new roadbeds and other new infrastructure in coastal areas planned for future development; and
- Locate and estimate the long-term losses of shoreland from coastal erosion and sea level rise.

The hazard identification and mapping work leads to the following conclusions:

- Category 5 hurricanes approaching on several possible storm tracks would create large storm surges, rapidly followed by river floods that would be catastrophic for portions of the city. The city's development plan does not address these scenarios;
- Past hurricane damage to barrier islands, human modifications of beaches and dunes, and human encroachment on wetlands have weakened and compromised the city's natural defenses from the power of a storm surge and storm waves like those that came ashore with Hurricanes Katrina and Rita. The paths of those hurricanes were favorable to the city and luck was the city's primary defense;
- The present development plan for the coastal plain will place new neighborhoods at risk from damage and destruction by hurricane storm surge and storm waves. There is some indication that storm surge will become more focused and amplified as development continues, with a long-established neighborhood and adjacent industrial area bearing the brunt of the increased damage; and
- The majority of buildings within the city do not meet modern wind resistance requirements.

Estimates are obtained from U.S. Environmental Protection Agency and U.S. Geological Survey reports posted on agency websites about the present rate of sea level rise in the region.

Planning

From the work done to identify and map hazards, it is apparent that the existing river Base Flood Elevations (BFEs) are inadequate and need to be raised. The city's long-range development plans for the upstream watershed and the coastal plain need to be scrapped and re-written. A long-range natural coastal hazards plan needs to be written. A plan for retrofitting buildings to improve their resistance to hurricane winds needs to be developed. The advisory committee insists that new plans include provisions for avoiding adverse impacts on neighbors. During the hazards work, a number of potentially adverse neighbor-to-neighbor and city-to-neighborhood impacts were identified.

The city staff adopts a multi-objective-management (M-O-M) approach with the advisory committee and holds some town meetings to bring more participants into the planning process—people who represent the diverse, long-term interests of the community; those who live, work and recreate here. More objectives are added and the vision statement is revised to include smart growth and sustainability.

Sustainability becomes a critical issue in the planning effort. To guide the planning, floodplain management and coastal zone management practices are adopted that follow these six principles of sustainability:

- Maintain and, if possible, enhance, residents' quality of life;
- Enhance local economic vitality;
- Ensure social and intergenerational equity;
- Maintain and, if possible, enhance environmental quality;
- Incorporate disaster resilience and mitigation into daily local and regional land use decision making; and
- Use a consensus-building, participatory process when making decisions.

In this participatory process, the city staff makes sure that discussion is not confined to the competing present concerns, but includes consideration of the perceived needs of future generations who are not participating in this planning.

Regulations and Development Standards

Possible changes to regulations and development standards are drafted and revised through negotiation, debate, and consensus-seeking discussions between disparate representatives of the various interests in the city, upstream watershed, and coastal plain. This effort is aided by a shared desire to realize the accepted NAI vision statement.

The city staff reviews relevant reference materials including the Federal Emergency Management Agency's *Coastal Construction Manual* and the American Society of Civil Engineers' *Flood Resistant Design and Construction*. The city staff investigates several possible measures that address the issue of record floods approaching the city from the extensive and distant watershed upstream. One possibility is a new flood elevation based upon a revised 0.2% annual chance (500-year) flood. Another possibility is major acquisition of upstream watershed property for flood storage or bypass around the city. A third possibility is a new initiative to obtain inter-State and regional cooperation of developers in protecting natural areas that provide

a vital flood storage function, and using all reasonable measures for intercepting surface water runoff from developing properties. The biggest challenge is to draft regulations and development standards to protect against damage from storm surge and storm waves generated by a Category 5 hurricane approaching on several possible storm paths. Draft regulations and development standards are written for presentation to decision makers.

Mitigation

Facilities in the coastal floodplain with functions that affect many people (such as infrastructure) receive the most attention and get the highest priority in the mitigation discussions. Revising the coastal development plan is a top priority and alternative approaches are reviewed for lessening the city's exposure to risk from coastal hazards.

The hazard identification work identified some adverse impacts of existing and planned development in the coastal plain. Storm surge simulation showed that a river levee and railroad and roadway embankments crossing a wetland and other portions of the coastal floodplain focused and funneled storm surge flow toward a city neighborhood, or provided some useful buffering of storm waves, depending on the orientation of the structure to the surge and direction of the waves. The existing development plan shows more of these raised roadways.

The hazard identification work also identified hurricane damage to barrier islands and human modifications of beaches and dunes as contributing to the weakening of the city's coastal defenses.

Mitigation options are identified for the coastal plain that include:

- Piling-supported roadways over wetlands and selected other portions of the floodplain to eliminate the roadway embankments focusing and funneling effect on the storm surge. Removal of portions of the embankment of the abandoned rail line;
- Removal of embankments crossing wetlands and restoration of wetlands to include their natural floodwater storage function;
- Public acquisition and restoration of barrier islands;
- Public acquisition of private property and structure demolition in the coastal floodplain to expand its storm surge dissipation and flood storage capacity;
- An increased setback for new structures along actively eroding portions of the shore; and
- A new policy on shore protection structures that limits them to a "last resort" option with "do no harm" requirements for design and monitoring.

Infrastructure

Infrastructure in the riverine and coastal floodplains and in the city receives special attention because the roads, bridges, water, power, wastewater treatment, parks, public buildings, and other facilities are vital to the life of the city. Hurricane Katrina provided examples of the cascading impacts of a catastrophic hurricane on the intricate, interdependent activities in neighboring Gulf Coast communities.

An inventory is made of all infrastructure, including public buildings and critical facilities; facilities that are vital to maintaining or restoring normal services, facilities that are

critical to public health and safety, and facilities that produce, use, or store dangerous materials. The 0.2% annual chance river flood and the worst-case storm surge/storm wave combination from a Category 5 hurricane are adopted as the standard hazards for new and existing critical infrastructure.

A capital improvements plan is developed that includes a schedule for the staged replacement, or relocation of infrastructure believed to be vulnerable to flooding, erosion, and other identified hazards.

A recommendation is considered and debated within the advisory committee to refrain from extending city services into undeveloped floodplain land or into erosion hazard areas in order to discourage intensive development in these areas. Such areas are viewed as prime candidates for acquisition and public use as parks, greenways, and for restoration to natural habitat.

The road network is studied to identify vulnerable areas where flooding or erosion and road closure might create transportation bottlenecks and blockages. Major roads, routing procedures, and signage are evaluated for their adequacy when mandatory evacuations are ordered in advance of a hurricane.

Emergency Services

The city staff obtains the services of an emergency management consultant to satisfy the city council's request for an evaluation of the city's emergency preparedness, state of resilience in quickly returning to provision of full services, and identification of needed improvements.

The GIS system and simulation modeling are used to show areas of the upstream watershed, city, and coastal floodplain that will be inundated by river flood or storm surge, stages, and tsunami wave inundation. A series of training sessions is begun for emergency responders in order to rehearse the sequence and timing of the steps needed to adequately respond to each of the identified coastal hazards. In these training sessions, readiness for pre-disaster preparations and post-disaster responses will be periodically assessed and corrective actions taken as needed. Each of these hazards has its own advance warning time and duration.

The consultant recommends

- Participation in the National Weather Service's StormReady and TsunamiReady programs to improve the timeliness and effectiveness of hazardous weather warnings to emergency responders and the public;
- Relocation of the city's emergency operations center; and
- Adoption of a risk analysis and management process.

A risk process manager is hired by the city and made an active member of the city management team. A risk management team is assembled from the city's department managers. The risk process manager initiates a series of periodic risk reviews. A risk mitigation strategy and risk response plans are developed. Individuals are assigned responsibility for specific tasks and charged with making adequate pre-disaster preparations and adequate post-disaster responses. Changes in risk exposures are monitored and the strategy and plans updated as warranted by such changes or by the occurrence of risk events, such as hurricanes, river floods, and unanticipated erosion.

Risk management becomes a conscious, ongoing part of city management. Risk management is extended to the management of the entire city's infrastructure. The working relationship on the risk management team and the work itself become preparation for future participation in a post-disaster redevelopment plan, should a disaster strike. A seasoned, well-informed team will be needed that can work under the pressure of public expectations for a quick recovery after a hurricane or flood.

Education and Outreach

The city staff takes FEMA's *Coastal Construction Manual* training in a two-day short course held in a major city nearby. The training helps the staff understand the rationale and the measures available and needed to retrofit the city's vulnerable buildings to make them more resistant to hurricane winds. Sea Grant specialists will help city staff conduct education and outreach to help residents understand the rationale for revised or new plans, regulations, and standards that are developed. They can also help establishing outreach partnerships with appropriate community organizations. Staff make a concerted effort to encourage public participation in the decision-making process.

CONCLUSION

The scenarios presented in this handbook demonstrate how States and communities can take advantage of innovations and ideas that have been successful elsewhere. These fictional coastal communities have been pro-active in their efforts to be responsive to the needs of all of their constituents, to protect the Public Trust, and to be good neighbors—all while reducing the vulnerability of their residents to coastal hazards.

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APPENDIX A. GLOSSARY AND ACRONYMS

A-ZONE—the Special Flood Hazard Area shown on a community's Flood Insurance Rate Map where no base flood elevation is provided

A1—A30 ZONES—Numbered A-Zones (e.g., A2 or A23). Special Flood Hazard Areas where the Flood Insurance Rate Map shows a base flood elevation in relation to National Geodetic Vertical Datum (NGVD).

AE-ZONE—the Special Flood Hazard Area where base flood elevations are provided. AE-Zone delineation is now used on new Flood Insurance Rate Maps instead of A# Zones.

ASCE—American Society of Civil Engineers

ASFPM—Association of State Floodplain Managers

BASE FLOOD—the flood having a 1-percent chance of being equaled or exceeded in any given year (one hundred-year flood) (Schwab et al., 1998). The BASE FLOOD has been adopted by the National Flood Insurance Program as the basis for mapping, insurance rating, and regulating new construction.

BASE FLOOD ELEVATION—the elevation in relation to sea level or other datum of the crest of the base flood

BEACH-A geological formation consisting of loose rock particles such as sand, gravel, shingle, pebbles, cobble or even shell along the shoreline of a body of water

BFE—Base Flood Elevation

BLUFF-A high, steep bank as by a river or the sea, or beside a ravine or plain; a cliff with a broad face

BMP—Best Management Practices

CBRA—Coastal Barrier Resources Act

CBRS—-Coastal Barrier Resources System

CCCL—Coastal Construction Control Line

CFR—Code of Federal Regulations

CHENIER—former beach ridge now surrounded by marsh (Kniffen and Hilliard, 1988)

CRS—Community Rating System

CTP—Cooperating Technical Partner

CZM—Coastal Zone Management

CZMA—Coastal Zone Management Act

COASTAL EROSION—the wearing away of land or the removal of beach or dune sediments by wave action, tidal currents, wave currents, or drainage
http://www.texasep.org/html/lnd/lnd_7bch_defs.html

The wearing away of coastal lands, usually by wave attack, tidal or littoral currents, or wind. Coastal erosion is synonymous with shoreline (vegetation line) retreat.
http://www.soest.hawaii.edu/SEAGRANT/bmpm/glossary.html

Coastal erosion is a process which affects the landmass of an area as a consequence of the sea acting upon it. Most often the primary causative factor is tidal erosion of the landmass.
http://en.wikipedia.org/wiki/Coastal_erosion

COASTAL STATE—a State of the United States in, or bordering on, the Atlantic, Pacific, or Arctic Ocean, the Gulf of Mexico, Long Island Sound, or one or more of the Great Lakes. For the purposes of the Coastal Zone Management Act (16U.S.C.A.§§1451 to 1465), the term also includes Puerto Rico, the Virgin Islands, Guam, the Commonwealth of the Northern Mariana Islands, and the trust Territories of the Pacific Islands, and American Samoa (16U.S.C.A.§1453.(4)).

COASTAL WATER DEPENDENT USES—those which must be carried out on, in or adjacent to coastal water areas or wetlands because the use requires access to the water body or wetlands or requires the consumption, harvesting or other direct use of coastal resources, or requires the use of coastal water in the manufacturing or transportation of goods. Examples include surface and subsurface mineral extraction, fishing, ports and necessary supporting commercial and industrial facilities, facilities for the construction, repair and maintenance of vessels, navigation projects, and fishery processing plants.

COASTAL WATERS—those bays, lakes, inlets, estuaries, rivers, bayous, and other bodies of water within the boundaries of the coastal zone which have measurable seawater content (under normal weather conditions over a period of years)

COASTAL ZONE—coastal waters (including the lands therein and there under) and the adjacent shorelands (including the waters therein and there under) strongly influenced by each other and in proximity to the shorelines ....”(16U.S.C.A. §1453. (1). The inland extend of the coastal zone is from the shoreline only as far as necessary to control shorelands, the uses of which have a direct and significant impact on the coastal waters and to control those geographical areas which are likely to be affected by or vulnerable to sea level rise (16U.S.C.A.§1453.(1)).

COASTAL ZONE MANAGEMENT—the process for providing "for the best long-term sustainable use of coastal natural resources and for perpetual maintenance of the most beneficial natural environments." (Clark, 1996, p. 25) Through management coastal States provide for "sustainable use of resources, biodiversity preservation, protection against natural hazards, pollution control, enhancement of welfare, development of a sustainable economy, and optimum multiple use." (Clark, 1996, p. 25)

COASTAL ZONE MANAGEMENT PROGRAM—includes, but is not limited to, a comprehensive statement in words, maps, illustrations, or other media of communication, prepared and adopted by the State in accordance with the provisions of Chapter 33—Coastal Zone Management, setting forth objectives, policies, and standards to guide public and private uses of lands and waters in the coastal zone (16U.S.C.A. §1453. (12))

COMMUNITY—a city, village, town, county, parish, or other governmental body with the statutory authority to enact development regulations, floodplain regulations, and participate in the National Flood Insurance Program

COMMUNITY RATING SYSTEM – a program that provides a flood insurance premium rate reduction from 5% to 45% based on a community's floodplain management activities. FEMA, 2004a also provides contact information for the State NFIP Coordinating Agency (FEMA, 2004a).

COOPERATING TECHNICAL PARTNER—communities, regional agencies, or States with the interest and capability to be an active partner in FEMA's flood mapping program. Cooperating Technical Partners enter into an agreement that formalizes their contribution and commitment to flood mapping. (FEMA and LDOTD, 2005).

CORRECTIVE MEASURES – activities that address existing flood problems, such as flood control structures (dams, levees, walls, channel modification) and evacuation, flood proofing, or urban development (TVA, 1983)

CRITICAL FACILITIES—type and location of police stations, fire and rescue facilities, hospitals, shelters, schools, nursing homes, water supply and waste treatment facilities, and other structures the community identifies as essential

DHS—Department of Homeland Security

DIRECT EFFECTS—1. Impacts that are caused by the action and occur at the same time and place (40 CFR 1508.8). May also be called primary impacts and applies to both adverse and beneficial impacts. 2. Are caused immediately by the event itself, such as a bridge washing out during a flood (FEMA, 2001a).

DMA 2000—Disaster Mitigation Act of 2000

DRY FLOODPROFFING-Sealing a building to ensure that it is watertight and impermeable to floodwaters. Normally dry floodproofing is applied to building entrances, windows and equipment rooms located inside a building for protection from flooding.

EO—Executive Order

EXTRATROPICAL CYCLONES—winter storms or typical low pressure areas (http://www.ndbc.noaa.gov/educate/tropstrm.shtml)

FEMA—Federal Emergency Management Agency

FETCH-An area of the water surface over which waves are generated by a wind having a constant direction and speed. Also the name given to the length of the fetch area, measured in the direction of the wind from which the seas are generated (source: The Weather Channel website).

FHBM—Flood Hazard Boundary Map

FIA—Federal Insurance Administration

FIRM—Flood Insurance Rate Map

FIS—Flood Insurance Study

FLOOD—a general and temporary condition of partial or complete inundation of two or more acres of normally dry land area or of two or more properties from overflow of inland or tidal waters, from unusual and rapid accumulation or runoff of surface waters from any source, or from mudflow (FEMA, 2001b) [notice how FEMA placed conditions on its definition, which omits smaller floods]

FLOOD FRINGE—areas outside the regulatory floodway but still inundated by the designated one percent annual chance flood (often referred to as the floodway fringe)

FLOOD INSURANCE RATE MAP (FIRM)—is the map used by nearly all 20,000 flood prone communities in the nation, which displays shaded areas in the community that are subject to flooding. Flood insurance rates are based on risk of the various areas shown on the map. In addition, most community's regulations are tied to the different risk zones shown on that map. FIRMs may be ordered or viewed on the internet by contacting: www.fema.gov and clicking on The FEMA Flood Map Store in the left column or by going directly to: FEMA Map Service Center

FLOODPLAIN (Flood-prone area)—any land area susceptible to being inundated by water from any source (Schwab et al., 1998).

FLOODPLAIN MANAGEMENT (FPM)—the operation of an overall program of corrective and preventive measures for reducing flood damage, including, but not limited to, emergency preparedness plans, flood control works, and floodplain management regulations (Schwab et al., 1998)

FLOODPLAIN MANAGEMENT MEASURES—an overall community program of corrective and preventive measures for reducing future flood damage. These measures take a variety of forms and generally include zoning, subdivision, or building requirements, and special-purpose floodplain ordinances (FEMA, 2001b).

FLOODPLAIN VALUES—the qualities of or functions served by floodplains which include but are not limited to: a) water resources values (natural moderation of floods, water quality maintenance, groundwater recharge); b) living resource values (fish, wildlife, plant resources and habitats); c) cultural resource values (open space, natural beauty, scientific study, outdoor education, archaeological and historic sites, recreation); and d) cultivated resource values (agriculture, aquaculture, forestry)

FLOODPROOFING—any combination of structural and nonstructural additions, changes or adjustments to structures which reduce or eliminate flood damage to real estate or improved real property, water and sanitary facilities, structures and their contents (44CFR59.1).

FLOODWAY—the channel of a river or other watercourse and the adjacent land areas that must be reserved in order to discharge the base flood without causing any cumulative increase in the water surface elevation. The floodway is intended to carry the dangerous and fast-moving water.

FMA—Flood Mitigation Assistance

FREEBOARD-A factor of safety usually expressed in feet above a flood level for purposes of floodplain management. “Freeboard” tends to compensate for unknown factors that could contribute to flood heights greater than that calculated for a selected size flood and floodway conditions such as urbanization, bridge openings and waves. (source: FEMA)

GROIN-Barrier-type structures that extend from the backshore into the littoral zone used to retard long shore transport of sediment in the littoral zone, generally constructed parallel to the shoreline. (Source: Floodplain Management Association)

HAZARD (1) —a source of potential danger or adverse condition (FEMA, 2002a)

HAZARD (2) —an event or physical condition that has the potential to cause fatalities, injuries, property damage, infrastructure damage, agricultural loss, damage to the environment, interruption of business, or other types of harm or loss.(FEMA, 1997; Schwab et al., 1998)

HAZARD EVENT—a specific occurrence of a particular type of hazard (FEMA, 2000a)

HAZARD IDENTIFICATION- the process of defining and describing a hazard, including its physical characteristics, magnitude and severity, probability and frequency, causative factors, and locations/areas affected (FEMA, 1997)

HAZUS-Acronym for "Hazards, U.S." a comprehensive geospatial mapping system developed by the Federal Emergency Management Agency which identifies natural and technological hazards for use in local risk assessment and emergency planning. HAZUS in its various forms is leading loss estimation software.

HMGP—Hazard Mitigation Grant Program

INCIDENT COMMAND SYSTEM (ICS)-An organizational structure for response to events including emergencies and large-scale disasters in which available personnel are assigned positions in Command, Operations, Planning, Logistics and Finance/Administration sections according to their experience and training, and work as a team under leadership of an Incident Commander or Unified Command element. ICS is the fundamental emergency response organization in use in the U.S. under the National Incident Management System (NIMS), originating in traditional practices of fire services and the military.

ICC—Increased Cost of Compliance

INDIRECT EFFECTS—1. Impacts that are caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable (40 CFR 1508.8). May also be called secondary impacts and applies to both adverse and beneficial impacts. 2. Usually, they involve interruptions in asset operations and community functions, also called functional use. For example, when a bridge is closed due to a flood, traffic is stopped, delayed or rerouted, which affects individuals, businesses, and public services, like fire and police departments that depend on the bridge for transportation (FEMA, 2001a, p. ix).

IPPC—International Panel on Climate Change

LIQUEFACTION—Temporary transformation of a soil mass of soil or sediment into a fluid mass. Occurs when the cohesion of particles in the soil or sediment is lost. Often triggered by seismic waves from an earthquake. For this condition to take place the pore spaces between soil particles must be at or near saturation. (http://www.physicalgeography.net/physgeoglos/l.html)

LITTORAL-Of or pertaining to the shore, especially the seashore (source: Floodplain Management Association).

MANUFACTURED HOME—a structure, transportable in one or more sections, which is built on a permanent chassis and is designed for use with or without a permanent foundation when attached to the required utilities. The term "manufactured home" does not include a "recreational vehicle."

MITIGATION—activities that can eliminate or reduce flood damage to existing or proposed land uses. Mitigation includes avoiding the impact altogether by not taking a certain action or parts of an action; minimizing impacts by limiting the degree or magnitude of the action and its implementation; rectifying the impact by repairing, rehabilitating, or restoring the affected environment; reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action; or compensating for the impact by replacing or providing substitute resources or environments (40 CFR Part 1508.20).

MITIGATION—means sustained action taken to reduce or eliminate long-term risk to people and property from hazards and their effects. Mitigation to moderate or lessen potential significant impacts can be accomplished by specific design changes or commitments, restoration efforts, offsetting measures, timing of actions, or planning and development commitments. Mitigation distinguishes actions that have a long-term impact from those that are more closely associated with preparedness for, immediate response to, and short-term recovery from a specific event. (FEMA, 1997)

MITIGATION MEASURES—actions that can be taken to reduce property damage and the threat to life and public health from flooding and other hazards

MULTI-OBJECTIVE MANAGEMENT (MOM)-As a flood management practice, Multi-Objective Management promotes use of floodplains for multiple purposes including recreation, transportation, drainage, economic development, fish and wildlife habitat, and water quality among others. Often MOM is stated as a major local or regional planning objective.

MSL—Mean Sea Level

NAI—No Adverse Impact, a floodplain management doctrine which states that actions of property owners or government shall not adversely affect adjacent or downstream property owners through increase of the flood risk to the adjacent owner.

NAS—National Academy of Sciences

NAVD—North American Vertical Datum of 1988 (replacing NGVD of 1929)

NATURAL HAZARD—an extreme event in nature that adversely affects human life, property, or activity (Lander, et. al., 1997)

NATIONAL INCIDENT MANAGEMENT SYSTEM-A program for integrating local, State and federal emergency response activities operated under authority of the U.D. Department of Homeland Security. Established by Homeland Security Presidential Directive 5 in 2003, NIMS uses the Incident Command System as a command and management structure and includes preparedness, resource management, communication and information management, supporting technologies and ongoing maintenance as key elements.

NEP—National Estuary Program

NFIP—National Flood Insurance Program

NGVD—National Geodetic Vertical Datum of 1929

NHC—National Hurricane Center

NOAA—National Oceanic and Atmospheric Administration

NONSTRUCTURAL MEASURES—the people approaches that address the susceptibility of people to flooding or modify the impacts of flooding.

- Acquisition and relocation
- Floodplain regulations and building codes
- Development and redevelopment policies
- Floodproofing and elevation in place
- Disaster preparedness and response plans
- Flood forecasting and warning systems
- Information and education
- Flood insurance
- Tax Adjustments
- Flood emergency measures
- Disaster assistance
- Post-flood recovery
- Preservation and restoration strategies to manage natural and cultural resources of the floodplain

NOR'EASTER—low pressure systems that move along the eastern seaboard, picking up moisture from the Gulf Stream as they move from the central state to the northeast. There, the storm drops the accumulated moisture in the form of heavy rain or snow.

Severe flooding and erosion can be associated with the rains, winds, and waves that are part of this type of storm system. (FEMA, 2000b, p. A-10).

NOS—National Ocean Service

NPDES—National Pollutant Discharge Elimination System

NRCS—Natural Resources Conservation Service

NWS—National Weather Service

OCRM—Office of Ocean and Coastal Resource Management (National Ocean Service)

O&M—Operation and maintenance

ONE-PERCENT ANNUAL CHANCE FLOOD—a flood of the magnitude that has a one-percent chance of being equaled or exceeded in any given year. Often referred to as the "100-year" flood or base flood, the one-percent annual chance flood is the standard most commonly used for floodplain management and regulatory purposes in the United States.

PERSON(S)—means any person; any corporation, individual; association, or other entity organized or existing under the laws of any State; the federal government; any State, regional, or local government; or any entity of any such federal, State, regional, or local government (16U.S.C.A.1453.(14))

PREVENTIVE MEASURES—activities that address potential future flood problems, such as flood insurance, zoning ordinances, subdivision regulations, open space, or tax adjustments (TVA, 1983)

REGULATORY FLOODWAY—the channel of a river or other watercourse and the adjacent land areas that must be reserved in order to discharge the base flood without cumulatively increasing the water surface elevation more than a designated height (Schwab et al., 1998)

REGULATORY FLOODWAY—the stream channel plus that portion of the over banks that must be kept free from encroachment in order to discharge the 1-percent-annual-chance flood without increasing flood levels by more than 1.0 foot (some States and many communities specify a smaller, (often zero) allowable increase) (FEMA, 2001b)

RIP-RAP A flood protective measure involving construction of tiered concrete or other abutments in a river or stream embankment to reduce water velocity.

RISK—the estimated impact that a hazard would have on people, services, facilities, and structures in a community; the likelihood of a hazard event resulting in an adverse condition that causes injury or damage. Risk is often expressed in relative terms such as a

high, moderate, or low likelihood of sustaining damage above a particular threshold due to a specific type of hazard event. It also can be expressed in terms of potential monetary losses associated with the intensity of the hazard (FEMA, 2001a, p. a-6).

SAMP—Special Area Management Plan

SCS—Soil Conservation Service

SEA LEVEL CHANGE—the long-term trend in MEAN SEA LEVEL. An increase in the mean level of the ocean. Eustatic sea level rise is a change in global average sea level brought about by an alteration to the volume of the world ocean. Relative sea level rise occurs where there is a net increase in the level of the ocean relative to local land movements. Climate modelers largely concentrate on estimating eustatic sea level change. Impact researchers focus on relative sea level change. (http://www.weather.gov/glossary/).

SETBACK — a required minimum distance that a structure must be positioned from a lot line, river channel, or other feature (FEMA and LDOTD, 2005)

SFHA — Special Flood Hazard Area

SPECIAL FLOOD HAZARD AREA (SFHA)—an area of land that would be inundated by a flood having a 1-percent chance of occurring in any given year (also referred to as the base flood or 100-year flood) (FEMA, 2001b)

STILL WATER LEVEL—the surface of the water if all wave and wind action were to cease. In deep water this level approximates the midpoint of the wave height. In shallow water it is nearer to the trough than the crest. Also called the undisturbed water level. (http://www.csc.noaa.gov/text/glossary.html)

STORM SURGE—rise of water surface above normal water level on the open coast due to the action of a wind stress and atmospheric pressure on the water surface (FEMA, 2000a, Vol. III, Appendix B. Glossary)

STRUCTURAL MEASURES represent engineered approaches and include the following corrective measures:

- Dams and reservoirs
- Dikes, levees, and floodwalls
- Channel alterations
- High flow Diversions and spillways
- Land treatment measures

SUBSIDENCE—1. The long term sinking of land level due to withdrawal of groundwater, draining of organic soils, or other reasons. (FEMA and LDOTD, 2005); 2. The loss of surface elevation due to the removal of subsurface support. (FEMA, 1997).

SUBSTANTIAL DAMAGE—damage of any origin sustained by a structure whereby the cost of restoring the structure to its before-damaged condition would equal or exceed 50 percent of the market value of the structure before the damage occurred. (FEMA and LDOTD, 2005)

SUBSTANTIAL IMPROVEMENT-Any repair, reconstruction or improvement of a structure, the cost of which equals or exceeds 50 percent of the market value of the structure either a) before the improvement or repair is started, or b) if the structure has been damaged, and is being retired, before the damage occurred.

TRANSFER OF DEVELOMENT RIGHTS (TDR)—A land-use planning mechanism by which development rights are transferred from areas designated for protection (sending zones) to areas designated for future growth (receiving zones). TDRs allow for growth in communities while maintaining rural or open space values.

TSUNAMI—an ocean wave produced by a submarine earthquake, landslide, or volcanic eruption. These waves may reach dimensions and have sufficient energy to travel across entire oceans. (http://www.weather.gov/glossary/)

USACE—U.S. Army Corps of Engineers

USGS—U.S. Geological Survey

V-ZONE—the Coastal High Hazard Area. Under the National Flood Insurance Program, an area of special flood hazard that extends from offshore to the inland limit of a primary frontal dune along an open coast and any other area subject high-velocity wave action from storms or seismic forces. On Flood Insurance Rate Maps, the Coastal High Hazard Area is designated Zone V, VE, or V1-V30. (FEMA, 2000a, Vol. 3, Glossary). These V-Zones correspond to A-Zone designations.

V-ZONE—areas along coasts subject to inundation by the 1-percent-annual-chance flood event with additional hazards associated with storm-induced waves Because detailed hydraulic analyses have not been performed, no base flood elevations or depths are shown. Mandatory flood insurance purchase requirements apply. (FEMA, 2004a)

VE and V1-V30 ZONES—areas along coasts subject to inundation by the 1-percent-annual-chance flood event with additional hazards associated with storm-induced velocity wave action. Base flood elevations derived from detailed hydraulic analyses are shown within these zones. Mandatory flood insurance purchase requirements apply (Zone VE is used on new and revised maps in place of Zone V1-V30). (FEMA, 2004a)

VARIANCE—a grant of relief by a community from the terms of a land use, zoning, building, code regulation, or flood damage prevention ordinance

WATERSHED—an area that drains into a lake, stream, or other body of water.

WAVE CREST—(1) the highest part of the wave. (2) That part of the wave above still water level.

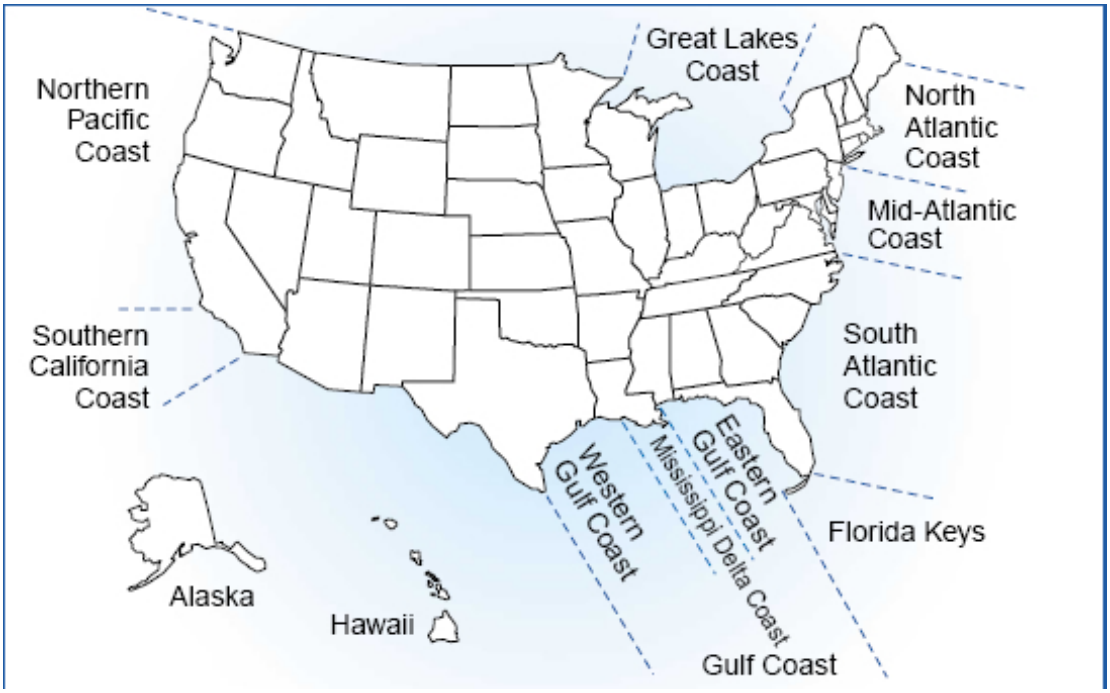
WAVE RUNUP—rush of wave water up a slope or structure (FEMA, 2000a, Vol. III, Appendix B. Glossary).

WET FLOODPROOFING—protecting a building from flood damage by using flood-resistant materials below the flood level and elevating things subject to flood damage above the flood level. (FEMA and LDOTD, 2005)

WMO—World Meteorological Organization

APPENDIX B. COASTAL LANDSCAPES OF THE UNITED STATES

The coastlines of the United States can be divided into major geographic segments, based on similar geological origins, natural characteristics, and hazards (see map) (FEMA, 2000a). Each geographic segment has a different combination of natural features that influences the local ecology, type of hazards that can occur, and the characteristics of the flooding, and the vulnerability of human development.



United States Coastline

The North Atlantic Coast

The North Atlantic coast (Maine to Long Island, New York) is deeply indented. In northern New England, glacial processes left **erosion**-resistant rocky **headlands** and pocket beaches that separate deep, riverine **embayment**. Offshore lie many islands created as a result of glaciers. The area has tidal ranges from 1 to 11 feet. From southern New England to New York City the coasts include erodible glacial bluffs, **estuaries**, and sandy **barrier islands**. Coastal ponds and wetlands lie behind short **barrier beaches**. High storm surges, coastal flooding, and shoreline erosion result from tropical storms, hurricanes, and extra tropical storms (**Nor'easters** and winter storms). Wave run-up on steeply sloping beaches and shorelines causes coastal

flooding and erosion. Rising sea level will increase flooding and erosion along the gently sloping beaches of Massachusetts.

The Mid-Atlantic Coast

The Atlantic coastal plain is characterized by an almost continuous line of barrier islands, beaches, sand spits, and a few large embayments, such as the Delaware Bay and Chesapeake Bay estuaries. Long, low barrier islands are separated by tidal inlets and bay entrances. Behind the barrier islands are extensive **wetlands** and ponds. High **storm surges**, coastal flooding, and shoreline erosion are caused by tropical storms, hurricanes, and extra tropical storms (Nor'easters and winter storms).

The South Atlantic Coast

The South Atlantic coast (North Carolina to South Florida) is divided into three regions:

- The coasts of North Carolina and northern South Carolina—Shorelines include mainland beaches and a series of long barrier islands sheltering salt marshes. Numerous tidal inlets separate the islands and connect the sounds to the ocean. The Outer Banks of North Carolina and the Grand Strand of South Carolina are the best-known features.
- The coast from Charleston, South Carolina, to the St. Johns River entrance at Jacksonville, Florida—Tides dominate this coast, which is composed of numerous short barrier islands, separated by large tidal inlets and backed by wide tidal marshes.
- The east coast of Florida—Barrier and mainland beaches are prevalent, interrupted in places by limestone reef outcrops, and backed by narrow bays, salt marshes, and rivers. Towards the southern end of the Florida peninsular are carbonate (coral) shores and mangrove forests.

All three regions of the Mid-Atlantic Coast are affected by high storm surge, waves, coastal flooding, and shoreline erosion resulting from extra tropical and tropical storms (particularly hurricanes). Rocky or cohesive shores retreat irreversibly under wave attack. Sandy coasts retreat and advance in response to storms.

The Florida Keys

The Florida Keys are a series of low-lying islands composed of limestone and reef rock. Narrow carbonate beaches are intermittent and reefs protect many of the islands from the full force of the open ocean. Surge from tropical storms and hurricanes wash over the islands resulting in coastal flooding and erosion. The Labor Day Storm of 1935 that made landfall on the Keys held the dubious honor of the having the lowest recorded barometric pressure of any Atlantic hurricane (892 mb) until Hurricane Wilma in 2005 (882 mb). Of the more than 400 deaths in 1935, many were Civilian Conservation Corps youths who drowned because they were not evacuated before the hurricane.

The Eastern Gulf Coast

The Eastern Gulf Coast (southwest Florida to Mississippi) is a region of low-lying sandy barrier islands south of Tarpon Springs, Florida, and west of St. Marks, Florida, to Mississippi. Between these two segments of the eastern Gulf Coast, the Big Bend area of Florida is a wetland-dominated environment. Hurricanes, the accompanying winds and tornadoes, and storm surge are the primary hazards. The wide, shallow continental shelf and low-lying uplands make the Big Bend area especially vulnerable to flooding. This region has the highest hurricane surge potential on any coast of the United States. Hurricane Katrina in 2005 pushed storm surges of over 28 feet onto the Mississippi coast, exceeding the storm surges of Hurricane Camille in 1969 by more than 10 feet at some locations. Common to all storms are pieces of debris (demolished buildings, unsecured materials, trees, docks, cars, and structures) that act as battering rams to damage and destroy anything in their path.

The Mississippi Delta

The Mississippi River of southeast Louisiana is a deltaic plain of low elevation and low relief. Like the Mississippi counties, this part of the north-central Gulf of Mexico shoreline experiences frequent landfall of hurricanes and tropical storms. Storm surges may exceed 14 feet across the barrier islands and surge levels of 13 feet (USACE, 1972) have been reported 40 miles inland. Barrier islands and beaches suffer shoreline erosion.

Estuarine wetlands are disappearing rapidly, exposing hurricane protection levees and development to the higher energy conditions of the open Gulf. The causes of wetlands loss are numerous, including natural regional and local human-induced subsidence, insufficient freshwater and sediment from the Mississippi River, saltwater intrusion along navigation and access canals, hurricane storm surge, chronic barrier island retreat, and sea level change. The relative rate of sea level rise is exaggerated because the sea is rising at the same time the land is subsiding.

The Western Gulf Coast

The Western Gulf Coast includes the **chenier plains** of southwest Louisiana and east Texas and the coastal counties and long barrier islands of south Texas (see Appendix A). Low elevations and virtually no relief characterize the coastal zone that in places may be 20 miles wide. Wetlands are turning to open water as a result of saltwater intrusion and a hydrologic network that has been significantly disrupted by navigation and access canals and accompanying dredge spoil banks. Hurricane storm surges exceeding 16 feet at the shoreline wash over these lowlands and flood estuaries more than 35 miles inland with 4-6 foot surges. Heavy, concentrated precipitation results from hurricanes, stalled tropical storms, and frontal passage in the spring. Consequently, flooding is a significant problem even for development that is miles inland.

Hurricanes and tropical storms push storm surges and high water onto the low-lying coastal plains. When combined with subsidence and wetlands loss, the threats from coastal flooding are severe and increasing.

The Southern California Coast

The Southern California coast (San Diego County to Point Conception in Santa Barbara County) is varied, with some wide, sandy beaches and areas of steep coastal cliffs fronted by narrow sand beaches, interrupted by small coastal lagoons. The coastal region is strongly influenced by seismic activity; many of the coastal bluffs are uplifted marine terraces. Most of the coast is being eroded as a result of the combined impacts of sea level change and major storms. El Niño/Southern Oscillation (ENSO) events tend to cause extremely high rainfalls and stream flows that carry large volumes of sediment to the coast. These same events cause an elevated sea level and more frequent high-intensity storms that erode the beaches and bluffs.

The Northern Pacific Coast

The Northern Pacific coast (Point Conception, California, to Washington) is characterized by high, rocky cliffs, pocket beaches, raised marine terraces, and occasional long sandy barriers near river mouths. Some barrier beaches (spits) shelter river estuaries.

Farther north, coastal storms are usually associated with the passage of winter fronts. Because of a narrow continental shelf and deep water close to shore, ocean storm surge heights are generally less than in shallower, more confined coastal waters. However, storm waves can be very high, causing bluff and spit erosion and severe damage to development. Winds can reach hurricane force and wind advisories are common.

Scientists have demonstrated that during El Niño years sea levels along the Pacific coast may change by as much as 12 to 18 inches above normal (Komar, 1992). The incidence of storms increases and storm tracks shift from the Pacific Northwest to southern and central California. In addition, shore erosion increases, erosion and deposition patterns of sediments shift, and more abundant rainfall results in an increased number of landslides.

Earthquakes, an ever-present hazard along the entire Pacific coast, may cause uplift or subsidence of lands along the shores. As a consequence, slopes may fail, dry ground may become compacted, and saturated sandy soils may liquefy and lose strength.

Although relatively infrequent, tsunami run-ups may be much higher and more damaging than floods resulting from Pacific storms. These long-period water waves are generated by undersea earthquakes, undersea movement of tectonic plates along the Cascadian Subduction Zone, landslides, or volcanic activity.

The Great Lakes

Great Lakes shorelines are as geomorphologically diverse as ocean shores. Great Lakes shores include wetlands, low-to-high cohesive bluffs, low-to-high rocky cliffs, river mouth barrier bars, low sandy banks, and lofty sand **dunes** perched on bluffs (up to 200 feet above lake level). High winds, tornadoes, storm surge, storm waves, and rare, large edge waves (seiches) are usually associated with low-pressure systems or cold fronts. Hurricane-force winds seldom reach the Great Lakes, but heavy precipitation from dissipating tropical storms can cause extensive flooding. Storm surges and damaging wave action are a function of wind speed, direction, duration, and **fetch**. Storm surges are generally 1–2 feet and up to 4 feet in bays. The exception is relatively shallow Lake Erie, where storm surges may be up to 8 feet near the east and west ends of the lake.

Active erosion is caused by processes similar to those on the ocean coasts: heavy precipitation, storm waves, storm surge, rising lake levels, and surface water and groundwater outflow. Another factor in the Great Lakes is the relative lake level. Great Lakes water levels fluctuate over decades in response to regional climate changes. A lower lake level for one or more decades may encourage people to over-extend development, only to be flooded, damaged, or destroyed as the lake returns to higher elevations.

Alaska

Alaska's 44,000-mile coastline is longer than that of the entire coterminous United States. Five distinct regions are typically used to describe Alaska's coast.

- The southeast coast or "Panhandle" consists of steep mountainous islands marked by long, deep fjords.
- The south coast has large bays, inlets, and prominent fjords, which were created primarily as a result of glacial action. Most of the Cook Inlet bluffs are experiencing erosion. High mountains of the Alaska Range skirt this part of the coastline.
- The southwest coast includes hundreds of islands, including Kodiak Island, the second largest island in the United States, and the Aleutian Island Chain extending 1,200 miles west.
- The western Bering Sea coastline is dominated by the large Yukon River and Kuskokwim River deltas. Erosion and flooding are serious problems in most of the predominantly Alaskan Native villages of this region.
- The northern coastal plains along the Chukchi Sea and Beaufort Sea in the Arctic Ocean are dotted with lakes and drained by numerous streams and rivers.

Coastal flooding results from tsunamis, landslides that cause surges, typhoon surge, and storms. In addition, barrier island villages are experiencing increased erosion due to longer

periods of open water wave attack and sea level rise. Three-quarters of the Alaskan population lives in coastal communities.

Hawaii and the Pacific Territories

The volcanic Hawaiian Islands and volcanic or coral Pacific Territories have shores that include sand or gravel beaches, outcrops or lava flows, muddy shores, raised reefs, or rocky cliffs. Low-lying coral islands and atolls are protected by reefs. Beaches on the Hawaiian Islands are smaller than those on the continental shores. Coastal flooding is caused by large swells, hurricane (typhoon) storm surge, and tsunamis. In addition, heavy rains can result in flash floods as water flows quickly to the coastal areas. Tsunami wave run-up may extend miles inland and reach over 50 feet above sea level. Development along coasts may be damaged by the initial run-up, flooding, erosion, and debris loads, and the too-often-ignored return of water to the sea (rundown).

Puerto Rico and the U.S. Virgin Islands

These volcanic Caribbean Islands have coastal lowlands created by deposited materials washed from the uplands. Waves and currents erode and build the beaches. Hurricanes, associated tornadoes, and much-less-frequent tsunamis (usually locally generated events) are the causes of coastal flooding.

APPENDIX C. COASTAL PROCESSES, FEATURES, RESOURCES, AND HAZARDS

The coastlines of the United States are diverse, ranging from steep, rocky shores to wide sandy beaches and dunes to grassy marshes. All of them share some characteristics that are inherent to the intersection of a land mass and a large water body—a high level of energy and a dynamic system composed of many different processes. These characteristics include, first, certain features that are the result of the natural processes at work, although these features vary from place to place. Second, all coastlines encompass natural and cultural resources that contribute to the coastal ecosystem and/or are beneficial to humans, such as habitat, wetlands, scenic beauty, historical assets, and open spaces. Third, all coastal areas have some vulnerability to natural hazards.

For the NAI approach to be effective, it must be recognized that flood risk and applicable mitigation measures differ from place to place in different dynamic environments. The presence, absence, frequency, and intensity of specific, processes, resources, and hazards along shorelines require management techniques sculpted and selectively applied to address local issues and solve unique problems. This appendix gives an overview of coastal characteristics: processes and features, resources, and hazards. Words in boldface type can be found in the glossary.

COASTAL LANDSCAPES OF THE UNITED STATES

The coastlines of the United States can be divided into major geographic segments, based on similar geological origins, natural characteristics, and hazards (see map) (FEMA, 2000a). Each geographic segment has a different combination of natural features that influences the local ecology, type of hazards that can occur, and the characteristics of the flooding, and the vulnerability of human development. The main characteristics of each of these segments are described in Appendix B. Each State legislature delineates its coastal zone in consideration of the landscape and political realities (see Appendix D).

COASTAL PROCESSES, FEATURES, AND RESOURCES

Coastal zones are extremely dynamic areas because of the abundance of wind and wave energy and the fact that many coastal landforms are dependent on a supply of sediment that is as variable as the wind and waves. Coastal environments tend to change at a fairly constant rate over time and seasonally, but these changes can be easily accelerated in the short run by hurricanes, seasonal storms, excessive winds, and tidal extremes that result in severe flooding and related damage, as discussed below. Many coastal processes are subject to greater variability as the climate changes and sea levels rise.

- Coastal floodplains are natural resources that must be properly managed in order to protect the shorelines, low-lying inland areas, and the species these areas support. These

resources include mainland beaches, barrier islands, rocky intertidal shores, salt marshes, and wetlands, and encompass a wide range of wildlife species.

Tidal Flow

The sea rises and falls rhythmically due to the gravitational pull of celestial bodies (primarily the moon) and the centrifugal force caused by a spinning earth, creating the astronomical tides. As the relative positions of earth and other celestial bodies change, tidal amplitude changes. The maximum amplitudes are “spring tides” and the minimum amplitudes are “neap” tides. Atmospheric pressure changes and wind exert additional influence to contribute “meteorological tides or surges” to the astronomical tide (Carter, 1988).

Tide-induced flow in water bodies such as bays, **lagoons**, **estuaries**, and rivers adjacent to the sea follows a pattern of ebb (water moving toward the sea as the local sea level drops) and flood (water moving into the water bodies as local sea level rises). Tidal flooding is caused by high astronomical tides that may be augmented by local, low atmospheric pressure and onshore wind. The greatest potential for tidal flooding occurs when the moon is closest to the earth and when the gravitational pull of the sun and moon join forces—a condition that occurs about three months each year (Carter, 1988).

Sediment Movement

Currents, tides, and waves distribute sediment along shorelines and into and out of estuaries. Sediment also is carried by streams from inland watersheds, the erosion of **barrier islands** and beaches, coastal uplands, and offshore sand deposits. The underlying geology of the coast determines both the degree of resistance to erosion and the nature of the material that forms the beaches. On sandy shores, the wind causes erosion and transports sand that can help rebuild ridges and dunes.

Coastal sediments tend to function on a budget system. The amount, type and source of the sediments in the near shore determine the extent and characteristics of the beaches that form along a coast. Waves, especially the intense wave energy generated by coastal storms, cause beach sand to be pulled offshore in to deeper water. The amount of sediment that needs to continually be entering the system to maintain beaches along a coastal segment is called the “sediment budget” for that segment.

When sediment is removed form a given location it often causes soils to begin accumulating rather unpredictably in another locale. The budget system also works in reverse. If sediments are accumulating in one location, it means they are being removed from elsewhere in the system. In an attempt to regain equilibrium, the coastal sediments will continue to shift, eroding from one area only to be deposited in another. When dredging or filling takes place within coastal areas, the natural processes that play an instrumental role in storm damage prevention and flood control may become compromised.

Long shore Transport

On many coasts, the **long shore transport** of beach material (sand, gravel, and stones) by the water is an important process in building and re-nourishing beaches. The process is also known as **littoral drift** and occurs when waves approach the shore at some angle other than perpendicular to it. The transport takes place between the highest part of the beach reached by the waves and the deepest near shore waters with sufficient breaking wave energy to move seabed or lakebed sediments. Within this zone of moving sediment, breaking waves create a long shore current that transports the sediment. The direction of this sediment transport usually follows a dominant direction until changed by waves coming from a different direction, by wind or storms, or by extreme events such as hurricanes.

Erosion and Aggradation

The landforms that extend above the margins of the sea, lakes, streams and rivers are in a constant state of erosion. While erosion has inconvenient consequences on human development, it is a natural process that feeds the coastal resource. Erosion generates the sediment that feeds the wetlands at the mouth of the Mississippi River. Erosion along coastal bluffs provides the sediment that builds beaches.

Coastal **erosion** is a natural process whose characteristics and impacts are influenced by a changing regional climate, severe coastal storms with storm waves riding ashore on storm surges, tidal flooding, relative sea level change, earthquakes, tsunamis, and the adverse impacts of human development, including the elimination of near and distant sources of new sediment from watersheds and shorelines.

Changes in Sea Level

The local level of the sea changes from hour to hour and day to day due to tides and changing winds. The level of the sea rises and falls during the year as a result of seasonal warming and cooling and seasonal shifts in prevailing wind patterns. For example, the level of the sea along the East Coast of the United States is about one foot higher during September and October than it is over the winter months (Pietrafesa et al., 2005). There is a great deal of variability in sea level, and in relative changes in sea level, even over a fairly small stretch of coastline. The difference in elevation between the land and the sea changes the depth of water near and at the shore and can either exacerbate or minimize height of storm surges, storm waves, and rare tsunami waves that come ashore.

Dunes

Dunes are ridges or mounds of unconsolidated sandy soil that extend continuously or nearly continuously parallel to and landward of the beach. They are naturally occurring features of the coastal area caused by wind and water transport of sediments and wave action. Sometimes artificial dunes are constructed, or degraded dunes replenished by importing sand from other sources. On retreating shorelines the coastal dunes bordering the beach migrate landward, either

over a gradual period of time from tidal and wave influences or very rapidly, as in a major storm. The erosion of coastal dunes by waves, usually during storms, supplies sand to the adjacent coastal beaches. Without this supply of sediment, beaches will gradually be depleted, either migrating or disappearing from the onshore sediment system. The height and width and shape of coastal dunes provide a buffer that resists wave run-up during storms and retards shoreline retreat. Vegetation contributes to the growth and stability of coastal dunes by providing conditions favorable to sand deposition and stability.

Filtration

Wetlands and marshes that filter pollution are a typical feature of intertidal areas. The chemical characteristics of estuarine waters, particularly the levels of nutrients, dissolved oxygen, and biological oxygen demand, are modified each time estuarine waters flush a salt marsh area. **Salt marshes** act to reduce pollution of the coastal zone by removing excess nutrients and heavy metals delivered by surface runoff from upland areas.

Wave and Storm Buffer

Barrier islands and **coastal banks** play an important role in storm damage prevention and flood control. Barrier islands provide one of the strongest coastal defenses against shoreline erosion through their natural processes of migration. Barrier islands hinder wave action and storm overwash. Coastal banks have the ability to adjust in response to wave action, which allows them to supply sediment to coastal beaches, ridges, and dunes and to barrier beaches, all of which in turn provide protection from storm waves.

Rocky **intertidal shores** act in much the same manner as coastal beaches. The sloping shore and/or boulders dissipate wave energy and serve as natural buffers from the sea for the land behind the rocky intertidal shore. They also store flood waters.

Marshes also play an important role in storm damage prevention and groundwater supply. Marsh vegetation and underlying peat are resistant to erosion and dissipate wave energy, thus providing another coastal zone defense against wave damage. The properties of marshes slow water and spread it out during periods of inundation until it gradually flows back to the sea or estuary.

Habitat

In addition to functioning as a geological interface between the land and the ocean, the coastal zone also has biological and ecological functions. It provides habitat for plants and animals. The intertidal habitat of **wetlands**, **mudflats**, and other areas serves as nesting sites, food sources, and shelter for many important coastal organisms such as crabs, fish, shellfish, wading birds, and turtles. Rocky intertidal shores provide protection for fish and shellfish.

Marshes are recognized for their importance as habitat for marine fish and shellfish. Salt marshes are extremely productive natural systems and a source of large volumes of organic material for the ocean and estuaries where it supports extensive marine food chains.

Human Values

Coastal floodplains provide cultural, educational, recreational, and scenic values that enrich communities. The coastal zone encompasses an important public land base on which nearby residents and tourists can enjoy passive and active recreation.

Cultural resources found along the coast are important to the nation and to individual localities. Native American settlements and early cities located along the coasts for access to water supply, waste, disposal, water transportation, and trade. Consequently, coastal areas contain many of the nation's earliest archaeological and historical treasures. In addition to their historical richness, coastal zones contain invaluable resources for scientific research and can serve as sites for nature study centers and laboratories for outdoor learning experience. Wildlife resources can be managed for observation as well as for recreational hunting and fishing. Many coastal floodplains can be valuable as constituents of the "wilderness experience" that is an important aspect of American culture.

COASTAL HAZARDS

Coastal lands are subject to dynamic, potentially destructive natural processes. Because of the human tendency to inadequately account for these processes, this section goes into some detail about these processes as well as the additional hazards posed by occasional extreme events like hurricanes and earthquakes. The processes that pose coastal hazards are described, along with some common impacts caused by those hazards. Ways to avoid or at least reduce some of the negative consequences of coastal development and redevelopment after a disaster are described in the chapters of this handbook.

Climate Change

The earth's climate is changing. This shift is most noticeable in the Arctic, where temperatures are rising at twice the rate of average global temperatures, permafrost soils are thawing, seasonal sea ice is diminishing, land is eroding, and glaciers are retreating (Hassol, 2004). A changing climate is a coastal hazard for at least four reasons. First, many sections of the coasts are vulnerable to certain consequences of climate change, including sea level rise and increases in the severity and/or frequency of coastal storms. Second, some features of climate change already evident have not been experienced in modern history (such as the climate changes in the Arctic). Third, climate change alters the historic record of floods and storms upon which protective measures are based, creating more uncertainty about the adequacy of these protective measures. Fourth, climate changes are occurring at a time when coastal development is on the rise, exposing swelling populations, intensified coastal investments, and diminished natural habitat to damage and loss.

To take one example of the effects of global warming, the ice-rich permafrost that underlies much of Alaska and supports a significant portion of the State's infrastructure and natural ecosystems is now changing. Although its name suggests the permanence of this crucial subterranean layer, recent thawing of Alaska's permafrost proves that it too is subject to climate change. Thawing of the permafrost and melting of shore ice are likely to continue and bring widespread changes in coastal and related ecosystems and increased erosion and damage to buildings, roads, and other infrastructure. In Siberia, many buildings already have been severely damaged and rendered unusable because the underlying permafrost has thawed (Hassol, 2004).

Permafrost damage, Alaska

Coastal Storms

Severe storms affect all coastal regions of the United States. Winds in severe coastal storms damage and rip open buildings and generate large storm surges and storm waves that attack the coast and drive across low-lying land.

NorEaster

History records a succession of severe storms that resulted in death and destruction striking unprepared communities in the United States (FEMA, 1997). As coastal communities have rapidly grown in recent decades, they have experienced loss of life, high property losses, high relief costs, many business interruptions and failures, social disruption and dislocation, and natural resource damage associated with severe coastal storms.

In 2005, Hurricane Katrina became the nation's most destructive natural disaster, far exceeding destruction from earlier natural disasters in the United States (White House, 2006). According to the White House report, Hurricane Katrina affected nearly 93,000 square miles across 138 parishes and counties of the Gulf Coast, destroyed or made uninhabitable an estimated 300,000 homes, killed more than 1,330 people, displaced about 770,000 people (the largest displacement since the Dust Bowl migration of the 1930s), and resulted in property damage that is approaching $100 billion and likely will exceed that. By the end of 2005, about 500,000 of the displaced people had not returned home, and more than 2,000 people remained missing.

Hurricane Katrina, satellite photo

Storm Surge

During a hurricane or tropical storm, reduced atmospheric pressure and strong winds pile water up along the coast, causing a temporary local rise in sea level known as storm surge. The surge associated with coastal storms and hurricanes usually consists of a slow gradual rise in water level beginning before the storm's arrival; a sharp rise in water level as the storm center passes; and a fall of the water level as the storm goes by. Combined with high-energy storm waves and astronomically high tides, storm surges can be extremely destructive. Storm surge can also affect tidally influenced bays, rivers, and creeks far inland, causing river flooding and erosion. Besides being a significant cause of damage during hurricanes, storm surge can result from Nor'easters or extra tropical cyclones in the Atlantic and Great Lakes and severe low pressure systems in the northern Pacific Ocean and Gulf of Alaska, particularly during the winter.

In 2005, the Gulf Coast experienced devastating storm surges from Hurricanes Katrina and Rita. Along the Mississippi and Louisiana coast, the storm surge from Hurricane Katrina reached up to 27 feet above sea level, surged over 6 miles inland in many coastal parts of Mississippi and up to 12 miles inland along rivers and bays (White House, 2006). Three weeks after Katrina, the storm surge from Hurricane Rita destroyed structures in southwestern Louisiana and southeastern Texas as it crossed the coast at about 16 feet above sea level. The waters surged across the coastal wetlands and up waterways, and were over 6 feet high as far inland as Lake Charles, 30 miles from the Gulf of Mexico (Lockwood et al., 2006).

Katrina coastal surge topping levee

Waves

> The sea attacks relentlessly, marshaling the force of its powerful waves against the land's strongest points. It collects the energy of distant winds and transports it across thousands of miles of open ocean … (Bascom, 1980, p. xvi).

Storm winds whip up storm waves that break and crash on the shore. The moving waters of storm surge and waves rise to sweep over low shorelands. As the sea encroaches on the land, sheets of water spread rapidly across streets and parking lots. The water deepens and waves rapidly appear, formed and driven by the wind across the water. The rapidly deepening storm surge on the land is nearly matched by the growing height of waves generated by the wind. Cars are picked up and moved when the water reaches several feet in depth. Waves the size of small hills no longer lose all their energy far offshore but come ashore with destructive force.

Waves batter doors and windows, sweeping into buildings and opening up building walls to the ripping force of storm winds. Trees are downed and buildings demolished. With surprising speed, familiar neighborhoods are transformed as the chaotic sea comes to parking lots, streets, and yards. Large waves lift and transport large boats, trucks, shipping containers, and the remains of buildings thousands of feet inland. Debris from destroyed and damaged structures along the shore is carried by the surge and waves inland to batter and destroy other structures in its path.

Earthquakes

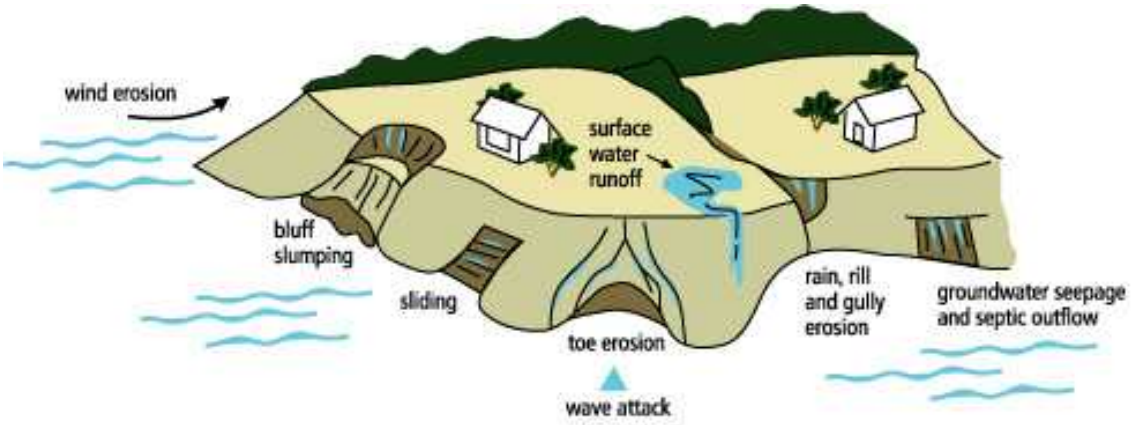
The coasts of North America are vulnerable to earthquakes. Earthquakes on land or under the sea can cause the coastal land to shake, rise, or subside. Certain soils that appeared to be solid act like putty as the shaking weakens the delicate structure of the water-saturated soil; a process called liquefaction. During the Great Alaska Earthquake of March 27, 1964, roughly 100,000 square miles of land and seabed rose as much as 40 to 50 feet, and another 100,000 square miles of land and seabed subsided as much as 8 to 10 feet in a few minutes (Stover and Coffman, 1993). Land in some coastal communities moved horizontally more than 40 feet (Rozell, 2004). Landslides and tsunamis were generated that killed 125 people. The earthquake also caused about $311 million (1964 dollars) in property damage.

Erosion

Coastal erosion (and aggradations) is a natural process by which by which the sea transfers some of its energy to the land. Beaches, dunes, and ridges are continually worn down, moved, and rebuilt through this process. Coastal erosion becomes a hazard when it takes place where human development has relied on a static landscape, or when its effects are exacerbated by human development.

Slope Failure

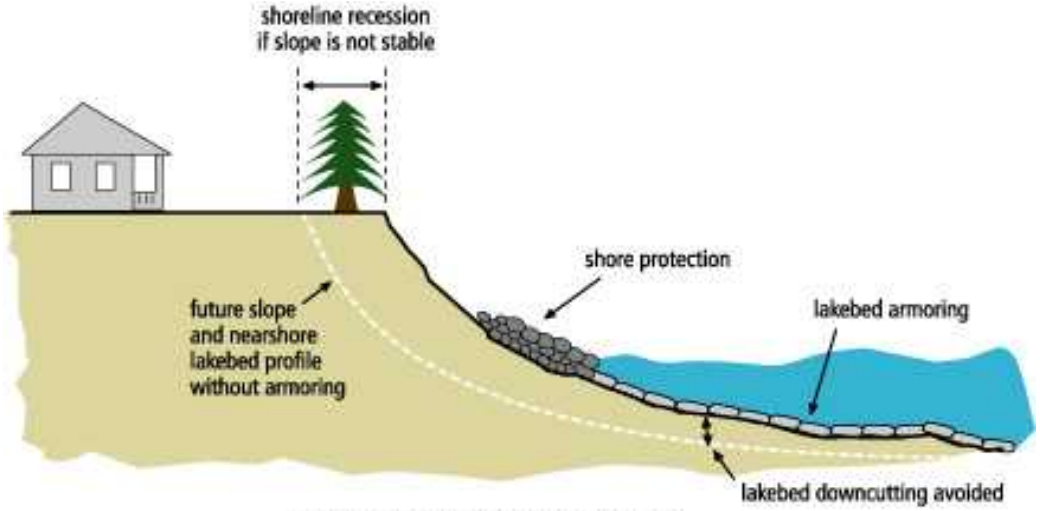
On coastal slopes, erosion can result in landslides or other mass movement toward or into the water. Gravity carries loosened soil downward to the water's edge, propelled by wind and flowing water. Rocky shores and cohesive, clayey slopes retreat because the water gradually penetrates, weakens, and disintegrates rock. In areas with freezing temperatures, the water within rock fissures expands upon freezing and contributes to fracturing, causing rock falls. Water in the cohesive, clayey soils of some slopes reduces the slope's resistance to failure and adds weight that causes additional stresses. Surface water that trickles or floods over exposed soil on slopes removes the soil particle by particle or in masses, moving it down to the water's edge. Erosion is aided by wave action that removes material from the toe of the slope and transports the material along the shore.



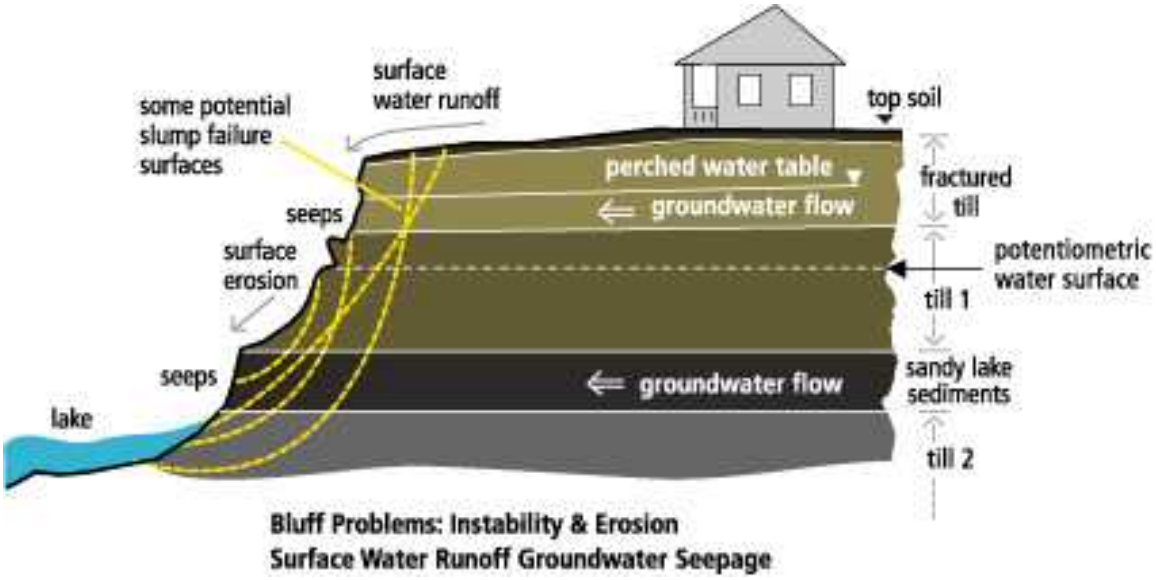
Causes and Effects of Coastal Erosion

Slopes subject to deep-seated failures tend to fail catastrophically, infrequently, and unpredictably, sometimes after decades of stability. As it slides, everything on the slope is destroyed, including trees, bushes, and buildings. Landslides, mudslides, rockslides, and debris flows, are common in many coastal regions, including California. In the Alaskan Arctic, thermal degradation causes an undercutting of permafrost that result in large block failure and the erosion of coastal shorelands.

Sandy shores respond to the sea with more flexibility than do rocky or cohesive soil shores, as material from wind- and water-based erosion builds and rebuilds beaches, dunes, and ridges.



Lakebed Paving and Shore Armoring to Protect Land from Shore and Lakebed Erosion



Along all coasts with ice, ice scour can cause extensive erosion of the shore. This has become a particularly serious problem in Alaska where a warming climate causes more melting of shore ice during warmer months than in earlier times, and ice that is no longer fast to the shore is driven onshore by waves.

Relative Sea Level Rise

The level of the sea is rising around the world at an increasing rate and has become of concern as a coastal hazard. Sea level is rising because the changing climate both warms the oceans (causing thermal expansion of the water) and melts glaciers and ice caps. Global sea level rose between 4 and 10 inches over the last century (WMO, 2003). The largest contribution to this rise (about one-third of it) is from thermal expansion of the ocean (Houghton, 2004). From 1990 to 2050, the global average sea level is expected to rise from 3 to 18 inches, assuming no abrupt changes in the global climate or in the major ice sheets (Neumann et al., 2000, citing IPCC, 1996). In the next 100 years, global sea level is expected to rise, on average, an additional 4 to 36 inches. The effects of thermal expansion of the ocean will vary with location and sea level will not rise uniformly all over the globe (Houghton, 2004).

In recent years, increased attention and concern has focused on the stability of the Greenland Ice Cap and the West Antarctic Ice Sheet, where there is evidence of increasing melting and ice flow towards the sea. The Greenland Ice Cap contains enough water to raise global sea level about 23 feet (Houghton, 2004). The West Antarctic sheet contains enough water to raise global sea level 16 to 20 feet and both East and West ice sheets in Antarctica contain enough water to raise global sea level more than 33 feet (Houghton, 2004, IPCC 2001). If the rate of movement and melting of these ice masses increases and in Greenland and/or Antarctica, the rates of global sea level rise can be expected to increase.

Subsidence

Subsidence is a loss of elevation, a lowering of the land surface. Regional subsidence occurs due to ground motion caused by tectonic forces in the underlying bedrock layers, faults, and joints; by the consolidation of sediments deposited into coastal waters; and by down-warping of the earth's crust. Subsidence from sediment consolidation is most noticeable at the mouths of rivers such as the Mississippi. Localized subsidence may be due to human causes, such as withdrawal of oil, gas, and groundwater; extraction of minerals; or drainage within levees. Subsidence can increase vulnerability to hazards by resulting in greater inundation by floodwaters, increased wave heights affecting beaches, and loss of coastal wetlands (which buffer coastal areas from storm surge and wave energy).

In Louisiana (a State with areas of severe subsidence), draining levee-bordered wetlands and extracting oil are two causes of subsidence (National Research Council, 1991). Coastal soils in this State are generally very poorly drained, having muddy or unconsolidated surface and underlying material, and low strength. These soils subside because of "shrinkage caused by desiccation, consolidation from loss of the buoyant force of groundwater or from loading, compaction, and biochemical oxidation" (SCS, 1983).

Subsidence may be slow and continuous over time, but there are exceptions. In the lower Mississippi River Valley and along the northern Gulf Coast, subsidence rates at individual points are not constant (Shinkle and Dokka, 2004). Subsidence due to groundwater withdrawal is a serious problem. For example, in the Houston, Texas, area groundwater withdrawal has resulted in more than 6 feet of subsidence over the last few decades, causing the inundation of over 30 square miles of land and the abandonment of entire subdivisions (FEMA, 1997).

Tsunami

Tsunami is a Japanese word meaning "harbor wave" (sometimes defined as sea waves or ocean waves with very long lengths). Tsunamis are unique waves produced by earthquakes, asteroid impacts on the sea, volcanic eruptions, or massive slope failures into or beneath the ocean. Tsunami waves may come ashore from points of origin thousands of miles away, or from sources closer to the shoreline they strike. One potential source of earthquakes and therefore tsunamis is the Cascadian Subduction Zone, which extends from the continental slope off of the U.S. West Coast and beneath portions of northern California, Oregon, Washington, and northward beyond Vancouver Island, British Columbia (Madin, 1992). A similar subduction zone lies under and offshore of Alaska. There are at least two subduction zones on crustal plate boundaries beneath the Caribbean. Tsunami waves are rarer, but do occur, on the Atlantic coast. There is a long history of tsunami generation and damage around the geologically-active margins of the Indian and Pacific Oceans.

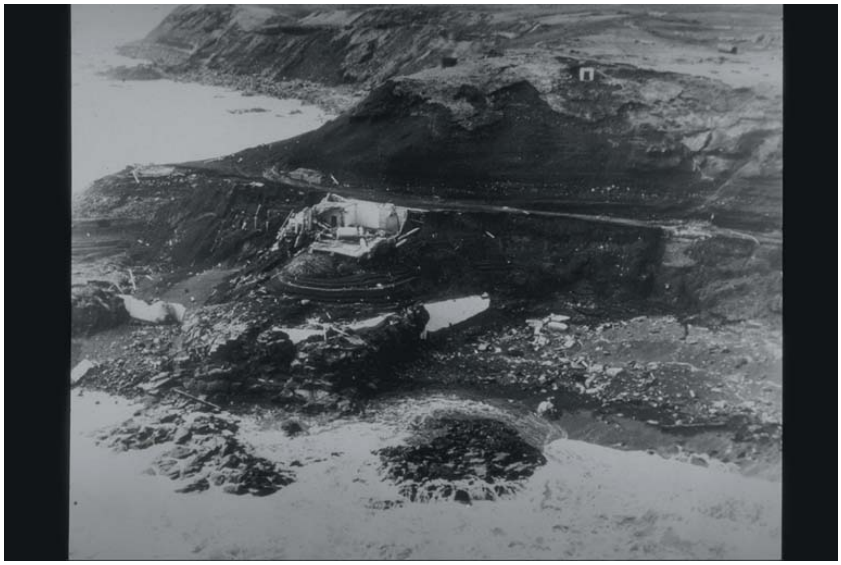
"Looking out to sea, I noticed a dark black object through the gloom, traveling toward the shore. At first sight it seemed like a low range of hills rising out of the water—but I knew there was nothing of the kind in that part of the Sunda Strait. A second glance—and a very hurried one at that—convinced me that it was a lofty ridge of water many feet high."

The description of a tsunami as seen by a veteran ship's pilot in Anjer, Java, during the climatic eruptions of the Krakatoa volcano in 1883 (Winchester, 2004, p. 240).

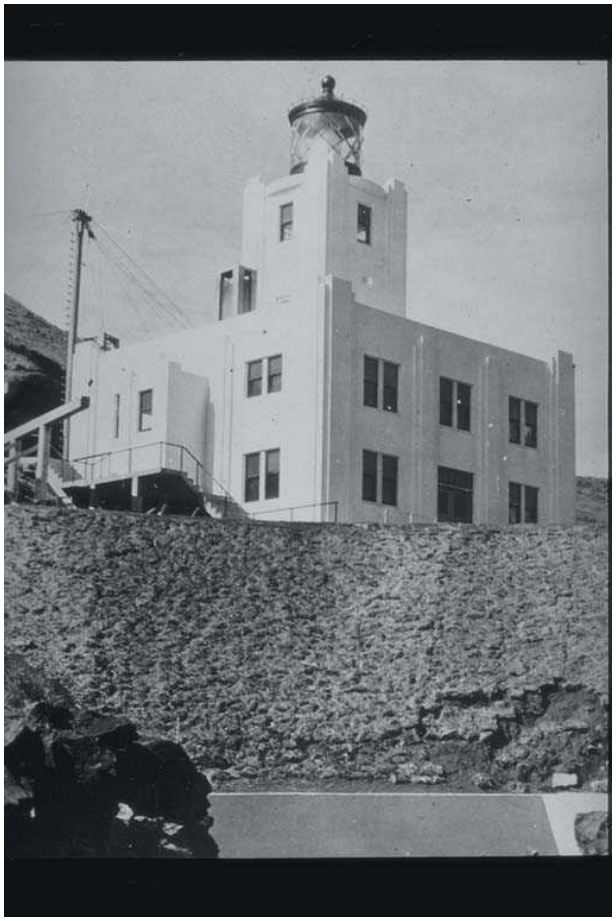
Tsunamis are like no other sea waves as they travel: one or more low waves, widely spaced, racing across the deep ocean at the speed of jet planes. Tsunami waves slow as they near the coast, rise in height as they cross the shoaling seabed and come ashore at the speed of vehicles traveling on city streets. When a tsunami reaches near shore waters about 33 feet deep, the wave front, according to theory, is traveling at a speed of about 22 miles per hour (NOAA et al., 2002).

Tsunamis can have high crests as they cross shoaling water depths. The 1964 Alaskan earthquake generated tsunami waves as high as 30 to 90 feet and a surveyed wave run-up about 220 feet above sea level in Shoup Bay of Valdez Inlet (Stover and Coffman, 1993; Alaska Sea Grant, 1981). Tsunamis coming ashore on the Island of Hawaii in April 1946 and November 1975 had reported wave run-up heights of 55 feet, and 26–47 feet, respectively (Pacific Tsunami Museum, 2003). In a tsunami, the height of the first wave is not an indication of the height of the following waves. In extreme cases, tsunami water levels have risen more than 100 feet (NOAA, 2002).

Hawaii tsunami wave, 1946



Lighthouse destroyed in tsunami



Lighthouse before tsunami

As a tsunami wave moves across the land and becomes burdened with debris, its speed slows. A tsunami water mass onshore can be a wall of destruction, sweeping across and flooding low-lying land. Tsunamis destroy buildings, trees, cars, people, animals, and much of whatever else is in their way. At Banda Aceh, Indonesia, the December 2004 tsunami reportedly swept inland three and one-half miles. Tsunami water also retreats at high velocity, carrying debris, people, and animals from its destruction out to sea.

The only warning of a tsunami may be a felt earthquake. Tsunamis can arrive onshore after a strong, locally generated earthquake in as little as a few minutes. Some survivors reported that the December 2004 tsunami came ashore in Indonesia about 25 minutes after the earthquake occurred in the region. Sometimes before the tsunami waves arrive, people standing on the shore may see a sudden lowering of the sea, like the tide going out rapidly, leaving fish stranded. They may hear a rumbling sound. Such warnings have sometimes allowed sufficient time to clear beaches and save lives. In the United States, tsunami warning systems are in place on Hawaii, the West Coast, and Pacific islands. New warning systems are planned for the Atlantic coast and Gulf of Mexico.

APPENDIX D. STATE COASTAL ZONE BOUNDARIES

ALABAMA

Alabama's coastal zone extends inland to the continuous 10-foot elevation contour in Baldwin and Mobile Counties.

ALASKA

Alaska's coastal zone is based on three zones based on biophysical relationships: (1) zone of direct interaction—the area where physical and biological processes are a direct function of contact between land and sea; (2) the zone of direct influence—the area closely affected and influenced by the close proximity of land and sea; and (3) the zone of indirect influence—the area beyond the zone of indirect influence to the limit of identifiable land/sea interaction. Local coastal programs may establish more specific boundaries.

AMERICAN SAMOA

American Samoa's coastal zone is the entire territory.

CALIFORNIA & BCDC

California's coastal zone generally extends 1,000 yards inland from the mean high tide line. In significant coastal estuarine habitat and recreational areas it extends inland to the first major ridgeline or 5 miles from the mean high tide line, whichever is less. In developed urban areas, the boundary is generally less than 1,000 yards. The coastal zone for the San Francisco Bay Conservation and Development Commission (BCDC) includes the open water, marshes and mudflats of greater San Francisco Bay, and areas 100 feet inland from the line of highest tidal action. The boundary also includes: the Suisun marsh and buffer zone: managed wetlands diked off from the Bay; and open waters diked off from the Bay and used in salt production.

CONNECTICUT

Connecticut's coastal zone has two tiers incorporated within the 36 coastal townships. The first tier is bounded by a continuous line delineated by a 1,000 foot linear setback measured from the mean high water mark in coastal waters; or a 1,000 foot linear setback measured from the inland boundary of State regulated tidal wetlands; or the continuous interior contour elevation of the one hundred year frequency coastal flood zone; whichever is farthest inland. The second tier is the area between the inland boundary of the 36 coastal communities and the inland boundary of the first tier.

DELAWARE

Delaware's coastal zone includes the whole State.

FLORIDA

Florida's coastal zone is the entire State, but has two tiers. Local governments eligible to receive coastal management funds are limited to those Gulf and Atlantic coastal cities and counties which include or are contiguous to State water bodies where marine species of vegetation constitute the dominant plant community. Florida's seaward boundary in the Gulf of Mexico is 3 marine leagues (9 nautical miles) and is 3 nautical miles in the Atlantic.

GEORGIA

Georgia's coastal zone includes the 11 counties that border tidally-influenced waters or have economies that are closely tied to coastal resources.

GUAM

Guam's coastal zone encompasses the entire territory.

HAWAII

Hawaii's coastal zone encompasses the entire State.

INDIANA

Indiana's coastal zone is based on watershed boundaries within coastal townships and the counties of Lake, Porter and LaPorte. To create an inland boundary that is identifiable in practical landmarks, the coastal zone boundary is described based on the U.S. Geological Survey Quadrangle maps and major roads for each county. The coastal zone boundary is located in the northern portions of Lake, Porter, and LaPorte Counties. At its widest extent, the boundary extends away from the shoreline 17 miles to the Crown Point area and at its narrowest point, less than 2 miles, just north of Hudson Lake in LaPorte County. *See* NOAA, *Indiana Lake Michigan Coastal Program and Final Environmental Impact Statement*, Appendix C (April 2002), to determine the precise coastal zone boundary in a particular area of the State.

LOUISIANA

Louisiana's coastal zone varies from 16 to 32 miles inland from the Gulf coast and generally follows the Intercostals Waterway running from the Texas-Louisiana State line then follows highways through Vermilion, Iberia, and St. Mary parishes, then dipping southward following the natural ridges below Houma, then turning northward to take in Lake Pontchartrain and ending at the Mississippi-Louisiana border.

MAINE

Maine's coastal zone follows the inland line of coastal towns on tidewaters and all islands.

MARYLAND

Maryland's coastal zone extends to the inland boundary of the 16 counties bordering the Atlantic Ocean, the Chesapeake Bay, and the Potomac River (as far as the municipal limits of Washington, D.C), and includes Baltimore City and all local jurisdictions within the counties.

MASSACHUSETTS

Massachusetts' coastal zone extends 100 feet inland of specified major roads, railroad tracks, or other visible right of ways that are located within a half mile of coastal waters or salt marshes. The coastal zone includes all islands, transitional and intertidal areas, and coastal wetlands and beaches. In instances where the road boundary excludes significant resource areas, the boundary line may depart from the road to encompass.

MICHIGAN

Michigan's coastal zone, generally, extends a minimum of 1,000 feet from the ordinary high water mark. The boundary extends further inland in some locations to encompass coastal lakes, river mouths, and bays; floodplains; wetlands; dune areas; urban areas; and public park, recreation, and natural areas.

MINNESOTA

Minnesota's coastal zone is divided into three areas. The first includes the area of the St. Louis River in Carlton County, south of Duluth. The second is the city of Duluth and surrounding areas of urban growth and expansion to the north and west. The third is the region between the Duluth city limits north to the Canadian border, also known as the "North Shore," which includes portions of St. Louis, Lake, and Cook Counties. *See* NOAA, *Minnesota*'s *Lake Superior Coastal Program Final Environmental Impact Statement*, Chapter One, (May 1999), to determine the precise coastal zone boundary in a particular area of the State.

MISSISSIPPI

Mississippi's coastal zone includes the 3 counties adjacent to the coast. The coastal zone includes these counties, as well as all adjacent coastal waters. Included in this definition are the barrier islands of the coast

NEW HAMPSHIRE

New Hampshire's coastal zone is the 17 coastal municipalities.

NEW JERSEY

New Jersey's coastal zone recognizes four distinct regions of the State and treats them separately. From the New York border to the Raritan Bay, the boundary extends landward from mean high water to the first road or property line. From the Raritan Bay south along the Atlantic shoreline and up to the Delaware Memorial Bridge, the boundary extends from half a mile to 24 miles inland (1,376 square miles of land area). From the Delaware Memorial Bridge northward up the Delaware River to Trenton, the boundary extends landward to the first road inclusive of all wetlands. The fourth boundary serves a 31-mile square area in the northeast corner of the State bordering the Hudson River (New Jersey Meadowlands Commission).

NEW YORK

New York's coastal zone varies from region to region while incorporating the following conditions: The inland boundary is approximately 1,000 feet from the shoreline of the mainland. In urbanized and developed coastal locations the landward boundary is approximately 500 feet from the mainland's shoreline, or less than 500 feet where a roadway or railroad line runs parallel to the shoreline at a distance of under 500 feet and defines the boundary. In locations where major State-owned lands and facilities or electric power generating facilities abut the shoreline, the boundary extends inland to include them. In some areas, such as Long Island Sound and the Hudson River Valley, the boundary may extend inland up to 10,000 feet to encompass significant coastal resources, such as areas of exceptional scenic value, agricultural or recreational lands, and major tributaries and headlands.

NORTH CAROLINA

North Carolina's coastal zone includes the 20 counties that in whole or in part are adjacent to, adjoining, intersected by or bounded by the Atlantic Ocean or any coastal sound(s). Within this boundary, there are two tiers. The first tier is comprised of Areas of Environmental Concern (AEC) and is subject to more thorough regulatory controls. AECs include: coastal wetlands, estuarine waters, Public Trust areas, estuarine shorelines, ocean beaches, frontal dunes, ocean erosion areas, inlet lands, small surface water supply watersheds, pubic water supply well fields, and fragile natural resource areas. The second tier includes land uses which have potential to affect coastal waters even though they are not located in AECs.

NORTHERN MARIANA ISLANDS

Northern Mariana Islands' coastal zone is the entire Commonwealth. (Note: a recent federal court decision ruled that the Commonwealth does not own the adjacent territorial sea. A consent decree allows the CNMI to manage the area.)

OHIO

Ohio's coastal zone includes portions of 9 counties bordering Lake Erie and its tributaries and varies depending on biophysical characteristics of various coastal regions. In the western part of the coast the boundary extends inland up to 15 miles along certain low lying wetland and floodplain areas; in most of the eastern part of the State, areas with high bluffs, the boundary extends inland for only about an eighth of a mile, with the exception of the Mentor Marsh area.

OREGON

Oregon's coastal zone extends inland to the crest of the coastal range, except for the following: along the Umpqua River, where it extends upstream to Scottsburg; along the Rogue River, where it extends upstream to Agness; and except in the Columbia River Basin, where it extends upstream to the downstream end of Puget Island.

PENNSYLVANIA

Pennsylvania's coastal zone along Lake Erie varies from 900 feet in urban areas to over 3 miles in more rural areas, and encompasses the floodplains of Lake Erie and tributary streams, bluff hazards recession areas, and coastal wetlands. The coastal zone along the Delaware River Estuary extends inland to 660 feet in urbanized areas, to 3.5 miles in rural areas, and includes floodplains of the Delaware and Schuykill Rivers and their tributaries to the upper limit of tidal influence, and tidal and freshwater wetlands.

PUERTO RICO

Puerto Rico's coastal zone, generally, extends 1,000 meters inland; however, it extends further inland in certain areas to include important coastal resources. Puerto Rico's seaward boundary is 3 marine leagues (9 nautical miles).

RHODE ISLAND

Rhode Island's coastal zone includes the whole State. However, the inland extent of the regulatory authority of the State's CZMA agency is 200 feet inland from any coastal feature, to watersheds, and to certain activities that occur anywhere within the State that include: power-generating plants; petroleum storage facilities; chemical or petroleum processing; minerals extraction; wastewater treatment and disposal plants; solid waste disposal facilities; and, desalination plants.

SOUTH CAROLINA

South Carolina's coastal zone includes all lands and waters in the counties which contain any one or more of the critical areas (coastal waters, tidelands, beaches, and primary oceanfront sand dunes).

TEXAS

Texas' coastal zone is generally the area seaward of the Texas coastal facility designation line which roughly follows roads that are parallel to coastal waters and wetlands generally within one mile of tidal rivers. The boundary encompasses all or portions of 18 coastal counties. Texas' seaward boundary is 3 marine leagues (9 nautical miles).

VIRGINIA

Virginia's coastal zone includes the 29 counties, 17 cities, and 42 incorporated towns of *Tidewater Virginia*, including the Atlantic Coast watershed and portions of the Chesapeake Bay and Albemarle-Pamlico Sound watersheds.

VIRGIN ISLANDS

The coastal zone of the Virgin Islands encompasses the entire territory.

WASHINGTON

Washington's coastal zone is the 15 coastal counties that front saltwater.

WISCONSIN

Wisconsin's coastal zone is the 15 counties that front Lake Superior, Lake Michigan, or Green Bay.

APPENDIX E. LEGAL QUESTIONS AND ANSWERS

(Reprinted from the *NAI Toolkit* (ASFPM, 2003, pp. 97–108))

COMMON QUESTIONS ABOUT FLOODPLAIN REGULATIONS IN THE COURTS 2003 UPDATE

Prepared by Jon A. Kusler, Esq.

For the Association of State Floodplain Managers

This summary was prepared for the Association of State Floodplain Managers (ASFPM) by Jon Kusler, Esq., Associate Director of the Association of State Wetland Managers. Preparation involved a review of the legal literature on floodplain regulations as well as the last 15 years of federal and State case law concerning floodplain regulations. Detailed reviews of cases from the period 1960–1990 were prepared by Kusler in an earlier document.

Acknowledgements

Edward A. Thomas, Esq. provided extensive review of this document. Funding was provided by The McKnight Foundation and the ASFPM Foundation. Opinions expressed in the document are those of the authors and do not necessarily reflect the view of the sponsoring organizations.

COMMON QUESTIONS

Have courts continued to uphold the overall constitutionality of State and local floodplain regulations?

Yes. Courts at all levels, including the U.S. Supreme Court, have broadly and repeatedly upheld the general validity of floodplain regulations in the last 15 years. They have, however, held regulations unconstitutional as "takings" of private property in several cases where certain regulations, not clearly based on principles of hazard prevention or "no adverse impact," denied all economic use of lands, Lucas v. South Carolina Coastal Council, 505 U.S. 1003 (1992) or permitted the public to enter private property, Nollan v. California Coastal Commission, 483 U.S. 825 (1987); Dolan v. City of Tigard, 512 U.S. 374 (1994).

Does general validity mean that regulations are valid for all properties?

No. A landowner may attack the constitutionality of regulations as applied to his or her property even where regulations in general are valid. Regulatory agencies need to be able to support the validity of the regulations as applied to particular properties. However, the overall presumption of validity for regulations and a presumption of correctness for regulatory agency information gathering and regulatory decisions help the agency meet its burden of proof. Courts have broadly supported State and local floodplain regulations as applied to particular properties.

A court decision that regulations are unconstitutional as applied to specific property will not necessarily determine site-specific constitutionality or unconstitutionality as applied to other properties.

Has judicial support for floodplain regulations weakened in recent years?

No. Quite the contrary. The U.S. Supreme Court has recently issued a series of opinions strongly endorsing planning to prevent damage from hazardous development. State courts continue to strongly uphold floodplain regulations in the more than 125 appellate cases over the last decade, including many challenges to regulations as "takings" of private property. See, for example:

- Beverly Bank v. Illinois Department of Transportation, 579 N.E.2d 815 (Ill. 1991), in which the court held that the Illinois legislature had the authority to prohibit the construction of new residences in the 100-year floodway and that a taking claim was premature.
- State of Wisconsin v. Outagamie County Board of Adjustment, 532 N.W.2d 147 (Wis. App., 1995), in which a variance for a replacement fishing cottage in the floodway of the Wolf River was barred by the county's shoreland zoning ordinance.
- Bonnie Briar Syndicate, Inc. v. Town of Mamaroneck, et al., 94 N.Y. 2d 96 (N.Y., 1999), in which the court rejected the claim that the rezoning of a 150-acre golf course property important for flood storage from "residential" to "solely recreational use" was a taking of private property.
- Wyer v. Board of Environmental Protection, 747 A.2d 192 (Me., 2000), in which the denial of a variance to sand dune laws was held not to be a taking because the property could be used for parking, picnics, barbecues, and other recreational uses.

At the same time there is a national movement, referred to by some commentators as the "property rights movement," which supports landowners who challenge regulations. Courts are examining floodplain regulations with greater care than they did a decade ago.

What have been the most common challenges to regulations in the last 15 years?

The most common challenges to regulations have been claims that regulators permitted construction that later caused harm. There are dozens of cases that allege damage caused by development that caused problems. On the other hand, there are very few cases that allege unconstitutional over-regulation of property. Those few include 1) challenges to floodway regulations and floodway restrictions; 2) coastal dune and high hazard area restrictions, and buffer and setback requirements; and 3) variances and regulations for nonconforming uses. Generally speaking, courts have broadly upheld these hazard prevention restrictions against claims that they take private property without payment of just compensation, have been adopted to serve invalid goals, are unreasonable (lack adequate nexus to goals) or discriminate.

May local governments regulate floodplains without express statutory authority to do so?

Yes. Courts have upheld local floodplain zoning regulations adopted as part of broader zoning. Courts have also, in some cases, upheld local floodplain ordinances adopted pursuant to "home rule" powers. But this is rarely an issue since States have broadly authorized local governments to adopt floodplain regulations.

May a local government adopt floodplain regulations that exceed State or federal (National Flood Insurance Program) minimum standards?

Yes. Local government regulations may exceed both State and federal regulations. There is no preemption issue. The National Flood Insurance Program regulations specifically encourage State and local regulations that exceed federal standards (see 44 CFR §60.1(d)).

May States and local governments regulate some floodplains and not others?

Yes. Typically States and local governments only regulate mapped floodplains.

Are the factual determinations of federal, State, or local floodplain regulatory agencies (e.g., mapping of floodways and flood fringe boundaries) presumed to be correct?

Yes. The burden is on landowners to prove their incorrectness. Courts overturn agency fact-finding only if they find that such fact-finding lacks "substantial evidence." Courts are particularly likely to uphold factual determinations of federal and State "expert" agencies. However, courts look more closely at the adequacy of the information-gathering in instances where regulations have severe economic impact on specific properties.

How closely must regulatory standards (including conditions) be tailored to regulatory goals?

Courts have broadly upheld floodplain and other resource protection regulations against challenges that they lack reasonable nexus to regulatory goals. But, as indicated above, courts have required a stronger showing of nexus where regulations have essentially extinguished all value in the property. They also increasingly require a showing that conditions attached to regulatory permits are "roughly proportional" to the impacts posed by the proposed activity if dedication of lands is involved, see Nollan v. California Coastal Commission, 483 U.S. 825 (1987); Dolan v. City of Tigard, 512 U.S. 374 (1994).

Must a regulatory agency accept one mapping or other flood analysis method over another?

No. Not unless State or local regulations require the use of a particular method. Courts have afforded regulatory agencies considerable discretion in deciding which scientific or engineering approach to accept in fact-finding as long as the final decision is supported by "substantial" evidence. Also, courts have held that regulatory agencies do not need to eliminate all uncertainties in fact-finding.

Does an agency need to follow the mapping, floodway delineation or other technical requirements set forth in its enabling statute or regulations?

Yes. Agencies must comply with statutory, administrative, regulatory and ordinance procedural requirements. They must also apply the permitting criteria contained in statutes and regulations.

Are floodplain and floodway maps invalid if they contain some inaccuracies?

No. Courts have upheld maps with some inaccuracies, particularly if there are regulatory procedures available for refining map information on a case-by-case basis.

Can landowners be required to carry out floodplain delineations on impacts of proposed activities on flood elevations or provide various types of floodplain assessment data?

Yes. Courts have held that regulatory agencies can shift a considerable portion of the assessment burden to landowners and that the amount of information required from a landowner may vary depending upon the issues and severity of impact posed by a specific permit. And, agencies can charge reasonable fees for permitting. But the burdens must be reasonable and courts may consider the costs of such data gathering to be relevant to the overall reasonableness of regulations and whether a taking has occurred.

May a regulatory agency be liable for issuing a regulatory permit for an activity that damages other private property?

Yes, quite possibly. In fact a careful analysis of hundreds of cases in which the lawsuit involved permitting indicates that a municipality is vastly more likely to be sued for issuing a permit for development that causes harm than for denying a permit based on hazard prevention or "no adverse impact" regulations. The likelihood of a successful lawsuit against a municipality for issuing a permit increases if the permitted activity results in substantial flood, erosion or other physical damage to other private property owners. However, some States specifically exempt State agencies and local governments from liability for issuing permits.

Do local governments need to adopt comprehensive land use plans before adopting floodplain regulations?

Statutes authorizing local adoption of floodplain ordinances and bylaws do not require prior comprehensive planning. However, many local zoning enabling acts require that zoning regulations be in accord with a comprehensive plan. Traditionally courts have not strictly enforced this requirement and have often found a "comprehensive plan" within the zoning regulations.

Courts have also endorsed comprehensive planning and regulatory approaches as improving the rationality of regulations although they have also upheld regulations not preceded by such planning in many instances.

Under what circumstances is a court most likely to hold that floodplain regulations "take" private property?

Courts are likely to find a "taking" in circumstances where: 1) the regulation is not clearly based on hazard prevention or "No Adverse Impact;" 2) regulations deny all "reasonable" economic uses of entire properties, that is, the value of the property is reduced to zero or very near zero; or 3) proposed activities will not have offsite "nuisance" impacts. Landowners are also more likely to succeed if the property owner purchased the land before adoption of the regulations.

Are highly restrictive floodplain regulations, including buffers and large lot sizes, valid?

Courts have upheld highly restrictive floodplain regulations in many contexts, particularly where a proposed activity may have nuisance impacts on other properties. However, courts have also held floodplain regulations to be a "taking" without payment of compensation in a few cases (mostly older) where the regulations denied all economic use of entire parcels of land and there was no showing of adverse impact on other properties.

Would a No Adverse Impact performance standard incorporated in local or State regulations be sustained by courts?

Yes. Courts are very likely to support this standard if it is reasonably and fairly applied and if government agencies take measures to avoid successful "takings" challenges where regulations deny all economic, non-nuisance-like uses for entire properties.

How can a local government avoid successful "takings" challenges?

Local governments can help avoid successful "takings" challenges in a variety of ways:

1. Apply a No Adverse Impact floodplain management performance standard fairly and uniformly to all properties.

2. In local regulations, include special exception and variance provisions that allow the regulatory agency to issue a permit in instances where denial will deprive a landowner of all economic use of his or her entire parcel and the proposed activity will not have nuisance impacts.

3. For floodplain areas, adopt large-lot zoning, which permits some economic use (e.g., residential use) on the upland portion of each lot.

4. Allow for the transfer of development rights from floodplain to non-floodplain parcels.

5. Fairly tax and levy assessments based on what development will actually be allowed.

QUESTIONS ABOUT GOVERNMENT LIABILITYAND

NO ADVERSE IMPACT FLOODPLAIN MANAGEMENT

Prepared by Jon A Kusler, Esq.

For the Association of State Floodplain Managers

Preface

This question and answer summary concerning legal issues associated with No Adverse Impact floodplain management was prepared for the Association of State Floodplain Managers (ASFPM) by Jon Kusler, Esq., Associate Director of the Association of State Wetland Managers. It is based upon a larger paper with extensive case law citations, also prepared by Jon Kusler for the Association: No Adverse Impact Floodplain Management and the Courts. The summary and the larger paper are based upon review of the legal literature as well as federal and State case law concerning floodplain regulations.

Acknowledgements

Edward A. Thomas, Esq. provided extensive review to this document. Funding was provided by the McKnight Foundation and the ASFPM Foundation. Opinions expressed in the document are those of the authors and do not necessarily reflect the view of the sponsoring organizations.

COMMON QUESTIONS

In 2000, the Association of State Floodplain Managers recommended a “No Adverse Impact” approach or goal for local, State, and federal floodplain management to help control spiraling flood and erosion losses, new development which increases flood risks and additional flood losses. The “No Adverse Impact” goal could also potentially be applied to environmental and other impacts, if a community chooses to do so. The “No Adverse Impact” goal is not intended as a rigid rule of conduct. Rather, it has been suggested as a general guide for landowner and community actions in the watersheds and the floodplains which may adversely affect other properties or communities. It also could be incorporated as an overall performance standard into community and State floodplain regulations.

What major legal issues are raised by no adverse impact floodplain management?

Two major sets of legal issues arise with No Adverse Impact floodplain management.

1) Can No Adverse Impact floodplain management reduce community liability for flooding and erosion problems?

2) Will a community that is adopting floodplain regulations incorporating a No Adverse Impact standard be subject to liability for taking private property or be subject to other successful legal challenges?

These questions will be discussed individually in the following pages.

1) Can No Adverse Impact Floodplain Management Reduce Community Liability for Flooding and Erosion?

Legally, No Adverse Impact floodplain management can reduce community liability for flood and erosion losses. More specific issues pertaining to this overall conclusion include the following:

Are successful suits against local governments for increasing flooding and erosion growing more common?

When individuals are damaged by flooding or erosion, they often file law suits against governments or other individuals, claiming that the governments have caused the damage, contributed to the damage or, in some instances, failed to prevent or provide adequate warnings of natural hazards. Successful liability suits based upon natural hazards have become increasingly expensive to governments, not only because of the increasing damage awards but because of the attorney and expert witness fees which may exceed the damage award.

Successful liability suits of all types have increased in the last two decades for several reasons:

- A growing propensity to sue on the part of individuals damaged by flooding or erosion (historically, members of society were more willing to accept losses from a broad range of causes).
- Large damage awards and the willingness of lawyers to initiate suits on a contingent fee basis.
- Propensity of juries to view governments as having “deep pockets”.
- Expanded concepts of liability.
- Abrogation or modification of sovereign immunity in most jurisdictions.
- Uncertainties with regard to the legal rules of liability and defenses (e.g., “Act of God”) due to the evolving nature of the body of law and the site-specific nature of many tort actions.
- Limitation of the “Act of God” defense because most hazards are now foreseeable.
- Hazards are now, to a greater or lesser extent, “foreseeable” and failing to take such hazards into account may constitute negligence. See, e.g., Barr v. Game, Fish, and Parks Commission, 497 P.2d 340 (Col., 1972.)

- Advances in hazard loss reduction measures (e.g., warning systems, elevating structures) create an increasingly high standard of care for reasonable conduct.
- Advances in natural hazard computer modeling techniques, which can be used to establish causation.
- Reduction in the defenses of contributory negligence and assumption of risk. All levels of government, federal, State and local, may now be sued for negligence, nuisance, breach of contract or the "taking" of private property without payment of just compensation under certain circumstances, although vulnerability to suit varies.

In what situations are governmental units liable for increasing flood or erosion damage on private lands?

Courts have commonly held governments liable for increasing flood and erosion damage on private property by blocking natural drainage through grading, fill, culverts, bridges or structures; increasing the location and amount of runoff through channelization or drainage works; or constructing flood control works such as levees and dams. Courts have often held governmental units liable for inadequately maintaining or operating culverts, bridge crossings, channelization projects, and dams.

Some courts have also held local governments liable for issuing permits and approving subdivisions which increase flood damage on other lands and for inadequate inspections. Courts have held governmental units liable under a variety of legal theories including riparian rights, nuisance, trespass, negligence, strict liability and "taking" private property without payment of just compensation.

Can a governmental unit protect itself from liability by arguing "sovereign immunity"?

The sovereign immunity defense has been dramatically reduced by the courts and legislatures in most States. In addition, sovereign immunity is not a defense to a "takings" claim.

Can a governmental unit protect itself from liability by arguing an "Act of God"?

Increasingly, no. To successfully establish an "Act of God" defense, a governmental unit must prove that a hazard event is both large and unpredictable. This is increasingly difficult because hazard events are at least partially foreseeable.

Will a governmental unit be protected from liability by following regulatory guidelines or using "standard" engineering approaches for flood and erosion control?

Not necessarily. A court may hold that a "standard" approach is not reasonable in the circumstances as technologies improve and the standard of care in floodplain management increases.

May a governmental unit be held liable for failing to reasonably operate and maintain flood loss reduction measures such as channels, levees, dikes and warning systems?

Yes. Courts often hold governmental units liable for inadequate operation or maintenance.

May a governmental unit be held liable for issuing permits for development or approving a subdivision which increases flood or erosion damage on other lands?

Yes, in some but not all States.

May a governmental unit be held liable for failing to remedy a natural hazard on public lands which damage adjacent private lands?

Perhaps. Courts have, with only a few exceptions, not held governmental units and private individuals responsible for naturally occurring hazards on public lands such as stream flooding or bank erosion that damage adjacent lands (e.g., erosion, flooding). However, they are liable if they increase the hazards. In addition, a small number of courts have held that government entities may need to remedy hazards on public lands which threaten adjacent lands.

Do governmental units have discretion in determining the degree of flood and erosion protection provided by flood and erosion reduction works?

Yes. Courts have held that the degree of protection provided by hazard reduction measures is discretionary and not subject to liability. However, courts have held governmental units responsible for lack of care in implementing hazard reduction measures once a decision has been made to provide a provide a particular degree of protection.

2) Will Floodplain Regulations Incorporating a No Adverse Impact Standard be Susceptible to a "Takings" or Other Constitutional Challenge?

No. Courts are likely to provide strong support for a No Adverse Impact regulatory performance standard approach. However, no adverse impact regulations are subject to the same overall U.S. Constitution requirements as other regulations. These include the requirements that regulations be adopted to serve valid goals, be reasonable, not discriminate and not take private property without payment of just compensation. No Adverse Impact regulations are particularly likely to be supported because they apply a regulatory goal which is well established in common law and in regulatory programs.

Will courts support a No Adverse Impact goal?

Yes. Courts have broadly endorsed floodplain management goals and no adverse impact is an extension of such goals. No Adverse Impact codifies the maximum which has been broadly endorsed by courts, "Sic utere tuo ut alienum non laedas," or "so use your own property that you do not injure another's property." See Keystone Bituminous Coal Association v. DeBenedictis,

107 S. Ct. 1232 (1987) and many cases cited therein. See, for example, Hagge v. Kansas City S. Ry Co., 104 F. 391 (W.D. Mo., 1900) (Court held that damage done to land by occasional overflow of a stream caused by a railroad was a nuisance.)

Will courts support the reasonableness of No Adverse Impact standards?

Yes. Courts have already supported a variety of more specific standards such as increased freeboard requirements and no rise floodways.

May a local government adopt floodplain regulations which exceed State or federal (FEMA) minimum standards?

Yes. Local governments' regulations may exceed both State and federal regulations. There is no preemption issue. In fact, the FEMA program encourages State and local regulations to exceed federal standards through the Community Rating System.

May governmental units be held liable for uncompensated "takings" if they require that private development be elevated or floodproofed?

No. Courts have broadly and universally supported floodplain regulations against "takings" challenges. Courts have broadly held that regulations may substantially reduce property values without "taking" private property.

May governmental units be held liable for refusing to issue permits in floodway or high risk erosion areas because proposed activities will damage other lands?

No. In general, landowners have no right to make a "nuisance" of themselves. Courts have broadly and consistently upheld regulations which prevent one landowner from causing a nuisance or threatening public safety.

What can governments do to reduce the possibility of a successful "takings" challenge to regulations? Local governments can help avoid successful taking challenges in a variety of ways:

1. Apply a No Adverse Impact floodplain overall performance standard fairly and uniformly to all properties.

2. Include special exception and variance provisions in regulations which allow the regulatory agency to issue a permit where denial will deny a landowner all economic use of his or her entire parcel and the proposed activity will not have nuisance impacts.

3. Adopt large lot zoning for floodplain areas which permits some economic use (e.g., residential use) on the upland portion of each lot.

4. Allow for the transfer of development rights from floodplain to non-floodplain parcels.

5. Reduce property taxes and sewer and water levees on regulated floodplains.

APPENDIX F. RECOMMENDED READING

ACIA. 2004. Impacts of a Warming Arctic: Arctic Climate Impact Assessment. Cambridge University Press. 139 pages. A synthesis of an assessment called for by the Arctic Council; an international forum comprised of the eight arctic nations and Indigenous Peoples organizations. Alaska is included in the assessment.

American Planning Association. 2005. Landslide Hazards and Planning. James C. Schwab, Paula L. Gori, and Sanjay Jeer (Project Editors). Planning Advisory Service Report Number 533/534. American Planning Association Publications. Chicago Illinois. 209 pages. This book describes the nature of landslide hazards and how to incorporate the hazards into plans. Mitigation measures are described (including development standards and ordinances), technical tools are identified, case studies are provided, State and federal roles are summarized.

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Garbrecht, Jurgen D. and Thomas C. Piechota. 2006. Climate Variations, Climate Change, and Water Resources Engineering. ASCE Press. 192 pages.

Good, James W. and Sandra S. Ridlington (Editors). 1992. Coastal Natural Hazards; Science, Engineering and Public Policy. Oregon Sea Grant. ORESU-B-92-001. http://seagrant.oregonstate.edu/sgpubs/index.html

H. John Heinz III Center for Science, Economics and the Environment. 2000. The Hidden Costs of Coastal Hazards. Island Press. 220 pages. A report about the findings of a panel of experts who were asked to identify the costs of weather-related hazards associated with the rapid coastal development occurring in the U.S., and possible new strategies to reduce the costs (many of them hidden).

Houghton, Sir John. 2004. Global Warming, The Complete Briefing. Third Edition. Cambridge University Press. 351 pages. Dr. Houghton describes the scientific basis of global warming, the likely impacts of climate change on society, and possible mitigation actions. Dr.

Houghton is a former Chairman of the Scientific Assessment Work Group of the International Panel on Climate Change (IPCC).

Hwang, Dennis J. January 2005. Hawaii Coastal Hazard Mitigation Guidebook. Hawaii Coastal Zone Management Program. UNIHI-SEAGRANT-BA-03-01. 216 pages. An example of a State manual on coastal hazard mitigation.

The Institution of Civil Engineers and the Faculty and Institute of Actuaries. 2005. RAMP. Risk Analysis and Management for Projects. 2nd Edition. Thomas Telford Publishers. U.K. Available through ASCE Press. A new edition of the 112 page, 1998 first edition that describes a risk analysis and management process suitable for almost any construction project or operating facility.

The Institution of Civil Engineers. 2002. ICE Design and Practice Guides; Coastal Defence. Thomas Telford, Publishers. London. 104 pages. A guide to the design, consstsruction and maintenance of coastal defenses, and management of shorelines "in a cost effective and environmentally acceptable manner", (back cover). Available from ASCE Press.

Journal of Coastal Research. Published by the Coastal Education and Research Foundation (CERF). Charles W. Finkl, Jr., Editor in Chief. An important journal in North America for the publication of work on coastal processes and coastal hazards. Issues are published quarterly.

Keillor, Philip and Elizabeth White (Editors). 2003. Living on the Coast: Protecting Investments in Shore Property on the Great Lakes. U.S. Army Corps of Engineers and University of Wisconsin Sea Grant Institute. 49 pages. An example of a regional guide for coastal hazard mitigation.

Kraus, Nicholas C. and Kelly L. Rankin (Editors). 2004. Functioning and Design of Coastal Groins: the Interaction of Groins and the Beach – Process and Planning. Special Issue No. 33. Winter 2004. supplement to the Journal of Coastal Research Volume 20. 367 pages. CERF. This special issue contains 22 peer-reviewed papers on a literature review, management, design, case studies, monitoring and field measurements, numerical and physical modeling.

Kunreuther, Howard and Richard J. Roth, Sr. (Editors). 1998. Paying the Price, The Status and Role of Insurance Against Natural Disasters in the United States. Joseph Henry Press, National Academies of Science. 300 pages. One of five books in the series Natural Hazards and Disasters. This book examines the role of private and public insurance, insuability conditions, the changing demand for residential disaster insurance, challenges insurers face, and the functions of State insurance regulators.

Larson, L. and D. Plasencia. 2004. No Adverse Impact Floodplain Management. Published in Natural Hazards Review, November 2001. IAAN 1527-6988 or available on www.floods.org.

Mileti, Dennis S. 1999. Disasters by Design, A Reassessment of Natural Hazards in the United States. Joseph Henry Press, National Academies of Science. 351 pages. One of five books in the series Natural Hazards and Disasters. A synthesis of knowledge gained over the previous two decades since the first national assessment of natural hazards in the 1970s. Included: a proposed shift in thinking towards sustainability, tools for, and selected examples of, sustainable hazard mitigation including a hypothetical Hurricane Sirin that strikes Miami.

Mockett, I.D. and J. D. Simm. 2002. Risk Levels in Coastal and River Engineering: a Guidance Framework for Design. Thomas Telford Publisher. U.K. Available through ASCE Press. 242 pages. In this book for designers and decision-makers, the authors describe a risk framework for coastal and fluvial engineering that includes the use of an Acceptable Risk Bubble for situations with multiple risks. The risk framework is discussed in the context of facilities life-cycles and the framework is applied to specific engineering situations. Some case studies are included.

National Research Council. 2006. Drawing Louisiana's New Map: Addressing Land Loss in Coastal Louisiana. Committee on the Restoration and Protection of Coastal Louisiana. The National Academies Press. Website: http://www.nap.edu/

National Research Council. 2002. Abrupt Climate Change, Inevitable Surprises. National Academies Press, Washington, D. C. 230 pages. This book is the result of the work of the NRC's Committee on Abrupt Climate Change, and NRC staff. The book surveys the history of climate change, recent scientific evidence and theoretical understanding to describe what was then known about abrupt climate changes, patterns, magnitudes, mechanisms, and probability of occurrence. Critical knowledge gaps were identified and a research strategy proposed to close the gaps. Updates on this rapidly-changing field of science can be found on the NRC web site.

National Research Council. 2004. A Geospatial Framework for the Coastal Zone. National Academy of Sciences. National Academies Press. Washington, D.C. 149 pages. A report by the Committee on National Needs for Coastal Mapping and Charting that includes a description of the contributions of maps and charts in reducing risks of coastal hazards, and the needs for better information.

Schellnhuber, Hans Joachim, Wolfgang Cramer, Nebojsa Nakicenovic, Tom Wigley and Gary Yohe. 2006. Avoiding Dangerous Climate Change. Cambridge University Press. 392 pages.

Speth, James Gustave. 2005. Red Sky at Morning, America and the Crisis of the Global Environment. Nota Bene Edition, Yale University Press. 329 pages. This book describes global environmental crises, including global warming, and concludes with an updated afterword on the rapidly-developing results of the science of climate change.

Tierney, Kathleen J. (Editor). 2001. Facing the Unexpected, Disaster Preparedness and Response in the United States. Joseph Henry Press, National Academies of Science. One of five books in the series Natural Hazards and Disasters.

Titus, James G. 1998. Rising Seas, Coastal Erosion, and the Takings Clause: How to Save Wetlands and Beaches without Hurting Property Owners. Maryland Law Review. Volume 57.

Wallendorf, Louise, Lesley Ewing, Spencer Rogers and Chris Jones. 2005. Solutions to Coastal Disasters. Proceedings of a conference held May 8-11, 2005 in Charleston, S.C. American Society of Civil Engineers. ASCE Press. 817 pages. Eighty papers include papers on: storm surge, specific hurricanes (including hurricanes of 2004), erosion, and hazard mitigation planning.

APPENDIX G. WEBSITES

The following websites are a sample of information sources available at the time that this handbook was written. The Internet is constantly in motion with web site material and addresses changing, new sites being added, and some sites being dropped. The Association of State Floodplain Managers intends to periodically update a list of websites of value to its members. Website: http://www.floods.org

The NOAA Coastal Services Center publishes a quarterly Products and Services Bulletin that highlights new and updated products developed by the Center for State and local coastal government officials. The bulletin is issued quarterly. At the CSC home page (http://www.csc.noaa.gov/) go to Products and Services, then Publications, then Products and Services Bulletin to subscribe.

CERTIFIED FLOODPLAIN MANAGERS

Association of State Floodplain Managers http://www.floods.org/

CLIMATE CHANGE: LATEST INFORMATION

NOAA home page (http://www.noaa.gov/) . This home page has news, headlines, and media advisories. On the Home Page Menu, choose Climate, Global Climate Change, Events/Reports/Pubs.

U.S. Climate Change Science Program, NOAA. News updates, fact sheets, reports, etc. are available at this web site: http://www.climatescience.gov/

The Pew Center on Global Climate Change (www.pewclimate.org) What's New. In the left sidebar: click on Press Room, sign up for updates. The right sidebar (What You Need to Know) includes Basic Science and Latest Findings.

Science. American Association for the Advancement of Science (AAAS). Website: http://www.sciencemag.org/ Features include: News (Daily News, Science Shorts).

United States Environmental Protection Agency (USEPA). Global Warming: News and Events: Science and Policy News. Features news stories about most recent published studies and citations to the publications. Website: http://yosemite.epa.gov/oar/globalwarming.nsf/content/NewsandEventsScienceandPolicyNews.html

U.S. Global Change Research Program. Website: http://www.nacc.usgcrp.gov/ includes links to other web sites that contain regional and State assessments of climate change. For recent postings on Climate Variability and Change, to the following web page:

http://www.usgcrp.gov/usgcrp/new.htm On this page, one can also subscribe to email updates on new information about the nine focus areas.

Hadley Centre for Climate Prediction and Research (United Kingdom). Website: http://www.metoffice.gov.uk/corporate/pressoffice/research.html Press releases on research news.

United Kingdom's Department for Environment, Food and Rural Affairs (DEFRA) Environmental Protection: Climate Change: Latest Information. Web site: http://www.defra.gov.uk/environment/climatechange/latest.htm

Intergovernmental Panel on Climate Change (IPCC). Website: http://www.ipcc.ch/ Includes press releases and speeches, new reports from expert meetings, other news, users guide to the IPCC web site.

British Antarctic Survey. Web site: www.antarctica.ac.uk/index.php click on News and Information in the top navigation bar, or click on Press Releases to get findings from new research or significant events.

Arctic Climate Impact Assessment (ACIA). ACIA is an ongoing project of the Arctic Council; a high-level intergovernmental forum comprised of the eight arctic nations (Canada, Denmark/Greenland/Faroe Islands, Finland, Iceland, Norway, Russia, Sweden and the United States) as well as six Indigenous Peoples organizations and official observers from other nations and organizations. The Arctic Council periodically has climate change assessments made. The U.S. contact for the ACIA is at the following site: http://www.acia.uaf.edu . ACIA is also a project of the International Arctic Science Committee (IASC). IASC is a non-governmental organization of national science organizations involved in arctic research. IASC publishes a newsletter. The website: http://www.iasc.se/

COASTAL HAZARDS

Classes on coastal hazards are offered by the Emergency Management Institute (http://www.training.fema.gov/EMIweb/) and the NOAA Coastal Services Center (http://www.csc.noaa.gov/bins/training.html)

NOAA National Ocean Service, Coastal Management (http://www.oceanservice.noaa.gov/)

NOAA Coastal Services Center (http://www.csc.noaa.gov/themes/coasthaz/)

NOAA Office of Coastal Resource Management, Coastal Hazards (http://coastalmanagement.noaa.gov/hazards.html)

NOAA Office of Coastal Resource Management Shoreline Management Technical Assistance Toolbox (http://coastalmanagement.noaa.gov/shoreline.html)

NOAA Sea Grant Program Natural Hazards Theme Team (http://www.haznet.org/)

State-by-State Theme Team activities (http://www.haznet.org/haz_research/research_accomp.htm)

ASCE News. A newspaper for members of the American Society of Civil Engineers. The lead story in the April 2006 issue was "ASCE's External Review panel Warns Corps of Concerns over Safety of New Orleans Hurricane Protection System." The home page of ASCE (http://www.asce.org/asce.cfm) provides news stories. Through the Press Room link, there is access to recent and more distant press releases related to coastal hazards and other issues of concern to ASCE.

U.S. Ocean Policy Commission Report: "An Ocean Blueprint for the 21st Century". Chapter 10 (guarding people and property against natural hazards), Chapter 12 (Managing sediment shorelines), Chapter 31 (summary of recommendations). Available at: http://www.oceancommission.gov/documents/

The National Academies Press of the National Academy of Sciences occasionally publishes reports on climate change and on coastal hazards, such as "Drawing Louisiana's New Map: Addressing Land Loss in Coastal Louisiana" (2006). Website: http://www.nap.edu/

Hurricanes

NOAA, National Weather Service, National Hurricane Center (http://www.nhc.noaa.gov/index.shtml)

USGS Hurricane and Extreme Storm Studies Group. USGS Center for Coastal and Watershed Studies, St. Petersburg, FL 33701. (http://coastal.er.usgs.gov/hurricanes/).

HURREVAC; a national hurricane evacuation restricted-use computer program used by official government emergency managers to track hurricanes and assist in emergency decision-making. The web site includes a registration form for new users and a recently expanded version of the Inland Flood Planning and Response Tool that allows emergency managers in New England to quickly compare flood inundation maps with forecasts of rainfall and river levels. Web site: http://www.hurrevac.com

NOAA Coastal Services Center's Historical Hurricane Tracks website (http://maps.csc.noaa.gov/hurricanes/)

Coastal Storms

NOAA's Coastal Storms Program. A program to help coastal communities lessen the impacts of coastal storms. Website: http://www.csc.noaa.gov/csp/

NOAA Coastal Services Center's Storm Information for Coastal Officials website (http://www.csc.noaa.gov/storm_info/)

Coastal Erosion

United States Geological Survey (USGS). Coastal and Marine Geology Program, National Assessment of Shoreline Change Project. http://coastal.er.usgs.gov/shoreline-change/

U.S. Army Corps of Engineers' Institute for Water Resources is conducting a National Shoreline Management Study (NSMS). An overview of this on-going study of erosion is at: http://www.iwr.usace.army.mil/NSMS/nsmshomeframeset.html Examples of documents produced include: "Assessment of shoreline change knowledge", "Economic implications of shoreline change", and "Environmental implications of shoreline change"

Duke University Press has published more than 20 books in their Living with the Shore series about coping with erosion along the U.S. shores of the oceans and Great Lakes. Select: Books, Browse by series, and enter the name of the series. Website: http://www.dukeupress.edu/index.shtml

Shore and Beach. The quarterly, peer-reviewed journal of the American Shore and Beach Preservation Association. An example is the Spring/Summer 2005 issue: "Hurricane! A Special Look at the 2004 Season". Website: http://www.asbpa.org

Sea Level Rise

United States Environmental Protection Agency (USEPA). Global Warming, Sea Level Rise Reports. http://yosemite.epa.gov/oar/globalwarming.nsf/content/ResourceCenterPublicationsSeaLevelRiseIndex.html

USGS. National Assessment of Coastal Vulnerability to Sea Level Rise. Includes development of a Coastal Vulnerability Index. A description of the project and access to publications begins at this web site: http://woodshole.er.usgs.gov/project-pages/cvi/

StormReady Program of NOAA's National Weather Service. This program is intended to help communities and counties strengthen their emergency plans as they prepare for future storms. Website: http://www.stormready.noaa.gov/

Sea Level's Online of NOAA's Center for Operational Oceanographic Products and Services. Provides information on the long-term trends and the monthly, seasonal,

interannual, and decadal variations of mean sea level (http://tidesandcurrents.noaa.gov/sltrends/sltrends.html)

Tsunami

NOAA's Tsunami website : http://www.tsunami.noaa.gov/

Tsunami Risk Reduction for the United States : A Framework for Action. National Science and Technology Council's Subcommittee on Disaster Reduction's plan for tsunami risk reduction. Available on the Subcommittee's website : www.sdr.gov.

International Tsunami Information Center. NOAA National Weather Service and the Intergovernmental Oceanographic Commission of UNESCO. Website: http://www.prh.noaa.gov/itic/

TsunamiReady Program of the National Weather Service. NOAA Pacific Tsunami Warning Center. A program intended to help communities prepare for the possibility of a tsunami. Website: http://www.prh.noaa.gov/ptwc/tsunamiready/tsunamiready.htmwww.tsunamiready.noaa.gov

Pacific Tsunami Museum. http://www.tsunami.org

International Tsunami Recovery Report. Title: "Mitigating the Risk from Coastal Hazards: Strategies and Concepts for Recovery from the December 26, 2004 Tsunami." Cecember 2005. The report covers identification of hazard zones, where to locate buildings, construction methods, evacuation, strategies and options for recovery. The report can be downloaded from Hawaii Sea Grant Communication's web page: http://www.soest.hawaii.edu/SEAGRANT/communication/communication.php

COASTAL POPULATION AND SOCIOECONOMIC ISSUES

National Ocean Economics Program http://noep.csumb.edu/

NOAA Special Projects Office coastal socioeconomics website http://marineeconomics.noaa.gov/socioeconomics and

Coastal population report http://marineeconomics.noaa.gov/socioeconomics/Assesment/population/welcome.html

Citizen services

http://www.eden.lsu.edu/abouteden/default.aspx

DECISION SUPPORT TOOLS

NOAA Coastal Services Center's Vulnerability Assessment Techniques and Applications website: http://www.csc.noaa.gov/vata/

Risk analysis and management of projects (British): see RISK ANALYSIS AND MANAGEMENT

EMERGENCY SERVICES

First Response Coalition. The web site of this advocacy organization for emergency responders contains news, news releases and reports including an April 2006 report titled: The Imminent Storm 2006: Vulnerable Emergency Communications in Eight Hurricane Prone States. http://www.firstresponsecoalition.org/

EVACUATION and STORM READY

Hurricane evacuation studies with a lot of background materials http://www.csc.noaa.gov/hez_tool/ and http://www.csc.noaa.gov/hes

http://www.sam.usace.army.mil/pd/hes/hurricane_evacuation_study_progr.htm)

StormReady Program of NOAA's National Weather Service. This program is intended to help communities and counties strengthen their emergency plans as they prepare for future storms. Website: http://www.stormready.noaa.gov/

INFRASTRUCTURE (LIFELINES)

The American Lifelines Alliance (ALA) is a public-private partnership project funded by FEMA and managed by the National Institute of Building Sciences (NIBS), with the goal of reducing risks to lifelines from hazards (from the web site). Web site: http://www.americanlifelinesalliance.org/

Water Environment Federation. A search of Information and Resources shows some publications available that describe the types of damages such utilities suffer from severe hurricanes. Includes an April 2006 report; Assessment of Reconstruction Costs and Debt management for Wastewater Utilities Affected by Hurricane Katrina.. Web site: http://www.wef.org

LEGAL ISSUES

NOAA's Coastal Services Center offers an on-line course that presents a basic overview of the Public Trust Doctrine. Website: http://www.csc.noaa.gov/ptd/

MITIGATION SUCCESS STORIES

FEMA Best Practices and Success Stories http://www.fema.gov/plan/prevent/bestpractices/index.shtm

NOAA's StormReady and TsunamiReady Communities Program www.stormready.noaa.gov

NATURAL HAZARDS

Natural Hazards Center, University of Colorado. Publisher of the *Disaster Research* and *Natural Hazards Observer* newsletters. Web site includes a list of useful Internet sites dealing with hazards. Website: http://www.colorado.edu/hazards/index.html

NO ADVERSE IMPACT

The Association of State Floodplain Managers: http://www.floods.org

RISK ANALYSIS AND RISK MANAGEMENT

NOAA Risk and Vulnerability Assessment Tool (RVAT). An assessment tool that helps identify people, property and resources at risk from natural hazards and hazardous incidents. Website: http://www.csc.noaa.gov/rvat

Institute for Business and Home Safety (IBHS). News releases, publications and other information on floods, hurricanes, tornadoes, earthquakes and other natural hazards, and how to reduce damages. Website: http://www.ibhs.org/

Insurance Information Institute. News, hot topics, searchable files on insurance issues - including natural hazards that can be downloaded. Website: http://www.iii.org

Public Entity Risk Institute (PERI). PERI's goal is to connect local governments, small businesses and small non-profit organizations that have risk management needs, with tools, publications, and other resources. A Clearinghouse of links to other resources is provided. Website: http://www.riskinstitute.org/

"The gateway to project risk management". www.ramprisk.com/homepage/index.asp

A website sponsored by the Institute of Civil Engineers, the Institute and Faculties of Actuaries of the United Kingdom that supports a process known as: Risk Analysis and Management of Projects (RAMP).

Risk levels in coastal and river engineering: a guidance framework for design. A book by I.D. Mockett and J.D. Simm. 2002. H.R. Wallingford, U.K. Published by Thomas Telford. Also available from ASCE Press (Browse by Title) at this website: http://www.pubs.asce.org/books2.html

Risk Analysis and Management of Projects (RAMP). 2002. A book from the Institute and Faculties of Actuaries of the United Kingdom. Published by Thomas Telford, U.K.

Also available from ASCE Press (Browse by Title) at this website: http://www.pubs.asce.org/books2.html

SHORE PROTECTION

Coastal Engineering Manual (CEM). U.S. Army Corps of Engineers' Coastal Hydraulics Laboratory. Downloadable chapters of the manual are available at this web site: http://chl.erdc.usace.army.mil/ The site has other publications, updates, and resources. A CD professional edition of the CEM and software modeling tools in the Coastal Engineering Design and Analysis System (CEDAS) are available from Veri-Tech, Inc. at: http://www.veritechinc.net/main.htm

Living on the Coast. 2003. University of Wisconsin Sea Grant Institute and the U.S. Army Corps of Engineers (Detroit District). This 49 page booklet is about protecting investments in shore property on the Great Lakes. Available in paper copy from Wisconsin Sea Grant (http://www.seagrant.wisc.edu/), as a downloadable document from the Great Lakes Hydraulics and Hydrology Office,Detroit District, U.S. Army Corps of Engineers. (http://www.lre.usace.army.mil/coastalprocesses/Publications/Index.aspx).

Coastal Defense. 2002. The Institution of Civil Engineers. ICE design and practice guides. Thomas Telford, Ltd. and American Society of Civil Engineers. Available from ASCE Press (Browse by Title) at this website: http://www.pubs.asce.org/books2.html

APPENDIX H. RELATED PROGRAMS

The following are abstracts of FEMA programs that have mitigation potential. More information about these and other federal programs may be obtained from the *Catalog of Federal Domestic Assistance* or by directly contacting the agency.

As a consequence of a Presidential disaster declaration after a flood, additional options are provided to National Flood Insurance policyholders to mitigate or prevent future changes. In a post flood situation communities and others commonly consider relocation, acquisition or elevation of flood damaged structures. If the property has sustained extensive damage, the owner is often interested in avoiding the inconvenience or danger resulting from a recurrence. The primary hazard mitigation program that comes from a Presidential disaster declaration is the Hazard Mitigation Grant Program (Section 404 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act). Other FEMA programs are also available.

National Flood Insurance Program (NFIP) (*Catalog of Federal Domestic Assistance* No. 97.022)

The National Flood Insurance Program was enacted in 1968 and has been amended several times. Congress established the NFIP to enable people to purchase insurance against physical damage to or loss of buildings and/or contents caused by flood, mudslides, and flood-related erosion. As such, the NFIP contributes to a reduction in federal disaster assistant payments and promotes wise floodplain management practices in the Nation's flood-prone and mudflow-prone areas. The premiums are generally lower than normal actuarial rates. The details of the NFIP were discussed in Session 17 and need not be repeated here. We will move to considering additional federal programs that complement or supplement the NFIP.

Hazard Mitigation Grant Program (HMGP), Section 404, The Robert T. Stafford Disaster Assistance and Emergency Relief Act, as amended (*Catalog of Federal Domestic Assistance* No. 97.039)

These FEMA project grants can be used for implementing long-term hazard mitigation measures that permanently reduce or eliminate future damage and losses from natural hazards through safer building practices and improving existing structures and supporting infrastructure. These funds are based the federal funds spent on the Public and Individual Assistance programs in response to the disaster, minus administrative expenses, can be used for projects that protect both public and private property. Funding under Section 404 increases from 15% to 20% - depending on an acceptable mitigation plan by the State which demonstrates their interest and intent to track the effectiveness of this program. Types of eligible projects include, but are not limited to, elevation, acquisition or relocation of structures, dry floodproofing of non-residential structures, and retrofitting of facilities. The cost-sharing requirement is up to 75% federal and 25% local (nonfederal). Up to 7% of the Section 404 funds are available to States to be used in developing mitigation plans. HMGP funds are administered through a State agency. The

applicant should review the information in the *Catalog of Federal Domestic Assistance* for post assistance requirements, such as report, audits, and records.

Flood Mitigation Assistance (FMA) (*Catalog of Federal Domestic Assistance* No. 97.029)

The FEMA will help States and communities carry out cost-effective measures designed to reduce or eliminate the long-term risk of flood damage to buildings, manufactured homes, and other structures covered under contracts for flood insurance and reduce the number of repetitive-loss structures. Eligible projects include mitigation activities that are in conformance with the State's Flood Mitigation Plan, technically feasible, cost-effective, cost-beneficial to the National Flood Mitigation Fund, comply with minimum NFIP standards, and in a community that participates in the NFIP (not on probation). Examples of acceptable projects are acquisition, elevation, relocation, or demolition of NFIP-insured structures; dry floodproofing of NFIP-insured nonresidential structures; minor, localized structural projects; and beach nourishment activities. All funding is on a cost-share of up to 75% federal and 25% nonfederal. Up to one-half of the nonfederal share can be in-kind work (12.5% of the total) from third parties. The remaining half of the nonfederal share must be met by State and local government expenditures and cash funds identified at the time of the application. Funds are available before a flood disaster.

Public/Infrastructure Assistance (*Catalog of Federal Domestic Assistance* No. 97.036)

The FEMA makes project grants available (not less than 75% of the cost) to State and local governments for the repair, restoration, reconstruction, or replacement of a public facility or to a person who owns or operates a private nonprofit facility that is damaged or destroyed by a major disaster. Funds are available after a Presidential declaration. Private nonprofits that do not provide critical services need to apply for a Small Business Administration loan before they can receive disaster grant assistance from FEMA. This new section reduces the federal share of assistance to an eligible public facility or private non-profit facility that has been damaged on more than one occasion in ten years and has failed to implement appropriate mitigation measures to address the hazard. Types of projects that are eligible include protection and relocation of damaged water and sewer lines, floodproofing pumping stations, replacement of bridges with clear spans, and removal of wreckage and debris from private and public lands.

Increased Cost of Compliance

Each flood insurance policy includes a $75 premium to fund the Increased Cost of Compliance program. When a NFIP insured structure (home or business) within the special flood hazard area is declared substantially damaged (including cumulative substantial damage in applicable communities), the property owner may receive up to $30,000 for the cost of mitigation measures. Mitigation measures include elevation, floodproofing, demolition, and relocation. ICC coverage provides for the payment of a claim to help pay for the cost to comply with State or community floodplain management laws or ordinances after a flood event. This $30,000 can be used as part of the 25% nonfederal match required under the HMGP.

Federal Assistance to Individuals and Households—Human Services Programs(*Catalog of Federal Domestic Assistance* No. 97.048)

This new section of the "Disaster Mitigation Act of 2000" combines the Housing and Individual Family Grant Programs of the original Stafford Act. The federal cost will remain at 200% for housing and 75% for other financial assistance (grants). This program helps individuals and business owners with temporary housing, repair aid, food stamps, and grants and loans. Grants may be up to $25,000 per household. Housing assistance can be used for temporary lodging expenses, rent, home repair and replacement, permanent housing construction, and other approved disaster related needs. These moneys support small mitigation activities especially in areas subject to shallow flooding. For example, these funds can be used for small projects such as elevating furnaces, water heaters, washers, dryers, or electrical service boxes above flood levels.

Unmet Needs Program

The Unmet Needs Program provides grants designed to help applicants fund projects not covered under other programs (FEMA, Small Business Administration, or U.S. Army Corps of Engineers) when a Presidential Disaster Declaration is authorized. Funding must be used for disaster related unmet needs for the purposes of disaster relief, buyout assistance, long-term recovery, or mitigation. Programs must be implemented in a manner consistent with the Hazard Mitigation Grant Program. Contact the State agency for additional information and guidance.

These programs offer potential sources of funding for carrying out mitigation projects identified in your State. CAUTION! You should always visit the internet to update this list annually, review the requirements, determine what changes apply, and assemble the more recent information and forms.

Related FEMA programs

Related FEMA programs demonstrate that mitigation includes more than buildings and damage. I will refer to the *Catalog of Federal Domestic Assistance* for additional information on the following programs.

Individual and Family Grants. CFDA 97-035

Section 411 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act provides grants for necessary expenses and serious needs of disaster victims that cannot be met elsewhere (other disaster assistance programs or insurance). Households may receive up to $14,800 for each major disaster for real property, personal property, medical, dental, funeral, and transportation. Costs which are ineligible include: improvements or additions to real or personal property, recreational property, cosmetic repair, business expenses, and debts incurred before the disaster.

Disaster Housing Program. CFDA 97.037

Section 408 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act provides assistance to households affected by a disaster for their disaster-related housing needs. Direct payments are provided for transient accommodations reimbursement, home repair assistance, rental assistance, or mortgage and rental assistance.

The following federal and State programs and local actions have mitigation potential. More detailed information about these and other programs may be obtained from the *Catalog of Federal Domestic Assistance* or by directly contacting the agency.

RURAL HOUSING AND COMMUNITY DEVELOPMENT SERVICES, USDA

Section 502 Rural Housing Loans (*Catalog of Federal Domestic Assistance* No. 10.410)

The Rural Housing Service, Department of Agriculture administers this program. These direct loans are available to very low, low-income and moderate-income households for the construction, repair, or purchase of modest, decent, safe, and sanitary permanent housing in a rural area. Any actions must comply with NFIP elevation requirements.

Section 504 Rural Housing Loans and Grants (*Catalog of Federal Domestic Assistance* No. 10.417)

The Rural Housing Service (USDA) provides direct loans and project grants to very low-income rural homeowners, giving them an opportunity to make essential repairs to their homes, to make them safe, and to remove health hazards to the family or the community. These funds can be used to elevate homes and farm structures.

Emergency Loans (Catalog of Federal Domestic Assistance No. 10.404)

The Farm Service Agency (USDA) provides direct loans to assist established family farmers, ranchers, and aquaculture operators with loans to cover losses from major and/or natural disasters. Loans may be used to repair, restore, or replace damaged or destroyed farm property. These funds can be used to elevate homes and meet NFIP requirements.

U.S. ARMY CORPS OF ENGINEERS

Small Flood Control Projects, Section 205 of the Flood Control Act (*Catalog of Federal Domestic Assistance* No. 12.106)

The objective of the Section 205 projects is to reduce flood damage through projects not specifically authorized by Congress. The Corps of Engineers can develop and construct small control projects that are clearly shown to be engineering feasible from an engineering standpoint and economically justified. Each project is limited to a federal cost share of not more than $7 million. The total local contribution is 50% of the project cost and may be in the form of cash, provision of lands, easements, right-of-way, and relocation necessary for the project, and other requirements. Nonstructural alternatives are viable options for funding and include such

measures as flood warning systems, raising and/or flood proofing of structures, and relocation of flood prone facilities.

ENVIRONMENTAL PROTECTION AGENCY (EPA)

Clean Water State Revolving Funds (*Catalog of Federal Domestic Assistance* No. 66.458)

The EPA provides loans at below market interest rates for up to 20 years. These loans can be used for water quality protection projects for wastewater treatment, nonpoint source pollution control, and watershed and estuary management.

Drinking Water State Revolving Funds (*Catalog of Federal Domestic Assistance* No. 66.468)

The EPA loans can be used to repair, replace, or relocate community water systems (public and private) damaged by flooding. Loans are below-market interest rates for up to 20 years, although disadvantaged communities may qualify for 30-year loans. Additional information may be obtained from the State Revolving Fund Agency. Instructor should identify the agency for her/his State.

Clean Water Act Section 319 Nonpoint Source Implementation Program (*Catalog of Federal Domestic Assistance* No.66.460)

The EPA provides grants to States, territories, and tribes to address water quality threats and impairments from nonpoint sources. The grant funds can be used for technical assistance, financial assistance, development of watershed plans, education, training, technology transfer, demonstration projects, and monitoring.

SMALL BUSINESS ADMINISTRATION

Physical Disaster Loans and Economic Injury Disaster Loans (*Catalog of Federal Domestic Assistance* No. 59.008)

These disaster loans are available after a declared disaster to non-farm, private sector owners of disaster damaged property for uninsured losses. All loans must be repaid although at a low interest rate of 4% and a 30 year term. Loans may be used for relocation of non-farm and nongovernmental structures. Additional information is available from the Disaster Area 3 Office, Fort Worth, TX.

NATIONAL OCEAN SERVICES

Coastal Zone Management Administration Awards (*Catalog of Federal Domestic Assistance* No. 11.419)

The Office of Ocean and Coastal Resources provides several types of grants to coastal States (including the Great Lakes) and territories for a variety of purposes including coastal wetlands and estuarine management and protection; natural hazards management (including potential sea and Great Lakes level rise); public access improvements; reduction of marine debris; assessment of cumulative and secondary impacts of coastal growth and development; special area management planning; and implementation of the Coastal Nonpoint Source Pollution Program.

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT

Community Development Block Grant (CDBG) — Entitlement Communities Program (*Catalog of Federal Domestic Assistance* No. 14.218)

Department of Housing and Urban Development CDBG formula grants can be used for acquisition of real property, clearance, relocation, housing rehabilitation, public services, public facilities and improvements (such as water and sewer facilities, streets, and neighborhood centers), or mitigation activities directly related to an event. The program targets low and moderate income people in metropolitan cities and urban parishes. The nonfederal matches are derived from a formula based on the characteristics of each metropolitan city and urban county. Additional information is available from HUD.

Community Development Block Grant (CDBG) — State Administered Program (*Catalog of Federal Domestic Assistance* No. 14.228)

Department of Housing and Urban Development CDBG formula grants can be used for acquisition of real property, clearance, relocation, housing rehabilitation, public services, public facilities and improvements (such as water and sewer facilities, streets, and neighborhood centers), or mitigation activities directly related to an event. The program targets low and moderate income people in non-entitlement areas. Non-entitlement areas are cities with populations of less than 50,000, and parishes with populations of less than 200,000. The nonfederal matches are derived from a formula based on the characteristics of each State. Additional information is available from HUD.

Home Investment Partnerships Program (*Catalog of Fed. Domestic Assist.* No. 14.239)

Department of Housing and Urban Development formula and project grants can be used to provide assistance in floodplain management areas to assist renters, new home buyers, and existing homeowners with acquisition, new construction, rehabilitation, and tenant-based rental assistance. The target audience is low-income persons. A 25% match is required, but this may be waived due to fiscal distress or in presidential declared disaster areas.

HUD Disaster Recovery Initiative

These HUD grants must be used for buyouts, relocation, long-term recovery, and mitigation to a covered disaster. Activities that can be funded include:

- Acquisition of real property, including the buy out of properties in a floodplain and the acquisition of relocation property;

- Relocation payments and assistance for displaced persons, businesses, organizations, and farm operations;

- Repair, rehabilitation or reconstruction of residential and non-residential structures;

- Acquisition, construction, reconstruction, or installation of public facilities and improvements, such as water and sewer facilities, streets, neighborhood centers, and the conversion of school buildings for eligible purposes;

- Acquisition, construction, or reconstruction of buildings for the general conduct of government damaged or destroyed as a direct result of a Presidential declared disaster.

These funds are available to States and local governments experiencing a Presidential declared disaster. Coordination is with HUD.

Public Housing Modernization Reserve for Disaster and Emergencies

HUD grants may be used by public housing agencies for modernization needs, such as elevation and floodproofing, caused by a disaster. Disasters may be either Presidential declared or any event that HUD determines would qualify for a Presidential declaration if it were on a larger scale. Public Housing Agencies should contact HUD for additional application materials.

Section 108 Loan Guarantee Program

HUD provides loan guarantees to public entities for community and economic development. Loans may be used for acquisition of real property; relocation of property, homeowners, and businesses; rehabilitation of publicly-owned property such as water and sewer systems; and housing rehabilitation, including elevation of properties. The target is low and moderate to income persons.

Single Family Home Mortgage Insurance for Disaster Victims — Section 203(h) (*Catalog of Federal Domestic Assistance* No. 14.119)

HUD provides guaranteed/insured loans for individuals on a new principal, single-family residence after displacement by a disaster. This Federal Housing Administration program supports relocation of residences outside of the floodplain. The borrower may finance 100% of the annual cost of the insurance.

ECONOMIC DEVELOPMENT ADMINISTRATION (EDA)

Post-Disaster Economic Recovery

Congress may appropriate supplemental funds to the Economic Development Administration after a disaster. Economic Development Administration construction project grants to States, local governments, and certain non-profit organizations may be used for construction of infrastructure. Public works direct grants have a cost share of 80% federal and 20% local. Contact the EDA for additional information.

Other Federal Agencies With Natural Hazards Missions

The following information about the hazards-related aspects of federal agencies' missions is taken from Mileti (1999). Missions of agencies are subject to revision, priorities and projects change. Updates on this information should be sought. The following list is not a complete listing of all federal agencies with a natural-hazards mission component.

Centers for Disease Control and Prevention (CDC). The CDC responds to natural disasters in terms of human health effects and medical consequences. The Centers provide support for disaster planning and response and recommends ways to mitigate the health consequences of future disasters.

Department of Energy (DOE). The Office of Environment, Safety and Health develops and implements policies, standards, and practices that will reduce the effects of hazards on buildings, hazardous materials facilities, and electrical transmission structures.

Department of Transportation (DOT)

The department is responsible for transportation safety improvements and continuity of transportation services, and provides technical assistance and transportation funds to cities and States.

Federal Energy Regulatory Commission (FERC). This agency regulates all non-federal hydroelectric projects in the U.S., including a dam safety program with engineering guidelines, flood methodology and criteria, seismic analyses and evaluations, and emergency plans for warnings, training, and public safety.

Federal Housing Administration (FHA). FHA programs aim to provide safe, affordable, and sanitary housing in a suitable living environment.

National Institute of Standards and Technology (NIST). Their Building and Fire Research Laboratory conducts research and development to improve standards and practices for buildings and lifelines to reduce losses from earthquakes, extreme winds, and fire and to predict the behavior of fire and smoke and the performance of detection and suppression systems.

National Aeronautics and Space Administration (NASA). NASA obtains information from satellites to help investigate natural hazards processes; provides space-based: hazards mapping, risk assessment, and hazard monitoring; and develops systems for information dissemination and hazards mitigation. NASA funds landslide hazard research.

National Institutes of Health. The National Institute of Mental Health conducts and supports research on mental health and related services following disasters.

National Oceanic and Atmospheric Administration (NOAA). NOAA, including the National Weather Service, describes and predicts changes in the earth's environment; promotes coastal management and the wise use of natural resources; and develops, maintains, and disseminates information on severe storms, flood warnings, weather forecasts, water resources forecasts, climate change predictions, ocean and coastal analyses.

National Science Foundation (NSF). The foundation funds scientific and engineering research and education projects that generate knowledge needed for better understanding, managing, and mitigating natural disasters, including basic research on the physical processes that underlie hazards; impacts; prediction and warning; risk assessment and mitigation; disaster recovery and reconstruction; and social and behavioral responses. NSF funds landslide hazard research.

Office of U.S. Foreign Disaster Assistance (OFDA). This office coordinates the U.S. response to natural and technological disasters worldwide; provides assistance for emergency shelter, water, and sanitation; and promotes disaster prevention, mitigation, and preparedness.

U.S. Army Corps of Engineers (USACE). The Corps manages and executes engineering, construction, and real estate programs for federal agencies and for foreign governments; supervises and conducts research and development; responds to natural emergencies; and provides information, technical services, and planning assistance regarding, floods, floodplain, and coastal hazards issues.

U.S. Environmental Protection Agency (USEPA). The agency works to improve and preserve the quality of the environment and to protect human health and the productivity of natural resources. USEPA provides information on global warming and on sea level rise.

U.S. Department of Agriculture (USDA). The USDA Forest Service provides fire protection for life, property, and natural resources and technical assistance in training, prevention and other areas including research and mitigation of landslide hazards.

U.S. Geological Survey (USGS). The Survey conducts research, transfers technology, and fosters policies and practices to reduce losses from earthquakes, volcanic eruptions, landslides, coastal erosion, and hydrological hazards. The USGS has a Landslide Hazard Program and a National Landslide Information Center.

Other federal agencies with responsibility for large land holdings or infrastructure have natural hazards experts on staff and programs to address natural hazards. These agencies include: the Bureau of Land Management, the National Park Service, the Office of Surface Mining Reclamation and Enforcement, and the Bureau of Reclamation (Schwab et al. 2005).